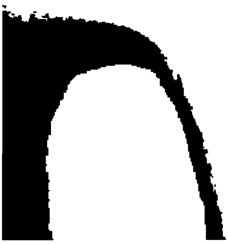

SYSTEM OF

PHYSIOLOGIC THERAPEUTICS

VOLUME IX

A SYSTEM

OF

PHYSIOLOGIC THERAPEUTICS

A PRACTICAL EXPOSITION OF THE METHODS, OTHER THAN DRUG-GIVING, USEFUL IN THE PREVENTION OF DISEASE AND IN THE TREATMENT OF THE SICK

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VOLUME IX

Hydrotherapy, Thermotherapy, Heliotherapy, and Phototherapy

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Balneology and Crounotherapy

BY

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Translated by AUGUSTUS A. ESHNER, M.D., Professor of Clinical Medicine in the Philadelphia Polyclinic, etc., and with notes on American Springs by GUY HINSDALE, A.M., M.D. Including Special Chapters on The Classification of Mineral Waters and their Distribution in the United States, by A. C. PEALE, M.D., Aid in the National Museum, Washington, D.C., In charge of Mineral Water Statistics of the United States Geological Survey; On the Practice of Phototherapy and Thermotherapy, by J. H. KELLOGG, M.D., of Battle Creek, Michigan; and on Saline Irrigation and Infusions, by HARVEY CUSHING, M.D., of Johns Hopkins Hospital, Baltimore; also an Appendix by the Editor.

ILLUSTRATED

PHILADELPHIA

P. BLAKISTON'S SON & CO.

1012 WALNUT STREET

1902

WM. F. FELL & CO.,
ELECTROTYPERS AND PRINTERS,
1220-24 SANSOM STREET,
PHILADELPHIA.

EDITOR'S PREFACE

The subjects discussed in this volume have a twofold association: that of fundamental principle, and that of convenience. Much of the therapeutic utility of water depends upon what Professor Winternitz terms its 'thermic influence'; that is to say, upon its physical availability for altering the body-temperature, generally or locally, primarily or secondarily, by addition or by abstraction of heat. The consideration of other methods of thermotherapy—as also that of psychrotherapy or excessive cold—is thus naturally associated with the study of hydrotherapy; and, as a part at least of the physiologic, therapeutic, and morbific powers of the radiations of the sun and other luminous bodies is due to heat, the subjects of heliotherapy and of general phototherapy likewise find here an appropriate connection. If, on the other hand, the chemical effects of the actinic solar rays and of the electric light be given prominence, it is to be remembered that baths of water, and especially of mineral waters, have important chemical relations, and that these, moreover, may vary with temperature; so that the association from this viewpoint is no less intimate. Furthermore, neither direct chemical nor direct thermic influences, alone or in association, will fully explain the remedial actions of water, of heat, or of light; but there must also be considered certain indirect, and largely innervational, changes, governed in each case by the same physical and biologic principles, and brought about in all by similar, or even identical, physiologic mechanisms.

These changes and their effects, constituting as a whole the 'physiologic reaction'—perhaps even better termed the 'therapeutic reaction'—upon which Professor Winternitz rightly lays so much stress, are of the highest import in treatment, and, indeed, form the immediate object of most of the measures discussed in the present volume. It has, therefore, seemed best to bring together, and in the same book with the exposition of these reactions, the descriptions of the various expedients by which they can be evoked. Moreover, the procedures described, whether in the use of water, of heated air, or of light, are largely of the nature of baths, general or partial; and are not only similar in method and in the character of the apparatus employed, but are often and of necessity associated in their application. This is true alike of those comparatively simple measures available at the patient's home, and which it is the purpose of this volume to emphasize in the hope of extending their use; of those, slightly more elaborate, that can be applied in the physician's office; and of those which, because of their complexity or of their time-consuming character, require the facilities and elaborate apparatus of special institutes. Thus, both from the viewpoint of theory and from that of practice, the association is necessary.

The medical and surgical uses of irrigations and of saline infusions form an important part of hydrotherapy; and with the external use of water, its internal administration for other than dietetic purposes must likewise be considered. This is the more necessary in the case of the complex solutions derived from mineral springs, whose use, indeed, trenches upon the borders of pharmacotherapy—a further illustration, were one needed, of the absence of sharp division-lines in nature or in art. The important subject of drinking-cures with mineral waters here given a new name, 'Crounotherapy,' or 'spring-treatment' (*krounos* and *therapeia*), to distinguish it from balneotherapy,[1] or 'bath treatment' deserves more attention than it has yet received from others than physicians practising at spas. Especially does the classification of mineral waters need to be cleared up. The text of Professor Kisch, authoritative from the therapeutic standpoint, conforms largely to the German usage in respect to classification and has been left practically unchanged, because that usage is, on the whole, a convenient one clinically. It has been deemed wise, however, to insert an introductory chapter, comparing and correlating the differing schemes of American, English, French, and German writers. Dr. A. C. Peale, of the United States National Museum, whose original studies of the subject are well known, and whose scheme of classification seems to the editor the best yet proposed, has written this valuable chapter, which should serve to dissipate much of the unnecessary confusion and vagueness hitherto prevailing. At the same time, Dr. Peale has contributed a much-needed systematic arrangement of the [illegible] waters of the United States grouped according to their pre- [illegible]

[illegible]

be sought in many scattered and even recondite sources, and much of which, indeed, has not previously been published.

Other supplementary chapters are those by Dr. J. H. Kellogg, upon 'Phototherapy and Thermotherapy,' detailing experiences which Professor Winternitz and his collaborators omit or refer to but briefly; by Dr. Harvey Cushing, upon 'Saline Irrigations and Infusions,' a subject believed to be worthy of considerable detail in description; and the editorial Appendix, dealing with certain hydriatric methods as practised in the United States—especially cold baths and other procedures applicable in typhoid and other fevers, and artificial carbonated baths.

The notes upon American mineral baths and waters incorporated with the text of Professor Kisch are largely by Dr. Guy Hinsdale. The editor is indebted to his clinical assistant, Dr. R. Max Goepp, for valuable aid in preparing the manuscript for press and in reading proof.

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HYDROTHERAPY, THERMOTHERAPY, AND PHOTOTHERAPY

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Part I

PHYSIOLOGIC BASIS OF HYDROTHERAPY

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A SYSTEM OF PHYSIOLOGIC THERAPEUTICS

HYDROTHERAPY, THERMOTHERAPY, AND PHOTOTHERAPY

PART I

PHYSIOLOGIC BASIS OF HYDROTHERAPY

CHAPTER I

FUNDAMENTALS

Definition. Primary Thermic, Mechanical, and Chemical Stimulation. Effects upon the Nervous System. Secondary Thermic, Mechanical, and Chemical Effects. Local Cooling and Heating. General Cooling and Heating. Heat Regulation.

Hydrotherapy may be defined as the systematic application of water at various temperatures and in varying form to the surface of the body for dietetic, prophylactic, and therapeutic purposes. The definition as given is as incomplete as definitions generally are and must be—a fact that at once becomes apparent when it is considered that in order to attain a successful result, mechanical, chemical, and other influences must often be operative simultaneously. We shall better arrive at a conception of what is comprehended by hydrotherapy if we attempt to present in general lines an analysis of the **mode of action** of this remedial procedure.

Water, in liquid, solid, or gaseous state, brought into contact with the normal surface of the body, acts (1) through its **temperature**, or (2) through its **volume**; also (*a*) **mechanically**, and (*b*) **chemically.**

Primary Thermic, Mechanical, and Chemical Stimulation

Cold and heat are appreciated as cold or heat, or also as pain, in accordance with the difference in the temperature of the media brought in contact with each other. As sensations are conveyed only through the nervous system, we may speak of cold and heat and all gradations of temperature as nerve-stimuli. Careful investigation has shown that when substances warmer or colder than the animal body are brought into contact therewith, and in accordance with the degree of temperature employed, there results an increase or a reduction in the energy, or a modification in the quality, of the innervation at the point of contact. The sensory peripheral nerve terminations are brought to a state of more delicate or more dull perceptive power; therefore, to a state of increased, or diminished, or altered function. The result to be expected in advance is dependent upon the absolute difference in temperature between the skin and the medium employed; upon the duration of the action; its suddenness; the extent of the surface of the body exposed; the variable sensibility of the subject treated, and other cotemporaneous factors that may affect stimulation; the physical form of the irritant measure; and, as I may anticipate, the simultaneous mechanical and chemical stimulation.

Thus, an endless diversity of **effects** due to the possibility of innumerable combinations of these various irritant factors is theoretically to be expected. Those that follow immediately upon the application of the irritant are in part to be observed locally at the point of irritation and in part are conducted, communicated, or reflected throughout the organism, by means of the nervous system. The influence of the irritation is not concluded with this. **Secondary effects** also may be observed, and these in part represent the reaction of the living organism to the irritation, but in part also are dependent upon primary and secondary alterations in the organism due to the supply or the withdrawal of heat. That these complicated processes have not been and cannot be studied with mathematic certainty in the living healthy or diseased organism will surprise no one; as the same difficulties and deficiencies exist everywhere in the domain of therapeutics.

Effects upon the Nervous System

Demonstrable changes in innervation can be induced in the healthy and the diseased organism by means of hot, warm, tepid, cool, and cold applications, as well as by electric, mechanical, and chemical influences. These changes consist in increase, inhibition, reduction, modification, or destruction of the nervous influence at the point of application, or in sensory, motor, and sensorial paths; and they are conducted, reflected, and otherwise communicated throughout the entire nervous system. Not only, therefore, may we increase, diminish, modify, or destroy the perceptive power of the sensory nerve-endings at the point of application by thermic, mechanical, or chemical stimulation,—and thus acquire an influence over hypesthesia, hyperesthesia, and paresthesia,—but we may also accelerate, retard, modify, or inhibit conduction in the nerve channels. Furthermore, we may, through the medium of the conducting paths within the central organ, induce both quantitative and qualitative central changes of innervation, and, again, through the efferent and reflex nerve paths, influence peripheral organs. Inasmuch as the nervous system incites, stimulates, inhibits, and regulates the functions of all the organs, it will be possible to make an impression upon the functions of all organs through an influence exerted upon the nervous system. Every advance in our knowledge of innervational processes must therefore naturally indicate a similar advance in the comprehension of the effects of water.

Although it is known that mechanical and chemical agencies applied to the skin act as irritants, and the significance of the stimuli with regard to life or vital processes may be considered as established, —inasmuch as life is scarcely conceivable without irritation,—the comprehension of the process of irritation, of the transformation of the physical force applied into vital energy in the cell, in the nerve, in complex organs, is as yet wholly wanting. Only hypotheses and phrases can be brought forward with regard to the nature of the irritation. This much is known : that the withholding of irritation may give rise to enfeeblement and even to derangement of function and of structure, while the application of irritation, so long as it is adequate, stimulates and strengthens, and, in excess, injures.

A comprehension, not of the mode of action, but of the value of stimuli for the relief of nutritive disorders, may be afforded by the simplest possible examples. If an undersensitive or an oversensitive area of skin be exposed to a transitory thermic or, as I may anticipate, to a mechanical irritation, such as contact with a bit of ice or with a current of hot air, or dry friction, or transitory sprinkling with cold or hot water, the sensibility of the skin exposed to the thermic or chemical irritation will have undergone a change. The stimulation has modified the innervation, and, if properly applied, has corrected the existing derangement of innervation. It will not be difficult to give also illustrations of the remote effects of peripheral thermic and mechanical irritation. To what is due the restoration of a person who has fainted, by sprinkling the face with a few drops of water, but to the conveyance of the irritation from the sensory peripheral nerve terminations to the medulla oblongata ? Also the cerebral hemispheres, the common sensorium, are accessible to thermic irritation from the periphery. The changes in our nervous state, mood, capacity for work, and desire for activity following cold and hot spongings, affusions, etc., represent nothing more than the result of adequate nerve-stimuli, and are available hygienically and therapeutically.

The excitation and the inhibition of **peripheral stimuli** are among the most powerful hygienic, dietetic, and therapeutic factors at our command. **Primarily** they act by stimulation and depression; the systematic repetition of which induces a cumulative effect in the desired direction, and thus transforms the temporary reaction into a permanent result. But the primary nerve-stimulation will also cause demonstrable changes in the function of almost all other organs; and these **secondary effects** are of considerable importance. The nerve-cell exposed to thermic irritation requires, for example, just as does every other organ, more or less nutritive material in accordance with its increased or diminished activity. Thus circulation, metabolism, digestion, and other nutritive processes and the organs of such processes are stimulated or depressed. The formal comprehension of thermic and mechanical, and also of chemical, effects is simplified by the demonstration that, together with nerve-stimulation, inhibiting and stimulating impulses are conveyed to the corresponding vascular territories, rendering possible simultaneous increase or diminution in the supply of nutritive material, and, as a result, increase, diminution, or modification in function, local and general. The transmission of the innervational impulse to muscular tissue—animal as well as vegetative, striated as well as unstriated—constitutes one of the best-studied chapters of the physical influences that may be exerted on the living organism.

Vascular contraction and dilatation, with preserved and increased, but also with diminished and abolished, vascular and tissue tone; changes in the **vigor** and in the **frequency** of contraction of the **heart** are the most important thermic and mechanical effects attainable by hydrotherapeutic measures. By means of these we are able to regulate the circulatory processes in a manner often to be determined accurately in advance; thus obtaining a control over the most important nutritive conditions that may, in the presence of nutritive disorders, enable us to modify them in any desired manner. Thus, we may regulate the influx of blood and the efflux of blood, thereby not merely producing localized arterial hyperemia and venous stasis, but controlling the general distribution of the blood, and thus influencing local and general nutrition.

Not only the heart and the muscular coat of the vessels fall within the range of our therapeutic irritation, but also the **muscular coat of the intestine** and **striated muscular masses**; and all of these are not alone susceptible of increase in function, but may also be restricted in their activity. Instances of this are found in the stimulation and inhibition of peristaltic movement, and in the invigoration and enfeeblement of the musculature of the entire body. From this point of view it is comprehensible that an influence will be gained, by means of the stimulating measures at our command, over more **complex organic functions.**

By means of the primary stimulation we may modify the respiration as well as the action of the heart. The absorption of oxygen and the elimination of carbon dioxid are increased by suitable irritation, and, as a result, intra-organic oxidation is favored. The most diverse disorders of metabolism, the most varied secretions and excretions, undergo alteration qualitatively and quantitatively. It is hardly necessary to cite illustrative instances. I may refer to the manner in which the function of the skin may be modified at will, either to heighten or to diminish the sensible and insensible perspiration; to the elimination of various odorous substances through the skin; to the increase and diminution in the secretion of urine; to the chemical changes in this secretion; to alteration in the secretion of bile, etc.; with regard to all of which, further evidence will be presented in the course of this treatise.

Secondary Thermic, Mechanical, and Chemical Effects

The living animal organism is not exempt from the power of purely physical laws. Heat is conveyed to it by means of high temperatures, and heat is abstracted from it by exposure to low temperatures. The organism must therefore be heated by the former and cooled by the latter. Although the absorption, and likewise the dissipation of heat, even in the living body, are dependent upon the difference in temperature between the media brought in contact with each other, the final result is not the same as that which would occur in the case of inanimate objects of different temperature. The living body generates heat, and gives it off, and the balance between these two functions is responsible for the constancy of the temperature in the body of warm-blooded animals. This balance can be maintained when heat is conveyed to or abstracted from the body, only by increase in heat dissipation in the first instance, or diminution thereof in the second instance; or by diminution in the production when heat is conveyed to the body, with increase in the production when heat is given off from the body. Thus by increase in the amount of heat-dissipation through cooling, when there is increase in the production or simultaneous reduction in the loss, or by exciting an opposite alteration in both factors, influences affecting the temperature of the body through the conveyance or the abstraction of heat arouse the nervous and functional regulating (taxic) and protecting mechanisms for maintaining the body-temperature at a constant level. As the organic processes take place normally only when the body-temperature is normal, and this depends upon an equilibrium between heat-production and heat-dissipation, the supply and the withdrawal of heat must have an influence resulting in increase or diminution in both these functions. We are thus able to increase or diminish each at will. As the generation of heat takes place principally at the expense of nonnitrogenous body substances, we become able arbitrarily to govern metabolism in a definite direction by controlling the production and the dissipation of heat. The processes to be taken into consideration in this connection are the results of heat abstraction and heat conveyance, as secondary or **reactive** manifestations.

Local Cooling and Heating

The **effects** of the local application of cold and heat may be summarized as follow:

1. There results cooling or heating of the surface of the part in contact with the thermic medium, and, provided the period of application be sufficiently long, until the temperature is almost that of the medium employed. The superficial temperature always remains somewhat higher, however intense the cooling, so long as this does not destroy the vitality of the part, and likewise somewhat lower when heat is applied, if this be not unduly excessive, and not incompatible with the continuance of life.

2. Local cooling and heating do not modify the general body-temperature, or, at most, but inconsiderably, even after prolonged application, unless the field of application comprises almost one-fourth of the surface of the body.

3. Every portion of the body can be warmed or cooled locally to any desired depth by supply or withdrawal of heat for a sufficient period of time and in sufficiently intense degree.

4. Heating and cooling in the sequence of reduction and elevation of the temperature take place the more rapidly, the higher and the lower the surrounding temperature after the thermic application.

5. The promptitude and the degree of the reaction succeeding heat abstraction and heat supply are directly proportional to the intensity and inversely proportional to the duration of the application.

6. The condition of the part after the thermic application likewise exerts an influence upon the promptitude (rapid or gradual occurrence) and the degree of the reaction. Thus, active and passive movements of the part under treatment bring about more rapid restoration of heat or cold than occurs when it remains at rest.

7. Individual circumstances, especially affecting innervation and circulation, exert a great influence upon the reactive processes following thermic applications.

8. Local warming is followed by cooling of the surface in the vicinity, and local cooling by warming—a sign of altered heat distribution.

9. Metabolism is retarded in the cooled tissues and accelerated in the warmed organs. In the cold, inflammations exhibit, as Samuel has demonstrated experimentally, a considerably slower and milder course. This is due in part to contraction and slowing of the blood current, in

part, however, also, to the reduction in temperature itself. The chemico-physical process and the intimate vital process are always related to a given temperature. They are retarded by cooling, possibly in some respects entirely inhibited. Experimental investigation shows that the process of diffusion between fluids of different chemical constitution—endosmosis and exosmosis—undergoes the greatest variation qualitatively and quantitatively in consequence of alteration in temperature. Exudation and suppuration subside under the influence of cold, the pus becomes more diffluent, more nearly serous, more deficient in pus corpuscles. When heat is applied locally, the suppuration becomes more profuse and the pus richer in cells.

Esmarch has called attention to the slowing and prevention of chemical decomposition and the retardation and inhibition of fermentation and putrefaction by cold, and their acceleration by warmth; and also to the significance of these facts with regard to the treatment of wounds, ulcers, and zymotic processes. Also the acceleration of metabolism in the period of reaction following local reduction of temperature, and the slowing following such elevation of temperature, will be found to be susceptible of therapeutic application.

General Cooling and Heating

What is true of the local effects of cold and heat—namely, that it is ultimately possible through them to overcome the local automatic resistance of the living body to temperature influences—is true also of general thermic temperature influences.

There are several **automatic protective agencies** against general reduction of body-temperature.

1. There is a **reduction of the temperature of the surface of the body.** Thereby is brought about a diminution in the heat tension between the skin and the heat-abstracting medium employed; thus, according to physical laws the loss of heat is diminished.

2. There is a **limitation of the circulation through the skin,** and in consequence **collateral hyperemia in the muscular layer** surrounding the entire body. Thus, while the former process is attended with diminished loss of heat, the muscular layer, well supplied with blood, and therefore also warmer, prevents too deep and too ready extension of the cooling influence to the internal organs.

3. The **rise in temperature of the muscular layer** when heat is withdrawn, which is recognizable from the rise of axillary temperature, is brought about, not only by the collateral hyperemia, but also by reflex thermal influences. While cold causes contraction of the cutaneous vessels, its effect upon the vessels of the muscles, as appears from the observations of various investigators, is to induce dilatation.

4. The **increased amount of blood** thus brought to the muscles appears to give rise to **increased production of heat** in the tissues.

The most powerful protection against the too rapid penetration of cold to the internal organs is this muscular layer that, storing up and generating heat, surrounds them like a shield, and is itself protected in turn by a covering of bloodless skin, poorly conducting heat.

The automatic protective measures against the effect of **heat** are:

1. **Dilatation of the cutaneous vessels** and acceleration of the circulation through the skin and the subcutaneous connective tissue. If a medium of a higher temperature than that of the skin and the blood is brought in contact with the surface of the body, the cutaneous vessels become dilated, the circulation in the skin accelerated, the secretion from the cutaneous organ stimulated. By this means the dissipation of heat from the skin is increased; the sweat, at the temperature of the blood, deposited upon the surface of the body, evaporates under favorable circumstances; and in this way considerable amounts of heat are abstracted from the body. In consequence of the sweating and the evaporation of the sweat, the blood circulating in the skin is cooled, and returning to the internal organs at a lowered temperature, prevents overheating of them.

2. Should the action of the heat be continued for a longer time, a large amount of **blood will be retained in the skin** in consequence of loss in tonicity of the cutaneous vessels; the cutaneous circulation will be slowed, and thereby the blood heated at the surface of the body is prevented from returning to the internal organs and heating these.

3. In consequence of the increased accumulation of blood in the skin, a **diminished amount of blood** will remain in the **internal organs**; thus the activity of these, and thereby also the production of heat, will be lessened.

In these processes will be found a safeguard against excessively rapid penetration of the heat to the internal organs, and against the unduly rapid elevation of the body-temperature through thermic influences. This is the automatic protection against heat residing in the living animal organism.

Heat-regulation

The important rôle that must be played by the **cutaneous circulation** in affording protection against heat and cold will have been made clear from these considerations. Only a quantitative investigation into the difference in the degree of heat given off in accordance with varying circulatory conditions in the skin, would be capable of affording a conception of the actual significance of the cutaneous circulation with relation to the thermal economy of the body.

I have shown that the amount of heat given off may vary between more than 60 per cent. in a downward direction, and more than 90 per cent. in an upward direction. The importance that must be attached to the function of the skin with relation to heat-regulation will thus become clear. Within the limits in which constancy of the body-temperature persists, this may be explained by alteration in loss of heat alone. It is thereby in no way implied that heat-production may not cause variations; and, as a matter of fact, the quantitative investigations of the end-products of metabolism afford sufficient support for such an assumption. Although the function of the skin is capable of compensating for one-half of the normal average heat-production, as my calorimetric studies of heat-dissipation from the skin have shown, experience has taught me in this connection that by means of voluntary and involuntary muscular activity the greatest loss of heat can not only be compensated, but even overcompensated by increase in the production of heat. From this may be deduced a practical rule of great importance—namely, that by systematic repetition of powerful demands upon the heat balance (as by extremely hot and extremely cold baths) the regulation is placed at a higher or a lower degree; the first after cold, and the latter after warm baths.

As a result of careful investigations and determinations of the consumption of oxygen and the elimination of carbon dioxid, according to the method of Geppert-Zuntz, Dr. A. Löwy reaches the following conclusions as to that which is actually established with regard to the regulation of the body-temperature in human beings:

That, as a result of the stimulating influence of cold, there first occurs contraction of the skin and its vessels, which, by restricting the dissipation of heat, brings about perfect compensation if the abstraction of heat be but slight, and but partial compensation if the abstraction of heat is more marked. In the latter event the body-temperature will continue to decline in greater or lesser degree, while in the former it will remain constant. Alterations in heat-production may be superadded. They depend upon tonic or clonic muscular contractions; that is, muscular tension or tremulous movements that occur involuntarily, or even in opposition to the will, as a result of the profound effect of severe cold, just as they do in the sequence of other forms of irritation. Their importance as a heat-regulating measure is far less in man than is that of the skin; for they are incapable of preventing reduction in the body-temperature.

It has now been determined that abstraction of heat causes increase in metabolic activity only if at the same time voluntary or involuntary muscular contractions occur. So long, therefore, as with abstraction of heat the temperature in the muscular layer is increased and remains increased, the stimulation induced thereby will obviously be the cause of increased production of heat, and this is certainly also a powerful factor in the regulation of heat.

By systematic exercise the heat-regulating powers of the body are so greatly strengthened that they become capable not alone of compensating, but also of overcompensating, the supply and the dissipation of heat. The Japanese, accustomed to a hot bath at a temperature of from 42° to 44° C. (107.6° to 111.2° F.), exhibits a temperature scarcely higher than normal; while I have observed in the case of Dr. Tschurtschenthaler that after a cold bath of twenty-five minutes' duration at a temperature of 6° C. (42.8° F.) the body temperature was almost 39° C. (102.2° F.) on leaving the bath. This illustrates how powerfully exercise improves heat-regulation. On the whole, the function of the **skin** controls the **loss of heat**; voluntary or involuntary increase or reduction in **muscular** tone and in muscular contraction controls the **production of heat.** Both can be increased or diminished at will by thermic and mechanical influences.

CHAPTER II

EFFECTS OF HYDROTHERAPEUTIC MEASURES UPON SPECIAL TISSUES AND ORGANS

Muscular Tissues—The Heart and Vessels. Circulation and Blood Pressure. Constitution of the Blood. Metabolism. Secretion and Excretion.

THE INFLUENCE OF INNERVATION UPON THE MUSCULAR TISSUES

Next to the influence exerted upon the nerves themselves, the transmission of modified neural impulses to **muscular tissues** is of the greatest importance in the practice of hydrotherapy. By means of cold, heat, and mechanical effects, increase and diminution in the tension of all muscular tissues can be brought about. Both striated and unstriated, both voluntary and involuntary muscles, can thus be influenced, and almost with physical certainty; physiologic function being heightened or reduced—even abolished for the time—as predetermined.

Adequate thermic stimulation, particularly that of cold, and also adequate mechanical stimulation,—massage, friction, concussion,—induce a heightened tonicity in all the **voluntary muscular structures** in the area directly or reflexly affected by the irritation. In accordance with the intensity of the stimulation there may result simple increase in muscular tension or even clonic and tonic spasm—chill. The reaction of voluntary muscle under the influence of topical or general application of cold constitutes one of the most interesting and, with relation to hydrotherapy, one of the most important processes. The increased muscular function due to thermic and mechanical stimulation causes increased production of heat and augmented resistance of the muscles to fatigue. It has been demonstrated with relation to the topical and general influences of thermic measures that heat temporarily produces effects similar to those of cold, but if the application be long continued, weakness, fatigue, and diminished heat-production result.

The thermic and mechanical nervous stimulation, however, affects also striated and unstriated **involuntary muscular tissue.** In this connection the influence upon the heart and the muscular coat of the vessels, and upon the stomach, the intestine, and the bladder, should be mentioned.

Thermic Influences upon the Heart

The action of the **heart** may be influenced by cold and heat in a manner subject to determination in advance. Whether the application be made directly over the precordium (topical), or to the whole body (general cutaneous application), there results, in the case of **cold,** acceleration of the heart's action at the instant of application, with subsequent slowing; in the case of **heat,** primary slowing, with subsequent acceleration. The ultimate degree of acceleration and retardation will be inversely proportional to the frequency of the heart's action prior to the thermic and mechanical application. Other things being equal, the individual contractions become more vigorous after the application of cold, and are enfeebled by the application of heat.

The influence of high and low temperatures upon the heart is thus twofold: First, the innervational reflex following immediately upon the application; and, second, the effect of the actual cooling or heating of the body or of the blood. The therapeutic significance, however, that is to be attached to the slowing and the strengthening of the action of the heart that can always be brought about, may be indicated in a few words: It is the action of digitalis without toxic and cumulative effects—namely, prolongation of the diastolic pause and thus of the period of nutrition for the heart.

Effects upon the Circulation and the Blood Pressure

The thermic and mechanical nervous stimulation has not only an influence upon the central organ of the circulation, the heart muscle, but also upon the muscular coat of the vessels; or, as it may be not inaptly phrased, upon the peripheral heart.

Contraction and dilatation of the vessels by action of their muscular coat can be brought about at the point of application, and in other areas standing in functional relation with the nerve-endings acted upon. Vascular contraction and dilatation induce anemia and hyperemia respectively.

The **primary vascular contraction** under the influence of heat and cold is followed, more or less rapidly, in accordance with the intensity of the nervous stimulation and the susceptibility of the parts to irritation, by **vasodilatation.** I have presented arguments tending to show that the vascular dilatation resulting from the influence of heat or cold or mechanical stimulation cannot be in each case the same process. It has been assumed that the contraction of the vessels under the influence of either cold or heat is an irritative effect, while the dilatation in both instances is looked upon as a paralytic condition resulting from overstimulation. This view I cannot accept. I regard the vascular dilatation occurring as a result of the action of low temperature and of moderate mechanical irritation as an active process, perhaps due to the influence of inhibitory nerves. The vascular dilatation occurring as a result of the action of heat, on the other hand, appears to me to possess the character attributed to it in so far that it is a passive relaxation, and possibly paralytic in origin.

There is no analogy to warrant the conclusion that moderate degrees of cold such as suffice to bring about dilatation of the vessels are capable of causing paralysis. Vessels dilated as the result of the action of heat and cold respectively, exhibit quite opposite relations to the entering wave of blood. Whereas the vessel dilated by heat is flaccid and exhibits all the signs of loss of tension, the vessel dilated under the influence of cold exhibits tonic resistance and all the signs of heightened tension of its walls.

I cannot concede that one is justified in denying significance to the **pulse tracing.** This is the less justifiable, as measurements of the blood pressure also yield results of a like character. Tschlenoff also has confirmed my statements in this connection.

New measurements, that I have made with the aid of Gärtner's tonometer, of the **blood pressure** in vessels dilated as a result of the influence of heat and cold show quite constant and uniform results, such as could not be obtained with the instruments formerly employed. Following local and general applications pushed to the verge of complete vasodilatation, I was able to observe increase in blood pressure up to 30 mm. of mercury, after the application of **cold**; and an equivalent lowering of the blood pressure, after application of **heat.** I was, moreover, able to demonstrate by still another method, one that had not previously been employed, the different effect upon the circulation of the vasodilatation resulting from the influence of heat and the vasodilatation brought about by cold. This is the influence upon the pressure in the tissues, which I tested according to the method of Landerer. Landerer has shown that a portion of the blood pressure is conveyed through the walls of the capillaries to the tissues. If the tissues are in an elastic state and their tension is sufficient, this portion of the blood pressure will be thrown back upon the vessels, and continues to contribute its effect to the onward movement of the blood. If, however, the tissues have lost their elasticity, the blood pressure is correspondingly diminished. This condition is observed as a result of the action of heat. To this cause are due the hypostasis and the hypostatic inflammation that are so frequently observed, for instance, in cases of typhoid fever treated without hydriatric applications. I have adduced a number of clinical arguments in favor of this fact in connection with the consideration of the effects of hydriatric antipyresis.

Here I must again insist, in spite of the contrary opinion of Matthes, that the vasodilatation occurring as a result of the action of heat represents quite a different process from that which is brought about by cold ; and while the former exhibits, in fact, a paretic character, the latter does not. The theory of overstimulation or paralysis has obviously arisen in consequence of our inability to conceive how dilatation of the vessels can be brought about by contraction of their longitudinal muscular fibers. Nevertheless, Exner, in a communication presented to the Academy of Sciences at Vienna in 1877, has called attention to the physical possibility of active dilatation of the lumen of the vessels. By stretching a rubber tube in its longitudinal axis we may imitate approximately the conditions that obtain in the vessel. When the tube is stretched, the lumen is contracted ; on relaxing the traction, or, in other words, upon shortening the longitudinal fibers, the lumen of the tube is widened. It is certainly inconceivable that cold is capable of bringing about a reduction in tone simulating the effect of paralysis.

The influence transmitted to the muscular coat of the vessels, in consequence of thermic and mechanical impression upon the peripheral nerve-endings, constitutes one of the most powerful effects of the physical remedial forces under consideration, inasmuch as by this means active and passive hyperemia and anemia can be brought about in the most varied areas of circulation. There will be, in the section on "Hydriatric Technic," opportunity to present a sufficient number of instances of the influence upon blood-distribution, of thermic and mechanical derivation of the blood from individual organs, of active hyperemia and modification of the blood current, and of a revulsive influence upon the circulatory processes in organs remote from the point of application of stimuli.

Changes in the Constitution of the Blood

It was an extremely surprising observation when I was able, more than seven years ago, to demonstrate that after the action of cold and heat the morphologic and chemic **constitution of the blood** exhibits changes. At first I found that immediately after the influence of **cold**, marked leukocytosis was present. As a result of continued investigations by myself, and by my pupils, Strasser and Wertheimer, the following facts have been demonstrated :

1. After the application of all **general** thermic (**cold**) and mechanical procedures to the entire surface of the body, there is observed, with rare exceptions, not only an increase in the number of leukocytes, but also a considerable increase in the number of red corpuscles in a specimen of blood obtained from the tip of the finger or the lobule of the ear. It is possible also to show that, following general procedures, the percentage of hemoglobin in the blood is likewise increased.

2. The maximum increase in the number of red blood-corpuscles in 80 cases examined was 1,800,000 in the cubic millimeter.

The maximum increase in the number of leukocytes was almost thrice the previous number, and the hemoglobin percentage was increased 14 per cent.

3. The maximum increase was not observed in all cases immediately after the application. The highest figures were often obtained only after the lapse of an hour.

4. It is noteworthy, and possibly important in its bearing upon the significance of certain clinical observations, that often an increase in the number of leukocytes was still observable at a time when the number of erythrocytes had begun to diminish.

5. These remarkable alterations in the constitution of the blood persist for varying periods. Often the increase in the number of erythrocytes, as well as in that of leukocytes, could be demonstrated so long as two hours after the application. Usually, however, both varieties of blood-corpuscles had begun to diminish again by this time.

6. In some cases, particularly in the presence of anemia, the reduction in the number of erythrocytes did not progress to the original level. In other words, the increase induced by thermic and mechanical influences did not entirely disappear. There is, therefore, no doubt whatever that, after the action of cold affecting the surface of the entire body, blood removed from the superficial vessels exhibits the alterations described. In experiments upon animals, moreover, Rovighi has observed that also blood obtained from internal organs—as, for instance, the liver and the spleen—exhibited like alterations.

7. Our own investigations showed, further, that **active muscular movements** had a similar, though less pronounced, effect. The number of red blood-corpuscles, which had increased immediately after the action of the cold, was in many instances augmented by the reactive movement, and even in the absence of any antecedent action of cold the number of erythrocytes increased after active movement.

8. **Steam cabinet baths, warm water baths,** as also **warm electric ferrated baths,** were followed immediately in many cases by moderate reduction in the number of erythrocytes. This was followed after a time, particularly in the case of healthy and full-blooded individuals, by a moderate increase.

9. Of importance in connection with this alteration in the morphologic elements brought about by thermic influences, is the observation that if, for instance, the thermic irritation affected only a **limited portion of the body,** such as the feet and the legs, the number of erythrocytes in specimens of blood obtained from the lobule of the ear or the tip of the finger exhibited a reduction, while in those parts of the body exposed directly to the thermic and mechanical irritation a marked increase in both varieties of cells was observed.

10. The changes in the blood that have been described were wanting

only in those cases in which it was not possible to bring about marked hyperemia of the skin in the sequence of the application of cold. Under such circumstances a reduction in the number of erythrocytes was often observed, and generally in the number of leukocytes also.

11. The **local action of cold** causes mostly an increase in the cellular elements of the blood, in the percentage of hemoglobin, and also in the specific gravity of the blood-mass at the point of application, and a reduction in parts remote from this point, and in peripheral portions of the body; thus, for instance, when running foot-baths are employed, an increase is observed in blood taken from the toes and a reduction in that taken from the tips of the fingers, or from the lobule of the ear. This is also an evidence of the alteration in the distribution of the blood in the body that can be effected through thermic and mechanical influences.

12. **Warm sitzbaths** generally cause a reduction in the cellular elements, in the hemoglobin, and in the specific gravity, by the same method of examination. [I may mention here, because it has as yet received little attention, in spite of my publications relative thereto, the highly surprising fact that comparative observations of the constitution of the blood from peripheral portions of the body and from the trunk yield widely varying results. A comparison of the constitution of the blood, as exhibited in specimens obtained from the skin of the finger and that of the abdomen respectively, disclosed in all instances a great difference. Thus, in one instance taken at random the blood from the tip of the finger contained 4,955,000 red corpuscles in the cubic millimeter, with a hemoglobin percentage of 91 per cent.; while the blood from the abdominal wall, obtained at the same time, contained 7,266,000 erythrocytes, with a hemoglobin percentage (or color test) of more than 115 as estimated upon the scale of Fleischl.]

13. The results of the following observations were, however, far more surprising. A determination being made of the constitution of the blood taken from the tip of the finger and from the abdominal wall, a **stimulating,** that is to say, a **cold, compress,** well surrounded by a dry covering was applied about the abdomen, and after complete warming had been effected, therefore after about an hour, a second examination was undertaken of specimens of blood taken, as before, from the tip of the finger and from the abdominal wall. The difference between the two specimens was found to be greater than at first. While the cellular elements in the blood from the tip of the finger exhibited a material reduction, a marked increase in the erythrocytes and in the hemoglobin percentage, as well as in the specific gravity, was observed in that from the abdominal wall covered by the stimulating compress—an increase that in some cases equaled 2,000,000 for the erythrocytes;

while the hemoglobin, estimated with the apparatus of Fleischl, could only approximately be determined, as it exceeded 120, the highest figure upon the scale.

14. **Cataplasms and warm fomentations,** however, exhibit quite a different, almost opposite, effect. As a result of these applications there is generally an increase in the number of leukocytes and a reduction in the number of red corpuscles.

If an attempt be made to interpret the alterations in the physical elements of the blood that have been described as following the general and local action of cold; following the action of stimulating and directly warming influences; following mechanical procedures; and following muscular activity; the question will at once arise: Can this increase in the number of red and white cellular elements of the blood, following immediately upon the influences named, be considered a reproduction so rapidly brought about? This explanation is characterized by but slight probability. If it be remembered that one may endeavor fruitlessly, often for months, and by all the measures at his command, to bring about an increase in the percentage of hemoglobin and in the number of blood-corpuscles even in a case of simple anemia or chlorosis, it must appear highly improbable that hematopoiesis should take place with such marked rapidity following the action of cold. Numerous facts indicate that the additional cells that gain entrance into the general blood stream and the channels of circulation after the procedures described have existed preformed in the blood. The tumefaction of dependent portions of the body that can be demonstrated with the aid of the plethysmograph, and the reduction in size of elevated parts, the globular stasis of Hüter, the well-known sudden increase in the number of red blood-corpuscles to the extent of several millions in the course of a few hours in connection with the critical termination of febrile diseases, indicate that when there occurs a sudden increase in the number of erythrocytes in the circulating blood, the phenomenon requires a different explanation from that of reproduction.

The circumstance that, following the action of heat, the number of erythrocytes appears to be diminished, is indicative of the direction in which is to be sought the explanation for the increase following the action of cold and muscular activity, but particularly the state of affairs attending the local action of cold. It resides obviously in **changes in the circulation,** in the action of the heart, in the tone of the vessels, and in the tissue tone. From organs in which, under ordinary conditions, there is stagnation, stasis, accumulation of white and red blood-corpuscles, the blood-cells will, under the favorable circulatory conditions brought about by the influence of cold and muscular activity, be swept out into the general stream. To demonstrate this was, I believe, the successful endeavor of numerous of my earlier studies.

Thus, from the most diverse tissues and organs the stagnating cells must be thrown into the general circulation. This takes place as a result of the action of cold affecting the entire surface of the body. The reduction in the number of red blood-corpuscles at what may be termed indifferent points that is associated with local applications of cold, together with the increase that occurs in the portions of the skin directly affected,—as in the toes following the foot-bath,—indicates, furthermore, that there occurs a change in the distribution of the cellular elements of the blood in the vascular stream. The so-called **derivative method** is hereby given an experimental basis.

It must not, however, be overlooked, that the **effect** of this alteration in the blood upon the intimate metabolic processes will be the same as if an actual increase in the number of corpuscles had taken place. The blood elements previously stagnating in various organs and tissues, and not subserving their functions, are carried into the circulation and are saturated with oxygen in the lungs; thus being rendered serviceable to the metabolism in the tissues and organs precisely in the same way as if they were actually newly generated corpuscles. From this it will be understood, as was determined in the study concerning the respiratory interchange of gases, undertaken with Dr. Otto Pospischil, my assistant at the time, how, after the action of cold, the absorption of oxygen and the excretion of carbon dioxid must be so greatly increased. Blood containing a larger number of cells, each well laden with oxygen, will, moreover, render the total metabolism more complete.

That which has hitherto been difficult of comprehension—namely, how thermic influences act upon all of the functions—is brought much more nearly within our range of knowledge. The curative influence of cold or heat will, as I have maintained for years, no longer be sought in their effects upon the body-temperature alone; but still another aid, which has long been sought in vain, appears to be furnished by this method of investigation. It may be found that the more or less marked increase in the number of red blood-corpuscles may serve as an indication of the complete or incomplete reaction of the individual to thermic and mechanical applications, and that the completeness of the reaction is in direct relation to the increase in the number of erythrocytes following the procedures employed. This is true, for instance, especially of **anemic** patients. In these, the number of blood-corpuscles and the percentage of hemoglobin increase for a few hours. The blood thus approaches more nearly the normal, while at the same time also, in all probability, all nutritive processes are similarly heightened; and, as a result of methodic repetition, this temporary effect is rendered permanent. The interesting investigations of Friedländer may also be looked upon as supporting this view.

Influence upon Metabolism

As there can be no doubt that organic heat is to be considered as the end-product of all organic processes; and as the body-temperature, when lowered by means of physical measures, quickly regains its previous level, while by preventing or diminishing the heat-loss this reactive elevation of temperature can be avoided, it is obvious that the effect has been to induce an increased generation of heat; that is to say, an augmentation of the total metabolism. All trustworthy studies of metabolism have shown that oxidation processes, as estimated upon the elimination of carbon dioxid and the absorption of oxygen, are considerably increased in the cold, and that in general the opposite effects take place in the heat. Careful inquiry, however, shows that this is the case only so long as the body-temperature remains approximately constant. The greater the thermic nervous irritation, in connection with any procedure, the more considerable, under otherwise like conditions, will be the reflex acceleration of metabolism. This primary acceleration of metabolism is neither marked nor persistent. "Of itself, the increased reflex disintegration would not be capable of protecting the inhabitants of Arctic regions from freezing. It is even not sufficient to render unnecessary the use of clothing at a temperature of 7.5° C. (45.5° F.)." The acceleration of metabolism brought about through the reflex influence of cold occasions no increased consumption of proteid. The increase in interchange primarily brought about through the action of the cold affects principally nonnitrogenous substances (Hagenbach, Röhrig, Zuntz, Voit).

The conditions are different, however, with regard to the acceleration of metabolism induced secondarily as a result of **heat abstraction.** This resembles the metabolism attending artificial elevation of the body-temperature, or which characterizes fever. Consistent and systematic abstraction of heat causes, as a secondary effect, an increase in the body-temperature, which may even attain a febrile level, and will always bring about analogous modifications in metabolism. Reactive elevation of temperature, and increase in metabolism, after abstraction of heat, stand in direct relation to the degree of actual cooling. If, in a normal person, the body-temperature be reduced below the normal by means of measures that abstract heat, the body exhibits a tendency to regain the normal temperature; and under such circumstances the reactive tendency may even carry the temperature above the normal. It is certain that several hours after a cold bath there may be observed a higher hourly average of the body-temperature than prevailed before the employment of the bath (Jürgensen). Obviously, under such conditions increased heat-production is associated with disturbed dissipation of heat. In this connection reference may be made also to my experiments with cold sea-baths (5° C.—41° F.) of excessive duration. Under the influence of systematic daily repetition of such marked loss of heat, there occurs gradually, as a result of the voluntary and involuntary muscular activity, an increase in heat-production sufficient to prevent cooling of the body, often even to cause elevation of temperature.

With regard to the influence of heat-abstraction upon the metabolism of individuals with a normal temperature, it is highly probable that the thermic nervous stimulation, and the actual reduction in temperature, as well as the reactive elevation of temperature, exert quite varying influence upon the metabolism. The **thermic nervous stimulation** brings about by reflex action, principally in the muscles, increased tissue change, involving chiefly nonnitrogenous substances; while the **secondary** or **after-effect** of heat-abstraction consists in febrile increase in metamorphosis, probably, therefore, also in heightened proteid metabolism. The increase in the absorption of oxygen and the augmentation of carbon-dioxid elimination are proportionate to the voluntary and involuntary muscular activity brought about as a result of the thermic and mechanical stimulation, and particularly of the increase in muscular tone, which may, indeed, in highest degree be manifested as 'chill'; a condition that must be considered as a protective measure of the organism against the reduction in temperature. Speck's, Löwy's, my own, and Pospischil's investigations have demonstrated this fact.

As a general result of studies in metabolism it has been found that hydriatric therapy influences metabolism quantitatively and qualitatively in a special manner—namely, by producing an increase in the general normal activity of the living organism, which, however, in the presence of an adequate state of nutrition, never passes beyond normal limits. Thus, it was never possible to observe among many hundreds of individuals, at times treated with vigorous measures, any evidence of pathologic increase in proteid metamorphosis, such as acetonuria and the like (Strasser). As numerous clinical observations show that it is possible to confine the action to an increase or a diminution in the functions of all organs, down to the simplest cell, it should be feasible at all times, by accurate regulation of the thermic and mechanical measures employed, to control the total metabolism under all circumstances with certainty. It is thus possible so to graduate the individual procedures that any special irritative effect is forced into the background; and, instead, there is effected a general increase in function, with a heightening of innervation and with any desired guidance of circulatory processes, and thereby also of metabolism. Details concerning the adjustment of the individual elements of metabolism will be found in the investigations of numerous observers (Röhrig, Zuntz, Senator), in the publications from the laboratory of Pflüger, in numerous Russian publications emanating from the school of Manassein, all of which arrive at almost the same results. The most recent of these publications is by Strasser, and is contained in the "Fortschritte der Hydrotherapie," by Strasser and Buxbaum.

INFLUENCE UPON SECRETION AND EXCRETION

Cold, warm, and mechanical applications induce changes also in the functions of all of the secretory and excretory organs of the body.

The Skin.—Whether or not the accelerated desquamation of the horny cells of the epidermis facilitates gaseous interchange, or the dilatation of the peripheral vessels, particularly of the superficial capillaries, renders possible the percutaneous absorption of oxygen, even though in small degree, has not yet been determined with certainty. The circumstances that irrespirable gases have caused symptoms of intoxication when brought into adequate contact with the uninjured skin is certainly an indication thereof. Increase in the perspiratory and transpiratory elimination of water, that is to say, of the insensible and sensible **perspiration,** as a result of thermic and mechanical applications, has been demonstrated by Weyrich. The secretion of sweat certainly undergoes considerable augmentation. The small amount of organic matter eliminated at the same time, the trace of urea, the various fatty acids, and the numerous aromatic substances, as well as gases, particularly carbon dioxid, should certainly be given consideration in this connection. That toxic substances, probably various kinds of infectious matter, and even micro-organisms, may leave the body with the sweat, has already been demonstrated by numerous investigators. The **depurative action** of the sweat is in this way revived in the modern sense.

It may be said in general that, as a result of profuse sweating, the body loses some of its water. If this loss through the skin be considerable, the elimination of urine becomes diminished and the urine more concentrated; the excretion of nitrogenous matters appears, on the whole, to be diminished. "In the simplest manner a retention of urea in the blood takes place," says Beneke, "if the elimination of water through the skin is increased in abnormal degree, or the supply of water of the organism is in general materially diminished."

The principal **utility of sweating** when the functions of the kidney are normal, may be sought (1) in the changed channel for the elimination of water, and (2) in the altered diffusion processes thereby brought about in certain internal organs; (3) in the distribution of the blood so greatly altered by the process of sweating—the change in current; and (4) principally in the depurative effect of the sweating.

The Kidneys.—That increase in the secretion of **urine** is a result of thermic influences upon the surface of the body is a long-established fact, and it appears to depend not alone upon the antagonistic relations between the excretion process of the kidneys and that of the skin, but to be attributable principally to innervational and circulatory alterations.

Alimentary Tract and Glandular Apparatus.—With regard to other secretions than sweat and urine, it may be said that it is possible in many cases to exert an influence upon the quantity of the secretion of the glands of the **stomach.** In innumerable instances in the sequence of general or local thermic and mechanical applications, a profound alteration in the gastric secretion has been observed on repeated examination; the quantity of hydrochloric acid being found normal, or even increased somewhat above the normal. Also the remaining clinical symptoms agree often with these findings; for instance, the digestion, previously sluggish, is completed within the normal limit of time.

It appears to me that an influence is exerted by thermic and mechanical stimulation upon the secretion of **bile.** This is indicated not only by the clinical experience that stimulation of peristaltic activity, increase in the blood pressure in the radicles of the portal system, and accelerated movement of the blood in the portal vein may be brought about by thermic and mechanical applications, but also by the surprising fact that in some cases of jaundice the dejection, ordinarily free from bile (clay-color stool), exhibits an admixture of bile after a cold irrigation or after a cold sitzbath. Possibly this observation may serve as a stimulus to the study of the pathogenesis of certain forms of jaundice.

In addition, cursory reference may be made to the fact that in rare cases icteric discoloration of the skin, and also hemoglobinuria, have been observed immediately in the sequence of cold baths. At this point I do not wish to enter more fully into the theories relating to this occurrence, and shall only point out that attention has been called by several observers to a more rapid destruction of red blood-corpuscles under conditions as yet not understood.

CHAPTER III

THE CHEMICAL EFFECTS AND INTERNAL USE OF WATER

External Application—Influence of Carbon Dioxid. Internal Use of Water —Drinking; Irrigation; Effect on Pulse and Temperature; Vasomotor Effects; Absorption; Effect upon the Blood. Therapeutic Methods—To Increase Fluidity of Tissue; to Increase Absorption and Elimination. Effects upon Metabolism and Excretion.

Not only physically—that is to say, by reason of its temperature, its volume, and its pressure—does water induce in the organism changes susceptible of therapeutic utilization, but also chemically; and this chemical effect, dependent upon the varying constitution of the water, reacts upon physiologic and pathologic nutritive processes, whether the agent be employed internally or externally.

EXTERNAL APPLICATION

When applied externally, the chemical composition of the medium that comes in contact with the surface of the body influences both the quantity and the intensity of the effect. The stimulation of the peripheral sensory nerve-endings must vary also in accordance with the chemical constitution of the stimulant. As Scouttetten, Heymann, Krebs, and others have demonstrated, the intensity of the electric contact current—temperature and mechanical impression being the same—varies in accordance with the varying composition of the fluids employed. The heat-absorbing and the heat-conducting power of waters of different composition differs; and Basch, Santlus, Beneke, and others have shown that diverse fluids differ in their influence upon the organs of touch. Finally, as appears from the studies of Röhrig and others, the reflex influence upon metabolism is subject to similar variation. The chemical effect of various waters applied externally will be discussed in the balneologic section of this volume. I cannot, however, refrain from pointing out at this place the special effect of the chemical constitution of the water associated with the thermic stimulation, in so far as **carbon dioxid** may play a part. This gas, when contained in the water used for external application, has quite a special rôle. It augments the physical influence of heat and mechanical stimuli. It is possible, by this means, to employ water of lower temperatures without the consciousness of the individual exposed to its action, inasmuch as the bubbles of carbon dioxid collecting upon the skin so stimulate the sensory peripheral nerve terminations as to benumb the thermal sensibility. Attention will be recalled to these carbon dioxid baths in the chapters devoted to "Technic" and in those concerned with "Special Hydrotherapy." (The preparation of artificial carbonated baths is described in the appendix.)

THE INTERNAL ADMINISTRATION OF WATER

The Drinking of Water

Even the systematic drinking of ordinary water is employed for remedial purposes, and the mode of action of the water when thus employed, although discussed in the volume on "Dietotherapy," must receive additional consideration here. In this connection weight must be given to the thermic and chemical effects of the water, which have an influence directly upon the organic economy and the temperature, as well as upon metabolic processes. Water, when introduced into the stomach, is actually taken up by the body. It remains in relation with the body for a considerable period of time, and through the stomach and the intestinal canal it enters into direct contact with the most diverse portions of the digestive apparatus. By reason of the equalization of its temperature with that of the body, as a result of absorption into the fluids and the blood-mass, and by reason of its chemical constitution, water must have an especial effect upon the most intimate nutritive processes. When taken internally, water will play an important rôle also as an imbibition material, inasmuch as it enters and penetrates all of the tissues and their interstices, and renders them permeable to water-soluble substances.

Effect on Pulse and Temperature.—Lichtenfels and Fröhlich found that if 0.3 liter (quart) of water at a temperature of 18° C. (64.4° F.) were drunk rapidly, the frequency of the pulse was at first diminished by 22 beats in thirty seconds, but that after the lapse of twelve minutes it had resumed its original rate. The temperature declined in the course of six minutes from 37.05° C. (98.7° F.) to 36.95° C. (98.5° F.), and continued at this level for ten minutes after ingestion of the water, then returning to 37° C. (98.6° F.). When 0.3 liter (quart) of water at a temperature of 16.3° C. (61.3° F.) was drunk rapidly, the pulse declined 16 beats in twenty-two seconds, and rose in the course of fifteen minutes to its original frequency. The temperature of the body declined 0.4° C. (0.7° F.) in the course of six minutes after ingestion, and returned to the original level in the course of seven minutes more.

In my earlier observations a liter (quart) of water at a temperature of 6.7° C. (44.1° F.) was drunk in the morning when the stomach was empty. The pulse-frequency declined from 72 to 52 in the minute; respiration increased by 5 in the minute; the axillary temperature declined from 37.3° C. (99.1° F.) to 36.5° C. (97.7° F.); while the temperature of the recently voided urine declined 0.7° C. (1.3° F.).

Nevertheless all of these investigations have yielded but incomplete results. In order, therefore, to determine accurately the influence upon the **temperature** and **heat-distribution** of water introduced by the mouth or the rectum, I have instituted a series of careful experiments. The temperatures were first taken in the axilla, in the rectum, and in the stomach. Then the desired amount of water was drunk at short intervals or introduced into the rectum by means of a tube. The thermometers, previously carefully compared with one another, were now read at convenient intervals, and the temperature noted. The determination of the temperature in the stomach was effected by attaching securely a maximum thermometer, 4 cm. (1 ½ in.) long, in a soft rubber tube, which was then swallowed by the patient, precisely in the same manner as for lavage. I believe that I was the first to make temperature-observations in the stomach of the living human being. In this way the thermic influence of water taken internally can be determined more accurately than has hitherto been possible.

As a result of my observations I may state that the temperature of the stomach is lowered considerably, and for a considerable time, by the drinking of cold water. Fully thirty minutes after the ingestion of 500 c.c. of water, I have been able to demonstrate a reduction of 0.6° C. (1° F.) in the temperature of the stomach as compared with that observed before the ingestion of water. Even after the lapse of three hours the original temperature had not yet been completely regained. The temperature in the rectum observed at the same time was quite remarkable. Immediately after the ingestion the rectal temperature declined continuously for twenty-five minutes, until a reduction in the temperature in this situation of 1.05° C. (1.9° F.) was observed. After a transitory ascent, a decline in temperature occurred also in the axilla, and this continued for an hour and fifteen minutes. After the lapse of seventy-five minutes more a reduction of the axillary temperature of 0.22° C. (0.4° F.) could still be demonstrated. The **pulse** at the same time exhibited a reduction of ten beats.

In order to verify also by control observations the striking relations between the stomach and the rectum that have forced themselves upon me in this and similar experiments, I introduced cold water into the rectum by means of enemata. The previous experiments, as stated, had disclosed the remarkable fact that after the drinking of cold water, the greatest reduction in temperature, next to that of the area immediately cooled, was appreciable in the rectum. So, also, after the introduction of cold water into the rectum the most marked reduction of temperature was noted in the stomach. The temperature of the stomach declined 0.9° C. (1.6° F.) after cold enemata.

In addition to the demonstration that it is possible to influence the body-temperature effectively by the internal administration of cold fluids, these experiments showed that by means of the ingestion of water and of cold enemata it is possible to regulate at will the temperature in even deeply seated organs of the abdominal cavity. It is possible, as I have shown, by means of an injection into the rectum, to lower the temperature in the stomach and adjacent viscera in the shortest period of time, and, conversely, through the stomach to reduce the temperature of the organs of the pelvic cavity. These facts afford explanation for various general and local therapeutic effects, such as may be secured by the systematic drinking of water, and through systematic irrigation.

The effects described are not dependent upon the actual physical cooling alone, but **vasomotor influences** are certainly to be taken into account as well. In favor of this view there are numerous phenomena; thus, the change in the state of the skin; its pallor; the decline of the temperature at the periphery after the injection of cold water; and the reduction in pulse frequency, which possibly may be brought about by stimulation of the intragastric terminations of the fibers of the vagus.

That, however, **reflex transmission** of the irritation due to cold takes place from the stomach and the intestine to the vasomotor center, I demonstrated years ago by means of pulse tracings taken before and after the ingestion of cold and warm fluids. Only on the basis of this conception can the results obtained with the aid of such manipulations in the presence of hyperemic and inflammatory disorders of parenchymatous abdominal organs be comprehended. The channels by which the water introduced into the stomach may be conveyed into the blood stream are the lymph vessels and the veins, as has been shown by Bouisson, who found in animals after the drinking of water a greatly distended portal vein containing blood with a large proportion of water.

Absorption of Water and its Effect upon the Blood.—Various circumstances have an influence upon the rapidity of **the absorption of water.** The lower the degree of tension in the vascular system, the more rapid, under otherwise like conditions, will be the absorption of water into the blood-vessels. After considerable loss of fluid, as by diarrhea, hemorrhage, profuse sweating, copious elimination of urine, or other normal or pathologic process, more rapid absorption of water from the intestinal tract will be observed. Water holding less saline matter in solution is more readily taken up into the blood stream than water containing much saline matter. Free alkali increases considerably the attractive power of a fluid, especially for one with a feebly acid reaction. Thus a fresh water rich in carbon dioxid, and deficient in saline matters, is likely to be most rapidly absorbed, and is particularly suitable as a beverage. Water containing saline matters is absorbed much more slowly, and will therefore cause a sense of pressure and fullness in the stomach, even when taken in small quantity.

Schultz, Nasse, and others, have demonstrated that after the abundant ingestion of water the blood contains about 5.7 per cent. more water than after thirst of long standing. The rapid absorption of water into the blood stream increases the tension in the vascular system, as a result of which, as Magendie and Falk have shown, dropsical states may readily develop. The circumstance, however, that the blood retains its constitution with great persistence is responsible for the fact which Böcker especially has shown, that this increased amount of water can be demonstrated in the blood for but a short time, scarcely more than fifteen minutes. So early as half an hour after the ingestion of a large quantity of water, however, the blood is again more dense, more consistent, and less rich in water than even after abstinence from fluid for twenty-four hours.

The proportion of fibrin present in the blood is said to increase or diminish with that of water, while the number of blood-corpuscles in a given volume of serum of course varies inversely with the dilution. Böcker has further made the interesting observation that after the ingestion of water the blood-clot contains a smaller number of red blood-corpuscles incapable of respiration and therefore failing to become red on exposure to the air, than was the case prior to the drinking of the water.

Therapeutic Methods

Upon the facts set forth I have evolved, and have found verified by experience, a method for the **internal administration of water** for therapeutic purposes. When it is desired to **flood the tissues** with fluid, to increase the weight of the blood-column, to augment the tension in the vascular system, to increase the capillary pressure, water should be administered in small single doses, but repeated at short intervals of from twenty to thirty minutes throughout a considerable period of time. When, however, it is desired to cause **disappearance of fluid effusions** and to stimulate absorption powerfully, it will be possible—however paradoxical it may seem—to effect this by the drinking of cold water if we alternate the administration of fluid with considerable intervals of abstinence from all drink. By this means the blood becomes more consistent, more impoverished in water, and best suited to take up fluid from the tissues and to initiate absorption and elimination. The ingestion of somewhat larger quantities of fluid from every six to every eight hours, and the withholding of all fluids in the intervals, best fulfil these indications.

The more rapid absorption, once initiated, does not remain confined to the elimination of fluid. It will thus not only be possible, by means of the systematic drinking of water, to render a useful service in the presence of dropsy, but also opportunity will often be afforded of observing the more rapid absorption and elimination of solid products of exudation and inflammation. As Böcker likewise has shown, the loss from the body is in general much greater after generous administration of water; and if the amount of food is not enlarged, or is even restricted, the blood, in order to retain its normal constitution, must regenerate itself from the tissues of the body and not alone from the circulating fluids. In this way increase of waste and of retrogressive metamorphosis is brought about.

The gain in body-weight that occurs with moderate increase in the amount of water consumed and a corresponding supply of food, is dependent upon the fact that constructive metamorphosis may under such circumstances be stimulated secondarily. With excessive ingestion of water, however, the body-weight declines, although it is soon restored if the amount of water be restricted.

The increased ingestion of cold water exerts a **diuretic effect** in the strict sense. The organism relieves itself, especially through the kidneys, of the larger amount of water taken. Coincidently with the increased elimination of water through the kidneys, the solid constituents of the urine also are excreted in greater amount, as numerous investigators have found. This is true especially of the urea. In this way also the metamorphosis of the nitrogenous tissues of the body is materially augmented.

That under the same influences the **oxidation processes** are heightened and become more complete is shown by the reduction in the amount of uric acid eliminated; and by the reduction and even the complete disappearance of the oxalic acid that may have been present in considerable amount before the increased ingestion of water. The stimulation of oxidation processes attending increased ingestion of water can be demonstrated also directly by the measurement of the greater quantities of carbon dioxid eliminated and oxygen absorbed. Likewise, salts and inorganic substances, such as the potassium salts, which result principally from muscular metabolism, the incombustible salts of the bones, the phosphates and sulphates of the brain and the glandular structures, are excreted in increased amounts.

This universal stimulation of retrogressive metamorphosis and acceleration of metabolism by means of systematically increased drinking of ordinary water has hitherto been employed far too little therapeutically.

Excessive cooling of the stomach during digestion, together with excessive dilution of the gastric juice, will be a reason for avoiding excessive ingestion of water with the taking of food. Mosler has found that with rapid ingestion of considerable quantities of water, the direct elimination of solid matters through the kidneys is smaller than with gradual ingestion of the same quantities.

The drinking of cold water has an influence also upon other functions. It appears to stimulate actively the peristaltic movements, thereby exerting a favorable influence upon the circulation in the vessels of the stomach and the intestine. This accelerates, moreover, the rapidity of the current in the portal vein, and thus favorably influences the functions of the liver and augments the secretion of bile. The latter effect has been pointed out especially by Bidder, Schmidt, Nasse, Lehmann, and recently by Röhrig.

CHAPTER IV

THE REACTION

Effects Due to Reaction. Conditions Governing the Reaction. The Necessity of Complete Reaction. Recapitulation.

A large part of the effects described in the foregoing chapters are not attributable to the direct influence of the measures employed, but are to be ascribed to the automatic processes of the organism in countereffect against the alterations primarily induced; that is to say, to the **physiologic reaction.** The intensity of the reaction in response to a given procedure varies, however, with the individual and with divers circumstances, and is only partially dependent upon the character of the therapeutic procedure itself. The production of complete reactive processes is one of the most important and most difficult tasks of the hydrotherapeutist, the thermotherapeutist, and the balneotherapeutist. The mechanical or thermic nerve-stimulation must be carefully proportioned to the irritability of the individual organism, generally or locally, at the given instant, and the abstraction of heat often must be minimal. In many cases some means of supplying heat generally or topically must be used in supplement to the application of cold, in order to bring about the complete reaction desired.

The **restoration of heat** after heat-abstraction, which is the essential factor in the reaction, exhibits the greatest variations in different individuals, and these variations may indicate certain points of support and attack in regard to pathogenesis, to prognosis, and to treatment. In treatment it is of especial importance that the reactive temperature elevation following reduction of temperature should be efficiently controlled; and, accordingly, we so adapt our measures as to increase or diminish its rapidity and its degree. This restoration of heat, at once the most reliable indication and the most prominent symptom of the reaction,—which may be recognized, further, by alterations in innervation, in circulation, and in metabolism,—depends, other things being, equal, upon:

1. **The absolute degree of heat-abstraction**: the greater, within certain limits, the reduction in temperature, the greater will be the reactive elevation of temperature.

2. **The time occupied**: the more rapid the abstraction of heat, the more rapid will be the secondary rise of temperature.

3. **The duration of the cooling** has an influence in determining whether the restoration of heat shall set in early or after a considerable length of time. Protracted and gradual abstraction of heat is followed by a slower and less intense reactive elevation of temperature than cooling of short duration, even to a lower temperature.

4. **The state of the body-heat before the cooling** likewise influences the reactive elevation of temperature. A body previously highly warmed reacts more markedly than a cool body.

5. **The supplying of heat before the application of cold** increases, together with the irritability of the body, the intensity of the reactive processes.

6. **The combination with cold of a mechanical stimulation** increases the reaction.

7. **The state of the body after the abstraction of heat** also has an influence upon the more or less prompt occurrence of the reaction. A condition of quietude delays, while exercise and muscular activity accelerate and increase, the reactive processes.

8. **The internal administration of stimulants,** especially of alcohol, after the abstraction of heat, favors the reactive processes.

9. In general, the reaction as well as the production of heat is in direct proportion to the **thermic nerve stimulation**; the more powerful the latter, the more pronounced the former.

10. **Excessive cooling** may give rise to delayed and excessive or to incomplete reaction. While the former may manifest itself by fever-like or actually febrile conditions, the incomplete reaction exhibits rather the character of algidity and collapse.

11. The reactive processes are dependent also upon the **adaptation of the body and all of its functions** to systematically repeated thermic and mechanical stimulation, and the loss of heat.

The Necessity of Complete Reaction

It must be considered as an essential condition of every systematic course of hydriatric procedures that the individual measure should always be followed by perfect reaction. It may be a part of the plan of treatment that the reaction should take place but slowly, and should not become excessive. This is true especially of the treatment of febrile diseases. It may be desired to bring about rapid and adequate reaction. This will be the case in the presence of most chronic nutritive disorders, and of all conditions attended with retarded metabolism. In no event, however, will an incomplete reaction be considered desirable, as this is always attended with morbid manifestations, such as nervous disturbance, lassitude, pallor, small pulse, constant chilliness, unequal heat-distribution, and derangement of various functions; and it may even be followed by serious nutritive disorders. Observance of the foregoing rules will readily contribute to the avoidance of this danger. The cumulative after-effect of the baths may have a beneficial influence upon the nutritive disturbance through its influence upon metabolism and secretion, but through the same influence it may have an injurious effect in certain individuals and in the presence of certain processes. Both conditions are comprehensible if the changes in metabolism that take place as a result of abstraction of heat are borne in mind.

Recapitulation

The effects upon the organism of thermic and mechanical stimulation, as described in the foregoing pages, will be brought about only when the action is followed by a corresponding and **complete reaction.** It is this reaction alone that arouses and intensifies the natural and independent protective and defensive forces of the organism. This fact explains also the effect of physical remedial agents when directed against any recognized or suspected infection, intoxication, or autointoxication. It thus appears that the judicious employment of appropriate physical remedial measures is to be considered as a natural vital stimulus, which supports, hastens, and facilitates that restoration of nutritive and functional balance, which in a sufficiently vigorous organism would take place without the aid of the physician. A study of the natural independent remedial resources of the human body has been undertaken on numerous sides, and I have myself attempted to show that the actual remedial value of the measures applied in treatment—as the editor of this series has likewise pointed out—is to be found in the invigoration of the organism and of all of its functions; and that hydrotherapy, balneotherapy, thermotherapy, and phototherapy exhibit these effects only when the processes of reaction are efficiently controlled. The description of the technic of hydrotherapy that is given in Part II will make this fact even more clear.

CHAPTER V

FUNDAMENTAL PRINCIPLES AND PRACTICAL APPLICATIONS OF HELIOTHERAPY AND PHOTOTHERAPY [1]

Physics and Physiology—Thermic, Luminous, and Actinic Rays. General Effects of the Various Rays. Special Effects of Actinic Rays. Therapeutic Experiences—Sun Baths; Electric Light Baths.

PHYSICS AND PHYSIOLOGY

Phototherapy—the employment of **natural or artificial light** to influence a diseased or disordered organism in the attempt to restore integrity of structure and function—may for convenience be discussed at this point; the more appropriately that I had originally entertained the view that all of the effects that can actually be brought about by means of natural and artificial light baths were to be attributed only to thermal influences. Enlarged experience and more careful observation have shown, however, that this view was incorrect, and I now wish to retract it in view of the demonstration that light is not a definite entity, and that the various known and as yet unknown elements constituting the light ray exert widely different effects. What I shall have to say concerning light therapy must be limited in various directions. I shall not discuss radiotherapy and X-rays, but shall confine myself to **sun baths** (heliotherapy) and **light baths** as remedial agents, and refer cursorily to the studies of Finsen and the results obtained by him. At the same time I shall consider it my duty to present the physiologic action of this powerful remedial agent in so far as it is known.

Not even the physicists have progressed much beyond the beginning of their labors in this direction, in spite of recent remarkable investigations. It has even been proposed that light should be considered a chemical element, if it be definitely confirmed that the substance, radion, found in uranium, is capable of furnishing light independently, and of penetrating opaque substances and rendering them transparent. I shall, however, not undertake a discussion of such future science. It is known, moreover, that the radiant force which we

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[1] For further discussion of this subject, see the special article contributed to this volume by Dr. J. H. Kellogg (pp. 209 to 225).

recognize as light is no simple element. The light ray is a composite thing of which we are as yet scarcely able to grasp the individual constituents; hence a portion thereof are designated X-rays. Even that which manifests itself in the solar spectrum as various colors is only light more or less refracted, and nevertheless each of these rays, in accordance with the angle of refraction, has a different mode of action. Just as within recent years we have stood in surprise before new developments daily in the field of acoustics,—phenomena that are dependent upon comparatively coarse vibrations of the demonstrable air,—so is it also, and so in still greater measure will it be, with the more delicate force, light, dependent upon vibrations of the ether that can only be imagined.

In the study of the physical properties of light, in the physiology of the visual sense, in spectral analysis, white light is considered as a combination of the three primary colors—red, green, and violet. From the view-point of the therapeutist, a distinction is made between heat rays, light rays, and chemical or actinic rays. The heat rays pass principally through the red and the ultra-red of the spectrum; the actinic rays can be found principally in the violet and ultra-violet; while the remaining portions of the spectrum, particularly green and yellow, include most of the luminous rays. For the physiologic investigation of the effects of light no exact method has yet been devised. The results hitherto obtained in this connection are therefore by no means sufficient for a scientific basis of treatment, although many writers have occupied themselves with the question in comparatively numerous publications, some of which have much empiric value. If, however, I raise objections to premature dogmatizing upon light as a remedial agent, it is not only the failure of tuberculin that should be a warning against immature therapeutic experience.

Heliotherapy

I may briefly summarize that with which I am familiar—and let me premise that this will not be much. We may discuss, first, **unmodified natural light**—that is, **sunlight.** I can only confirm the old knowledge that is applicable to every physical force—namely, that sunlight may be a source both of usefulness and of injury. I will omit consideration of the general cosmic and telluric effects of the sun. It may be admitted that sunlight, and in a similar way also the electric light, although in less marked degree, is to be considered as an irritant that may exert both a useful and an injurious effect upon living protoplasm, upon the cell, and upon the entire organism. Its mode of action upon all of the organs and functions has not as yet been so thoroughly studied as that of heat-irritation. Investigations by numerous observers have seemed to show that the pure light separated from the heat rays is also an irritant. It is possible, it is true, to separate the heat rays from the luminous rays, so that the effect of the latter is alone manifested, but this pure light is then no longer, as Schönenberger happily points out in his industriously prepared inaugural dissertation, natural light—that fortunate combination of heat rays, actinic rays, and illuminating rays upon which probably depends the great hygienic significance of the sun.

The first question that will always be asked—as to the influence of light upon **metabolism**—may be answered thus:

1. It has been established that absorption of oxygen and elimination of carbon dioxid in the living organism undergo an increase under the influence of light.

2. It has been established that the nerves exhibit heightened irritability under the influence of light.

3. It is affirmed that the muscles acquire greater functional power under the influence of light. The names of Moleschott, Pettenkofer, Voit, Fubini, and many others, go to support this view.

So long as the ether-vibrations of light pass through the medium without obstruction, so long as they are not interrupted, refracted, or reflected, so long will they exhibit no other effect than that of the illuminating rays. The depth to which the light rays penetrate into the tissues is not known.

It was extremely interesting to me to have been able to furnish a demonstration that it is not, as I formerly believed, simply the thermic effects that are observed in the therapeutic employment of sunlight or of electric light. I have on innumerable occasions noted the remarkable fact that, for instance, in Lindemann's electrotherm quite high degrees of temperature could be borne by the patient without evidence of pain, so long as the space was heated by dark rays. When, however, the small incandescent lamp was turned on for the purpose of viewing the part of the body inclosed within the electrotherm, severe pain-reaction was immediately induced in the member in question, without material elevation of temperature. When the incandescent lamp was turned off, the pain at once disappeared. I therefore made the experiment of using an incandescent lamp inclosed in a red globe, or covered simply with translucent red material, usually silk. As soon as this was done the patient no longer reacted with pain. This is therefore an evidence that the cutting off of the chemical rays that is effected by means of the red glass, or the covering of red material, is alone sufficient to render tolerable the high temperature of the electrotherm.

I availed myself of this hint also in the employment of **sun baths**, and I have succeeded in the simplest manner by covering the parts of the body exposed to the sun, or the entire body, with red material. With the sole aid of this simple means of preventing access of the chemical rays, have I found it possible to obtain the effect upon the skin and various cutaneous affections that I have elsewhere described —namely, lessening of chronic hyperemia of the skin; the induction of ischemia in hyperemic portions of the skin; the improvement and cure of eczema. I have also seen various chronic rheumatic affections of the joints and of the feet influenced most favorably by sun baths when the affected parts were covered with red material.

Concerning the effects of the **heat rays** it can be demonstrated that they differ from those due to heat in other forms, and that they induce elevation of temperature at varying depths.

The **chemical rays** behave in a different manner. Concerning these it is known that they apparently pass through opaque structures. The proof of this is furnished by the fact that silver chlorid sealed in the dark in capillary tubes, and introduced at varying depths beneath the skin, exhibits the effects of penetration of the chemical rays by its decomposition. Likewise indicative of the absorption and resorption of chemical rays is the interesting observation that portions of the body previously exposed to the sun or to some other form of light and soon afterward placed in a dark chamber still have an influence upon sensitized paper, so that, for instance, it is possible to photograph in the dark chamber a hand that has previously been exposed to the sun (Moleschott, Fubini, Godeneff).

The **quantity and the quality of light** have a widely varying influence upon the intensity of these effects. **Incandescent lamps** give off more heat rays and fewer actinic rays than arc-lamps and sunlight. The actinic rays have a greater influence upon protoplasm and cells. The effects of the heat rays will be discussed in the consideration of the therapeutic methods.

At this point a few words will be devoted cursorily to the **physiologic effects of the chemical or actinic rays.** Various investigators, and especially Finsen, the leader in questions relating to the physiologic effects of light, have confirmed the observation that the actinic rays are direct stimulants for animal and vegetable life, and the carriers of vital energy in all forms. This may possibly be of great importance in its bearing upon treatment. The wonderful results yielded by sun baths must probably be attributed in large part to the effects of the chemical rays.

The most thorough investigations hitherto made as to the influence of light, and especially its chemical rays, upon **micro-organisms,** and especially bacteria, are those of Finsen. He has shown that the actinic rays, in accordance with their intensity, inhibit the development of various organisms within a longer or a shorter time, and, if the exposure be sufficiently prolonged, also destroy them. The observations of hygienists, particularly those of the pupil of Pettenkofer and Voit, Professor Soyka, who died prematurely, with regard to the self-purification of streams, would indicate that this is probably attributable in part to the chemical rays of the sun.

The chemical rays are responsible for **solar erythema,** an affection that differs markedly from a burn, inasmuch as it appears only several hours after the affected part has been exposed to the sun or to an intense electric light. This solar erythema is constantly followed, as is likewise the direct action of the sun's rays, by deep pigmentation of the affected portion of the skin, which then protects this area against further effects of the chemical rays. Most writers attribute to the pigmentation of the skin the protection enjoyed by negroes against the injurious effects of intense sunlight.

Schönenberger has also made investigations as to the constitution of **the blood** under the influence of light and with exclusion of light. It was found that with exclusion of light the percentage of hemoglobin and the number of erythrocytes undergo increase, a statement that at the present day can scarcely be harmonized with the results of therapeutic experience. My own observations with ordinary **incandescent-light baths** in the case of anemic patients showed that after each bath an increase in the percentage of hemoglobin and in the number of erythrocytes occurred. These investigations also cannot be considered as by any means conclusive.

To summarize: The chemical rays penetrate all tissues. They are most thoroughly absorbed by the blood. Only light that bodies take up is of influence upon them. The chemical effects of light are in direct proportion to the amount of light absorbed. Provisionally, it must be assumed that the chemical rays in large amount are injurious; but in appropriate amount, probably beneficial. The pigment of the skin is a protection against the chemical rays. In any event, the light is a stimulant to all irritable matter, and the dosage thereof must be determined by future investigation. Light, in itself, as well as its effects upon inanimate bodies and upon living beings, thermically and chemically, and by means of its luminous as well as of its dark rays, requires unlimited study before we shall be informed concerning its physiologic action as a whole or in detail.

THERAPEUTIC EXPERIENCES WITH SUN BATHS AND OTHER LIGHT BATHS

It seems more convenient to continue here the account of my experience with light as a remedial agent, rather than to make this the theme of a separate section, as in the case of the more extensive subject of hydrotherapeutics. "All experienced physicians consider the great value of the sun's rays to consist in a stimulation of organic processes," and a large part of these effects may be obtained also by means of appropriate baths in **electric light.** It is principally chronic disorders of hemogenesis, derangements in digestion, some dyscrasic processes, and especially states of debility of a congenital character and during convalescence from exhausting diseases, that furnish the **indication** for this procedure. If at this point, I shall to a certain degree give only an outline of the nutritive disturbances amenable to sun baths and electric light baths, this will be owing to the fact that we are in this connection still dependent upon an empiric rather than upon a rationally comprehensible explanation of our observations.

That enfeebled innervation can be relieved by sunlight and electric light; that the movement and the constitution of the blood can be influenced thereby; that all the functions of metabolism are stimulated; that certain injurious influences—I may refer here again to the influence of chemical rays upon micro-organisms—can be removed directly or indirectly; that superficial disease dependent upon micro-organisms, such as divers diseases of the skin, as lupus and the like, can be affected favorably; that it will be possible to increase elimination through the various emunctories—these facts will certainly establish our sun baths and electric light baths as an empirically justifiable remedial agency. I have been able to observe quite specific effects as the result of the judicious employment of sun baths, and also from the use of electric incandescent-light baths in cases of anemia, chlorosis, and scrofulosis. It is particularly scrofulosis that, according to the view of other physicians also, can be favorably influenced by sun baths and light baths. Rheumatic affections; disorders due to exposure to cold; gout, as numerous trustworthy reports show; nephritis; obesity; some forms of neuralgia; and, what perhaps appears more comprehensible at the present time, various forms of autointoxication and the neuroses dependent upon them, may be influenced by phototherapy, in part symptomatically, and in part by action upon the cause. I have personally observed tuberculous ulcers disappear as a result of systematic exposure to the sun. Naturally my observations are not simple, inasmuch as I employ other agents of a thermic, mechanical, and dietetic character in my course of treatment. Among the most interesting facts is the employment of phototherapy in ophthalmology. I may call attention to the publication of Daxenberger in the "Wochenschrift für Therapie und Hygiene des Auges." This writer attributes to light baths especially a powerful sorbefacient effect in the presence of chronic inflammations of the sclera, the iris, the choroid, the retina, and similar affections.

The foregoing are the principal effects of unmodified light rays, in which heat, light, and chemical rays act in association. To the future must be left the determination of the mode of action of the different classes of rays.

The **bactericidal properties** of the **chemical rays** promise much in the treatment of superficial bacterial affections of the skin. Finsen's treatment of lupus belongs to this category. On the other hand, the **exclusion of the chemical rays** has been successfully practised by Finsen in the treatment of variola. In more than 70 cases this simple method of treatment in cases of variola by exposure to red light prevented suppuration and suppurative fever, as well as the development of cicatrices; and thereby the whole disease was transformed into a comparatively mild one.

The **symptomatic indication** for the treatment of various diseases by means of light baths may be found if it be borne in mind that profuse perspiration without excessive acceleration of circulation can be brought about in the electric light bath. This renders possible its employment in the presence of heart disease, when there might be objection to the employment of ordinary diaphoretics. Some dyscrasic processes demand powerful stimulation of definite secretory organs. Some good effects of the incandescent-light bath for which other explanations have been given may be attributable to this fact. Thus various results considered as specific effects are to be attributed only to the symptomatic effect.

In conclusion, it may be said that the whole question is still the subject of heated discussion. It has not yet been cleared up in all directions, and extended investigation will be required before the indications and counterindications can be laid down with precision. That, however, the entire field is most promising is evident from the fact that we have to do here likewise with a **natural vital stimulus** of great potency. It would be presumption to attempt at the present time to lay down the limitations of this powerful agency. The matter is deserving of thought and labor on the part of the best investigators.

PART II

THE TECHNIC AND THE METHODS OF HYDROTHERAPY

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PART II

THE TECHNIC AND THE METHODS OF HYDROTHERAPY

CHAPTER I

GENERAL BATHS

General Considerations. Precautionary Measures. The High Bath. The Plunge Bath. The Half-bath. The Ziemssen Graduated Bath. The Cold Full Bath.

General Considerations

The technic of hydrotherapy has, it is true, attained a high state of development; nevertheless the description of any of its procedures must not be viewed as the statement of an inflexible prescription. The physician familiar with the physiologic effects of thermic and mechanical measures will himself devise the technic for his therapeutic applications, selecting the procedure appropriate in the given case from among those familiar and described by authors, or modifying these extemporaneously in accordance with necessity. His prescription must nevertheless in every instance have a definite purpose and be expressed in precise terms.

The technic to be described here is that practised by Winternitz; it is at present sufficient for most therapeutic requirements and was based upon the technic of the older hydrotherapeutists, especially that of Priessnitz.

The most important consideration in the technic is that the 'measure of stimulation' (Winternitz)—that is, the temperature, the duration, and the mechanical elements (water-pressure, friction, etc.), and not the form—must be the distinguishing feature of the procedure adopted. In other words, by varying these elements, different effects can be produced by the same form of procedure and similar and even identical effects with a variety of procedures; for whatever in the difference of routine pursued, it is possible, after all, to vary only the degree and the quality of the resulting irritation.

Precautionary Measures.—Before every **general cool or warm application** it is customary to cool the head thoroughly, and to [illegible] it with a cool covering, which is kept in place during the procedure. The reason for this lies in the fact that on applying the stimulation of cold to the surface of the body, the blood expelled from [illegible] intestinal vessels), affected directly or reflexly, [illegible] into other parts of the body. Winternitz designates this [illegible] as "retrograde hypostatic congestion". The [illegible] of the vessels of the head may be a source of [illegible], and under certain conditions (arteriosclerosis [illegible]) as well. Provision against this manifestation [illegible] from which exception is made when cooling of the head is attended with unpleasant subjective sensations, or when [illegible] is considered not injurious or even useful—as [illegible] of some cases of chlorosis, etc. In many cases [illegible] the neck (ice collar) may suffice.

In many **hot applications** also, cooling of the head is necessary. [illegible] the cerebral condition to be prevented is not [illegible] of hypostatic congestion, but of fullness of the vessels and true congestion, as a result of overheating. Ice collars here render [illegible] than when cold applications are made.

It may further be mentioned as a general rule **that after the application**, unless it be specifically prescribed otherwise, the patient should be rubbed thoroughly dry. He should feel comfortably warm and should then complete his reaction (warming) by movement.

The **principal methods** and applications used in the practice of hydrotherapy, all of which may be general or partial, or even strictly localized in their use, are (1) **baths**; (2) **douches and affusions**; (3) **wet and dry packs**; (4) **steam, hot-air, and electric light baths** (the last-named two being mentioned here because they are used in combination with hydriatric measures strictly so called); (5) **compresses**; (6) **bags and coils** for **hot water, cold water, and ice**; (7) **irrigation.** With most of these, **manipulations** by attendants and **movements** of the patient are associated. In all, the elements already referred to,—namely, temperature, pressure (intensity), quantity, and duration,—as well as the character, force, and duration of the manipulations, must be prescribed accurately and with careful individualization; as has been so forcibly insisted upon by Baruch in his admirable treatise.[1]

[1] "Hydrotherapy," p. 404, New York, 1899.

I. BATHS

We distinguish (1) general and (2) partial baths.

GENERAL BATHS

The general baths comprise (*a*) the **high bath,** (*b*) the **plunge bath,** (*c*) the **half-bath,** and (*d*) the **full bath.**

The High Bath

This is a form of tub-bath in which the water reaches above the shoulders of the seated patient. The temperature of the water should be high—from 32° to 38° C. (89.6° to 100.4° F.); the duration of the bath should be rather long—from five to twenty-five minutes; and the mechanical manipulations are confined to a minimum. The patient is gently rubbed, or rubs himself gently, without materially changing the semirecumbent posture. The high bath is wholly a **sedative measure,** and is employed in cases of erethistic neurasthenia; of hysteria; in the presence of marked diffuse nerve-pain (polyneuritis, tabes); for the relief of the marked itching attending disease of the skin—in which case mucilaginous substances may sometimes be added; and, finally, as a hypnotic. When in the course of hydriatric measures a condition of heightened nervous irritability, sleeplessness, etc., develops—'nervous reaction'—high baths are employed until sedation occurs.

The Plunge Bath

This form of bath, in contradistinction from that just described, is cool (or cold—from 22° to 15° C. (71.6° to 59° F.)—and brief—one or two minutes. The water reaches about half the height of the tub, and the patient should engage in active movement. The brief irritation induced by the cold generally gives rise to rapid and good reaction, and the bath therefore has a **stimulating effect** upon innervation, circulation, and function in general. The patient acquires a sense of warmth. The effect can be greatly increased by previous warming of the patient's body and by using water of the lower temperatures. The abstraction of heat by this method, in view of the good reaction, is slight. Heat-dissipation may be somewhat increased, but this cannot lower the temperature materially because heat-generation also is increased by reason of the stimulating influence of the cold.

Cool and cold plunge baths are **indicated** whenever general stimulation is desired, without material abstraction of heat; and they constitute a good stimulating measure by reason of their brief, active irritative effect through cold. The effect, as stated, can be materially augmented by previous warming, as the temperature-differentiation is then greater. These baths may even be employed for hypnotic purposes, as the resulting reaction is generally followed by sedation. When it is desired to induce sleep in this manner, it is advisable not to dry the patient, but to place him in bed while still moist, and to permit him to dry between the sheets.

The Half-bath

This measure is much employed, and, on account of the readiness with which it may be modified, meets a considerable number of indications.

The **mode of application** is as follows [1]:

The head being first cooled and the chest sprinkled with water, the patient enters (or is lifted into) the tub, in which, with the bather in the sitting posture, the water should reach to the level of the umbilicus. After an initial immersion to the level of the shoulders, the patient assumes the sitting posture while the upper portion of the body is actively douched (Fig. 1). Subsequently he assumes a semirecumbent dorsal posture, when friction is applied successively to the chest, the abdomen, and the extremities (Fig. 2). In typhoid fever, however, the abdomen is not manipulated. After repeated douching the bath is terminated. Douching with the water of the bath, and even with colder water, is especially indicated in depressive nervous manifestations such as stupor or coma.

Effects.—The **action** of the half-bath varies in accordance with the mode of administration. On entering the bath there results general stimulation from the cold, and reaction must be brought about or increased through the mechanical manipulations. In general, the following considerations should be borne in mind in connection with the mode of action: A greater stimulating effect is produced by cool baths of short duration with considerable mechanical manipulation; while more protracted baths at a higher temperature with little mechanical manipulation are less stimulating, and may even have a sedative effect. The quantitative heat-abstraction depends on the reaction or the volume of blood passing through the skin; from which consideration, the great importance of the reaction is apparent.

Methods and Uses.—The **mode of employment** of the half-bath and the **indications** therefor may be summarized as follows: Brief, moderately cool half-baths—from 28° to 20° C. (82.4° to 68° F.) for three or four minutes—serve as a **hygienic** measure; in the case of full-blooded patients, baths of somewhat longer duration

[1] The illustrations, figures 3 to 6, of the method of bathing in typhoid fever commonly used in the editor's service at the Polyclinic Hospital, Philadelphia, differ in some particulars from the description in the text. The subject will be discussed more fully in the Appendix.

FIG. 1.—HALF-BATH WITH AFFUSION.—(*Polyclinic Hospital, Philadelphia; German Method.*)

FIG. 2.—HALF-BATH WITH FRICTION.—(*Polyclinic Hospital, Philadelphia; German Method.*)

may be employed, and vigorous friction applied as soon as the general reflex irritability, which serves as a guide for the degree of stimulation, permits. Used in this manner half-baths constitute a good general, stimulating, refreshing measure, and may be employed as such under all conditions.

In disease of the central nervous system (diseases of the spinal cord) half-baths of a somewhat higher temperature (from 32° to 27° C.—89.6° to 80.6° F.) are indicated. The amount of mechanical manipulation should only be sufficient to make the patient comfortably warm in the bath. In the choice of a temperature within the limits named the preponderance of irritative or paralytic symptoms should be the guide. In the presence of the former the temperature should be higher, and the duration longer; and in the presence of the latter, the temperature should be lower and the duration shorter. Thus, for instance, to relieve the lancinating pains in a case of tabes dorsalis **warm baths** will be employed, and for paralytic symptoms and marked ataxia, **cool baths** of **short duration.** In functional neuroses and psychoses the existing degree of irritability will serve as the guide.

In gastro-intestinal affections the **dietetic half-baths** just mentioned are employed, but when atonic states and circulatory disturbances in the abdominal cavity exist, a modification is practised, in so far as the half-bath is combined with **high douches** to the abdomen. An assistant scoops water with a large dipper from the tub and pours it from a considerable height (from 1 to 1 ½ meters—3 to 4 ½ feet) upon the abdomen of the patient. This combination of thermic and mechanical stimulation ('thermic massage,' Winternitz) has a good effect.

In infectious diseases, as in fever generally, the half-bath has to meet a number of indications; it is believed to abstract heat, to strengthen the action of the heart and to overcome circulatory weakness, to improve conditions of nervous depression and muscular weakness, and to have a favorable effect upon gaseous interchange, metabolism, and diuresis. As a matter of fact it is capable of exerting a good influence in all of these directions.

In general, **temperatures** of 7° or 8° C. (12.6° or 14.5° F.) below that of the body are selected for the first baths; thus, from 32° to 30° C. (89.6° to 86° F.), the water being cooled 2° or 3° C. (3.6° or 5.4° F.) while the patient is seated in the bath. Subsequently, lower temperatures (down to 20° C.—68° F.) are employed and continued so long as the body-temperature inclines to an ascending type. Rarely is a bath temperature below this made use of, and then only when states of profound depression appear to render necessary the marked stimulation of the low temperature. When the body-temperature again assumes a declining course, the temperature of the bath is again increased until it reaches that of the first baths. Baths of a higher temperature will be required when the patients are greatly stimulated or excited by those of a low temperature. Often, especially in the presence of fever of short duration, lasting for a few days, it is not at all necessary to depart from the higher temperature of the initial baths. The variations in the temperature of the bath mentioned refer rather to intense fever of long duration, as typhoid fever. (See also Appendix, pages 508 to 512.)

The practice of giving the patient a **warm drink**, with or without alcohol, or the latter alone, before the bath, should be omitted only in the case of strong patients. The reactive power of the patient appears

FIG. 3.—LIFTING PATIENT INTO TUB.—(*Typhoid Fever, American Method.*)

to be increased by this procedure, and the action of the heart is undoubtedly strengthened. Warm drinks (milk, tea, coffee) or alcohol given even during the bath are useful in protecting the patient against chilliness.

The **duration** of the half-bath in cases of fever will be determined as follows: For purposes of observation, and to avoid abruptness in beginning, short baths of from three to six minutes are at first employed; gradually the duration is increased, so that in cases with intense fever the bath may be continued for from twelve to fifteen minutes. As a matter of course, individual peculiarities may render necessary wide variations in this connection.

Every patient shivers on entering the bath. This chilliness is neutralized by vigorous rubbing and douching, and as soon as reaction has developed, the heat-abstracting effect of the bath sets in; the well-flushed skin being capable of giving off considerable amounts of heat.

In Ziemssen's method of bathing, which will be discussed later, a second chill is induced, and even Brand believes that the antipyretic bath should be continued until a second chill occurs. In our method the second chill is unconditionally to be avoided, and the patient should be removed from the bath as soon as he becomes chilly notwithstanding vigorous rubbing. As a rule, baths of from ten to twelve minutes' duration will suffice, even in the presence of intense fever and severe infectious diseases; in the case of robust individuals the bath may be continued for as long as twenty minutes.

The **frequency** of the bath will be governed in accordance with various considerations. It will generally be observed that immediately after the bath the febrile temperature declines more or less (1° or 2° C.—1.8° or 3.6° F.). The reduction in temperature may persist for a variable time; as a rule, however, it will be found that after a good cooling bath one or two hours elapse before the previous temperature is again attained. Nevertheless it may occur in severe fever that the temperature again rises to a high level in the course of an hour or even a still shorter time. In practice it has been found to be a good rule that the patient should be bathed as soon as the axillary temperature reaches 39° C. (102.2° F.). In general, this rule may be observed, but it has certain drawbacks, inasmuch as, on the one hand, other indications may be present which may render necessary the repetition of the bath, and, on the other hand, a strict observance of the rule may at times bring about an undue frequency of bathing. At the beginning the patient is bathed twice or three times a day; later the frequency is increased in accordance with circumstances, so that in the course of twenty-four hours so many as seven or eight baths may be given; although even in severe cases from four to six baths during the day, and one or two during the night, will completely suffice. In addition to high temperature, conditions of debility and depression involving the nervous system—stupor, coma, delirium—and the circulation—weak heart-action, marked dicrotism—are **indications for the repetition** of the bath. **Undue frequency** of bathing is equally injurious with unduly low temperature, because the cumulation and increase of the stimuli give rise to a pathologically increased reaction. The stimulation of the cool bath and of the rubbing also excite the processes of heat-production to increased activity; and we have often observed that frequently repeated cold baths not only do not reduce the febrile temperature, but may even cause it to rise. The nervous system responds to such cumulative and increased stimuli with states of marked excitement—great restlessness, delirium, carphologia (versatile nervous fever artificially induced). The occurrence of such states of excitement may necessitate immediate elevation of the temperature, or suspension of the bath-treatment for a half or even an entire day, or the substitution of other measures for the half-bath. On the other hand, great weakness or profound nervous

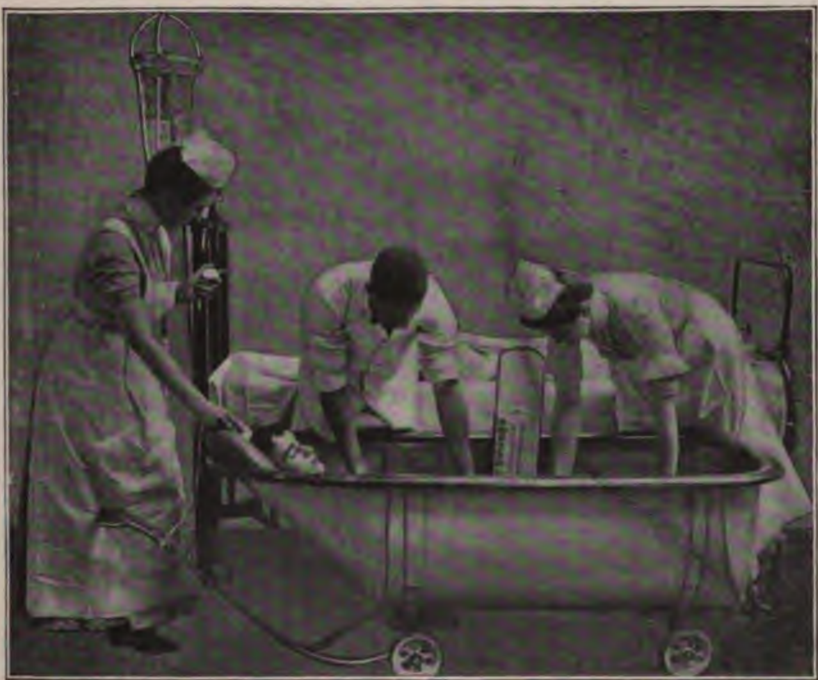

FIG 4.—RUBBING THE PATIENT IN THE TUB. COLD DOUCHES TO HEAD AND SHOULDERS. (Thermometer Exaggerated to Show its Presence.)—(*Typhoid Fever, American Method, Polyclinic Hospital, Philadelphia.*)

depression may necessitate frequent repetition of the bath within a short time without reference to the occurrence of possible states of excitement.

After the half-bath it is customary to dry the patient and place him in bed. (See Figs. 5 and 6.) Brand and many others followed the practice of removing the patient from the bath and placing him upon a linen sheet spread upon the bed, and permitting him to lie, well covered by the sheet, without being dried. The subsequent evaporation that takes place increases still further the dissipation of heat from the periphery in a short time, it is true, but permits the temperature to rise again rapidly. This procedure, however, is eminently sedative, and is especially indicated in the presence of violent cardiac action, which is not sufficiently corrected by the half-bath. With us the patient after the half-bath is often placed in a **chest compress**, a large cool compress which covers the trunk and prevents the elevation of temperature for a considerable time. It is, in any event, advantageous to make use occasionally of each of these three methods, the choice being determined by the conditions in the individual case.

FIG. 5.—LIFTING PATIENT INTO BED AFTER TUBBING.—(*Typhoid Fever, American Method, Polyclinic Hospital, Philadelphia.*)

The Ziemssen graduated bath belongs also in this category. Ziemssen has the patient sit in a bath the temperature of which is 5° or 6° C. (9° to 11° F.) lower than that of the patient's body, and, in addition to vigorous chafing, permits the addition of cold water at short intervals until the temperature of the bath is reduced to about 20° C. (68° F.) in the course of ten or fifteen minutes. The duration of the entire bath is from twenty to thirty minutes, until the patient does not cease to shiver in spite of vigorous friction and affusion. He is then removed and placed in a previously warmed bed.

The bath is far more efficacious in its antipyretic effect than the cool baths of short duration. There will be observed a decline in the temperature of so much as 2½° C. (4.5° F.); but the stimulating influence upon the vascular and the nervous systems is wanting, and depression is often more serious than even a considerable elevation of temperature.

It is possible also to induce a marked revulsive effect by means of one or two baths, if the water is abruptly cooled from 35° C. (95° F.) to 22° C. (71.6° F.) by the sudden addition of cold water, or by giving alternately baths at different temperatures in two

FIG. 6.—DRYING THE PATIENT AFTER TUBBING. ICE-CAP TO HEAD; HOT-WATER CANS TO LOWER EXTREMITIES.—(*American Method, Polyclinic Hospital, Philadelphia.*)

tubs placed side by side. Vinay has described an apparatus permitting the removal of water from the tub by means of large discharge openings, and the immediate addition of previously prepared water of other temperature through a lateral opening. The apparatus is complicated, and can readily be replaced by a more simple procedure. **Alternating half-baths** are **indicated** wherever a general revulsive effect is desired, especially in cases of neuroses and neuralgias.

Counterindications for half-baths scarcely exist, in view of the readiness with which the method can be modified. Half-baths of considerable duration may not be employed when abstraction of heat is forbidden, as, for instance, in conditions of great weakness, under which circumstances the giving of the bath is both difficult and dangerous; and in collapse with subnormal temperature. Every variety of half-bath is interdicted during a chill and when hemorrhage is taking place.

The Cold (Full) Bath

In a reservoir of from 1 ½ to 2 meters (4 to 7 feet) long and wide, and 1 ¼ meters (4 feet) deep, that is to say in a very large tub, the water should be kept at a low temperature (from 8° to 12° C.—46.5° to 53.6° F.) by means of constant addition and removal. The duration of these baths is exceedingly brief, from one-half to at most one minute, and the patient is directed to submerge himself in the water once or twice, and to engage in active movement. Preliminary careful cooling of the head is indispensable. The **action** depends upon the intense stimulating influence of the cold upon the entire surface of the body. The reaction following the initial marked stimulation is in most cases rapid and adequate; the skin becomes reddened, circulation and respiration are powerfully stimulated, even during the bath; the cutaneous vessels become dilated, so that the bath, though brief, abstracts a certain amount of heat. These baths are among the most powerful measures in the domain of hydrotherapy. They are not often employed alone, but rather in combination with heat-conserving and heat-producing measures (hot pack, sweat chamber, etc.). The patient may be permitted to pass directly from the heat into the full bath, when an extremely intense stimulus is desired—providing the vascular system is intact. Under other circumstances it is advisable to prepare the previously heated body for the full bath by a tepid application—for instance, by means of a half-bath or a douche—and to employ the full bath as a final most intense stimulus. An especially marked antipyretic effect can be induced by permitting the patient to step from the full bath into a half-bath of not too low a temperature (from 16° to 20° C.—60.8° to 68° F.). This bath will feel tepid after the full bath, and render possible a considerable reduction in temperature.

Indications.—Cold full baths are employed when metabolism is retarded, in states in which excretory activity is to be greatly increased, especially in obesity, in syphilis, in some cases of gout, in scrofulosis, in chronic metallic poisoning, less commonly in diabetes, and, without combination with warming procedures, in tuberculosis. The cold full bath without previous warming of the patient is highly lauded by Aberg in tuberculosis; it is claimed that pulmonary hemorrhage or other complications have never occurred during courses of treatment by this procedure.

A **counterindication** is found in all states of debility of any considerable degree, and in states of exhaustion.

CHAPTER II

PARTIAL BATHS AND OTHER PROCEDURES

The Occipital Bath. The Elbow-bath. The Hand-bath. The Foot-bath. The Sitzbath. The Cold Rub. Ablutions. Douches and Affusions.

PARTIAL BATHS

This group includes (*a*) the **occipital bath,** (*b*) the **elbow-bath,** (*c*) the **hand-bath,** (*d*) the **foot-bath,** and, finally, (*e*) the **hip-bath** or **sitzbath.**

The Occipital Bath

The head of the patient, who is in the horizontal position, is immersed in a basin resembling a shaving-dish, into and out of which water at ordinary temperature flows continuously. The duration of the bath is from five to ten minutes. The **mode of action** has not been thoroughly investigated, but experience has shown that the bath is capable of exerting a reflex influence upon the nervous system through the medulla oblongata, and it is **employed** to relieve anemic headache; but much more commonly in states of sexual excitement (pollutions, vaginismus); in cardiac neuroses; and in nervous asthma. A simplification of the method consists in cooling the occiput by means of a suitable coil. (See Figs. 7, 8, and 9.)

The Elbow-bath

Immersion of the elbow-joint in (running) cold water,—8° to 14° C. (56° to 57° F.),—the forearm being supported on a rubber pillow. The duration is from ten to twenty minutes.

Action and Indications.—The action of this procedure depends on the tense contraction of the brachial artery, which diminishes the blood supply to the peripheral parts—forearm and hand; and on the anesthesia induced in the distribution of the ulnar nerve by overstimulation. The **indications** are limited: inflammatory processes in the forearm and hand, such as phlegmon and panaris; neuralgia and neuritis of the trunk and branches of the ulnar nerve.

Hand-baths and Foot-baths

The hands or the feet are immersed in water in suitable basins or small tubs, the water being maintained at the original temperature by frequent changes or continuous supply and discharge. Both high and low temperatures may be employed, from 38° or 40° C. (say, 100° or 104° F.) down to 8° to 12° C. (say 46° to 54° F.); intermediate temperatures are less commonly employed

Action and Mode of Employment.—The object of these baths is to stimulate remote vascular areas and to exert a revulsive effect—that is, direct derivation. When **hot** hand-baths and foot-baths are employed, marked dilatation of the vessels soon results; when **cold running baths** are employed, the dilatation must be induced through reaction, which is encouraged by vigorous **rubbing.** The bath is continued until the feet in the water become intensely red. Cooling of the head is indispensable until the reaction in the extremities has set in. Subsequently the decongestive effect is evident both subjectively and objectively. The reflex effects have been determined

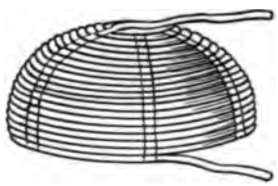

FIG. 7.—HEAD-COIL READY FOR USE.

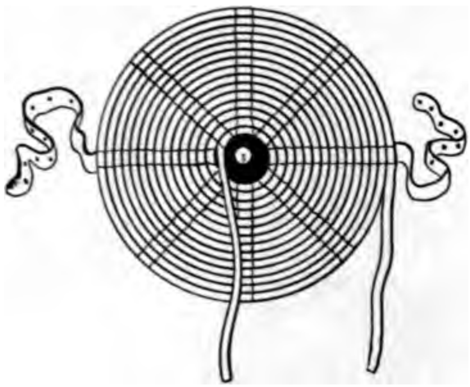

FIG. 8.—HEAD-COIL FLATTENED.

empirically, being exerted from the hands upon the innervation of the thoracic organs (heart and lungs), from the feet upon the entire abdominal and pelvic circulation, as well as upon the meningeal vessels. Marked peristalsis, uterine contractions, and spasm of the bladder may also be induced reflexly.

The **indications** are obvious from what has been stated, but are generally confined, in spite of the theoretic possibility of extensive employment, to states of congestion and hyperemia, as meningeal irritation, headache, angioparalytic migraine. **Hot hand-baths** and those of **alternating temperatures** are employed occasionally with success for the relief of asthma and angina pectoris; **foot-baths** of a similar character may be used as emmenagogues; Habitual coldness of the extremities, as well as sweating of the hands and the feet, may be successfully treated by the systematic employment of cold baths and those of alternating temperature. The decongestive effect of foot-baths just mentioned permit their employment either hot or cold for hypnotic purposes.

These measures are **counterindicated** in cerebral anemia, and cold foot-baths especially in cases of irritable bladder and of uterine colic.[1]

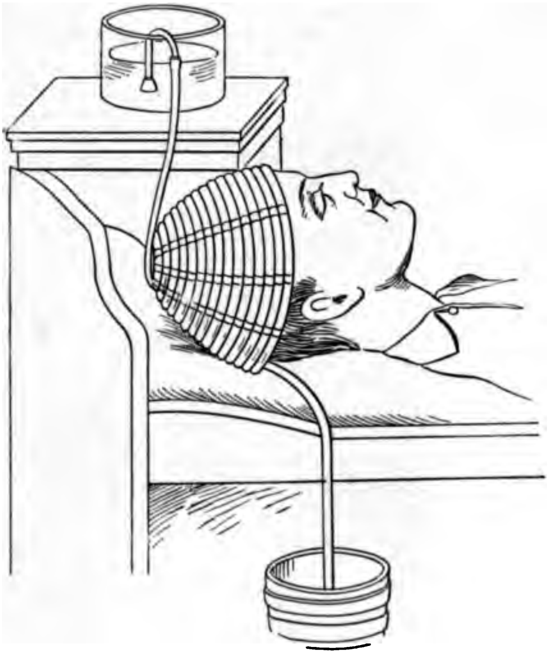

FIG. 9.—HEAD COIL IN POSITION.

Sitzbaths

Sitzbaths or **hip-baths** are taken in the well-known tubs of wood or zinc (Fig. 10). The amount of water necessary for adults is from 20 to 25 liters (5 to 6 gallons); that is, about enough for the water to reach the level of the patient's umbilicus. During the continuance of the sitzbath the patient is carefully covered in order to protect him from becoming cold. The temperature and duration of sitzbaths vary within wide limits. We employ sitzbaths with very cold to very hot water, and of from quite brief to quite long duration.

The **mode of action** of the sitzbath varies in accordance with the temperature of the water and with the duration of the bath, and depends upon reflex stimulation of the abdominal and pelvic vessels. We are taught that the more deeply lying vessels, when a stimulus is

[1] Standing in water up to the level of the ankles, for a period of one or two minutes, and the well-known practice of walking on the grass, or so-called dew-walking, etc., are similar in their mode of action. These procedures were at one time much in vogue, and especially walking on the grass became fashionable as a method newly discovered by Kneipp. Standing in water in the tub may take the place of running foot-baths, and can readily be carried out in any house. Walking in the wet grass has the advantage of associated movement in the open air; but it is very apt to be overdone.

applied, act like those directly affected; that they contract when the application of cold is of considerable duration, and dilate when warm applications are used; and it is also our belief that the vessels contracted as a result of reflex influences become dilated in reaction when the effect of the cold has ceased. If the effect of the cold persists for a considerable time, it will give rise to ischemia of the intestinal wall and of the glandular organs. The movement of the intestines

FIG. 10.—COLD RUBBING SITZBATH.—(*After Kellogg.*)

—that is, peristalsis—also is affected, inasmuch as brief irritation by cold is stimulating, and excites reflex muscular contraction, while **long-continued sitzbaths** exert a paralytic effect on the muscular fibers of the intestine, the diminution in peristalsis being due probably to ischemia, brought about by the action of the splanchnic nerve. **Warm sitzbaths** exert a distinctly sedative, antispasmodic, and anodyne effect.

The **indications** and the **mode of employing** sitzbaths may be summarized as follow:

Cold sitzbaths of short duration, at a temperature of from 10° to 20° C. (50° to 68° F.), and of from two to five minutes' duration, are indicated in all diseases of the abdominal and pelvic organs, attended with anemia, passive hyperemia, motor weakness or insufficiency, nervous depression, and torpid metabolism; also in chronic catarrhal gastro-intestinal disorders, constipation, hyperemia of the large glandular organs, amenorrhea, menostasis, torpid endometritis, anemic leucorrhea, impotence, diminished sexual desire, prostatorrhea and spermatorrhea, atony of the bladder, and fecal incontinence. The reaction, which brings about a flow of blood to the abdomen, has a decongestive effect upon the head, and renders these sitzbaths available for hypnotic purposes.

The **counterindications** for cold sitzbaths of short duration consist in acute inflammatory processes in the abdominal and pelvic organs, in profuse uterine hemorrhage, in marked irritative motor and sensory states, especially in seminal emissions, and in acute diseases of the bladder.

The **protracted cold sitzbath,** at a temperature of from 10° to 20° C. (50° to 68° F.) for from eight minutes to half an hour, induces anemia of the intestinal mucous membrane and lessens peristaltic activity. It is, therefore, **indicated** in acute and chronic diarrhea and even in dysentery and choleriform diseases; in acute inflammatory processes in the abdominal and pelvic organs, especially inflamed hemorrhoids; and in general inflammatory disorders of the rectum and its vicinity. Uterine and vesical colic constitute **counterindications.**

The **tepid sitzbath** (20° to 30° C.—68° to 86° F.; twenty minutes to an hour) exerts essentially a sedative and to a certain degree an antiphlogistic effect, and is employed for such purposes in all acute and chronic inflammatory processses. In constipation with anemia brief sitzbaths, beginning at 86° F. (30° C.) and reduced daily two degrees until 60° F. (15.5° C.) is reached, are sometimes useful. **Warm sitzbaths,** of from 30° to 38° C. (86° to 100.4° F.), are always protracted and are employed to relieve spasm and pain, especially colic of all kinds. Their action as an emmenagogue is well known. Very **hot sitzbaths** of 40° C. (104° F.) and above are much employed in France, especially in the treatment of chronic intestinal catarrh. The temperature is rapidly raised to 42° or 43° C. (say, 108° or 110° F.) by constant addition of hot water. The effects are said to be similar to those of protracted sitzbaths.

THE COLD RUB

Mode of Employment

The cold rub is employed by us in the following manner: A linen sheet 2½ or 3 meters (yards) long and 1½ or 2 meters (yards) wide, is folded lengthwise and immersed in water of the prescribed temperature. The sheet is now partly wrung out, and wrapped about the patient in the following manner (see Figs. 11, 12, and 13): The attendant unfolds a portion of the folded border, about 1 meter (yard) long, with the left hand, approaches the patient, who is in the erect posture, from in front, washes his face and chest, introduces the free border of the sheet in the right axilla, passes the sheet transversely across the chest and abdomen, and through the left axilla around the back, and finally brings the remainder of the sheet over the shoulders so as to envelop the entire body. The end of the sheet is tucked in securely at the neck. Now the mechanical manipulation is begun, which consists in vigorous chafing of the entire body through the sheet.

The **effect** of the cold rub consists in active stimulation, which includes the primary stimulation of the cold affecting the entire body at once, and the mechanical manipulation on the part of the attendant. The purpose of the procedure is to bring about increased activity of the circulation, which not only becomes apparent upon the surface of the body, but, extending from the skin, also involves the entire circulation. At first the cold shock induces deep, quickened respiration and increased pulse-frequency. Both effects soon subside, and after reaction has set in, the distribution of blood is changed and the skin is reddened.

The **duration** of the cold rub cannot be specified. The attendant must continue rubbing until the patient has become warm, and this will vary greatly in individual cases. The stimulating effect is increased by having the patient as warm as possible before the cold rub is begun; therefore the patient is generally rubbed on getting out of a warm bed, or after being previously warmed by some other procedure. As a result of the contrast in temperature, the stimulation is increased and reaction is accelerated. It is further customary to precede the cold rub by brief warming in a steam-bath or hot-air bath. It is a matter of practical importance that debilitated and sensitive patients tolerate a cold rub much better if their feet are warm. Upon this is based our practice to have such patients stand in water at a temperature of 40° C. (104° F.) or to cover their feet with hot cloths during the rubbing. When the cold rub is over, the warm feet are chafed separately. Then the patient is either rubbed dry or partly dry, is placed in bed, and is carefully covered.

The cold rub itself does not exert any special **antipyretic effect**; or at most, only in so far as the skin being in a state of reactive hyperemia gives off an increased amount of heat. If, however, it be desired under these circumstances to effect considerable abstraction

FIG. 11.—COLD RUB. PASSING THE SHEET ACROSS CHEST AND ABDOMEN.

of heat, cold water is again poured upon the sheet in which the patient is enveloped after the rubbing has been completed, and renewed slapping is practised. The freshly moistened sheet then becomes less quickly warmed, and thus abstracts a greater amount of heat from the body. This combination is designated by us '**Lakenbad**' (**sheet-bath**).

The **temperature** of the water that we customarily use for a cold rub is rather low. Naturally, the reaction obtained is the better, the lower the temperature employed. It is not wise to rub patients with

FIG. 12.—COLD RUB. BRINGING SLACK OF SHEET OVER RIGHT SHOULDER.

water of a higher temperature, because a good reaction may then fail to take place on account of absence of stimulation. In the case of a sensitive patient, we begin with a temperature of 20° C. (68° F.) and are generally in a position to employ water at a considerably lower temperature in the course of two or three days, without causing the patient discomfort. It should, however, not be forgotten that the action of a cold rub of brief duration, but with vigorous chafing, is much better than that of a rub with one with tepid water.

Should the sudden stimulation of the entire surface of the body appear excessive, as may be the case in febrile, or otherwise debili-

FIG. 13.—COLD RUB. SHEET IN FINAL POSITION; FRICTION BEGUN.

tated, or very sick patients, a partial rub may be employed—so-called **partial ablution.** This is one of the mildest procedures applied to a patient at Kaltenleutgeben. It consists in rubbing the various parts of the body separately while the patient lies in bed, so that while, for instance, one extremity is being subjected to treatment, the entire remainder of the body remains carefully covered. The shock in this method is naturally slight, but the effects are cumulative, and the total result of a partial ablution is, on the whole, the same as that of a total rub, possibly only slightly less quantitatively.

Indications.—The general indications for partial ablutions coincide with those for the cold rub, and are set forth in that connection.

The most important special indication for **partial ablutions** resides in the ability to estimate, by means of this procedure, the irritability and the capacity of the patient for irritation. It is a fact of great importance that in the practice of these procedures guidance may be obtained as to whether a febrile patient, for instance, suffering from an infectious disease, may be treated with half-baths.

The general **indications** for the cold rub comprise almost all diseases. The procedure often serves as a **dietetic measure**; that is, as a general invigorating procedure, improving the circulation, metabolism, etc. Beyond this, the chief indications are presented by diseases of the circulatory and respiratory organs, by catarrhal conditions of the intestinal tract,—thus, in disease of the heart, lungs, blood-vessels, stomach, and intestines, etc.,—and, further, by disorders of metabolism. Partial ablutions are also readily applicable in the last-named diseases, and the resulting effect is quite favorable.

The cold rub is **counterindicated** in inflammatory disease of the skin, in pronounced general nervous irritability, and in diseases in which marked augmentation of circulation, with increase in blood pressure, is interdicted—for instance, marked arteriosclerosis.

Drip Sheet

A procedure similar to the cold rub is the more familiar drip sheet. According to Baruch, its technic differs from that of the cold rub in that the sheet is not wrung out, but is taken from the water dripping, and wrapped around the patient as shown in the illustrations (Figs. 11, 12, and 13). The attendant applies rapid friction over the sheet, occasionally slapping the surface to increase mechanical irritation. A basinful of water about ten degrees cooler than the sheet water is poured over the head and shoulders two or three times at short intervals, and this is alternated with friction for from five to ten minutes. Baruch insists upon the exact technic. In his experience the effect of the cold rub, in which the sheet is only moist, is more stimulating and evanescent, because less heat is abstracted, while that of the drip sheet is more sedative, and these apparently slight differences are important elements in the production of different therapeutic results.

DOUCHES AND AFFUSIONS

The most characteristic feature of these procedures consists in the circumstance that the mass of water falling from a certain height gives rise to constantly renewed mechanical stimulation. There are **jet, fan,** and **spray douches,** according as the stream of water is thrown upon the body directly, in the form of a fan, or through a perforated nozle, varieties which at the same temperature differ in greater or lesser degree in the amount of stimulation. With reference to the direction of the stream, there are **vertical** and **horizontal** douches, the former generally **fixed,** the latter **movable,** and so arranged that the entire body may be acted upon by them. The temperature employed varies from the lowest to the highest, and the pressure of the water varies in accordance with the character of the orifice or orifices through which it escapes, inasmuch as an interrupted stream itself exerts a lower pressure than an uninterrupted one. A pressure of not less than two atmospheres (about thirty pounds to the square inch, *i. e.*, 60 inches or 1520 millimeters of mercury) suffices for all purposes. A pressure of less than from one to one and a half atmospheres, or one of more than from four to five atmospheres, cannot be employed without a certain diminution in effect, or, on the other hand, without the risk of unpleasant results. The douche, by means of which high and low temperatures are applied alternately to the same part of the body,—that is, a long-continued douche of alternating temperatures,—has received the special designation of the '**Scotch douche.**'

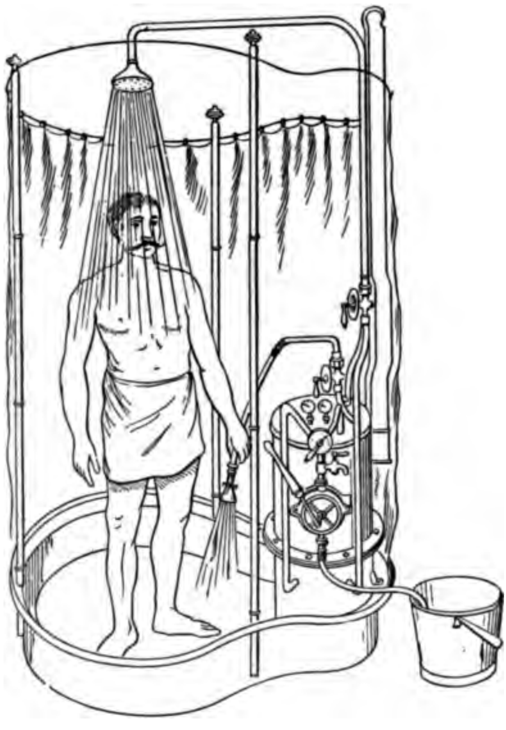

FIG. 14.—RAIN BATH.

Affusions of various kinds are much employed as general and partial measures. Their modification—that is, the application from a greater or lesser height—is within the control of the attendant.

The affusion is regarded by Baruch as an important measure. He applies it by dipping up water at the required temperature—using a basin with a handle—and pouring it with some force upon the upper parts of the trunk and upon the head. In home treatment the affusion is a useful substitute for the douche, if given with force and regardless of wetting the floor, which may be protected with cloths or blankets. The patient should, according to Baruch, always sit or stand in hot water (90° to 100° F.—32° to 38° C.).

Varieties and Mode of Employment.—Among douches, those most employed are (1) the **vertical rain douche**,—rain bath or shower-bath (Fig. 14),—in which the water, passing through a number of small openings, falls upon the entire body; (2) the **movable jet or fan douche** (Fig. 14), by means of which applications can be made to certain parts of the body or to the entire body; (3) the **ascending spray** (Fig. 16), which is arranged in a manner analogous to the rain douche, only directed from below upward; and, finally, (4) the **Scotch douche** just mentioned.

The action of the douche consists in a combination of thermic and mechanical stimulation, in which the latter can scarcely ever be entirely excluded, since the water, as has been mentioned, is always under a certain pressure. The degree of stimulation that is intended may be modified as desired by combining temperature and pressure. If the entire body is treated, the effect is the same as that of every other general stimulating procedure. Parts treated locally will exhibit a local reaction. The most pronounced effect that can be induced locally is brought about by the **Scotch douche**, in which a marked mechanical impression and the stimulating effect due to the contrast of the high and the low temperature are considerable. We employ live steam[1] and cold water for the Scotch douche. In other apparatus warm water and cold water escape from two tubes placed side by side. Both varieties have their advantages and disadvantages. Live steam renders possible a high temperature (up to 90° C.—194° F.). Warm water maintains its original temperature for some time even at considerable distances. By means of the rapid alternation in the application of the high and low temperatures to the same part of the body, the most profound local revulsive effect is brought about that is possible by any local measure. It is employed wherever local circulatory enfeeblement, motor weakness, and accumulation of toxic products are to be overcome.

[1] Before applying the steam douche, the water of condensation that has collected in the tubes must be expelled. Neglect of this precaution is the most common cause of scalding.

Mode of Action.—The mode of action may be summarized as follows: **Cold douches of short duration** at a temperature of

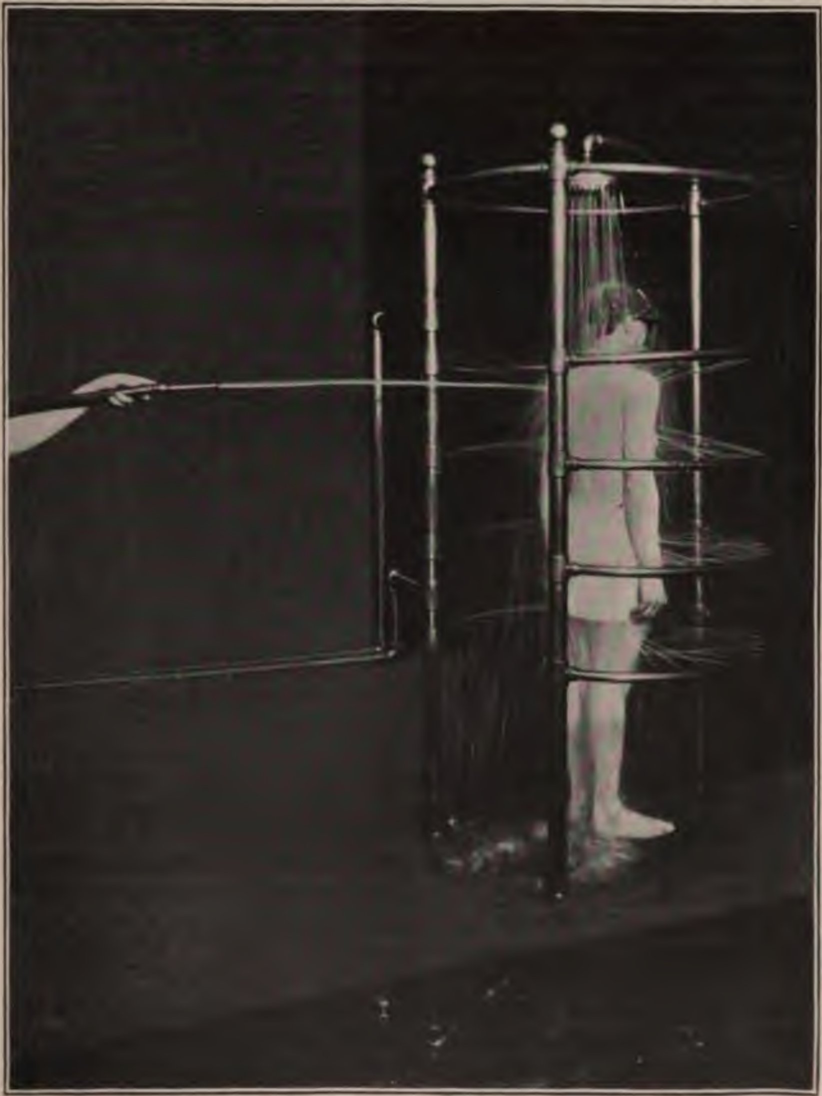

FIG. 15.—COMBINED RAIN DOUCHE, HORIZONTAL JET, AND MULTIPLE CIRCULAR DOUCHE.—(*After Kellogg.*)

from 10° to 20° C. (50° to 68° F.), and up to half a minute in duration, or exceedingly **hot douches,** of from 35° to 40° C. (95°

to 104° F.), act as a vigorous stimulant, cause hyperesthesia of the surface of the body, and increase muscular vigor and electromotive irritability. More **protracted cold or hot douches** have the opposite effect, so long as the pressure is not so great that the effect of the temperature is exceeded by the effect of the mechanical irritation. **Tepid and warm douches** at a temperature of from 26° to 35° C. (78.8° to 95° F.), for from half a minute to two minutes, have a sedative and relaxing effect, and diminish the general tone and the muscular vigor. The same statement is, on the whole, applicable to **partial douches.** Here also the following law may

Fig. 16.—Ascending or Perineal Douche.—(*After Baruch.*)

serve as a guide: Douches of low temperature, of brief duration, and of high pressure, have a more stimulating effect; while those of higher temperature, longer duration, and low pressure, may have a less stimulating, and even a sedative effect.

The **indications** for douches, by reason of the possibility of numerous combinations, comprise almost all kinds of disease. **Cold shower-baths,** at a temperature of from 10° to 20° C. (50° to 68° F.), are employed as a **nutritional measure** whenever profound general stimulation is desired, in part in a manner analogous to the cold rub. The indications here also are almost the same. A greater measure of heat-abstraction can take place if the pressure is reduced and the douche is permitted to continue for a longer time. This necessity may arise when, for instance, the douche is employed for cooling purposes after warm applications. **Tepid rain baths** serve as an invigorating measure for sensitive patients, and, on account of their sedative effect, in the case of nervous persons. Further, they are employed as an **intermediate measure** between hot and cold applications. **Warm douches** are employed only in erethistic cases of neurasthenia and hysteria; they cause slight relaxation, quiet the entire nervous system, and are employed for hypnotic purposes. The **ascending spray** (the patient being seated upon a stool with a central opening of from 25 to 30 cm.) is invariably employed at low temperatures; it is indicated in weakness of the bladder, in states of sexual depression, and in psychic impotence. The **movable jet** or **fan douche** is employed variously in accordance with the part of the body to which it is applied. If the entire body is exposed to its influence, the effect is comparable with that of a general stimulating procedure. **Partial douches,** applied to the nape of the neck, act well in asthmatic states and cardiac neuroses (low pressure). Douches at low pressure applied to the entire length of the vertebral column increase the general reflex irritability, and especially the irritability of the sexual organs, when the temperature employed is quite low. This method has been designated by us '**running irrigation of the back.**' The attendant applies the hose directly to the nape of the neck, permits the water to flow down over the vertebral column, and rubs the back throughout the entire procedure. In functional diseases of the spinal cord, such as spinal neurasthenia or sexual debility, the application is made to the entire spinal column.

Applied to peripheral nerves, the douches are useful, especially in the treatment of paralytic states and neuralgia of various kinds. **Fan douches** are applied to the chest in catarrhal states, for the purpose of stimulating absorption of exudates and facilitating expectoration; to the abdomen in conditions of torpid circulation and muscular weakness of the abdominal viscera; to the hypogastrium and to the inner surface of the thighs to favor menstruation and in conditions of sexual depression; to the feet as a derivative measure analogous to the foot-bath; and to certain joints to favor absorption of exudates. Under all of these local conditions the best effects can be obtained by the application of the Scotch douche.

In **domestic practice** affusions can be given from pitchers suitably elevated; douches and sprays, by means of tubing attached to any convenient faucet, when the bath-room is not fitted with the elegant appliances now so easily obtained.

Carbon Dioxid Douches.—Quite recently the technic of the douche has been improved by an apparatus introduced by Winternitz and Gaertner under the name of '**ombrophore,**' which permits the application of a douche with water saturated with carbon dioxid. The device will be readily understood from the accompanying illustrations (Figs. 17, 18, and 19). The receptacle for the water is connected by

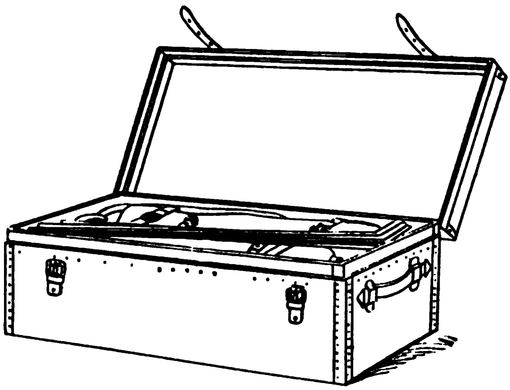

FIG. 17.—OMBROPHORE PACKED.

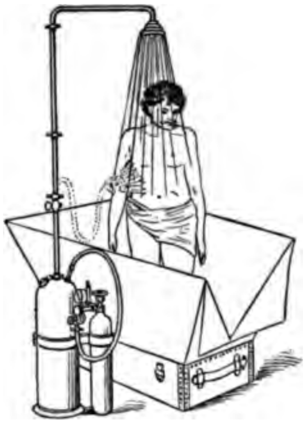

FIG. 18.—OMBROPHORE IN USE.

means of a reduction valve for regulating the pressure with a carbon dioxid tank (Fig. 18). The carbon dioxid not only furnishes the pressure; it is also absorbed by the water, and confers upon the douche a number of advantages. It is not necessary, even when the object is to obtain a good stimulating effect, to employ water at a low temperature, as the carbon dioxid itself also acts as a strong cutaneous irritant; on the other hand, the lowest temperature may be employed without causing discomfort, as the bubbles of carbon dioxid upon the skin cause a sense of warmth. The apparatus is applicable especially in the case of debilitated patients; and naturally whenever douches are at all indicated.

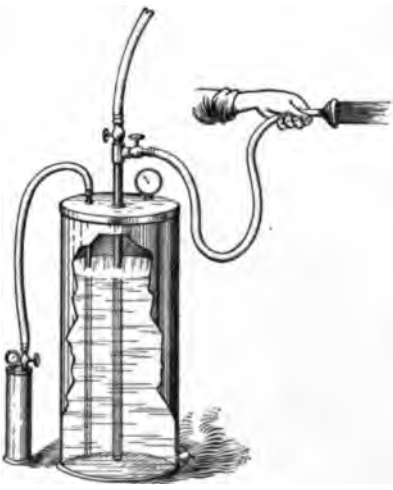

FIG. 19.—CONSTRUCTION OF CARBONIC ACID DOUCHE IN OMBROPHORE.

Recently a number of other methods have been proposed in which certain parts of the body may be heated by means of **circulating hot air, or circulating heated carbon dioxid.** The methods are not complicated, especially those of the latter character, which emanate from the establishment of Dr. Bom and Dr. Herz in Vienna, and in which the carbon dioxid, from a carbon dioxid tank, is driven through an appara-

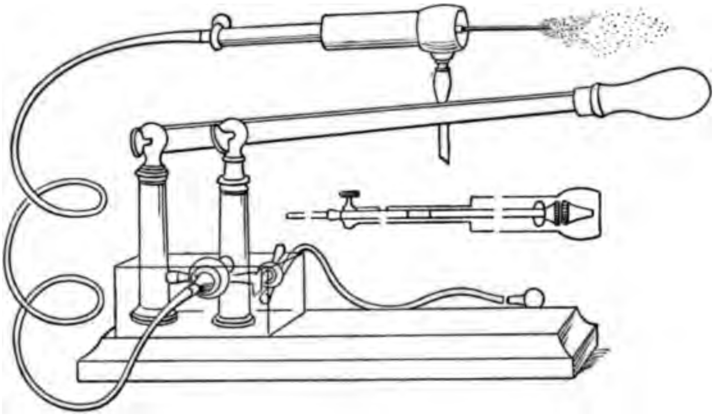

FIG. 20.—FILIFORM DOUCHE.

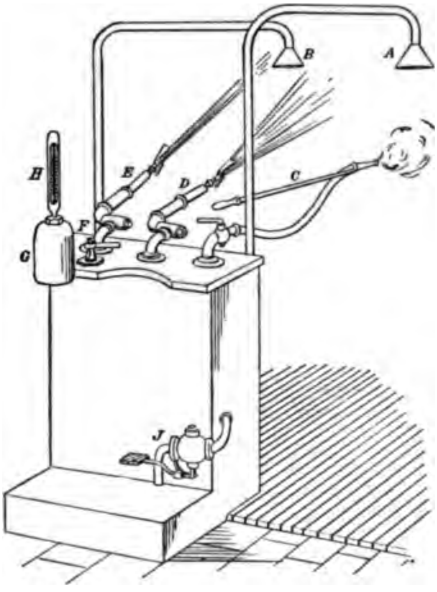

FIG. 21.—WINTERNITZ'S DOUCHING TABLE.

A, Cold shower. *B*, Adjustable shower. *C*, Steam douche. *D*, Cold fan douche. *E*, Adjustable fan douche. *F*, Lever for regulating adjustable douche. *G*, Mixing kettle. *H*, Thermometer. *J*, Foot valve for cold shower.

tus heated by electricity, and the movable nozle can be directed to any desired portion of the body from a greater or lesser distance.

Indications.—These hot-air or carbon dioxid douches do not differ in their mode of action from ordinary steam douches; nevertheless they possess certain technical advantages, and render possible the application of much higher temperatures under greater pressure. Their range of indications extends to all of those diseases in which the Scotch douche is employed, but it comprises also the essentially more subtle manifestations, inasmuch as, for instance, the course of a single nerve, or minute areas that are not accessible to the large Scotch douches,—such as, for instance, certain branches of the trigeminus,—may be treated by means of this fine apparatus.

FIG. 22.—BARUCH'S STATIONARY DOUCHE APPARATUS, SHOWING ALSO CIRCULAR DOUCHE WITH MOVABLE ROSES.

The **douche filiforme** of Lauré (Fig. 20) is an apparatus by means of which a capillary stream of water is driven under high pressure through a hard, yet flexible tube. The stream maintains its compactness for a distance of several centimeters (from 5 to 6 cm.—2 inches), and, acting somewhat like the point of the cautery, at once causes the formation of a small blister. The water penetrates into the subcutaneous connective tissue, and intense redness soon appears about the point of contact. The penetrating stream gives rise to considerable pain, which continues until the penetrating fluid is absorbed, and which may persist in lesser degree for many hours, even for so long as twelve hours. The reaction at the point of application diminishes coincidently with derivation from remote regions. Reflex effects appear in accordance with the site of application, as, for instance, slowing of the action of the heart and of respiration when the application is made to the nape of the neck. The procedure is most frequently **employed** in cases of migraine and of cerebral hyperemia; of irritative states of the meninges (applied to the mastoid process); in cases of spinal irritation (along the vertebral column); and in cases of neuralgia (in the course of the affected nerves).

The **indications** for the **Scotch douches** are included in the foregoing. They are employed especially to effect absorption of exudates (pleurisy, diseases of the joints); in motor disorders of the stomach and intestine; in various forms of neuralgia, especially sciatica; and, finally, applied directly to the genitalia, in the presence of conditions of sexual depression.

Reference may be made, further, to the **portable douche apparatus** shown in figure 14, page 81. The water is subjected to pressure in an air chamber by means of a portable pump, and by this means rain douches and movable fan douches may be applied.

Baruch, of New York, has described a **stationary douche apparatus** (Fig. 22), by means of which the utmost precision can be attained, and which fully meets all the requirements. It permits both the temperature and the pressure to be regulated most accurately, so that applications may be made with scientific precision. Although practical experience shows that the physician in personally applying the douches will make the necessary modifications in accordance with his own observation, even without refined apparatus, nevertheless such devices for securing precision in hydrotherapy are of great importance.

CHAPTER III

THE WET COMPRESS

Cold and Warm Compresses. The Stimulating Compress. Buxbaum's Steam Compress. The Thermophore and Electrothermophore. Head, Throat, Chest, Trunk, Hemorrhoidal, and Genital Compresses. The Abdominal Binder. Winternitz Combination Compress. The Sural Compress. Circular Compresses.

A **wet compress** (Umschlag) consists of a number of folds of linen, raw silk, or other suitable material, more or less thoroughly wrung out of water of suitable temperature, and applied to the body. In general, two varieties may be distinguished: (1) **cold,** and (2) **warm,** while the former are subdivided into cooling, and stimulating or heating.

Mode of Employment.—The cooling—in the true sense of the word, cold compresses—and the warm compresses must either be frequently changed or be kept at the desired temperature by means of the well-known tubular apparatus with circulating water (Leiter's coil), so much used in clinical and in private practice. It is customary with us to **cover** the wet compress with flannel or with a dry piece of linen, partly to prevent loss of heat, and partly to prevent evaporation of water when the application is long continued. It is especially important for the reason first named to cover warm compresses, which, if left exposed to the air, soon become cool; and when stimulating compresses are employed, covering is likewise requisite for reasons that will be more fully discussed later on. It is less necessary to cover cooling or cold compresses, but it is customary to do this also, the manner being a matter of indifference.

Warm compresses are covered with dry, or, still better, impermeable material. In the case of stimulating compresses, the character of the covering is of some importance. They are often covered with impermeable material, but in our practice only with dry material (linen, flannel, etc.), as it has been our experience that the heating effect is not materially better beneath an impermeable, than beneath a good dry covering. Furthermore, a wet compress does not become dry under an impermeable covering, as evaporation is entirely prevented, and, in consequence of maceration of the skin, irritative conditions of this structure may be much more intense and much more frequent. Only certain conditions may render an impermeable covering necessary, and these will be more fully discussed later on.

The frequency with which the wet compress is **renewed** depends upon the purpose for which it is applied. **Cold** and **warm compresses** are renewed, as has been mentioned, with sufficient frequency to maintain the desired temperature; thus, cold compresses are renewed so soon as they begin to be warm, and warm compresses as soon as they have lost an undesirable degree of their original temperature. It is of importance to know, especially in the case of cold

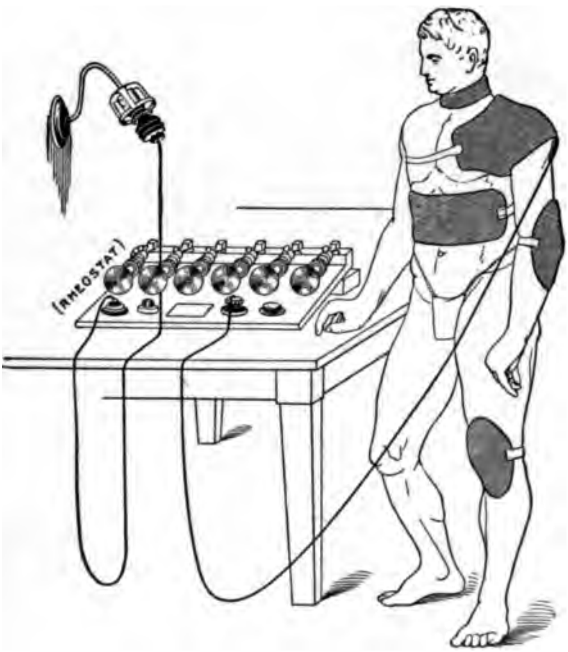

FIG. 23.—LINDEMANN'S ELECTROTHERMIC COMPRESSES.

compresses, that, if not renewed with sufficient frequency, they act less as cooling, and rather as stimulating agents, so that their effect is opposed to the object of true cooling compresses. Thus, an inflammation that it is intended to subdue by the application of cold compresses may be intensified if the compresses are renewed infrequently, and become rather warm. The cooling or heating apparatus previously referred to, obviates the necessity of changing the compress.

With regard to the **stimulating compress**, it may be stated as a general rule that it should be changed as soon as it has become dry. The course of events, when stimulating compresses are employed, is that the covered portion of skin, following the primary stimulation of the cold, exhibits a state of reaction. The compress becomes warm, evaporation takes place through the permeable dry covering, and the compress becomes dry in a shorter or longer time. The compress may become dry within an hour, especially if the skin is hot, as in the case of febrile patients, in phlegmonous conditions, etc.; so many as four or five hours may, however, elapse before this takes place. Apart from individual variations, there may be general and local causes that delay the warming up or drying out of the compress, and in some cases even prevent this entirely. Thus, the wet compress warms up and dries out slowly in individuals with sluggish peripheral circulation, in cachectic persons, and in various exhausting diseases, such as tuberculosis, diabetes, and hyperidrosis. In acute processes a temporary reduction in the cutaneous circulation may occur locally, giving rise to deficient reactive power. Baruch calls attention to an important point. The cold compress (60° F.—15° C.) is regarded by him as very useful in all febrile conditions in which the temperature is above 100° F. (38° C.). This is a stimulating compress if renewed every hour, or, in very high body-temperatures or conditions of stupor or other nerve depreciation, every half hour. The antithermic effect is increased, according to Baruch, by wringing the cloth out less, and he makes it a rule to warn the nurse to allow the compress to remain beyond the period ordered if it is not thoroughly warm.

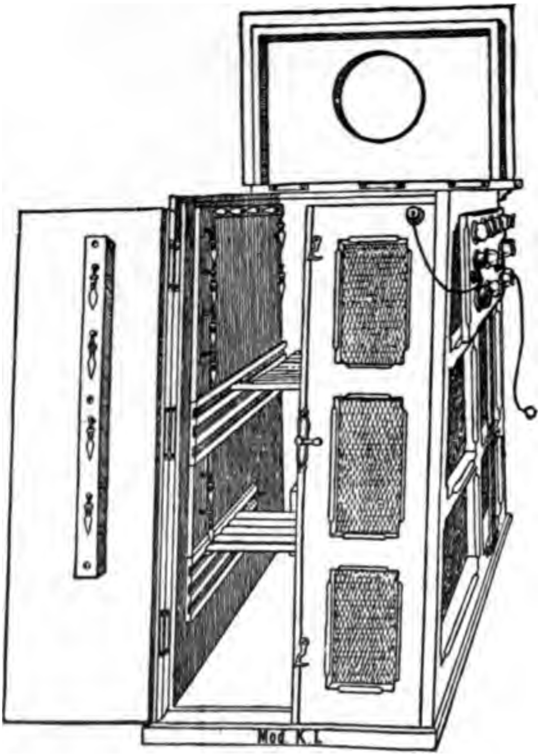

FIG. 24.—LINDEMANN'S ELECTROTHERMIC CABINET.

Winternitz has called attention to the fact that in otherwise healthy persons wet compresses applied to the abdomen become warm more slowly when acute dyspeptic conditions are present. Hence, reaction under such circumstances occurs late or not at all. Patients do not experience the desired sense of warmth, but a sense of chilliness; the skin covered by the compress feels moist and cold, and this feeling persists until the application is removed and the skin is made warm by friction. Under such circumstances an impermeable covering may be employed, but even this does not always suffice to bring about reaction. On the other hand, the local reactive powers may be improved by means of certain **preliminary procedures.** These consist either in dry rubbing of the skin before the compress is applied, or in rapid cold ablution, and it is especially important for the compress to be immersed in water at the lowest possible temperature, for the more powerful the primary stimulation, the better, under otherwise similar circumstances, is the reaction. Should all of these precautions, and even an impermeable covering, not suffice, then the application of cold compresses should be abandoned.

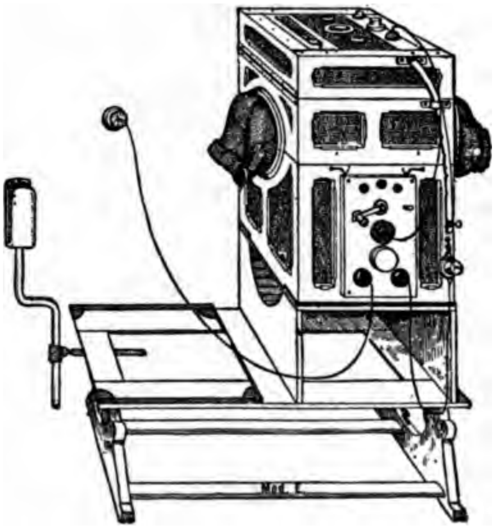

FIG. 25.—LINDEMANN'S ELECTROTHERMOPHORE.

Application of Heat by Means of Compresses and Other Apparatus.—A form of compress used for supplying heat and causing stasis has been advocated by Buxbaum and described under the name of **steam compress.** The selected portion of the body is covered with dry flannel, upon which is placed a very hot compress, and over this another layer of flannel. This is a form of hot compress readily applied in practice.

A considerable number of apparatus are employed for making local applications of heat; among them are the devices recently introduced by Lindemann and shown in the accompanying illustrations (Figs. 23, 24, 25). For a **general electrothermic bath,** the patient sits in the cabinet with his head free; **local** applications are made by means of the electrothermophore. The effects of these electric heating apparatus can be accurately regulated.

Actions and Uses

The mode of action of the wet compress does not require elaborate discussion. The general rules for the action of local cold and warm applications relate also to cold and warm compresses, and for this reason they need not be further detailed, but reference can be made to the section in this article dealing with the physiologic effects of local applications of heat and cold.

In the employment of **stimulating compresses** a reaction is sought, the occurrence of which will be clear from a knowledge of the physiologic processes. When the compress is applied, the peripheral vessels in certain parts of the body and even in the deeper parts contract. The human organism evinces a strong tendency to neutralize the difference in temperature; the vessels dilate, the circulation becomes greatly increased; with the hyperemia are associated its effects—namely, increase in local metabolism and in the local vital processes generally. It is clear that under these circumstances a materially greater effect can be obtained by means of procedures with alternating temperatures, such as cold and warm compresses applied in succession to the same part of the body, just as with Scotch douches.

General Indications for the wet compress are as follow:

Cold compresses (cooling) are employed in the treatment of all local processes dependent upon hyperemia, congestion, or inflammation, and whenever heat, pain, hemorrhage, exudation, or processes of decomposition are to be prevented or corrected.

The **warm compress** is employed to favor the escape of the cellular elements of the blood; that is, to promote suppuration, to increase the local nutritional and vegetative processes, metabolism, and the disintegration and absorption, as well as the regeneration of cells. It is therefore indicated in local anemia, stasis, unyielding exudates and infiltrates; and as a **sedative** and **antispasmodic application** to relieve pain of a noninflammatory character, such as neuralgia or cramp.

It is exceedingly difficult to summarize the general indications for the **stimulating compress**. They may, however, be easily inferred from a consideration of the mode of action. These compresses, as well as compresses of alternating temperatures, may often be employed [illegible] temperatures [illegible] local revul- [illegible] compress less [illegible] an effect similar [illegible] the stimulating [illegible]

VARIETIES OF COMPRESSES

In accordance with the different portions of the body, various forms of compresses are distinguished—namely, **head, throat, chest, trunk, hemorrhoidal,** and **genital compresses**; the **abdominal binder** or compress; the **sural** (calf) **compress**; and long, narrow, **circular compresses** (Longetten).

The Head Compress

The application of compresses to the head is a generally familiar measure. Several layers of linen in the form of a hood or cap serve for this purpose. To keep the compress cool the well-known cooling apparatus shown in figures 7, 8, and 9, on pages 72 and 73 (head coil), are employed.

Indications.—Cold compresses are applied to the head in hyperemia and every variety of congestion involving the head, especially inflammatory states of the brain and of the cerebral meninges; for the relief of hypostatic congestion, in conjunction with all hydriatric procedures, as has been detailed at the beginning of this section. Cooling compresses to the head may be applied continuously for a considerable period of time, even for days and weeks. Experience has shown that, in order to prevent the development of rheumatic disorders, it is advisable to rub the head dry after removing the compress. A **stimulating compress**—that is, a cool compress covered by a dry one—is applied when it is desired to establish hyperemia about the head; thus, in anemic migraine, anemic states of the head, in some cases of neuralgia, especially neuralgia of the first branch of the trigeminus and of the occipital nerve; according to Winternitz, it is also a useful measure in cases of chronic coryza. **Hot** compresses are employed when it is desired to correct spastic states of the vessels as quickly as possible, as in angiospastic hemicrania, particularly if this occurs in a severe form.

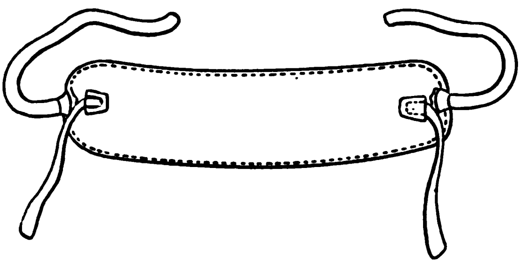

FIG. 26.—COLD COLLAR.

The Throat Compress

The various forms of this application should be generally familiar, as well also as the various **rubber coils** and **ice-bags** that serve as cooling applications to the throat—**cold collars** (Fig. 26). Their employment is confined to diseases in the region of the throat, especially inflammatory processes of the soft palate, laryngitis, glandular affections, and the like.

The following observation appears to me important. In the presence of inflammation of the throat cold is applied locally, as a rule, and always with good results, particularly when the inflammation has not yet attained an especially marked degree of severity. In the latter event, however, as experience has shown, cold compresses increase the pain and exert an unfavorable influence, if any, upon the inflammatory process. The reason for these manifestations is to be sought in the fact that in the highest grades of inflammation with complete circulatory stasis, the circulation cannot be reestablished by means of cold; under such circumstances it is far more advisable to employ **a stimulating** compress. Even a **hot** compress applied for a short time, and replaced by a stimulating compress, renders better service, as by this means the circulation is put in much better condition. The external evidence of these processes is cyanosis of the mucous membranes, such as occurs especially in phlegmonous angina. It is a matter of course, and need not be especially mentioned, that **warm** compresses (fomentations or poultices) are applied to promote suppuration in suppurating glandular enlargement. Chronic inflammatory processes are best influenced by means of the stimulating compress.

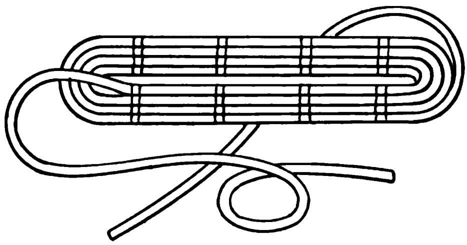

FIG. 27.—THROAT COIL.

The Chest Compress

Cooling compresses, in any desired form, are generally applied only to certain parts of the chest. They are **indicated** in hyperemia, pulmonary hemorrhage, and in inflammatory processes of the lungs and pleura.

Of the commoner forms of chest compress, the most important is the **precordial compress**, which is kept cool by means of the precordial coil (see Fig. 38, p. 109). It is not advisable to apply the precordial coil directly upon the cutaneous surface, but to interpose a thin layer of linen, moistened, and then to cover the whole with a dry cloth. The temperature of the water employed should be low, even down to that of ice-water. Nevertheless, it appears to be better to reduce the temperature gradually; that is, to employ rather high temperatures at first, and reduce them rapidly. The duration of the application should at first be not more than ten or fifteen minutes; later, it may be continued for one or two hours and more. The **effect** of the precordial coil is powerful. The accelerated pulse becomes slower, arrhythmia is corrected, the pulse-wave and vascular tension are increased, and the arterial blood pressure is augmented. The precordial coil appears to be **indicated** in all diseases of the heart, principally in cases of valvular disease of not too severe a degree, of slight disease of the myocardium, of functional arrhythmia, and especially of increased frequency with diminished vigor of contraction, such as occurs most frequently in connection with the cardiac weakness of infectious diseases. The effect is somewhat less certain, but nevertheless attended with satisfactory results, in cardiac neuroses, severe valvular disease, and grave disease of the myocardium. In profound degeneration of the myocardium the heart-muscle may react with paralysis instead of with vigorous contraction to the stimulation of cold, and then the heart, instead of exhibiting strong contractions, becomes irritable and arrhythmic, and on theoretic grounds may be arrested in diastole. This occurs with extreme rarity. Such an unfavorable effect may be exhibited objectively in the occurrence of arrhythmia, in increased restlessness, and eventually in cyanosis of rapid development; in this way the precordial coil serves as an agent in differential diagnosis in cases of profound myocardial degeneration. The application of **heat,** which may be made by passing hot water through the precordial coil, also causes stimulation, and reduces the number of cardiac contractions.

FIG. 28.—CROSSBINDER.

The **stimulating chest compress,** which is applied to the entire thorax, is designated **crossbinder** (Fig. 28), on account of its shape. It is applied in the following manner: One of two linen bandages, 1 ½ to 3 meters (yards) long and 15 to 40 cm. (6 to 15 inches) wide, in accordance with the size of the thorax, is well wrung out of cold water, rolled up, and applied to the chest as follows: Beginning at the right axilla, the bandage is carried over the left shoulder, across the back to the point of origin; it is now brought forward across the front of the chest to the left axilla, and finally transversely across the back and over the right shoulder, terminating on the front of the chest. The second, dry bandage is applied in the same manner as the wet one, and should accurately cover the latter at every point. The ends of the bandages are provided with tapes for securing them to the chest. A woolen shirt or tricot body over the bandage insures its being kept in place.

A large number of bodies and various kinds of shirts have been proposed as **substitutes** for the crossbinder, but their application always requires a certain degree of precision. In the ambulatory service of the Vienna Policlinic (in Winternitz's department) it is our practice to advise patients to apply two towels well wrung out of water crosswise over the chest, and to cover these with two dry towels.

Effects and Uses.—This form of compress has great advantages in the treatment of diseases of the lungs if reaction is sufficient. The principal **effect** consists, probably, in the rest afforded the thorax in the uniformly warm atmosphere, as a result of which the desire to cough is diminished, the viscid secretion in the bronchi softens, and the expectoration as a rule becomes considerably easier. The same favorable effect is usually exhibited in diseases of the pleura, the absorption of the exudate being accelerated. In acute inflammatory diseases the crossbinder is employed only after the fulminant symptoms have disappeared. In ambulatory cases it should be applied only during the night. In bed-ridden patients it should be renewed three or four times daily. Whenever the binder is changed, and, in general, whenever it is removed, the thorax should be well rubbed or dried, especially if, in consequence of enfeebled reaction or perspiration into the bandage, it has not become dry spontaneously. It is well with such patients to follow removal of the bandage in the morning directly by a partial or total rub.

The Hot Chest Compress.—The **steam compress** of Buxbaum, or the hot water coils, previously mentioned, may be employed as the source of heat. Hot chest compresses are, however, applied only to portions of the chest. They hasten absorption and quiet the nervous system; and are employed to promote absorption of viscid exudates; in chronic infiltrations; and in intercostal neuralgia.

The Trunk Compress

Action and Mode of Employment.—These consist in compresses applied by means of sheets, which cover the entire trunk, including the thorax and abdomen (Fig. 29). The moist sheet is covered by a dry one, the margins of the latter extending a short distance beyond those of the former. As the trunk compress is large, it is capable of taking up a large amount of water. It warms up slowly and may therefore abstract a considerable amount of heat. If the compress is changed frequently,—every hour or so,—the abstraction of heat will be quite considerable. **Antipyretic,** that is, frequently renewed, compresses are often employed in the treatment of fever, either in combination with other measures or alone, and under such circumstances they constitute a valuable therapeutic agent.

In many diseases, especially in children, these simple large compresses serve as the sole remedy, meeting perfectly all the requirements. In **applying** the compress the dry sheet is spread upon

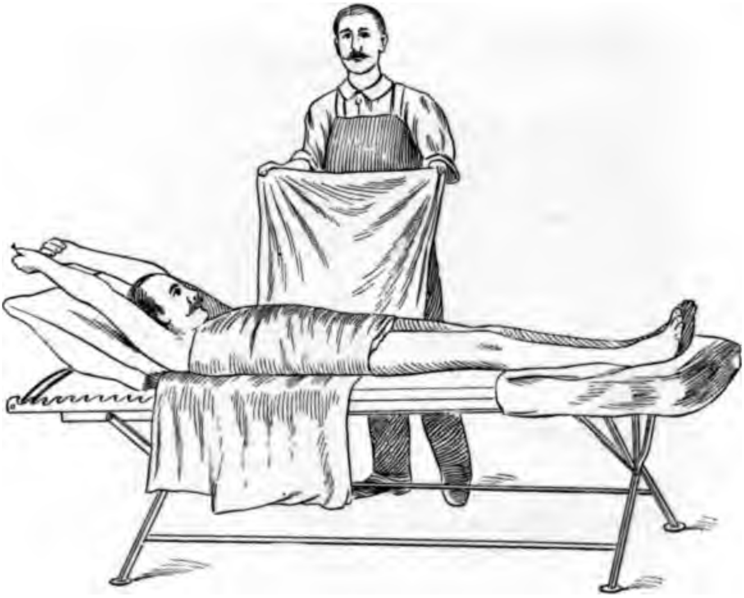

FIG. 29.—TRUNK COMPRESS.

the bed, and in it the wet sheet is then placed. Next, the patient lies upon the prepared compress, and, finally, is enveloped in the moist, and then in the dry compress. It may happen that in the case of profoundly ill patients—as, for instance, typhoid fever or intestinal hemorrhage—movement of the patient, which cannot be avoided in changing the compresses, is either impossible or forbidden. Under these circumstances the compresses may be changed in such a manner that only the dry sheet is withdrawn from beneath the patient, while the moist compress remains applied to the entire trunk, anteriorly and laterally, all but a small portion of the back which, it is true, remains uncovered.

In addition to febrile diseases, the cold trunk compress is **indicated** in all inflammatory disorders of the abdominal and pelvic organs, and in all varieties of hemorrhage from these organs; a low temperature is maintained by means of cooling apparatus of suitable size and shape.

The **stimulating trunk compress** may be permitted to remain in place for so long as four or five hours. In all ambulatory cases it is applied once or twice daily for one or two hours at a time.

Trunk compresses for **local stimulation** are **indicated** in all cases of local hyperemia, in all forms of inflammation of the abdominal

FIG. 30.—THE WINTERNITZ COMBINATION COMPRESS WITH EPIGASTRIC COIL.

and pelvic organs, and in all insidious inflammatory processes, to hasten the absorption of exudates. They yield better results also in cases of acute gastro-intestinal catarrh than frequently changed cold compresses. When reaction occurs, hyperemia of the abdominal organs with anemia of the head results; hence these compresses are serviceable in many cases as a valuable hypnotic.

Hot trunk compresses are applied only to certain parts, rarely to the entire trunk. They are **employed** for the relief of colic, and also for the purpose of promoting absorption of old exudates. A useful combination has been proposed by Winternitz, who incloses within a stimulating cool trunk compress a rubber coil through which circulates water, at a temperature of from 50° to 60° C. (122° to 132.8° F.). The apparatus and the mode of employment are shown in the accompanying illustration (Fig. 30). The application of this **Winternitz combination compress** with epigastric coil is attended with great success in cases of catarrhal and nervous disorders, and of functional insufficiency of the stomach. Nervous symptoms, irritative sensory as well as motor states, such as cardialgia, nausea, flatulence, singultus, and eructation, are especially favorably influenced. This method answers equally well in the treatment of secretory disorders and, when suitably applied, to relieve colic of any variety. Of all of the indications named, that which is most successfully met is, in our experience, obstinate vomiting. The patients gradually become able, under the influence of the compress, to take milk as well as other readily digestible food, and finally more solid nourishment. The patient is laid within the compress, and water is permitted to flow through the coil. After the lapse of perhaps a quarter of an hour an attempt is made to administer nourishment, and then warm water is made to flow through the coil, for at least a quarter of an hour, the patient being permitted to lie in the compress for a further quarter or half hour without running hot water.

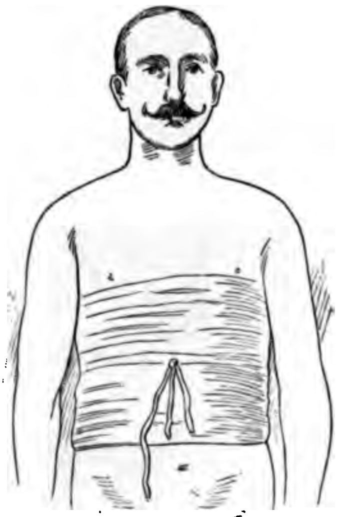

FIG. 31.—ABDOMINAL BINDER.

The Abdominal Binder

The abdominal binder, or **stimulating abdominal compress,** also called **Neptune girdle** (Fig. 31), is applied as follows: A linen bandage 2½ to 3 meters (yards) long and 30 to 50 cm. (12 to 20 inches) wide is wrung out of water for such a length that the wet portion will suffice for one and one-half turns around the abdomen; the bandage is then applied in such a way that the abdomen is covered first by the wet portion and then by the dry portion. The ends are secured by means of tapes. This compress plays quite an extensive rôle in the field of hydrotherapy as a **dietetic, sedative measure.** The binder is generally applied in the evening, and remains in place overnight. When the weather is favorable, the binder may be worn also during the day, and is then changed about every three or four hours. On account of its small size it is of no special significance as an antipyretic measure, but it exerts a favorable influence in diseases of the stomach and intestines, hyperemia of the liver, and venous stasis in the abdominal organs.

The abdominal binder is counterindicated in all conditions of sexual irritation, erections, and emissions. Under these circumstances it should at least not be applied at night.

Hemorrhoidal and Genital Compresses

T-Bandages are used; the horizontal portion is passed around the abdomen, while the vertical portion of the **genital** compress passes

Fig. 33. Circular Joint Compress.—(After Kellogg.)

from before backward, and that of the **hemorrhoidal** compress from behind forward, and is fastened to the horizontal portion. The application of these bandages is limited to hemorrhoidal conditions, inflammatory processes in the vicinity of the rectum, states of sexual debility, and inflammatory disease of the testicle.

Sural Compresses

A bandage from [illegible] meter (yard) long and [illegible] inches) wide is moistened for one-third of its length, and applied to the calves as a **stimulating compress.** As soon as the application becomes warm it exerts a depletory and decongestive effect upon the head; it is employed in hyperemic states of the head, and headache, and as a mild though useful hypnotic. **Wet stockings** may take the place of these compresses if covered by woolen stockings. Compresses applied to the entire lower extremities induce in women a flow of blood toward the genital organs, and are employed in amenorrhea.

Circular Compresses

These are long, narrow compresses (Longetten) wrapped around an extremity or a joint (Fig. 32).

Short strips of linen ½ to 1 meter (yard) long, and from 5 to 10 cm. (2 to 4 inches) wide, preferably old linen that has been frequently washed, are wrung out of water, and applied to joints or extremities in the form of a bandage, the wet layer of linen being covered with cotton batting or flannel and secured by tapes. In this way a **stimulating compress** may admirably be applied to the extremities, and especially to joints. Baruch claims great diminution of the duration of acute articular rheumatism from hourly applications of the circular compress at 60° F. (15° C.), covered with one layer of flannel to permit evaporation. He applies this in conjunction with large doses of salicylic acid ex gaultheria. The effect, in cases of articular disease, is quite satisfactory. The applications are **indicated** especially in acute inflammation of the joints, and in ulcerative processes involving the skin of the extremities. Under such circumstances the wet covering can be moistened repeatedly, without being removed, thus avoiding irritation or injury of the ulcerated parts. The latter form of application is valuable especially in the treatment of burns, inasmuch as the secretions are well removed. In torpid ulcers the application of **hot circular bandages** for many days successively, exerts a favorable effect; being replaced by ordinary circular bandages as soon as a good circulation has been established. It should be noted that when the circular bandage is constantly moistened with cold water for a long time, as may be the case in the treatment of burns, all shock from the falling water should be avoided; and that low temperatures cause considerable pain.

CHAPTER IV

WET AND DRY PACK; BAGS AND COILS; IRRIGATION

The Wet Pack. The Dry Pack. Bags, Coils, and Irrigation Apparatus.

THE WET PACK

A procedure well known and much employed is the wet pack.

Mode of Employment.—It is applied in the following manner: A woolen blanket (bath-robe), 2½ meters (yards) wide, and 2 or 3 meters (yards) long, is placed upon a large couch. Upon this is laid a recently immersed and rather well-expressed coarse linen sheet. The patient, after the head and face have been previously cooled, and a cold turban applied, lies upon the sheet (Fig. 33), which is so wrapped about him as to be smoothly applied to all parts of the body. This is accomplished in the following manner: The patient's arms are elevated above his head and one-half of the sheet is drawn across the body, its upper portion being tucked along the side of the trunk, and the lower portion dipping down between the lower extremities (Fig. 34). The arms are now brought down to the side of the body, and the other half of the sheet is brought around the body so as to include them, and its border is tucked in along the opposite side (Fig. 35). The sheet is so tucked beneath the arms and between the lower extremities that no two surfaces of skin come in contact. Finally the woolen covering is accurately brought together at all points, especial care being taken that close approximation is secured at the neck and shoulders by infolding the blanket (Fig. 36). The patient is now well surrounded with poor conductors of heat (blankets) (Fig. 37).

A large blanket will go around the chest of a person of moderate size one and a half times, and the feet about three times. It is necessary in enveloping the patient to draw the blanket rather firmly in order that the application to all parts of the body be quite intimate, and the mobility of the extremities be in some degree at least restricted. If the blanket is drawn too tightly, however, the patient may be made uncomfortable, and may at times suffer pain. The feet, which often are warmed with difficulty, either are made to react more vigorously by friction before the pack is undertaken, or are left out of the wet pack in such a manner that the moist sheet extends only down to the knee, or a small hot-water bag, or a thermophore, which is applied to the soles, is included in the pack.

Mode of Action.—The effect of the wet pack is as follows: At

FIG. 33.—WET PACK IN READINESS.—(*Polyclinic Hospital, Philadelphia.*)

FIG. 34.—WET PACK; SHEET DRAWN FROM LEFT TO RIGHT; PATIENT'S ARMS ELEVATED.—(*Polyclinic Hospital, Philadelphia.*)

first the stimulating influence of the cold upon the entire body, with all of its consequences, induces deep respiration, acceleration of the action of the heart, and hypostatic congestion of the head, which must be counteracted. As soon as the wet pack has become warm, the **secondary effect** is pretty much the same as that attending a stimulating compress. There are persons in whom the sense of cold disappears in the course of from ten to fifteen minutes, and who in the course of half an hour become quite warm, as the radiation of heat is prevented by the blanket. The cause of this manifestation is to be

FIG. 35.—WET PACK; SHEET DRAWN FROM RIGHT TO LEFT; PATIENT'S ARMS INCLUDED.—(*Polyclinic Hospital, Philadelphia.*)

found in marked dilatation of the peripheral vessels. The effects of this reaction are visible in various situations. In consequence of the resulting anemia of the brain, drowsiness appears, and the action of the heart becomes markedly slow, in some cases to the extent of 30 or 40 beats in a minute. As a result of the complete muscular rest a state of marked tranquillity develops, and finally, at least in most cases, sleep follows. If the pack is continued for more than an hour, the amount of heat may accumulate to such degree that sweating takes place. This may attain considerable proportions if the pack be continued for six or seven or even eight hours, a practice that is followed by us only in rare and exceptional cases.

The **duration** of the pack varies with us in accordance with the ends to be attained. The pack is employed as a preparatory measure or a preliminary warming measure for subsequent stimulating courses of treatment, and for such purposes a period of from twenty to thirty minutes suffices to render the patient warm. If the pack be changed as soon as the patient becomes warm, considerable abstraction of heat naturally takes place, and therefore every subsequent pack becomes less rapidly warm. Thus it happens that

FIG. 36.—WET PACK; ADJUSTING THE BLANKET—(*Polyclinic Hospital, Philadelphia.*)

in febrile cases the first pack becomes quite warm within five minutes, the second and the third not before ten minutes, and a fourth or a fifth remains cool for so long as one-half or three-quarters of an hour. That considerable reduction in temperature can be effected in this way is obvious. During the afternoon, when the body-temperature naturally exhibits an ascending tendency, the packs generally become warmed rapidly. It is customary with us to follow each pack by a suitable cooling procedure, in order to dissipate the accumulating heat from the surface of the body, and to restore the tone of the relaxed cutaneous vessels. The character of the cooling procedure varies with the conditions present in the case under treatment. Consideration should be given to the nature of the disease and to the degree of irritability of the patient.

The **indications** are as follows: Frequently renewed packs are employed in cases of fever. They exert a useful **antipyretic effect,** and are especially valuable when the pulse-rate is high. The patient should, however, not be kept in the pack long enough for the action of the heart to become impaired, a condition that may be a source of danger, especially in infectious diseases. Otherwise these

FIG. 37.—WET PACK COMPLETE.—(*Polyclinic Hospital, Philadelphia.*)

packs are attended with a **sedative effect** upon the action of the heart. The **number of renewals** will depend upon the conditions present in the individual case, and may reach as high as ten or even twelve in hyperpyrexia. Should the patient become chilly, and should the pack be no longer capable of making him warm, its continuation must naturally be suspended and the treatment terminated by some stimulating measure, by means of which the patient is warmed. Wet packs are **counterindicated** when the power of the heart is greatly lowered in cases of fever.

In one infectious disease,—namely, diphtheria,—and in others closely related to it (angina, even of the gravest character), the combination of frequently renewed packs in association with a subsequent stimulating measure constitutes almost a **specific.** For the consideration of these measures reference may be made to the appropriate place in the special section (Part III).

In functional motor neuroses, as chorea and athetosis; in neuralgia; in nervous disorders of the heart, as in exophthalmic goiter; in articular and muscular rheumatism; and in deforming arthritis, a wet pack of one or one and a half hours' duration renders good service. In cases of polyneuritis, even before the acme of the disease has been reached, wet packs may well be employed. They lessen the tenderness, and appear to shorten materially the course of the disease. In disease of the kidneys, and in

FIG. 38.—BUXBAUM'S MODIFIED WET PACK WITH PRECORDIAL COIL.

chronic metallic poisoning, this procedure is employed with advantage; and even in disorders of metabolism, especially diabetes. It is true no influence of the treatment upon the elimination of the sugar is demonstrable. Nevertheless a number of symptoms of the disease are most favorably influenced. The dry skin becomes pliable, the excretion of water from the skin is increased, in consequence of which a part of the burden is lifted from the kidneys and diuresis is generally diminished. The tendency to skin affections is not only not increased by the wet pack, but is even favorably influenced. I have observed distinct improvement in some cases of ichthyosis, pruritus, and furunculosis under the influence of the wet pack.

The **counterindications** for the wet pack consist in great weakness, and especially weakness of the heart.

Partial Packs.—The **three-quarters** and **half packs** that are so much employed, and in which the body is enveloped from below up as far as the armpits or the umbilicus respectively, in the same manner as in the full pack, exert a correspondingly lesser influence. They do not, however, wholly interfere with the activity of the patient, and this is an advantage in the case of nervous, timid patients. On the other hand, they do not possess the sedative effect in the same degree as the full pack. Priessnitz employed half packs for the relief of severe lancinating pains in cases of tabes, leaving his patients in the wet pack for from four to six hours, and even throughout the entire night, but without conspicuous success. The half pack exerts also a depletory and a sedative effect, and it is frequently employed with advantage for hypnotic purposes.

FIG. 39.—TOWEL CHEST PACK.—(*After Kellogg.*)

For persons in whom fright develops when they are placed in the full wet pack, and in whom one would be unwilling to dispense with the effect of the full pack, **Buxbaum's modification** (Fig. 38) may be employed. He applies a **crossbinder** well covered with flannel or a woolen cloth, and over this a **three-quarter pack** extending up to the armpits. The patient is almost wholly enveloped in the pack, but is able to move his arms freely, and this assists materially in relieving his anxiety. In addition, it is possible when this form of wet pack is used, to make a cooling application to the precordium. As a result, the possibility is afforded of employing the pack also when the force of the heart is reduced.

THE DRY PACK

The application of the dry pack is practised in the same manner as that of the wet pack, with the single difference that only a dry sheet, if any, is placed within the blanket. According to Baruch, the linen sheet is objectionable. He uses a flannel sheet, which can be washed more readily, covering it with a blanket.

Mode of Action.—It is customary with us to employ the pack without the sheet, and this seems to be the better method. The skin is irritated by the rough surface of the blanket and cutaneous hyperemia is speedily induced. The vessels become dilated, and the body is rapidly warmed. The dissipation of heat is prevented by the blanket, and the heat of the pack is increased to such a degree that perspiration appears considerably earlier than in the wet pack. The occurrence of sweating takes place with varying rapidity in different persons. In favorable cases it may begin within half an hour, while at times one or two hours may elapse before it sets in. The average period until free perspiration takes place is about one and one-half hours. The temperature of the body rises, and all of the symptoms of a simple fever make their appearance. The tongue becomes dry, pulse and respiration are accelerated, and the head feels full.

Mode of Employment.—If it be desired to hasten the appearance and increase the amount of sweating, certain **preliminary procedures** are employed. One method consists in warming the patient by putting him in a bath at a temperature of about 40° C. (104° F.) for about ten minutes, before wrapping him in the blanket. This measure is but seldom practised, except in nephritis and uremic states, when sweating must be rapidly induced. The mode of preparation as commonly practised by Winternitz is simply that usually employed. Preceding the dry pack, the patient, dressed in clothing as warm as possible, engages in active muscular exercise, such, for example, as hill climbing or wood-sawing, in consequence of which the production of heat is enormously increased, and not until he is thoroughly heated, or even in a dripping perspiration, is he placed in the pack. In the course of ten or fifteen minutes sweating will generally have appeared. After free perspiration has been induced, the patient may be given one or two glasses of cold water, both in order to increase the sweating still more and to quench his thirst. The dry pack also is generally practised in the afternoon, at which time, as has already been mentioned, the temperature of the body exhibits an ascending tendency. After the dry pack, cooling procedures (cool baths, douches, even cold full baths) are employed, on the one hand, to cool the heated patient, and, on the other hand, to exert a marked stimulating influence and thus obtain the greatest possible effect from a measure intended especially to increase metabolism in marked degree. It should, however, be noted that a daily repetition of the dry pack does not seem advisable, as the frequent practice of this procedure makes too profound an impression upon the body, and causes marked loss of weight and a state of exhaustion and depression.

Indications.—On account of its severity the indications for this procedure are rather restricted. Chronic metallic poisoning, obesity, and syphilis are the principal conditions in which it is employed. It should not be forgotten that the greatest importance is to be attached to the action of the heart.

Wasting diseases, as well as severe organic disease of the heart, are **counterindications** to the employment of the dry pack. A relative counterindication may be presented by persons of debilitated constitution, even although no grave organic disease can be demonstrated.

BAGS, COILS, AND IRRIGATION APPARATUS

Chapman's Ice-bags and the Spinal Coil.—The first-named apparatus, not much employed at present, are ordinary rubber bags, usually filled with a cold mixture, cold water, or ice, but also used with hot water (Fig. 40). The bags are applied to the patient's back, care being taken to adapt them to the vertebral column. The rubber coil for the spine is probably better known. It permits an uninterrupted application, without changing the apparatus. It consists of thin rubber tubes, through which it is possible to pass a continuous current of water of any desired temperature (Fig. 41). It should be noted that this apparatus is always to be applied upon a thin moist compress, and never directly upon the skin.

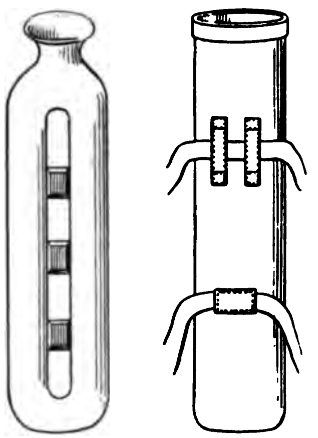

FIG. 40.—CHAPMAN'S BAGS.

The **effect** of the application of cold and heat varies in accordance with **the part of the vertebral column** to which the apparatus is applied. The local application of cold along the vertebral column in disease of the bone, in meningitis, and in myelitis is probably familiar to every one. The application of cold to the **entire spinal column** is practised in erethistic cases of spinal neurasthenia. By this means the general reflex irritability is diminished. The application of cold to the **nape of the neck** and to the cervical portion of the spinal column is practised in asthma, in conditions of great sexual irritability, and in cardiospasm. When cold is applied to the nape of the neck and occiput, the primary effect is a stimulating one. Subsequently the action of the heart and the respiration are quieted. The application of cold to the sexual organs likewise exerts an eminently sedative effect. It has been observed, though not regularly, that applications of cold over the **lumbar spine** cause a flow of blood toward the periphery, especially toward the pelvic organs, and toward the lower extremities. An antiphlogistic effect can be produced uniformly by means of local applications of cold, and a reflex effect upon certain remotely situated organs is obtained by applications at various places.

The action of **hot-water tubes** applied over the lumbar spine is not to be depended upon. They are said to lessen profuse menstruation.

The **head coils** (see page 95) and the **precordial coil** (see pages 96 and 97) have been discussed in previous chapters; the **abdominal coil** and the **general construction** and method of using coils over any portion of the body are referred to in the appendix.

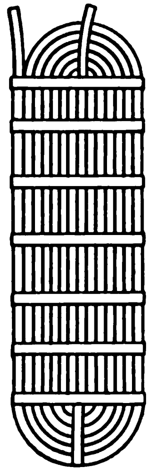

FIG. 41. — SPINAL COIL.

IRRIGATION

The Psychrophore (Cooling Sound for the Urethra).—This instrument has been devised by Winternitz, and is a two-way catheter, completely closed at its extremity (Fig. 42).

Mode of Employment.—It is introduced in precisely the same way as a solid sound, and to such a distance that the tip of the instrument extends to the bladder, but, as a rule, is not introduced into the viscus. With regard to orientation, the following rules should be observed in practice: If the patient is in the horizontal posture, and the instrument after it is introduced occupies a vertical position, the tip of the instrument has entered the membranous urethra. If the instrument is now rotated forward through about 30 degrees, the tip will pass into the prostatic urethra and almost up to the sphincter. It should be noted that while a thin instrument is selected at first in the case of patients unaccustomed to such manipulations, it should not be used for subsequent introductions, unless special sensitiveness exists. Otherwise treatment is, as a rule, continued with the thickest of these instruments that can be introduced. At first the temperature of the water passing through the tube should be about 21° or 22° C. (69.8° or 71.6° F.). Subsequently the temperature may be gradually reduced to 10° or 12° C. (50° or 53.6° F.).

Before the application of the psychrophore the patient should empty his bladder. On introducing the instrument, and at the commencement of the application, the occurrence of vesical tenesmus is extremely common, but this soon subsides. The duration of the application should at first not be extended beyond four or five minutes. Subsequently the application may be continued for so long as half an hour.

Effects.—As a result of the cooling effect upon the urethra, especially the prostatic portion, and the surrounding muscular structures, an improvement in the tone of these structures and of the surrounding tissues, especially of the excretory orifices of the seminal passages, is brought about. This invigorating effect can be recognized on withdrawing the instrument, which is then grasped by the contraction of the muscular fibers, and is therefore removed with some diffi-

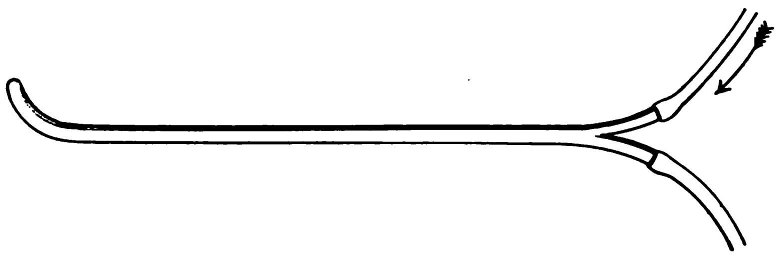

FIG. 42.—PSYCHROPHORE OF WINTERNITZ.

culty. As a result of the introduction of these sounds, irritation is produced, and this is followed by a profound cooling effect upon the mucous membrane. This, in turn, gives rise to anesthesia, which may persist for so long as an hour.

Indications.—The field of employment of the psychrophore is pretty extensive. The instrument renders good service in cases of nocturnal enuresis, and also in cases of neuralgia of the testicle. In the latter condition, however, it should be noted that it cannot be determined in advance whether the employment of hot or of cold water will be beneficial. The psychrophore is employed, further, for the correction of psychic impotence. The treatment should, however, not be repeated too frequently; at most, once or twice weekly. At times treatment with the psychrophore has been followed by apparent impairment of erectile power in patients suffering from premature ejaculation; this, however, proved to be only temporary. Improvement has set in after a time,—occasionally, it is true, only after several weeks,—so that in any event this procedure appears to be attended with success. The employment of the psychrophore is at times followed by most favorable results also in the presence of enfeebled sexual power. Under such circumstances, however, it seems necessary to forbid sexual intercourse. The psychrophore often renders good service also in the treatment of spermatorrhea and prostatorrhea. To these conditions is generally contributory a state of obstinate constipation, and this must therefore be promptly corrected. Treatment with the psychrophore is likewise to be advised in chronic gonorrhea, in which case the thickest instruments should be selected in order that, in addition to the thermic effect, by means of which it is thought the circulation in the mucous membrane will be improved, a special mechanical effect may also be obtained. Nevertheless the application of the cold psychrophore should, under such circumstances, not exceed ten minutes in duration. If a pronounced revulsive effect is desired, psychrophores of alternating temperatures are employed.

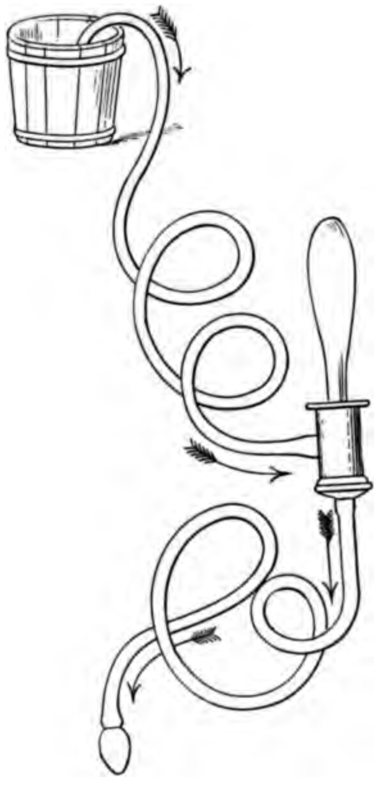

FIG. 43.—ATZPERGER RECTAL IRRIGATOR.

The Atzperger Rectal Irrigator.—This is a faucet-like hollow instrument (Fig. 43), which permits the inflow and outflow of water, the temperature varying with the object to be attained. Before being used the instrument is anointed, after which it is introduced into the rectum.

Mode of Employment and Effects.—The employment of water at a low temperature at the outset is counterindicated, especially in the presence of acute inflammatory processes at the neck of the bladder, as otherwise disagreeable tenesmus and strangury may be excited. Therefore the treatment is begun with water of a temperature of 20° C. (68° F.), and this may be lowered subsequently to 10° C. (50° F.). The **effect** induced by the cooling thus caused is manifest in the improved tone of the rectum and adjacent structures up to the neck of the bladder. The cooling also exercises an anesthetic, decongestive, and antiphlogistic effect. The duration of one application with this apparatus varies greatly. In some cases it does not exceed ten minutes, but it may be several hours.

Indications.—This apparatus may be used successfully in hemorrhoidal states, in which its systematic employment has often rendered operative treatment unnecessary; also in cases of chronic, as well as of acute, inflammatory processes. If the hemorrhoidal nodules can be reduced, it will be necessary to push them back into the rectum before applying the apparatus. If it be desired to exert a softening and a sorbefacient influence in chronic inflammatory processes and atrophic processes involving the prostate gland and its vicinity, with exudates and old infiltration, or if it be desired to stimulate existing suppuration, the indication is to make an application with **hot water.** In the presence of marked sexual irritability the employment of warm water is not permissible. If the application of a powerful thermic irritation be desired, alternating applications of hot and cold water will be employed.

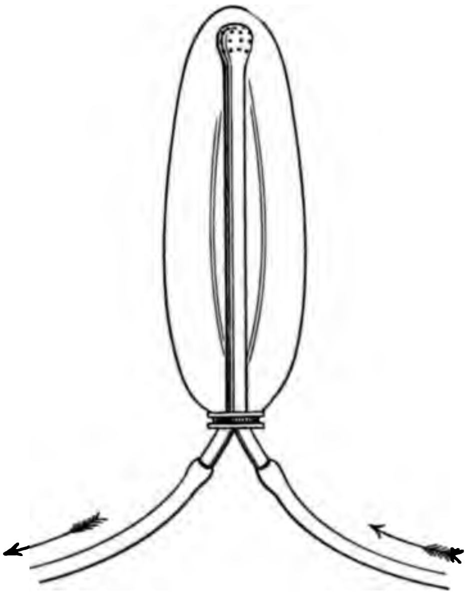

FIG. 44.—RECTAL DILATOR.

Rectal Dilator.—This apparatus, also, which permits thermic massage of the walls of the rectum by means of periodic distention and collapse, was originally proposed by Winternitz. By means of a rubber covering surrounding the catheter (Fig. 44), and through which a current of water is passed, a sac is formed in which the degree of pressure and of distention can be modified as desired by increasing the inflow or preventing the outflow.

With regard to the **indications,** they are the same as for the use of the Atzperger irrigator. In the rectum, the apparatus, if filled with hot water, acts like a cataplasm. It exerts an antispasmodic and a sedative effect. Suppuration is also favored by it. It may be employed also in the vagina, and either with **hot water,** for the relief of tenesmus and strangury, or with **cold water,** to allay vulvitis and vaginismus.

Vaginal Dilator.—This consists of a cylindrical apparatus (Fig. 45) provided with a supply and a discharge tube. The apparatus is first anointed and then introduced into the vagina. The **mode of application** is pretty much the same as that of the rectal dilator.

The Hydrophore.—This apparatus has been devised by Schütze. It consists of a short grooved catheter (Fig. 46), which is introduced into the urethra, where it acts as an irrigating dilator. The fluid enters

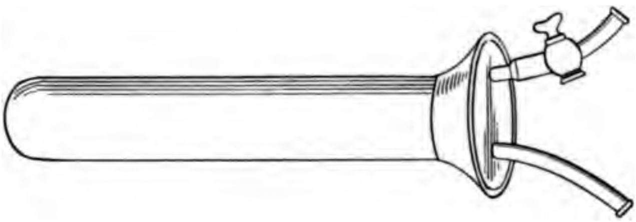

FIG. 45.—VAGINAL DILATOR.

through the central opening and escapes through longitudinal slit-like openings at the extremity of the groove. It then flows back in the grooves, and as a result the mucous membrane, which covers the grooves, is irrigated.

Mode of Employment.—In regard to the pressure that should be exerted by the inflowing water, this should not be too great. The height from which the water enters should not be more than half a meter, as otherwise secretion and fluid may be carried into the bladder, and there is also a possibility that the resistance of the sphincter may be overcome.

In the employment of this instrument water is used for irrigation, and this is principally the practice of Schütze, but antiseptic solutions also, if not too strong, render the same service.

FIG. 46.—HYDROPHORE.

Indications.—It is thought that the development of strictures can be prevented by the employment of this apparatus. In irrigation with cold water the principal end to be attained is strengthening of the circulation and cleansing of the mucous membrane. Special results are yielded by treatment with this apparatus in cases of subacute and chronic gonorrhea. In cases of acute gonorrhea the application of the hydrophore should be begun only when the marked inflammatory manifestations have subsided. Then, however, treatment with the apparatus should be instituted as early as possible

CHAPTER V

SWEAT BATHS; ADDITIONAL LOCAL APPLICATIONS OF HEAT AND COLD

Sweat Baths. Steam Cabinet Bath. Hot-air Bath. Electric Light Bath. Sand Baths. Baking Apparatus. Psychrotherapy.

Steam Cabinet Bath, Hot-air Bath, Electric Light Bath.—In the practice of hydrotherapy those steam baths are almost exclusively employed in which the body, with the exception of the head, is exposed to the action of the hot medium. Therefore steam-chamber baths will not be considered here, but exclusively hot cabinet baths.

Description.—The **steam cabinet** should, as nearly as possible, be steam-tight. A number of varieties are on the market. The accompanying illustrations will show those most commonly employed by us. The steam is either generated in apparatus contained within the cabinet itself and is heated, or it is conveyed to the cabinet from without from a separate source (boiler). The form most commonly employed by us is the upright steam chest, which is extremely simple in construction, the pipe for conveying the steam emptying into the cabinet by means of many small openings. The patient is seated upon a stool the height of which can be adjusted, and the head projects through the opening in the top.

Of **horizontal steam cabinets** I may mention here that of Lahmann as the most practically useful. The cabinet is constructed of sheet-iron covered with wood, and provided below on both sides with a network of iron pipes. This cabinet subserves two purposes: Either the steam may be driven through the opened tube into the cabinet, or the cabinet itself may be heated through the system of pipes, and be employed as a **hot-air bath.** The patient lies upon a lattice support, while the head rests upon a leather-covered roll, as will be seen in the illustration (Figs. 47 and 48).

Sweat cabinets with heated air are made in the same form as steam cabinets. The heating of the air is also effected in a protected space of the cabinet itself (generally beneath the seat), or by means of a system of heating pipes, or, finally, heated air is forced into the cabinet. [illegible] steam for the cabinet bath, and emplo[illegible] heat the air about the seated [illegible] cold compress applied

Effects.—The effect of the steam cabinet baths depends upon the general influence of heat upon the body. Even after a short period of time, in the course of two or three minutes, the cutaneous vessels become dilated and the surface of the body warm. After five or six minutes sweating begins, often with redness of the

FIG. 47.—LAHMANN'S HORIZONTAL STEAM CABINET (OPEN).

FIG. 48.—LAHMANN'S HORIZONTAL STEAM CABINET IN USE.

skin, and this may be maintained for a long time and greatly increased by protracted exposure and continuous heating. The internal temperature of the body is increased, the action of the heart and the respiration are greatly accelerated, and the metabolism is augmented. Diuresis is influenced in accordance with the profuseness of the sweating; and if this be excessive (loss of water), diuresis may be greatly diminished. The state of the blood with reference to its corpuscular elements is most variable. In experiments on animals (Breitenstein, *et al.*) a reduction in the number of blood-corpuscles at the periphery (ear vein) was observed. In sweating persons the condition, so far as is known from relatively few observations, is

FIG. 49.—BARUCH'S HOT-AIR CABINET, OPEN TO SHOW CONSTRUCTION.

variable. At times there is a reduction, but generally there is a more or less marked increase, which, when the sweating is considerable, is probably an indication of inspissation of the blood. These changes involve only the red corpuscles; the white are almost always increased. As a result of the sweating, reduction in body-weight takes place, even as much as 1 kilogram ($2\frac{1}{5}$ pounds) and more, in from twenty-five to thirty minutes. This is to be attributed exclusively to loss of water. It is known that in conjunction with the sweating a number of toxic and bacterial, as well as metabolic products, are eliminated. Thus, bacteria themselves, urea, uric acid, or metallic poisons (mercury, lead, etc.) may at times appear in the sweat in considerable amount.

The **temperature of the steam bath** rises more or less quickly in accordance with the rapidity with which the steam enters. A temperature above 60° C. (140° F.) is rarely necessary; a temperature of 50° C. will fulfil most indications. In general, patients become accustomed in time to tolerate the higher temperatures, and therefore it would appear advisable that the heat should gradually be increased. The subjective sense of burning in the skin becomes most pronounced before the patient begins to sweat. After the secretion of sweat has once become profuse, this feeling generally disappears or at least diminishes considerably. The cooling of the head throughout the sweat bath is, as was mentioned at the beginning of the section, an indispensable condition. It is often of great advantage to prevent the development of congestion by cooling the neck.

To increase greatly the secretion of sweat, it is useful to permit the patient to drink cold water during the process. This is subjectively most agreeable, and the sweating, which diminishes in the course of about thirty minutes, may again be increased. The patient should not be permitted to leave the bath apartment while the skin is hot, and it is our custom, when the sweating is not to be continued by means of subsequent dry covering, to cool the patient after the steam bath. The choice of the cooling procedure depends upon the object to be accomplished. When special stimulation is desired, we usually employ marked contrast stimulation; that is, the influence of decided cold immediately after the steam bath. Better abstraction of heat is effected, however, if moderate temperatures, from 25° to 30° C. (77° to 86° F.), are employed at first, gradually passing from these to cool applications, or even to cold full baths.

The **duration of the steam bath** also depends upon the object to be accomplished. We employ steam baths of quite **short** duration, from two to five minutes, as a preparatory measure, in order to intensify the effect of a stimulating procedure; baths of **longer** duration, from ten to thirty minutes, for the establishment of sweating under the conditions about to be considered. The steam baths of **exceedingly long** duration, an hour and more, employed in some places, are used by us only with extreme rarity. They constitute an enormously powerful measure, and presuppose the possession of great powers of resistance.

Indications.—The indications for steam baths are extremely varied. We employ steam baths of short duration as a preliminary

warming procedure in the presence of general atony, and of depressive neuroses, and especially in cases of anemia and chlorosis. Steam cabinet baths of **considerable duration** are employed in the following morbid conditions: (1) Metabolic disorders, especially obesity and oxaluria, less commonly in the obese forms of diabetes; (2) throughout the whole range of articular diseases, such as rheumatism, gout, and deforming arthritis; (3) dyscrasic processes and constitutional disorders, torpid scrofulosis, syphilis, chronic metallic poisoning (as, for instance, with lead, zinc, mercury); (4) diseases of the kidneys, and dropsical states in which the injurious influence of the steam baths upon the heart is counteracted by simultaneous application of the cold coil or ice-bag to the precordium; and, finally, (5) as a fomentation in cases of chronic diseases of the skin, with thickening of the epithelium, and sluggish, imperfect peripheral circulation.

The **secondary procedures** by which sweat baths should be followed vary in accordance with the disease present. **Vigorous** procedures will be selected in cases of obesity and syphilis, and **less intense** measures in the presence of diseases of the joints and metallic poisoning. The cooling process should be very carefully carried out in cases of nephritis.

Steam cabinet baths and general hot-air baths are **counterindicated** in febrile diseases in general, in profound structural disease of the central nervous system, and in marked arteriosclerosis. Among febrile diseases, an **exception** to the counterindications may be made when recent febrile affections due to exposure to cold (coryza, influenza) are to be treated with sweating procedures. The selection of cases should, however, be made with great care, and presupposes due resisting power. On the other hand, domestic procedures to produce sweating, as the hot foot-bath or tub bath with a hot drink, and followed by a hot pack, are, in the editor's experience, applicable and useful at the beginning of nearly every case of influenza, coryza, severe laryngitis and the like, and even in many cases of pneumonia.

Both steam and hot-air cabinets may be employed in reduced size for the application of heat to the lower half of the body. Such **half sweat baths** enlarge the range of **indications** so as to include cases in which there is some doubt as to the employment of general sweat baths, especially cases presenting dropsical conditions in connection with disease of the heart, and cases of nephritis. The simultaneous application of cooling apparatus to the precordium will insure protection against undue cardiac depression.

A valuable, practical, and simple arrangement for the application of hydrotherapy at home consists in the **steam bath in the tub,** proposed by Winternitz. The procedure is exhibited in the accompanying illustrations (Figs. 50 and 51). By means of a continuous supply and discharge of hot water, which gives off steam in the tub, an exceedingly high temperature (up to 50° C.—122° F.—and above) can be attained, if the tub is well covered. Metallic tubs must be appropriately lined with blankets, as otherwise they might become unduly heated and give rise to burns.

FIG. 50.—WINTERNITZ'S STEAM TUB BATH.

The **tolerance of high temperature** varies in accordance with the following principle, based upon experience. The degree of temperature that can be borne depends upon the rarity or density of the medium supplying the heat, and particularly upon its hygroscopic power. In other words, when the medium rapidly absorbs water, thus both facilitating perspiration and, in case of local application, avoiding the danger of scalding the patient in his sweat, a much higher temperature is permissible than under other conditions. A human being can tolerate a water bath at a temperature of 45° C. (113° F.) for eight minutes, with danger to life, so to say (Landois), while general hot-air baths of eight minutes' duration at a temperature of 127° C. (260.6° F.) are well borne, and temperatures exceeding this are endured, in properly applied local baths of hot air. **Sweating** (the physical regulation) is easy in the hot-air bath, more difficult in the water-saturated steam cabinet bath, and still more difficult in the water bath, in which the presence of the water interferes with the secretion of sweat. An exception to this rule is constituted by the electric light baths shortly to be mentioned, in the case of which the markedly stimulating effect of the light rays upon the nervous system renders impossible the toleration of high temperatures for a considerable length of time.

FIG. 51.—FRAMES FOR WINTERNITZ'S STEAM TUB BATH.

Light baths constitute a form of sweat bath introduced several years ago by Kellogg, of Battle Creek, and at present widely employed. These are given with the aid of cabinet-like apparatus supplied with electric incandescent lamps or arc lamps, which serve as a source of heat. The reflection of the light rays is effected in the apparatus of Kellogg by means of mirrors within the cabinet. With us (Winternitz) experience has shown that celluloid plates (which, however, are combustible and therefore not entirely desirable), and, still better, thick glazed paper, serve the same purpose at a lower cost.

With reference to the **action** of the electric light bath, we are as yet not clearly informed. We do not know with certainty whether it is to be considered as a simple hot-air bath, or whether a part of the effect is due to the chemical rays. Undoubtedly the chemical rays, and especially those of the arc light, exert a profound though hitherto not accurately defined influence, not alone upon the skin, but also upon deeper structures, and even upon metabolism. Kellogg [1] himself, whose ingenious investigations are thus far the most complete, explains the difference in the action of the light baths and that of hot-air baths by the circumstances that the elimination of carbon dioxid in the light bath is the greater, and that the occurrence of sweating, as we have also been able to confirm in hundreds of cases, generally sets in earlier, that is to say, at a lower temperature, and is more abundant, than after the use of other forms of sweat baths. It is often stated that the action of the heart is less accelerated in the electric light bath than when the steam bath is employed, but we are unable to confirm this statement.

The **indications** for light baths coincide in the main with those for steam and hot-air baths. The **effects** are quite noteworthy. The baths are found quite agreeable, the manipulations are cleanly and simple, and the regulation of the temperature can be pretty accurately governed by changing the number of lights as necessary. It is possible to keep the patient for a considerable length of time in the light cabinet at a temperature of 45° C. (113° F.); if the temperature does not become higher, changes in the action of the heart can be avoided. The light bath is thus well adapted for obese persons with diseases of the joints, also for a number of hysteric and neurasthenic patients, in whom, it is true, a part of the effect is due to suggestion. In any event, more attention will have to be given in the future to this form of applying heat, and Kellogg is deserving of much credit in this connection.

Sand Baths.—For the general application of heat, and as a sweating measure, **sand baths** are of importance.

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[1] See article on phototherapy by Dr. Kellogg in this volume, pages 226 to 241.

Mode of Employment.—Originally sand heated by the sun was employed, but the method has been elaborated in recent years, especially by Dr. Sturm, of Köstritz, and by Grawitz, of Berlin, and its indications have been defined. At present, artificially warmed, fine, hard, sea or river sand is used; the heating being effected in ovens especially constructed for the purpose. In the tub—a quadrangular wooden box upon rollers—is placed a layer of hot sand from 15 to 30 cm. (6 to 12 inches) high, and upon this the patient lies. With the exception of the head, which is elevated, the body is covered with sand, and finally with warm blankets. The floor of the cabinet is generally made of sheet-iron, and is heated by means of tubes placed below. The sand has a temperature of from 45° to 50° C. (113° to 122° F.), and even a temperature of 53° C. (127.4° F.) is well borne. The pulse, it is true, becomes accelerated, as in the case of other methods of overheating the entire body; and also the respiration is quickened; but serious discomfort is exceptional. The head must always be well cooled. Sweating occurs rapidly, and becomes abundant, as the sand exerts a hygroscopic influence, and favors the secretion of sweat. The sand bath is continued for from one-half to one and one-half hours, and is concluded with a **tepid** or **cool bath.**

The chief **indications** for sand baths are to be found in rheumatic, arthritic, and gouty processes, and in cases of neuralgia, especially of the sciatic variety. Favorable reports have been made as to the treatment of parenchymatous nephritis (Sturm), and of chlorosis (Grawitz).

LOCAL APPLICATION OF HEAT

In the chapter on the wet compress the means of making local applications of heat were in part discussed. At this place will be considered rather newer methods, that have been employed for a number of years, for the purpose of subjecting portions of the body to temperatures at times abnormally high.

The **tolerance of high temperatures** on the part of portions of the body depends precisely, as in the case of general applications of heat, upon the character of the thermal medium. If the skin can regulate its own temperature by means of sweating and protect the deeper structures, far higher temperatures are bearable. Burns occur only when the thermal medium is a good conductor of heat. In the **construction** of the various forms of apparatus use is made of a chamber that can be adapted to different parts of the body, and affords the possibility of ventilation, as otherwise the air within the chamber might become saturated with water to such a degree that sweating would be suppressed and scalding occur. The source of heat may be any steam-generating stove; a gas flame or other flame applied to a metallic cylinder externally; a flame with a chimney terminating within an apparatus of non-conducting material, or the like.

Varieties.—The number of apparatus already known is quite large, and the description of a few types will suffice. The most common, and the simplest, are the **small steam and hot-air apparatus** with chambers of varying form for the different parts of the body. The apparatus of Reitler, of Vienna, to which those of Bier and Quincke are similar, convey heat by piping from a number of lamps to a canvas or other stout frame in which the body or limb is placed. The apparatus of Tallerman for the extremities, the trunk, the shoulder, or the neck, are constructed of copper and are lined with asbestos. A gas flame beneath the apparatus supplies the heat. The temperature in the chamber rises rapidly, as high as 80° C. (176° F.), and even up to 150° C. (302° F.). The application is continued for from fifteen minutes to an hour. Sprague, of New York, has improved upon this and also adapted it to inclose the body. The apparatus of Lindemann [1] are shown in the illustrations on pages 92 and 93 (Figs. 24 and 25); one form is adapted only for application to the extremities. The source of heat consists in two wire rheostats on the floor of the cabinet, which are connected by means of a spiral rheostat with an electric current. The chamber can be raised to a higher or a lower level by means of an appropriate support, so that the extremity can be placed in a comfortable position. The source of heat (electric current) is easily regulated, and the extremity can readily be observed through a small window in the upper plate. The wire rheostats are not incandescent; therefore a small lamp with a separate connection with the electric current is placed in the interior of the cabinet for purposes of illumination. The use of this lamp shows that the sensitive, hyperemic skin does not bear well the effects of the chemical rays of light; for as soon as the extremity becomes greatly heated, the turning on of the light is often appreciated as a sense of tingling pain. If a red lamp be substituted for the white light, the painful effect does not occur. Fraley, of Philadelphia, has constructed a somewhat similar apparatus both for the body and for the limbs.

Kellogg has constructed appliances analogous to his electric light cabinet for individual portions of the body, the extremities, etc., concerning the application of which not much need be said. They are admirable in action and in application. In addition, there are various devices in the use of which hot air or hot carbon dioxid (passed over plates heated by electricity) is driven into the cabinet. Apparatus of this character are described by Reich, under the name of thermoaerophore, by Frey, Herx, and Bum. The instruments are em-

[1] "Münchener med. Wochenschrift," 1898, No. 46.

ployed either for the local application of hot air or, in the case of those devised by Herx and Bum particularly, as local hot douches.

The **indications** for all of the varieties of local treatment with heat are familiar. Rheumatic and arthritic processes, diseases of muscles and tendons, neuralgia (sciatica, etc.), occupy the foremost position in this connection. The treatment of gonorrhea and tuberculous joint affections, in accordance with the suggestion of Bier to utilize the influence of hyperemia, should be mentioned. Further, local overheating is useful in the treatment of chronic ulcerative affections of the skin, on account of the favorable influence exerted upon regeneration of tissues, and cicatrization of the ulcerated surfaces (Ullmann, of Vienna).

It is customary with us, **after the application of heat,** to cool off the greatly heated portion of the body, or at least to refresh the skin by means of affusions of short duration or by frictions, and subsequently to cover the part thoroughly. If the part is very tender it is often serviceable, after the overheating, to continue the sweating process beneath heavy covers, and to apply the cooling measure after about an hour.

PSYCHROTHERAPY

Under this head will be mentioned only those methods in the practice of which abnormally low temperatures are employed. The **effect of local cold** is familiar, and its employment as an antiphlogistic and analgesic, in so far as this is customary by means of water of low temperature, down to that of ice, has been considered in the chapter on the **wet compress.** The marked cooling of circumscribed portions of the body (nerve, trunk, etc.) by the **spraying of ether** or of **ethyl chlorid** or **rhigolene** is a pretty well-known method, so that it will not be necessary to say more concerning it. In the presence of trigeminal neuralgia or spasmodic tic this application is often of use. Extremely low temperatures may be employed therapeutically by means of applications of **solidified carbon dioxid.** If liquid carbon dioxid is permitted to flow into a sac loosely filled with cotton, so much heat will be taken up that the carbon dioxid freezes into a snow-like mass. The stream of carbon dioxid from the cylinder should be directed downward. In the presence of obstinate anorexia in cases of tuberculosis, such a sac, filled with 1 or 2 kilograms (2 to 4 pounds) of carbon dioxid, has been employed, it is stated, with surprising success, in the form of an **application to the stomach,** where it should remain in place for from one-half to three-quarters of an hour. A thick layer of cotton should be interposed between the skin and the cold sac. Necrosis of the skin does not result from the employment of this measure.

Of methods of applying abnormally low temperatures to the entire body, only the **cold spring or fountain** constructed by Pictet [1] is well known. A hollow double-walled cylindric chamber, 2 meters (yards) high, incloses the patient up to the neck, the head remaining free. By evaporation of sulphocarbonic acid, and condensation by means of a high degree of pressure, an atmospheric temperature of —110° C. (—166° F.) can be obtained; a temperature that, by reason of the lesser activity of the long-waved rays, is not at all appreciated as abnormally cold by the fur-wrapped patient. The sitting lasts from fifteen to twenty minutes, and is said to give rise to marked effects. Pulse, respiration, and metabolism are increased, and, what alone is decisive in its therapeutic employment, the appetite is said to be excessively stimulated. Animals became abnormally hungry in Pictet's experiments.

In cases of neurasthenia, especially of nervous dyspepsia, the results have also been most satisfactory. Unfortunately, the method is not susceptible of extensive employment on account of its great cost and relatively limited range of application.

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[1] "Blätter für klin. Hydrotherapie," 1897, No. 2.

PART III

SPECIAL HYDROTHERAPY

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PART III

SPECIAL HYDROTHERAPY

CHAPTER I

ACUTE FEBRILE INFECTIOUS DISEASES

Preliminary Considerations. Typhoid Fever. Malaria—Malarial Cachexia. Intestinal Infections.—Cholera Asiatica; Cholera Nostras; Dysentery. Acute Exanthematous Infections—Pulmonary Complications of Measles; Scarlet Fever. Diphtheria. Acute Articular Rheumatism.

Preliminary Considerations

The physiologic effects of thermic and mechanical stimuli teach that hydrotherapy constitutes a powerful remedial measure, symptomatic and radical, which, as has been shown, exerts a marked influence on nutritive disturbances. From a consideration of the wide range of indications for thermic and mechanical stimuli and the remaining physical remedial measures, it will not be difficult to understand that they possess a therapeutic value far beyond that of mere hygienic exercises, and it would really be necessary to review the entire field of special therapeutics and the whole subject of hygiene to give a comprehensive description of the effects of hydrotherapy upon all forms of disease. Inasmuch, however, as we shall confine ourselves to a consideration of the tonic and invigorating effects of thermic and mechanical nerve-stimulation, as we have pointed out, we may omit a detailed discussion of the great hygienic and nutritional value of cool and cold water applied every morning. At the same time the qualification should always be borne in mind that the special methods outlined in the following chapters are not to be looked upon as inflexible formulas. Accuracy in individualization, and adaptation of the effects of our physical remedial measures to the given case, are the first principles of special hydrotherapy.

In what follows an attempt is made to formulate the principles that should guide us in laying down definite indications for treatment; and an effort will be made to show, in connection with certain forms of disease, how our therapeutic principles can be applied. It is not necessary to describe all forms of disease in detail; but by means of one or two examples of a group of diseases it will be shown how the clinical picture is to be analyzed, and what measures are to be employed in conformity with this analysis. It will then be comparatively easy for each physician to institute for himself the proper method of treatment in those forms of disease which are not analyzed in detail in this work.

ACUTE FEBRILE INFECTIOUS DISEASES

There are practically two questions that perpetually engage the attention of all physicians. The one has reference to the nature and the genesis of fever, and the other to its significance. Upon the answers to these questions depend the entire treatment of fever, and the solution of the further questions whether fever is necessary for the termination of the disease or not, and whether the fever should be combated or not. In the most remote times fever was considered simply and solely as an elevation of temperature, and the febrile elevation of temperature was also regarded directly as an important remedial measure. This view was at one time sustained and at another contradicted, and the discussion was renewed when bacteriologic investigations began to exercise their important influence. On the one hand, it was contended that the high temperature exerted no injurious influence upon the organism, while, on the other hand, the parenchymatous and fatty degenerations occurring in the various organs were attributed to the pyrexia. Finally, great importance was again attached to the elevation of temperature, in so far as it was considered as a natural curative effort and as a means of defense against the infectious agent.

It is a demonstrable fact that beyond certain limits, high temperature ought to be combated. It should not be forgotten, however, that efforts to lower the temperature as much as possible not only may prove unsuccessful, but are not even useful, since the infectious diseases under such conditions do not pursue either a more rapid or a more favorable course. It should therefore be borne in mind that there are febrile symptoms other than elevation of temperature which demand an equal, if not a greater share of attention. Circulatory derangement, next to elevation of temperature, is one of the most constant febrile symptoms. This is exhibited in acceleration of the heart action, in increase in the frequency of the pulse, and in an unfavorable influence upon the organs of the central nervous system and the vasomotor center. If it is recalled that the blood pressure falls, and that this may readily produce hypostasis in the lungs, stasis in various other organs, unequal distribution of blood and heat, various metabolic disturbances, diminished diuresis, bed-sores, and like disorders, it will be evident that these symptoms must be accorded the same attention as the elevation of temperature.

Of great importance, further, are the derangement of digestion and of respiration, the nervous manifestations, the febrile secretory and excretory disturbances, the reduction in the excretion of water through respiration and insensible perspiration, and, not least of all, the changes that take place in the blood in febrile infectious diseases. The percentage of hemoglobin, the number of red and white blood-corpuscles, and the alkalinity of the blood undergo changes during febrile infectious diseases, and these likewise furnish important indications for treatment. It will thus be seen that a number of symptoms of equal importance demand the attention of the therapeutist. But even if all these be remedied, it will not suffice. Advances in the field of pathology require that a rational therapeusis shall also be guided by the etiology. Treatment therefore should be directed against the infectious agents and their products.

Are we in a position by means of hydrotherapy to meet all of the requirements? That hydrotherapy is capable of reducing temperature has never been doubted. Winternitz was the first to show how this is brought about. He has demonstrated that heat-dissipation is increased and heat-production is diminished; in other words, both factors that cause elevation of temperature can be influenced by suitable hydriatric measures. Only when it is possible to cause dilatation of the cutaneous vessels by active thermic and mechanical stimulation, and to maintain this dilatation, can the dissipation of heat be increased; and under the same conditions the production of heat may be diminished. Nevertheless, a mere lowering of the temperature is not sufficient; an effort should also be made to maintain the temperature permanently at a suitably low level.

The second important question is whether it is possible by means of hydriatric measures to guard against circulatory disturbances, or to correct them when present. This question also has been answered by Winternitz. By means of both local and general measures it is possible to counteract, to overcome, and finally to remove the circulatory disturbances. The action of the heart may be slowed and strengthened, the blood pressure increased, and tone given to the vascular system, and, as a result, stagnation, hypostasis, bed-sores, and cardiac collapse are extremely rare. It is possible also, by combating the pyrexia, to lessen the digestive disorders, which are in large part attributable thereto. By lowering the temperature, moreover, the respiratory disturbances are corrected. The bactericidal power of the blood is favorably influenced by augmenting its alkalinity and increasing the number of red and white blood-corpuscles active in the circulating stream.

Thus the organism in its entirety is strengthened in its struggle with bacteria and their toxins, and the elimination of the latter is hastened by stimulating the action of the skin and kidneys. These facts firmly establish from the most modern viewpoint that superiority of hydrotherapy over other methods of treatment which has long been recognized empirically.

The procedures that we employ in the treatment of acute febrile infectious diseases are partial ablution, the partial rub, the cold rub, the wet pack, the half-bath, the trunk compress, stimulating compresses, and cold applications to the precordium, to the head, and to the abdomen. Full directions as to the methods of application have been given in the section on Technic and need not be repeated here.

Following will be found the statement of certain necessary details in relation to various forms of infectious diseases.

TYPHOID FEVER[1]

It is, above all things, absolutely necessary to begin the treatment of typhoid fever early. It has been demonstrated statistically that if the treatment of this disease is begun early enough, the mortality is not more than three or four per cent. It is equally important, however, that the hydriatric measures in typhoid fever be continued sufficiently long. The number of relapses is certainly lessened in this way.

With reference to the special measures to be employed, the desired result can no doubt be attained with the most varied hydriatric procedures, provided the thermic and mechanical stimulations are graduated in accordance with the indications of the individual case. Hence there can be no invariable and exclusive routine. Nevertheless it will be well to begin with partial ablution. With the aid of this procedure the irritability of the vasomotor nerves, the strength of the heart, and the intensity of the febrile process can be determined. It is, briefly, a measure for testing the reactive power of the body. If the reaction is not good, as will be indicated by a marbled, cyanotic appearance, or pallor and coldness of the skin, partial ablution with cold applications to the precordium should be practised repeatedly, in order to improve the heart-action and thereby to strengthen the powers of reaction. If the reaction following the partial ablution is good, tepid or moderately cool half-baths—28° to 26° C. (82.4° to 78.8° F.)—may be employed, and the temperature gradually lowered.

The duration and temperature of the bath should be regulated

[1] For further details, see Appendix.

according to the following principles: When **vigorous nerve-stimulation** is desired, or when the **circulation** is to be improved,—the state of the body-temperature occupying a subordinate place among the symptoms,—cold hydriatric applications of short duration (15° to 21° C.,—60° to 70° F.,—from five to eight minutes) are employed. When, however, a **reduction in body-temperature** is to be effected for a considerable time, a higher temperature (29° to 32° C.—85° to 90° F.) is at first selected and gradually lowered; and the bath is continued for as long a time as possible. The number of baths varies in accordance with the severity of the case. With reference to the **temperature of the patient**, it should be kept in mind that bathing should be practised whenever the temperature is **above 39.5° C. (103.1° F.)**; the state of the nervous system and the circulation may, however, justify, or even call for, the earlier repetition of the bath. By applying a trunk compress immediately after the half-bath, and changing it hourly, it is generally possible to maintain the temperature for several hours at the level attained.

A procedure that is also employed in typhoid fever—much less commonly, it is true, than the half-bath—is the wet pack, renewed at frequent intervals. This is **indicated** when the action of the **heart** is greatly **accelerated,** and in conditions of great **excitement.** Whenever a conservative measure is to be employed, as in profound **anemia**; when it is desired to **abstract heat gradually**; when the **skin** is burning **hot and dry,** and marked redness of the skin cannot be induced even by means of vigorous friction; finally, when the means for applying other procedures are wanting, the fever will be most effectively combated by means of a cold wet pack systematically renewed at regular intervals. The temperature and duration of these applications must be governed by the effect in the individual case. Only when the power of the heart is greatly depressed, in profound disturbance of consciousness, and when deep inspiration is to be induced will wet packs be **counterindicated.**

The effect of general measures may be materially augmented by means of various **local applications.** First of all is the Leiter or rubber coil applied to the precordium, the employment of which cannot be too urgently recommended; it is a prophylactic against collapse. It should be employed daily for one or two hours. It is also a useful agent for the **correction of cardiac weakness** that has already set in, more efficient than the large doses of alcohol so much employed. Cold water (12° to 18° C.—54° to 64° F.) is generally used in the precordial coil. Further, consideration should be given to the symptoms referable to the central nervous system—**stupor, coma, delirium, excitability.** In general, these will be most effectively combated by general procedures; and they are rarely observed in patients treated from the outset with hydriatric measures. In stupor, or even when the mental symptoms are merely subjective, the *head coil or compress* should be used as an adjunct to general procedures. This should be applied for a *long time*, and the *temperature* regulated in accordance with the conditions present.

On the occurrence of **intestinal hemorrhage**, a *trunk compress* is applied, in conjunction, if necessary, with the *abdominal compress or coil*. Under such circumstances every procedure involving mechanical stimulation should be omitted. If **hypostatic pneumonia** occur, a *crossbinder* and *precordial coil* are indicated. Neither this condition nor the occurrence of **bed-sores** is a counterindication for general treatment; on the contrary, recovery from these complications will by this means be accelerated.

MALARIA

The best water treatment for malaria consists in the employment of a *cold application*, combined with *powerful thermic stimulation*. The form of the application is a matter of indifference. The most important requirement, however, is the production of a good reaction. When this fails to take place, success will be wanting. With the powerful stimulating procedure, which may be chosen according to personal preference, a *fan douche* to the region *of the spleen* may serviceably be conjoined. The principal objects of the therapeutist's attention are the proper selection of the **time,** and the production of **a good reaction.** The *shorter the interval* between the procedure and the anticipated chill, the more *certain* will be the *result*. With regard to the procedures to be employed, they consist in *cold vigorous shower-baths*; a *cold rub* in coarse sheets in combination with sheet-baths; *cold sitz-baths of ten minutes' duration*; *cold full baths*; *plunge baths*, and other suitable measures. The treatment should be continued until the constitution of the blood, the digestion, and the circulation are restored to the normal—briefly, until every sign of cachexia has disappeared.

According to Strasser, the **effect** of hydriatric procedures is to be attributed to the fact that shortly before the attack the infected erythrocytes disintegrate under the influence of the powerful stimulation of the cold, so that the plasmodia thus set free are destroyed by the phagocytes.

The treatment of the **malarial cachexia** is quite difficult; often more difficult than that of primary malarial infection. The **anemic forms are the most** frequent, and their general hydriatric management **should** [illegible]les given for anemia. (See page 144.) In the case of patients presenting this condition, as well as in that of other greatly reduced persons suffering with profound nutritive disturbances of an ill-defined nature, it should not be forgotten that the cachexia results from a sort of chronic intoxication. We thus have a certain therapeutic guidance in the direction of an elimination of toxins. The particular manner in which this is to be brought about can readily be decided upon according to the special circumstances of each case. The suggestion to have the patients sweat periodically may in any event be adopted.

ACUTE INTESTINAL INFECTIONS

Cholera Asiatica and Cholera Nostras

The hydriatric management of cholera must begin with the **prophylaxis.** Personal disinfection, which consists in the most scrupulous cleanliness, is the fundamental prophylactic principle. The second important factor consists in combating the tendency to **diarrhea.** The cold rub in a sheet wrung out of very cold water (8° to 10° C.—46.4° to 50° F.), or in a dripping sheet, according as it is desired to abstract a greater or lesser amount of heat, fulfils these indications. A cool half-bath (26° to 20° C.—say, 80° to 68° F.) lasting from two to five minutes, or a cold rain-bath of very brief duration, say, from thirty seconds to one minute, may also be employed. Perfect **reaction** is absolutely indispensable. If the disorder has already advanced, and the **premonitory choleraic diarrhea** is present, or possibly only **vomiting** and **cramps** in the calves, which are indicative of the commencement of an attack of cholera, the object of the physician will be to check the discharges from the stomach and bowel. The control of diarrhea and vomiting is the principal **indication** in the treatment of cholera. There is no remedy more certain, more prompt, and more reliable than the appropriate hydriatric measure. The method by which the desired end is best to be attained is probably a cold rub in a sheet partially wrung out of very cold water, as near 0° C. (32° F.) as possible, followed immediately, without preliminary drying, by a very cold sitzbath (hip-bath)—8° to 12° C. (say, 46° to 54° F.)—for a period of from fifteen to thirty minutes. The patient is well covered in the sitzbath, the parts that are not immersed being well enveloped, and the abdomen should be vigorously rubbed. Following this procedure, a wet abdominal binder, covered by a dry one, is applied; the patient is placed in bed, well covered, and, if necessary, the extremities are vigorously rubbed beneath the blanket. As a result of this treatment, **complete reaction,** frequently accompanied with p **sweating,** generally occurs in a short time. In the event of a re exacerbation of the symptoms, the entire procedure is repeated

In **fully developed cholera,** the cold rub, the sitzbath, and the abdominal binder should be employed. Under these circumstances water of the lowest available temperature, often cooled by the addition of ice, should be employed, and the mechanical friction must be practised for a long time and energetically in order to bring about the desired reaction.

Dysentery

The treatment of dysentery is based upon the same general principles as apply in cholera. In this disease also the cold rub and cold sitzbaths of long duration are indicated. Ice suppositories are also recommended by English writers; a fresh suppository is introduced every three or four minutes, and the procedure is continued for one to one and one-half hours at a time. · The treatment by means of enteroclysis, with cold water,—12° to 16° C. (say, 54° to 61° F.),—is most efficacious. The patient assumes the knee-elbow posture, and a glass vessel with a capacity of from two to two and one-half liters (quarts) serves as an irrigator. The extremity of the tube is well oiled and passed into the rectum for a distance of at least 8 centimeters (3 inches). The fluid is retained in the bowel for at least ten minutes. The irrigation is practised twice or thrice daily, and is continued until the symptoms have entirely subsided.

ACUTE INFECTIOUS EXANTHEMATA

General Considerations

The treatment of the acute exanthematous infections is in general based upon the principles that have been laid down in the introductory portion of this chapter. Among the individual symptoms it is the **fever** and its accompanying manifestations that especially require therapeutic intervention.

It should be emphasized here with relation to **childhood,** which is the period in which the acute exanthematous infections occur most frequently, that the organism of the child responds violently, with a number of profound cerebral symptoms, to elevation of temperature. Children give off much more heat than do adults from the surface of the body, which is much larger in proportion to the body-weight; **more moderate temperatures** therefore suffice to bring about the necessary effect, while **collapse** occurs much more readily for the same reason.

Under such conditions, also, partial ablutions, half-baths with water of but moderately low temperature, as well as wet packs changed at intervals,—the latter especially in the presence of **cerebral symptoms,**—are **indicated.**

Measles

The diseases of the respiratory organs attending measles, such as **bronchitis, capillary bronchitis, pneumonia,** and **bronchopneumonia,** naturally require thorough consideration. The pulse should be the guide in the treatment of these complications. Cold half-baths with vigorous douching and friction of not excessive duration, at most five minutes, in combination with local applications, are the measures most to be depended upon in the treatment of diseases of the respiratory organs during childhood. No single hydriatric procedure suffices to fulfil all the indications or to provide for individual symptoms occupying a prominent place in treatment so effectually as the half-bath, if its duration and the thermic and mechanical stimulation are skilfully adapted to the individual case. In general, I would recommend moderately cool baths—26° to 22° C. (78.8° to 71.6° F.). A bath of five minutes' duration will suffice, as a rule, to induce a positive hydriatric effect with reference to all the symptoms. In no event should the bath be continued if the child begins to **shiver.** When the **heart-action** is **feeble** and the circulation begins to be poor, the **respiration superficial** and **frequent,** and the **innervation sluggish,** cold affusions in the half-bath are indicated. Affusions to the nape of the neck, by reason of their influence upon the respiratory and circulatory centers, will have a particularly good effect. In extremely severe cases momentary immersion in cold water,—16° to 12° C. (61° to 54° F.),—followed by vigorous friction, is practised.

A number of **local applications** may be mentioned as valuable adjuncts to the procedure described. Various forms of compresses, crossbinders, trunk compresses, and wet packs of the lower extremities are most frequently used. The crossbinders are applied continuously, being changed every two or three hours. Trunk compresses are employed when renewed elevation of the temperature is to be prevented. The lower extremities are wrapped either for the purpose of **supplying heat,** when warm compresses are used; or as a **derivative measure** to reduce **cerebral hyperemia,** when stimulating compresses are employed.

Scarlet Fever

Special attention should be directed to the vascular system, as here the peripheral vessels generally are relaxed and their tone lost. The secondary effect of this manifestation is apparent in reduction of the blood pressure, in acceleration of the action of the heart, in a tendency to stasis, and in a diminution of the amount of heat given off from the skin. Jürgensen very properly points out that the circulatory disturbance results in diminished functional activity of the blood, and treatment should have for its special object the diversion to the tl ened point of as much functionally active blood as possible, an object that can probably be brought about by improvement in the circulation. The **therapeutic indications** are thus clearly defined: to **strengthen the heart** and **raise the tone of the peripheral vessels.** The procedures employed for the attainment of these ends are the same as those that are indicated in all infectious diseases—namely, partial ablutions, half-baths with thorough friction, and affusions. In my experience, temperatures of from 26° to 22° C. (78.8° to 71.6° F.) are the best. The duration of the bath will depend upon the reaction. The more rapidly it is possible to bring about a good reaction, the briefer will be the duration of the bath. With regard to the **angina of scarlet fever,** this should be treated with stimulating throat compresses, renewed every one or two hours. It should, finally, be emphasized that the frequency of **scarlatinal nephritis** is appreciably reduced when hydriatric measures are employed, a result that has been confirmed by all observers. Saline infusions are here of great use, and in cases of actual suppression of urine may follow the hot bath—37° to 40° C. (98° to 104° F.)—or the hot pack, or a vapor or hot-air bath, employed to induce prompt sweating,

DIPHTHERIA

It is a thankless task to describe at the present day, in the era of antitoxin, the hydriatric management of diphtheria. Nevertheless. it is worthy of consideration, and all the more so, as the desired results had to be, and actually were, attained by means of appropriate measures at a time when antitoxin did not yet exist. The fortification of the resisting powers of the organism, the augmentation of the bactericidal elements of the blood, the neutralization of the toxins and their elimination from the organism, have at all times and in many cases been brought about by means of hydriatric applications.

The procedure that is best adapted to the treatment of diphtheria is the wet pack, renewed at regular intervals. The patient remains in the last pack, about the fourth or fifth, until **sweating** occurs. Following this, a moderately cool half-bath,—28° to 24° C. (82.4° to 75.8° F.),—with vigorous affusions, is to be given. The temperature falls, the prostration disappears, and the action of the heart becomes stronger. The subjective state also becomes materially improved. A most important factor in the treatment of diphtheria consists in the application of throat compresses, which are sometimes indicated for **stimulating,** at other times for **cooling purposes.** In cases of **laryngeal croup,** the respiratory disorders, continuous **dyspnea,** and threatening **cardiac weakness** constitute the most urgent **indications.** Winternitz explains the type of respiration in cases of laryngeal croup as due to **paresis of the dilators of the**

glottis beneath the inflamed mucous membrane. Only upon the basis of this explanation is it comprehensible that the most important requirement of hydrotherapy consists in the relief of this paretic state of the dilator muscles (abductors). The method consists in applying a powerful thermic and mechanical reflex stimulus, which experience has shown affects the respiratory center. Thus, a vigorous cold rub, and half-baths with cold affusions, are indicated.

ACUTE ARTICULAR RHEUMATISM

The general treatment does not differ essentially from that of other febrile diseases, except that here, even more than in other diseases, the greatest importance should be attached to inducing **hyperemia of the skin.** For the most part, such procedures are chosen as permit of **slow abstraction of heat** and at the same time produce the marked hyperemia desired. These consist in repeated wet packs. It is possible to attain the desired end with the aid of a few packs, especially as in this hydriatric procedure we possess a powerful means of stimulating the function of the skin. The patient is permitted to remain for a considerable length of time in the second or third pack, until **sweating** has taken place, which occurs quite early in cases of acute articular rheumatism. The sweating is permitted to continue for some time, and followed by a half-bath of moderate temperature. Should sweating not have taken place in the pack, the half-bath should nevertheless be given. Should the fever persist after the wet pack has been repeatedly changed, a cold rub should be given after the last pack; this will often lower the temperature.

The cold rub is not readily applicable in some cases, on account of marked **tenderness** and **swelling of the joints**; or it may be impossible for the patient to stand up to be rubbed in the erect posture. In the latter event it is advantageous to rub the recumbent patient. Enveloped in a wet sheet, he lies at first upon the right side, when the front and back of the body are well rubbed. Then he turns upon his back, and the lateral aspects of the body are rubbed. It is useful to permit evaporation from the body to continue for some time after the rub. Should marked tenderness be present, a sheet bath may be given.

Repetition of the procedures mentioned is indicated either by **recurrence of the fever** or by extremely severe **pain.** Following the general procedures, trunk compresses, and circular (long, narrow) compresses about the affected joints, may be applied. The circular compresses are wrung out of water and covered simply with cotton, which can easily be removed without annoying the patient, while renewed and rapid saturation of the compress is possible by allowing water to drop on it from a sponge. If the shoulder-j[illegible] are affected, it is advisable to apply a crossbinder, as this incloses the shoulder-joints most completely.

The **heart** must from the outset receive attention, and the development of endocarditis and other complications averted so far as possible. Should the slightest symptom referable to the heart appear, the immediate employment of the precordial coil will be indicated. This may be applied twice or thrice daily for from half an hour to an hour at a time, and even oftener and for a longer time. Whether it is possible by this measure to prevent involvement of the endocardium and of the pericardium cannot, of course, be determined positively, but it is a fact that endocarditis is observed with extreme rarity in patients thus treated. Another advantage of hydrotherapy, as compared with other methods of treatment, may be mentioned—namely, the rarity of relapses. Probably it is the general invigoration and the improved tone of the skin that increase the powers of resistance. Even after complete recovery the patient should continue for some time with a cold rub in the morning. **Residual processes** in certain joints, swellings, with tenderness or immobility, are rarely observed. When these are present, however, circular compresses, together with general procedures, should be employed. When these do not suffice, massage and electricity, especially faradization of the joints, may help to diminish the sensitiveness. Large joints may be treated successfully with Scotch douches.

CHAPTER II

INTOXICATIONS; ANEMIA; METABOLIC DISORDERS

Chronic Saturnism. Chronic Arsenic Poisoning. Alcoholism. Chlorosis and Anemia. Obesity. Diabetes. Gout.

INTOXICATIONS

In **acute intoxications** those procedures should naturally be first employed that are capable of expelling from the alimentary tract such portion of the poison as has not been absorbed,—thus, irrigation of the stomach and the intestine, bearing in mind the well-known counterindications. In the second place, in addition to chemical antidotes are those measures that combat dangerous symptoms, such as respiratory disorders, cardiac weakness, cramps. When **paralytic symptoms** are present, vigorous mechanical and thermal procedures are indicated, such as the cold rub and cold affusions in the warm bath. On the other hand, in the presence of increased motor activity, as **eclampsia** or **convulsions,** sedative procedures, such as prolonged warm baths, and wet packs, are to be employed. In alcoholic intoxication especially, and in many septic conditions, saline infusions are useful. (See page 279.)

In cases of **chronic poisoning** also, two indications are present. In the first place, the **toxic substances** should be **eliminated** from the body through the natural emunctories; and, in the second place, certain symptoms, such as **paralysis, excitement,** and **functional disorders,** should be relieved. For the fulfilment of the first indication we possess in dry and wet packs a well-known and powerful adjunct to steam cabinet baths, while the respiration and the functions of the kidneys and the intestines are most powerfully stimulated by means of a cold rub, the shower-bath, sitzbaths, and half-baths.

Chronic Saturnism

For the **elimination** of the lead, steam cabinet baths of considerable duration—about fifteen minutes—render admirable service. They may be followed by a bath of alternating temperature or a cold rain-bath. The distressing **gastric neuroses** and intestin are most favorably influenced by means of a trunk compress and hot abdominal coil applied for about an hour, and by means of warm, high enteroclysters and protracted tepid baths. At night a wet abdominal binder is applied. The characteristic **palsies** are influenced by alternating douches and cold, rapid, fan douches.

Chronic Arsenic Poisoning

The same procedures are applicable for the elimination of the metal as in cases of saturnism. The severe pain in the back and in the extremities is ameliorated by partial and full wet packs. For the correction of the **cachexia** invigorating measures of short duration and great momentary stimulation, the alternating douche, a steam cabinet bath followed by a cold douche of short duration, or other similar measures, are employed.

Chronic Alcoholism

Of the varied symptom-complex of **chronic alcoholism** it will be possible to select only some of the most important manifestations. In the presence of states of excitement, of sleeplessness, and even of **delirium,** wet packs of long duration render admirable service. The same statement may be made also concerning the multiple **neuritis** that not rarely occurs. Alcoholic **pseudo-tabes** is generally treated with half-baths, and with hot or cold coils to the back, according as symptoms of depression or of irritation predominate.

CHLOROSIS AND ANEMIA

With reference to the hydriatric procedures that are applicable to the treatment of chlorosis and anemia, it should be pointed out here that it is less the form of the procedure than the manner of its application that is important—in other words, that the **proper dosage** of the thermic and the mechanical irritation plays the most important rôle in determining the indications.

The rules for the treatment of chlorotic and anemic states should be:

1. Avoidance of a reduction of the body-temperature below the normal, therefore absolutely little abstraction of heat.
2. Increase in the irritability of the peripheral nerve terminations by means of preparatory heat-accumulation or heat-supply.
3. Vigorous nerve-stimulation by means of water at the lowest possible temperature.

The manner in which the objects outlined can best be attained will vary, but one can hardly go astray if the rules laid down are kept in mind. Avoidance of reduction in temperature and of increase in the irritability are to a certain degree necessary conditions in order that a favorable final result may be secured from the subsequent vigorous nerve-stimulation. These conditions can be satisfied by causing an accumulation of heat on the surface of the body of the patient, or by supplying heat in any one of a variety of ways. The patient may be enveloped in a wet or a dry pack until the body is warmed; or she may be placed for a few minutes in a steam cabinet; or a tepid douche—28° to 30° C. (82.4° to 86° F.)—may be applied as a preparation for the subsequent actually effective cold application. The warmth that accumulates during the night upon the surface of the body may also be utilized for the purpose of fulfilling the first two conditions mentioned. An accumulation of heat takes place on the surface of the body after a night spent in bed beneath suitable coverings. The antithermic procedure is therefore practised preferably immediately after the patient arises from the warmth of the bed. At this time also water of quite a low temperature is much more readily borne.

Vigorous nerve-stimulation must be brought about by having the water of the lowest possible temperature, and by means of procedures of very brief duration. Partial ablution or a cold rub for one or two minutes; douches lasting from a few seconds to half a minute, fulfil this indication. Often these procedures are ill borne by profoundly anemic patients when the stomach is empty. A glass of warm milk or tea, given from half an hour to an hour before the procedure is undertaken, generally induces the desired tolerance. With regard to the treatment of the patient after the procedure, this will depend upon the individuality. Spare patients with impaired nutrition, who are always chilly, should be permitted to remain in bed until the reaction—that is, the restoration of heat—takes place. Pasty patients, however, will accelerate the appearance of an appropriate reaction by active exercise in the open air.

In general, a deficiency of iron in the blood is considered the cause of chlorosis and of many cases of anemia, and by some also a congenital deficiency in the blood-making or circulatory apparatus is regarded as a condition for the development of chlorosis. Nevertheless other causes of chlorosis and anemia must be sought for before a rational treatment can be instituted. If this were done more systematically, it might help to discover the reason why, in many forms of anemia, iron proves useless, while suitable hydriatric measures render good service. Unequal distribution of the blood as the result of altered mechanical conditions constitutes one of the most frequent causes of profound anemia and chlorosis. Many years ago Winternitz reported under the distinctive title 'anemia spuria acutissima' a case in which profound anemia developed in consequence of traumatism. The patient did not lose a drop of blood by the injury; nevertheless, though perfectly well previously, she presented the symptoms of grave anemia, such as commonly occur only as a result of hemorrhage. The patient had preserved intact the total amount of blood—no other conclusion could be reached; nevertheless there occurred, obviously under the influence of the traumatism, just as in the percussion-experiments of Goltz, a relaxation of the vessels of the abdominal organs, and the larger portion of blood had collected in these channels—the patient had bled into her own vessels. A rational therapy, which I shall discuss more fully later, corrected the stasis of blood in the vessels in question, and the marked symptoms of profound anemia.

The conditions are similar, in my opinion, in **enteroptosis.** The total amount of blood and its qualitative condition undergo no material change, unless the disorder be complicated by profound general disturbances of nutrition; the absolute number of red and white blood-corpuscles and the percentage of hemoglobin in the blood suffer no reduction, and it is more than probable that the condition is one of unequal distribution of the circulatory fluid. I am far from believing that abdominal plethora in the ordinary sense of the word exists. This is due to active processes, and is dependent upon the special and more intense activity of one or more abdominal organs. In enteroptosis, however, the condition is certainly one of venous hyperemia—a passive hyperemia, which, on the one hand, is the consequence of enfeebled or insufficient visceral activity, and, on the other hand, is the cause of varied symptoms dependent upon passive circulatory disturbances. The venous hyperemia is not a sign of insufficiency in the forces that serve the purpose of propelling the blood, but it depends upon a temporary or permanent diminution in the average tone of the tissues, which makes room for considerable amounts of blood. It is an established fact that the activity of the organs is of great importance in the propulsion of the blood. When sufficient intraorganic acceleration does not take place, the supply, but still more the escape, of blood must be obstructed. Of quite special significance for the circulation in the intestinal vessels is the peristaltic wave of the intestine; in conditions of enfeebled peristalsis there undoubtedly results an accumulation of venous blood in the smaller and larger vessels, a mechanical embarrassment of the vascular system, which is one of the most characteristic peculiarities of enteroptosis.

With reference to the **treatment** of such cases, the following statement may be made: While in the cases of anemia spuria **acutissima** described by Winternitz a good result was obtained by means of general and local hydriatric procedures improving the circulation, I have obtained the desired result in cases of chlorosis and anemia in consequence of enteroptosis, only by the employment of such procedures as also improved peristalsis and the tone of the intestinal musculature, and accordingly increased the activity of the bowel. Cold sitzbaths of brief duration, half-baths with high abdominal affusions, shower-baths, with vigorous douching of the abdomen, will be in place under such conditions.

Anemia following hemorrhage can in some cases be improved, if not cured. In these cases, also, the method of treatment previously described is applicable. In cases of **secondary anemia,** causal treatment must necessarily be instituted.

Of individual symptoms attending chlorosis, **coldness of the feet** should first be mentioned. By improving the circulation and the distribution of the blood this condition will naturally be overcome. Success may, however, be attained also by means of running footbaths of short duration. Naturally, these are not applicable when headache is present as the expression of cerebral anemia. Under such circumstances the headache would be increased, and cold rubs of the lower extremities should therefore be employed instead of footbaths. For the relief of the **anemic headache** a stimulating head compress or hot water coil to the neck (cravat) may prove useful. The **gastric disturbances** of anemic origin will be effectively combated in many cases by means of a trunk compress and stomach coil with very hot running water—40° C. (104° F.). **Cardialgia, eructation, pyrosis,** and **vomiting** all yield to this treatment. The exciting cause of the symptoms explains the prompt action of the procedures named.

In conclusion, it may be mentioned that Scholz, of Bremen, recommends sweating-cures (hot-air baths) in the treatment of chlorosis. Baruch, of New York, reports favorable results from the use of hot-air baths followed by gradually cooled douches in order to overcome the spasmodic contraction of the arterioles, to increase metabolism, and thus to improve the assimilation of proteids.

DISORDERS OF METABOLISM

OBESITY

In the treatment of this condition quite remarkable results are attained by means of hydriatric procedures. What conditions attend the presence of obesity? The disorder is often considered as a retardation of metabolism, but this is only partially true, inasmuch as the nitrogenous balance remains within normal limits, or close thereto.

The combustion of fat alone is diminished, so that retardation or diminution in the activity of the cell-protoplasm is present only in a limited sense. As a matter of fact there is a disproportion between fat destruction and fat production in favor of the latter—deficient combustion of fat. Whether the percentage of hemoglobin is too low, and therefore the ability to form oxygen is less than normal, or whether the process of oxidation in the tissue-cells does not take place with normal activity, has not been decided. Cohnheim considers the latter as the more probable. However this may be, the **object of treatment is** to increase fat combustion, by bringing about **increased oxidation.** Our treatment is one of oxidation, as has been brilliantly shown by the labors of Winternitz, Pospischil, and Strasser. It will therefore be capable, as is no other form of treatment, of fulfilling the conditions arising out of the nature of the disease. The denutrition-cures most commonly employed are, as a rule, withdrawal-cures; courses of treatment by means of which a certain degree of emaciation is brought about, but which in many cases may be followed by conditions of debility, and even of chronic disease. They depend upon the fact that the patients are restricted within such narrow dietetic limits that in the course of time symptoms of inanition make their appearance, as one or the other of the elements of food necessary to maintain metabolic equilibrium is withdrawn; and thereby in the place of the existing nutritive disturbance another is substituted that at times is even more severe.

The **advantages of hydriatric measures** in the management of obesity, as compared with other methods of treatment, consist in the fact that by stimulating the oxidation processes—that is, the natural processes—the stored-up fat is burned up; that at the same time the general state of nutrition and hemogenesis are improved; and, finally, that it is possible without special difficulty, even after the period of actual treatment, to incorporate one or another of the physical procedures in the mode of life of the obese patient. It should further be stated that **muscular activity** also increases the oxidation processes. Systematically increased muscular exercise will, therefore, be included in the therapeutic program as one of the most important agencies in the combustion of fat. Increase in muscular activity is attended with elevation of temperature. In order to prevent the latter, the temperature of the body must be vigorously reduced before the muscular exercise is begun. Under such circumstances care should always be taken that the cutaneous vessels during and subsequent to abstraction of heat are and remain greatly dilated. Finally, sweating procedures should precede those directed to reduction of the temperature, and these bring about favorable conditions, especially for the absorption of fat.

Three factors are, accordingly, to be taken into consideration in the treatment of obesity: **induction of sweating, abstraction of heat, and muscular exercise.** For the purpose of inducing sweating, packs, steam baths, hot-air baths, and electric light baths of varying duration are employed. As heat-abstracting measures, the following may be considered: the cold rub, sheet baths, half-baths, full baths, immersion baths, douches, partial ablutions. Muscular combustion is increased by means of active and passive exercise. If the effects of these procedures are kept in mind; if, further, the entire constitution, the capacity for reaction, and the individual symptoms are taken into consideration, it will be possible in all cases to make a proper selection and combination from among the procedures named. Routine treatment may result in serious injury. This is more apt to be the case with denutrition-cures than with other forms of treatment, and especially with reference to the circulation and the heart. I would further particularly emphasize the fact that in cases of obesity with circulatory disorders or with **fatty heart,** the condition of this organ should first of all be taken into consideration, and hence those methods be employed—such as the cold precordial coil, partial ablutions, and the like—that improve circulation.

DIABETES MELLITUS

In the treatment of diabetes mellitus regulation of the **diet** has always played the principal, or the almost exclusive, rôle. In spite of a rigid diet, in spite even of drinking-cures, it is not possible in many cases to bring about improvement or cure. Our knowledge concerning the nature of the disease or syndrome is inadequate. Whether the condition depends upon acceleration or retardation of metabolism—or even whether and how this factor may vary—has not yet been determined. Equally little is known with regard to the powers of oxidation in diabetic patients. By some observers it is accepted as firmly established that the powers of oxidation are reduced, but this is denied by others. In the present state of science it is therefore impossible to explicate theoretically the fact noted empirically, that hydrotherapy is capable of rendering good service in cases of diabetes mellitus. Experience teaches us that properly applied hydriatric measures greatly increase the power of assimilating carbohydrates. They are capable, moreover, of increasing the absorption and the utilization of nitrogenous food, and thus of supporting the organism in its endeavor to maintain its nutritional equilibrium without loss of the fixed elements of the body, by drawing upon and stimulating all of the reserve forces. A further value of hydrotherapy consists in the circumstance that it **prevents the acid intoxication** so dangerous to the diabetic, which is exhibited in

marked elimination of ammonia in the urine, and, finally, in **diabetic coma.** In addition, certain symptoms, such as the distressing **bulimia and thirst,** gradually disappear, and the body-weight increases. Especially favorable changes take place in the condition of **the skin,** which, in cases of diabetes, is generally brittle and dry, and, in consequence of the poor circulatory conditions, is cold. The functions of the skin are markedly improved as a result of the water-cure. Finally, hydrotherapy is capable of relieving a number of profound disturbances on the part of the nervous system—**neuralgia, neuritis,** and **diminished sexual power.**

With regard to the **form** of hydriatric application to be employed, invigorating stimulating procedures directed to improvement of metabolism are generally used. A good reaction is the object to be attained here also. The treatment of **obesity associated with diabetes** is identical with the treatment of obesity described in the previous section.

GOUT

Hydrotherapy plays a double rôle in cases of gout, inasmuch as it aims at relief or cure of the defective metabolism upon which the arthritis depends and, on the other hand, tends to combat the local disorder, the acute attack of gout.

The treatment of the **acute attack** will first be considered. The most conspicuous symptom, and that which most urgently demands relief, is the **pain.** Among procedures capable of improving the local metabolism and of regulating the circulation, improvement is observed to take place most quickly under the influence of cold stimulating applications; that is, local cold applications of short duration. Only after these local cold applications of short duration are cold stimulating compresses employed, in the form of circular compresses, which, covered with cotton, remain in position for several hours.

As soon as the acute manifestations have disappeared, general treatment of the **gouty diathesis** must be begun. In gouty patients whose disorder has been caused by **high-living,** rich food, abundant drinking of wine and beer; in whom, therefore, the accumulation of fat is considerable and the veins are distended with blood, a hydriatric course like that recommended for obesity is indicated. In the case of patients in whom there has been **reduction in weight,** loss of muscular power, and derangement of digestion, in whom irritability and mental depression increase the intolerableness of the disorder, it will be necessary to employ hot and cold applications alternately, particularly wet packs of from three-quarters t 'd one-half hours' duration, followed by a cold uche of short duration and of low temperature. The degree of thermic and mechanical stimulation, and the duration of the procedure, will be governed here also in accordance with the conditions present in the individual case, and under such circumstances it will be necessary for an experienced physician to supervise the treatment.

The selection of the application that shall follow the pack depends, further, upon the sensitiveness of the patient. In the presence of marked tenderness, it is obviously not wise to increase this by vigorous friction. In such cases the rain douche is much more suitable. Diaphoretic measures, steam cabinet baths, hot-air baths, and electric light baths, with subsequent stimulating applications, are highly recommended by many writers. If symptoms of general **cachexia** have developed in cases of arthritis, if symptoms of deranged hemogenesis, pallor of the mucous membranes, edema of the feet, appear, then invigorating measures especially should be employed.

In addition to the general treatment, **local applications** also are indicated. Not only in acute attacks, but also in chronic cases, circular compresses and steam compresses may be utilized to favor absorption and to avert deformities.

Of other disorders of metabolism, **oxaluria** and **phosphaturia** may be mentioned, and in the treatment of both of these conditions, hydriatric measures increasing oxidation are to be recommended.

CHAPTER III

DISEASES OF THE NERVOUS SYSTEM AND OF THE MUSCLES AND JOINTS

Neurasthenia—Analysis of Symptoms. Hysteria. Epilepsy. Chorea Minor. Hemicrania. Exophthalmic Goiter. Occupation Neuroses. Neuralgia. Paralysis. Neuritis and Polyneuritis. Spasmodic Tic. Tabes Dorsalis. Myelitis. Diseases of the Brain and its Membranes—Acute Cerebral Leptomeningitis; Cerebral Anemia; Cerebral Hyperemia; Cerebral Hemorrhage; Cerebral Embolism; Psychoses. Diseases of the Muscles and Joints—Chronic Articular Rheumatism; Rheumatoid Arthritis; Gout; Arthritic Muscular Atrophy; Acute Myopathies; Chronic Muscular Rheumatism.

DISEASES OF THE NERVOUS SYSTEM

NEURASTHENIA

The hydriatric management of neurasthenia is one of the most difficult tasks of the physician. The difficulty in treatment resides first in the fact that almost nothing is known with regard to the nature of the disease and concerning the pathologic processes taking place in the organism. It is known that certain functions, or a whole series of functions, are morbidly altered, increased or diminished; that sensory, motor, and secretory disturbances are present. It is known, moreover, that these disturbances occur quite indiscriminately; that some patients present sensory disorders, others motor disorders, still others secretory disorders, while in a fourth group two or more classes of symptoms occur in combination. It is, however, not known why these disturbances take place, and this ignorance makes the whole question of treatment obscure and complicated.

The institution of **causal treatment**, moreover, is not merely difficult but is absolutely not to be depended upon. It is true the exciting cause can be discovered in most cases; it is not usually a [illegible] matter to determine the factors that have [illegible] the patient [illegible]. It is known that excesses [illegible]—[illegible] [illegible] [illegible] the [illegible] of [illegible] [illegible] only in memory, their consequences, the neurasthenic symptoms, persist. Under these circumstances hydrotherapy might effect its greatest triumphs if it possessed no other significance than that of psychic or suggestive treatment. It must, however, be insisted upon that the suggestive treatment that has recently come into vogue has, in spite of all, yielded less success than systematically employed hydrotherapy. In the form of neurasthenia that follows brain-fag the conditions are not much more favorable. In spite of cessation of mental work the morbid manifestations fail to disappear in many cases; in others, it is true, the symptoms remain in abeyance during the period in which work is abstained from, but as soon as intellectual activity is resumed, they reappear in all their unpleasantness. Thus it is impossible to fulfil either indications arising from the causal factors, or those furnished by an incomplete pathology.

Symptomatic Treatment

It is possible, however, to render good service from the symptomatic viewpoint, and thereby the physician's duty is in many cases fulfilled. The sufferer is relieved of his most distressing sensations, is imbued with courage and hope, with both the desire and the ability to work. Only in this way is the treatment to be termed psychic: that, noticing a degree of relief, hypochondriacal tendencies yield, and the patient begins to think of the possibility that he may be freed from all of his symptoms; that his condition is, after all, curable. But this is because under the influence of rationally directed hydrotherapy, symptoms of a certain order have, in fact, disappeared. Naturally, all available physical methods of treatment—all regiminal and hygienic measures at command, as discussed in the various volumes of this series—should be employed in order to support the effects of hydrotherapy. Here, also, strict individualization must be practised.

Analysis of Symptoms.—If it be desired to regulate the treatment of neurasthenia upon a symptomatic basis, it will be necessary to note and to take into consideration especially those symptoms that are present in all, or at least in a large number of neurasthenic patients. There will then be found **changes in the vascular system,** in the blood, in the nutrition, and in the metabolism. The heart is small and its walls thin, the vessels are small and their walls thin, the capillary system is delicate and extensive; the **blood** is watery, deficient in morphologic elements, particularly in red blood-corpuscles, and poor in hemoglobin. These conditions are pretty constant accompaniments of neurasthenia; some of them may be considered to be congenital and thus to have afforded a physiologic basis for the development of the disorder. Under such circumstances also **metabolism** is abnormal; there are formed in the organism metabolic products that exert an injurious, toxic influence. Of such products, especially uric acid, leucomains, alloxurs, and numerous aromatic substances are known to be present, and to their development from time to time exacerbations in the condition are to be attributed. As a further symptom, common to almost all neurasthenics, may be considered the **changes in the blood pressure** brought about through the vasomotor center. In almost all neurasthenics an increase in blood pressure is to be observed; this is especially marked when the general symptoms are exaggerated. Of equally great importance, further, is the marked instability of the blood pressure. It is known that the blood pressure is dependent upon position, upon physical and mental activity, and, finally, upon the mental state; that as a result of mental and physical activity the blood pressure increases, and that excitement of any kind will alter it. The range of alteration, however, is not large in healthy persons, not exceeding from 20 to 30 mm. of mercurial pressure. In cases of neurasthenia the fluctuations are considerably greater. Slight physical exertion, still more, however, mental activity, but most powerfully psychic shock, may increase the blood pressure enormously. Sudden differences of from 40 to 50 mm. in mercurial pressure and even more, are observed. In addition, there is another factor that likewise is of great significance—namely, that this increased blood pressure does not persist for a long time, and is followed by an inverse reaction; that is to say, by a reduction below the normal. Therefore, **increased irritability** and **rapidity of exhaustion**—in other words, the readiness of fatigue that is in general considered as characteristic of neurasthenia—are observed especially in the state of the blood pressure—an appreciable factor indicative of the fulcrum on which the therapeutic lever is to be applied.

The greater the irritability, the greater will be the exhaustion. If one must depend solely upon the subjective statements of the patient, this fact will be apparent. It will, however, be confirmed also if the reflex irritability and the subsequent exhaustion are studied. The latter occurs more rapidly, and is the more persistent, the greater the reflex irritability has been. Highly important **therapeutic conclusions** are to be drawn from these facts. Those hydriatric measures that lessen the irritability, that make allowance for the existing circulatory and innervational conditions, that influence metabolism in accordance with the changes indicated, that, finally, improve the state of the blood, will meet the requirements and will yield successful results. It is far from my intention to attach undue importance to definite hydriatric directions. This is the less required, because, as is well known, the most varied and even opposite effects can be brought about by means of the same procedure, in accordance with its duration and its thermic and mechanical gradations. With reference especially to this latter factor, I would nevertheless earnestly recommend, in the choice of the application to be used, that the **subjective sensations** of the patient be not ignored, but that in so far as practicable cheerful attention be given to them. The patient's sensations must indeed be considered as an important, and for the physician a most reliable, factor in determining the treatment of neurasthenia. Nothing is more injurious than rigid, unyielding adherence to a definite formula. While, on the other hand, it certainly does not appear wise to make undue concessions, especially to neurasthenic patients, with reference to the measures of treatment, yet there will never be reason for regret that as regards one or another efficient factor of hydriatric procedures, the comfort of the patient has reasonably been taken into consideration. Every hydriatric measure that gives rise to persisting disagreeable sensations will certainly be injurious rather than useful, just as, conversely, the feeling of well-being is generally a certain sign that the procedure is indicated and will be attended with success. One should naturally not be led astray by patients who make fallacious observations upon themselves, and who are fond of deceiving the physician to their own injury.

I have thus far invariably observed that neurasthenic patients do not well bear strong thermic and mechanical stimulation at the beginning of treatment. This is entirely in accord with the foregoing explanation. Moderate temperatures, those most closely approximating the point of indifference, will therefore be the most appropriate at first. They are especially suitable for the purpose of reducing the increased **irritability.** The patients feel best after such procedures, and in the last analysis, the subjective feeling of well-being on the part of the patient is far more important than all theoretic explanations. Tepid half-baths,—30° to 26° C. (86° to 78.8° F.),—with affusions and gentle friction, which, supported by the active participation of the patient, should be continued so long and be of such intensity that a suitable reaction is induced, have always yielded the best results.

There are many neurasthenics who do not tolerate even this procedure. I have often enough been told that the symptoms persist even after such measures. It would be a serious mistake if, nevertheless, one should adhere to the procedure prescribed. If the patients fail to secure the necessary tranquillity, the desired sense of well-being, after a half-bath, I should then consider it most advisable to employ wet packs of from one-half to three-quarters of an hour's duration, and then a half-bath in the manner described, or a brief plunge bath. Only after the lapse of some time can one proceed with the vigorous thermic and mechanical stimulation. The transition should be gradual, never unduly rapid. Half-baths at a low temperature and with vigorous affusions, shower-baths of shorter or longer duration, but always with an appropriate degree of pressure, and the cold rub may be employed successfully in accordance with the indications present.

It should further be kept in mind that an excessive degree of heat should never be abstracted from the patient. The efficacy of the procedure not only does not suffer, but, on the contrary, is increased by antecedent heating, either by supplying heat or by causing accumulation of heat on the surface of the body. Either the cool or cold application is made immediately upon getting out of a warm bed—and this is preferable, in view of the fact that neurasthenic patients feel worst in the morning—or a heating procedure is selected in accordance with the existing conditions. A hot shower-bath, or a hot wet pack, until the body is warmed, will best effect the desired result.

With reference to the steps to be taken **after the procedure,** no rules susceptible of general application can be laid down. It is, however, most appropriate to engage in exercise capable of bringing about a good reaction. I am not influenced in this connection by the subjective sensations of the patient, as neurasthenic patients are not always favorably disposed toward physical activity; but a good walk in fresh, dust-free air is in every respect advantageous. Only in the case of **anemic patients,** with impaired nutrition, do I make an exception, and permit the development of the reactive warming to take place in bed.

The activity and the field of usefulness of the hydrotherapeutist is not by any means exhausted with the general procedures described, although favorable results can be and are attained with their aid alone. The irritability and the stimulation subside, the functional activity increases, although at first only for a short time; but there remains a number of symptoms that must be relieved. Sensations, **subjective symptoms,** form the principal burden of the neurasthenic patient's complaint, and it is on this account quite natural that especial attention should be directed to them, without, however, ignoring the objective symptoms. It is as impossible as it would be supererogatory to discuss individually the various sensory disorders, the hyperesthesias, the hypesthesias, the anesthesias, and the neuralgias in various portions of the body, that are complained of. It would likewise be supererogatory to discuss separately the hyperesthesias of certain organs, including, for instance, nervous asthma, angina pectoris, cardialgias, various sensations of fear, and the like. One familiar with the mode of action of hydriatric measures will be able in every case to find a means of relief, and will avail himself of both stimulating and sedative procedures with a local effect, as well as of those acting reflexly, and influencing especially circulation and respiration.

Insomnia.—The treatment of the **sleeplessness** is of the greatest importance in this connection. For this purpose a large number of admirable hydriatric hypnotics are available, in addition to the regiminal and mechanical adjuvants. The most efficient hydriatric procedure is the wet pack, which by reason of its sedative effect, as also of its derivative effect upon the blood supply of the brain and its membranes, is one of the most certain hypnotics. Almost equally effective are partial packs, trunk compresses, and abdominal binders. Warm full baths—32° to 34° C. (89.6° to 93.2° F.)—of from fifteen to twenty minutes' duration; also moderately cool half-baths,—28° to 26° C. (82.4° to 78.8° F.),—with not too vigorous affusions and frictions, are further worthy of recommendation. Friction should, in general, be avoided as much as possible, as it causes irritation of the peripheral nerve-terminations, and through these of the central nervous system, whereby a result is obtained that is the opposite of the sedation desired. It is, therefore, desirable to permit the patient, after the application of the procedure, to enter his bed without being dried. The favorable effect of the bath can be increased by the addition of demulcent substances, as, for instance, a decoction of bran. An excellent procedure, which influences reflexly the circulation in the brain and its membranes, and thus acts by a sort of derivative effect, consists in the running foot-bath; or, as a substitute for this, a sural compress while the patient stands in water may successfully be employed for the purpose of inducing sleep.

In conclusion, it should expressly be pointed out that in cases of neurasthenia, more than in any other disease, **persistent treatment** for a long period is absolutely necessary. Although the patient is often dismissed from treatment improved, or apparently cured, the resistance of his nervous system is still feeble, and only a slight impulse is necessary to bring about a revival of the larger number of his symptoms or, indeed, of all. The end to be attained, therefore, consists in increasing the power of resistance, in invigorating the nervous system,—in a process of hardening. **Tonic procedures,** as shower-baths, and cold rubs of short duration, are now indicated. Relapses are rarely observed, if, after the conclusion of treatment in an institute, one of the procedures mentioned is practised at home daily in the morning.

HYSTERIA

The treatment of hysteria is not less difficult than that of neurasthenia. The nature of this disease likewise is unknown; the indications arising from the morbid process cannot be fulfilled, and the causal indications can be accepted in a few instances only. Consequently the treatment must be directed against certain symptoms. The choice will be governed by the conditions present in the individual case, so that all that is possible in this connection is to discuss the general outlines. The observations of Runge, that the disease is attended with abnormal alterations in vascular tone, have been confirmed by other investigators, and, beyond doubt, constitute a valuable guide in treatment. They are, however, not sufficient to explain all, or even a large part of, the morbid phenomena of hysteria, and we are thus again forced to the employment of symptomatic measures. I desire at once to point out that it is as little possible by means of hydriatric procedures as by other methods of treatment to remove the mental peculiarities of the hysteric patient, which are, indeed, only the expression of the psychopathic predisposition. It is nevertheless true that the specific hysteric symptoms, those physical disorders that involve especially the motor and sensory spheres, can be favorably influenced. That the psychic treatment of these patients plays an important rôle cannot be denied, but that hydriatric procedures possess another and greater significance than merely that of psychic treatment is shown by the results of observation and experience.

Hysteric Paralysis.—We may begin at once with paralysis, which may appear in all possible varieties, as hysteric monoplegia, hemiplegia, paraplegia; at times rapidly, at other times slowly; without any extraneous cause, or as a result of any slight psychic determining factor. The paralysis is generally associated with **anesthesia.** At times it assumes the character of astasia and abasia. In the discussion of fundamentals (see Part I) emphasis was placed upon the circumstance that cold applications of short duration increase the innervation, while procedures of longer duration diminish the innervation. As in these cases the condition is one of impaired innervation, it will be clear that the indication is for cold applications of brief duration. As a matter of fact, it is possible to cause disappearance of the paralysis by means of these procedures. Cold shower-baths of brief duration, plunge baths, the cold rub, cool half-baths—20° to 18° C. (say, 68° to 64° F.)—of short duration, yield good results under such circumstances.

Duration of Treatment.—I have repeatedly succeeded in causing the disappearance of hysteric paralysis by means of a single application. In many cases the period required is rather long. In the case of a girl suffering from astasia and abasia, weeks elapsed before this condition had disappeared. In the case of another girl, likewise suffering from astasia and abasia, recovery was complete after two half-baths. **Anesthesia** also yields quite rapidly to brief applications of cold. I have often succeeded in causing the disappearance of local anesthesia, for instance, by means of an ice rub, continued for a short time—about half a minute. It should especially be pointed out in this connection that in the choice of the special measure to be applied.

consideration should be given to the **general constitution** of the patient. The patients, for instance, are often anemic and chlorotic. Under such circumstances the application of cold should, as is well known, be preceded by some warming measure, the form of which is to be determined in accordance with the local conditions present.

Hysterical **hyperesthesia** and **pain** should in general be treated with cold applications of considerable duration. The localization of the pain and the individuality of the patient influence the choice of method. Cold compresses, with or without cooling coils, cold movable fan douches, with cold shower-baths, rubbing, etc., with or without previous warming, will yield successful results under such conditions. Whenever it is at all possible I employ Scotch douches, and have always observed good effects from their use. There are many hysteric patients who do not bear low temperatures. There is no objection, under such circumstances, to the initial employment of any suitable method to induce warmth, after which the cold application will be much better borne.

Motor irritability occurs in cases of hysteria in a great variety of forms. Among these, **singultus** occupies a prominent place. The treatment of this symptom, like that of other states of motor irritability, of hysterical **cough,** of hysterical **respiratory spasm,** is quite simple, and the results are extremely gratifying. In cases of singultus I have observed good results from the employment of the epigastric application proposed by Winternitz—namely, an abdominal binder with a coil heated by a continuous flow of hot water. The cold water coil for the back has often rendered good service in this condition and also exerts an admirable effect in hysterical cough and in respiratory spasm. The latter condition will at times yield rapidly to transient thermic stimuli, as, for instance, sprinkling the face with a few drops of cold water; a cold douche of brief duration, which induces deep inspiration; or for slightly longer periods, a cold rub. That this mode of treatment is not merely psychic is shown best by the circumstance that distinguished observers, such as Strümpell, report success from its employment after direct psychotherapy had failed.

Hysterical **contractures,** whose cause is to be found in morbid motor irritation, will, if recent, yield rapidly to warm applications. Hot water coils, warm douches, full baths, and the like are indicated under such circumstances. In the presence of contractures of considerable duration success can be attained with no form of treatment, but in a number of cases I observed favorable results from comparatively long-continued wet packs. In any event, it will be well to devote attention to the **atrophy** that develops with contractures of long standing, and to improve the nutrition in the atrophied or atrophying muscles by means of general as well as local measures.

Partial ablutions and partial rubs, in connection with which great importance is to be attached to the mechanical factor of the procedure, exert a good effect.

EPILEPSY

The best results are obtained from the **combined method**, comprising treatment by bromids and hydriatric measures. It has been observed in many cases that the epileptic attacks remain in abeyance or diminish in intensity—that at least the intervals between attacks become longer—if small doses of a bromid are employed in conjunction with hydriatric procedures. With regard to the choice of the form of application, it has been found that tepid half-baths —30° to 28° C. (say, 86° to 82° F.)—yield the best results.

CHOREA MINOR

Wet packs combined with the rubber coil for the back constitute the most appropriate application in the presence of this disease. The profound **sedative effect** of wet packs, of from three-quarters to one hour's duration, is especially important in this connection. The rubber coil for the back, if employed for a considerable time, diminishes markedly the **reflex irritability** and contributes to heighten the good effects of the pack. After each pack a cooling, invigorating procedure, preferably a tepid half-bath—30° to 28° C. (86° to 84° F.)—should be employed. **Cardiac complications** do not constitute a counterindication for hydriatric measures. It is, however, a matter of course that consideration should be given to any existing disease on the part of the heart. By means of an appropriately applied precordial coil, incorporated with the pack, the indications arising from cardiac complications will be met. With reference to the **number of applications** to be employed daily, this will depend upon the severity of the case. In mild cases a single application will suffice, in severe cases a repetition of the procedures named will be required.

HEMICRANIA

A severe task is imposed upon the therapeutist in this disease. In almost every individual case experimental observation must be made, and the treatment here advised must be understood to have no greater significance than that of a procedure which may bring about recovery in some instances. The course to be described has yielded us good results, both in cases of spastic hemicrania and in those of paralytic hemicrania, as well as in cases of the mixed form, in which at times symptoms of sympathetic spasm, and at other times of sympathetic paralysis, are present. The procedures consist in wet packs of considerable duration, from one to one and one-half hours, followed by a cold rub. The admirable reflex effect upon the vascular center and that for the vasomotor nerves reflexly produced by the rubbing led me to employ this procedure. The wet pack was designed to heighten the irritability and thus render the patient more amenable to the good influence of the cold rub. Diaphoretic measures, followed by rubbings, have been recommended by some writers.

EXOPHTHALMIC GOITER

Modern studies in the field of etiology of this disease have also directed the treatment into new lines. Upon the view that the condition depends upon autointoxication is based the practice of organotherapy. This, however, has not much success to its credit. On the other hand, hydrotherapy, which increases the processes of intraorganic oxidation through a natural influence upon organic function, and stimulates the elimination of organic matters, is wholly justifiable, both from the etiologic and from the symptomatic standpoint.

All the symptoms of exophthalmic goiter—the cardiac and vascular manifestations, the struma, the nervous symptoms, the tremor, the hyperidrosis, the intestinal disorders, and the metabolic derangements—can be influenced by hydriatric measures, and a large number of observations demonstrate the actual value of hydrotherapy in this affection. Naturally, it cannot be sufficiently emphasized that the treatment must be carried out systematically, and that it should be properly varied in accordance with the conditions present in the individual case. With reference to the **method** to be employed, the majority of writers have expressed themselves in favor of low temperatures. Many writers, and among them the editor of this series, advocate the application of cold (as by the coil or ice-bag) over the precordium. For a paroxysm of tachycardia, Weir Mitchell advises a general ice rub. The most serviceable applications, according to the experience of Winternitz and his pupils, are wet packs in combination with the spinal coil. Particularly the application of cold to the vertebral column has an excellent effect. With reference to the cardiac and vascular symptoms, as palpitation of the heart, it is far more efficient than applications of cold to the precordium. The explanation resides in the nature of the process, which is a nervous one. The application of cold to the vertebral column will combat still another symptom—namely, the **tremor of the extremities.** As is well known, reflex irritability is diminished by long-continued applications of cold. The patient is permitted to remain in the wet pack for from three-quarters of an hour to one hour, and with this, as stated, is combined the spinal coil. After this pack has been completed a moderately cool half-bath—26° to 24° C. (say, 79° to 75° F.)—is given.

OCCUPATION NEUROSES

The occupation neuroses are attended principally with spasm involving those groups of muscles that are engaged in the frequent repetition of a given movement, generally one required by the occupation. The spasm does not occur spontaneously, but only when an attempt is made to execute the movement in question. The first indication, therefore, will comprise withdrawal from the injurious employment.

In the **choice of hydriatric methods** two factors will require consideration. In the first place, as experience has shown, the patients are nervous and readily exhausted; and, in the second place, the condition is one of local exhaustion, either of central or of peripheral origin. The admirable investigations of Vinay and Maggiora have shown that vigorous thermic stimulation, particularly as induced by low temperatures, increases functional power and also the resisting power to fatigue. Low temperatures are still more efficacious when combined with vigorous mechanical stimulation. That mechanical stimulation—massage and gymnastic exercise—is attended with good results in cases of the various kinds of occupation neuroses is well known, and this agency plays an important rôle in the treatment of the diseases of this group; but hydriatric procedures also, providing they comply with the foregoing principles, undeniably exert a favorable influence. Vigorous shower-baths at a low temperature and of brief duration, in combination with labile cold fan douches to the affected member, are attended with excellent effects. Stimulating compresses supplement the treatment. Perseverance and systematic repetition of the procedures are indispensable for the attainment of the most favorable results. I have observed both spastic and paralytic forms to disappear entirely under this method of treatment.

NEURALGIA

In order to comprehend the mode of action of hydriatric procedures an answer must first be given to the question, How does neuralgia arise? In most cases the disorder develops when a disproportion occurs between the demand for blood and the supply, as a result of thermic or other injurious influences of a vasoconstrictor character. The products of retrogressive metamorphosis accumulate under such conditions, and give rise to irritation, nutritive disturbances, functional derangement, and pain in the affected nerve. In this way arises the so-called rheumatic neuralgia. In the case of neuralgia developing in the sequence of infection, the conditions probably depend upon changes induced and maintained by the presence of micro-organisms, or their metabolic products. Other forms of neuralgia depend upon intoxication with mercury, lead, alcohol, and the like.

Objects of Treatment.—The task for the therapeutist in cases of **rheumatic neuralgia** is to bring about an increased supply of blood to the affected structures, as well as a more effective removal of blood from them, and more active metabolism. This increased activity of circulation and augmented interchange between the blood and the tissues will have the general effect of removing, altering chemically, or neutralizing the inflammatory products, or the products of retrogressive metamorphosis or of function. In cases of neuralgia developing in the sequence of **infection**, the object is to stimulate the processes of oxidation by means of diaphoretic measures. The neuralgia dependent upon **intoxication** should, on the other hand, be treated with measures directed to elimination of the poison from the organism, with removal of the alterations that the poison has brought about in the nerves and the nerve-sheaths.

The douche of alternating temperature, or the Scotch douche, proves especially efficacious, particularly in cases presenting the rheumatic forms of neuralgia. The results are brilliant; it is possible definitely to cure recently developed neuralgia by this means. Often it happens that patients suffering from recently developed **sciatica**, and hardly able to undertake treatment with the douche, can dry and dress themselves without aid after the first sitting, and even walk to their homes without serious difficulty. Naturally, failures also may attend the use of the Scotch douche. It is a matter of course that, for instance, an attack of sciatica resulting from carcinoma of the pelvis, or from periostitis of the vertebræ, cannot be cured, and in most cases in which success is not attained it will be found that recovery is prevented by the presence of the diseases named, or similar serious affections. In default of the Scotch douche good results can be obtained by means of other measures utilizing alternation of temperature; that is to say, procedures supplying heat or causing accumulation of heat, followed by cold applications. Such measures as the steam cabinet, or the dry pack, with the cool half-bath, or cold ablution to the point of removing the heat accumulated upon the surface of the body, can always be utilized. It is not the special procedure employed, but rather the correct combination of heat and cold, upon which success principally depends. In the same manner not alone sciatica, but also **trigeminal, brachial,** and **intercostal neuralgia,** is treated. A few words may be devoted specially to **trigeminal neuralgia.** Here it is less the local than the general procedure influencing the entire surface of the body by means of which a favorable effect may be produced. As a matter of course, in the choice of a special method of application the etiology of the disorder is to be taken into consideration.

The forms of neuralgia dependent upon **intoxication** and **infection** yield most rapidly to diaphoretic measures, which naturally should be selected in accordance with the conditions present in the individual case, and should be followed by invigorating procedures.

PARALYSIS

The hydrotherapy of paralysis does not differ essentially from that of neuralgia. This is comprehensible from a consideration of the **etiology** of this form of disease. Apart from central disorders, from profound traumatism destroying continuity, from inflammatory affections of the bones, or from tumors the pressure of which gives rise to the paralysis, and which are not amenable to hydrotherapeutic measures, the cause of the paralysis, in the overwhelming majority of cases, is **rheumatism** or **exposure to cold. Toxic influences** and overexertion, and, finally, **infectious diseases,** must further be kept in mind. It is scarcely necessary again to emphasize the powerful manner in which hydriatric procedures influence the elimination of toxic substances, of infectious agents and their toxins. I need not again relate how the hydriatric procedures are capable of correcting the changes brought about by cold; and how, finally, as a result of therapeutic intervention, fatigue products also are eliminated or neutralized. I shall here deal with the practical results that are attained by means of hydriatric procedures, and desire especially to emphasize that it does not appear to me to be advisable to sit with folded hands, even in the presence of those paralyses, particularly facial paralysis, that often get well spontaneously. I have often enough observed a prolongation of the paralysis, especially in cases of facial paralysis designated rheumatic and treated expectantly. I have had come under treatment cases of paralysis of this character after six months' duration, during which a normal termination was vainly awaited, and in which it would, at any rate, have been better to have instituted a rational plan of treatment immediately after the onset of the palsy. I would likewise point out that in some cases of paralysis—I have in mind, for instance, a case of paralysis of the external popliteal nerve in consequence of alcoholic intoxication—the removal of the causative injurious factor should not be considered all-sufficient treatment. How often have I observed such cases of paralysis in persons who had long been removed from the sphere of influence in which the lesion developed! The laming persisted, however, and only after prolonged and active treatment was it possible to restore motion. The same statement is applicable to paralysis due to lead and like causes. I wish by the foregoing to imply that, in addition to removing the causal factor, **causal treatment** should be instituted as early as possible, even in cases in which experience has shown that spontaneous recovery may be expected.

Improvement of the **circulation** in the paralyzed part and throughout the entire body, and **stimulation of metabolism** and of the **excretions**, are essential factors to be kept in mind in the treatment. Procedures with alternating temperature of various kinds are the measures that will lead to the desired end under these circumstances. Shower-baths of alternating temperature, wet packs of from forty-five minutes' to an hour's duration, followed by a cold general invigorating application, a steam cabinet bath of from eight to ten or fifteen minutes' duration, succeeded by a cold ablution or rub, and, in addition, stimulating compresses, will in most cases yield good results, provided that irremediable alterations in the structure of the nerves have not already taken place. Even in neglected cases success frequently attends these procedures. In the case of a man in whom facial paralysis developed after mercurial poisoning of two years' standing, I obtained an unexpectedly favorable result by means of steam cabinet baths and subsequent rubbing.

Paralysis following infectious diseases, particularly in the sequence of **typhoid** fever and **diphtheria**, calls for invigorating treatment. Under such circumstances I have obtained the most gratifying results from moderately cool half-baths—22° to 20° C. (71.6° to 68° F.) or from 20° to 18° C. (say, 68° to 64° F.)—with vigorous affusion of from two to five minutes' duration.

NEURITIS AND POLYNEURITIS

Exposure to **cold, infection**, and **intoxication** play an important rôle also in the etiology of neuritis and polyneuritis. In addition, **anemia, chlorosis, diabetes, dyscrasias**, and **marasmus** have frequently been observed as causative factors. 'Not too active treatment' is the rule laid down by writers in this connection also. Although my experience is based on only a small number of cases,—neither isolated neuritis nor polyneuritis is a disease that daily comes under observation,—I can nevertheless state that careful hydriatric methods—that is, treatment adapted to the needs of the individual patient—possess great advantages.

Above all things, the **object** under such circumstances should be the institution, so far as possible, of **causal treatment**—namely, elimination of organic and inorganic toxic substances, and invigoration of the entire organism. In addition, improvement in the local nutrition of the nerve-trunks should be aimed at. Tenderness and impairment of motility will, it is true, in many cases, compel the adoption of the opposite course; that is, attention to the local disorder. Nevertheless, by means of proper treatment it will soon be possible to fulfil the indications furnished by the etiology.

Mode of Treatment.—Enveloping the affected extremities or parts of the body in circular compresses is often the sole, as well as the most efficient, mode of treatment that can be employed under such circumstances. Such compresses meet all of the indications present. The **relief of tenderness** is, in particular, one of the first beneficent results of this mode of treatment. At the same time the circulation is improved and the nutrition is heightened; so that those indications also are fulfilled that arise from the local nutritive disturbance, and from the deficient nutrition within the distribution of the affected nerves.

Pospischil further urges the employment of the cool spinal coil, and the cool precordial coil, by means of which the circulation and the nutrition in general, and especially in the extremities, are improved, and, particularly in cases of polyneuritis, the occurrence of **bed-sores** will be prevented.

So soon as the tenderness has diminished, and this early takes place in consequence of the anodyne effect of the stimulating compresses, measures should be directed to the fulfilment of the **causal indication.** This is met by wet packs. I need not here repeat the factors upon which the efficacy of these measures depends. Only with reference to the **method of application** will a few words be added. Pospischil also maintains the view that a partial pack—that is, one up to the axilla—is at first more suitable than the full wet pack, and that only after some time should the entire body be included. The indication exists, further, to continue the procedure at first for an hour, and later, in accordance with the conditions present in the individual case, for a longer period; that is, until diaphoresis occurs. After the pack, naturally, a cold, stimulating application should be made to the entire surface of the body. Polyneuritis attending **diabetes or gout** will require treatment directed to the underlying disorder. Progressive chronic polyneuritis of children is likewise to be treated in accordance with the principles laid down.

SPASMODIC TIC

I have observed a number of cases of spasmodic tic in which recovery took place within a short time, and others that persisted in spite of treatment continued for months or even years. Both groups of cases included patients some of whom came under treatment with the disease of recent development, while in others it had existed for years. In view of the circumstance that organic disease at any point in the peripheral or central course of the facial nerve may give rise to twitching and to spastic conditions in the face, and that, further, anemia, emotional disturbances, hysterical conditions, exhaustion-neuroses, and organic disease of the brain, may cause facial spasm, the foregoing statement will be readily comprehended. If a peripheral sensory irritation be found, this of course should be removed—so far as it is possible. In the presence of organic cerebral lesions all treatment will be fruitless. Under other circumstances it will be necessary to employ invigorating measures of the most varied form, yet in accordance with the conditions present. The best results are obtained from the employment of cold shower-baths of brief duration. I saw a case with Fodor in which the affection had been present for two years, and in which recovery occurred after five days' treatment with brief cold shower-baths. On the other hand, I have had under observation for three years a woman, thirty-three years old, suffering from hysteria, in whom the entire range of invigorating measures—shower-baths, half-baths, frictions, the thermic and mechanical stimulation being varied in degree, with or without preceding supply and accumulation of heat—were employed, and in which the intensity of the tic was lessened only at times.

DISEASES OF THE SPINAL CORD

TABES DORSALIS

The most efficient **thermic treatment** of tabes dorsalis consists in the employment of alternating hot and cold applications with only a slight difference of temperature, combined with mechanical manipulations of moderate force. We employ almost exclusively tepid or moderately cool half-baths,—30° to 28° C. (say, 86° to 82° F.),—of from four to eight minutes' duration, with friction of not too vigorous a character, and affusions from not too great a height. The most favorable results conceivable have been obtained from these procedures, which produce a surprisingly good effect even in the case of patients who are considered incurable. Quite frequently **paralysis of the bladder and rectum** is observed to disappear under the influence of this simple measure. If, however, only that degree of success is brought about that the morbid process remains stationary for years, and that aggravation does not take place, this form of treatment will have accomplished enough to justify it.

Careful attention should be given to the state of **reaction.** The patient should become warm after the application. Should this not be the case, then the thermic stimulation must be modified. The **subjective sensation** of the patient is a sufficient indication of appropriate choice of the temperature and the duration of the application. If there is a feeling of increased strength, then the bath has been correctly applied; but if there is a feeling of increased languor and debility, and if the patient is slow to warm up, a corresponding modification in the temperature of the water or in the duration of the bath should be made. With reference to the number of half-baths to be given, it should further be pointed out that two such procedures may be practised daily.

For the treatment of the **gastric crises** and the **lancinating pains** various measures have been recommended. Not much of an encouraging nature, however, is to be looked for from any of them. Compresses of alternating temperature, stimulating compresses, hot baths,—32° C. (89.6° F.),—and sitzbaths of alternating temperature may, nevertheless, be tried. Sometimes the lancinating pains may be mitigated temporarily also by means of the cold spinal coil. The method of treatment here outlined is applicable also to other chronic diseases of the spinal cord—**amyotrophic lateral sclerosis, progressive muscular atrophy, spastic tabes,** etc.

Acute and Chronic Myelitis

With reference to **chronic** myelitis, the same principles are applicable that have been laid down for the forms of disease just discussed. Only with reference to **acute** myelitis must some modifications in statement be made on account of the inflammatory character of this disease. In the first place, attention should be called to a mistake often observed. Hot baths and diaphoresis are frequently employed, and for a considerable length of time. Such measures are not alone useless, but even injurious. A patient suffering from myelitis needs above all things rest, and although, by reason of advances in technic, it is possible to administer applications of steam with the patient in bed, they are distinctly **counterindicated;** not only on account of the necessary manipulations attending them, but still more on account of the inflammatory hyperemia, which such procedures as cause elevation of the blood-temperature for a considerable time are calculated only to increase. At the **beginning** of the disease, and until a distinct standstill in the development of the morbid process has occurred, the only rational procedure is the application of the trunk compress with the cold water coil to the spine. The patient may lie for hours, and even days, upon this tubular apparatus. Care should be taken to secure constant renewal of the water, in order that the desired temperature (from 12° to 14° C.—53.6° to 57.2° F.) be maintained. By this means the best service will be rendered the patient. The acute inflammatory process will subside or reach its acme. This procedure will, in addition, have a marked prophylactic influence with reference to certain symptoms, particularly the development of **bed-sores.** Only after the acute inflammatory symptoms have subsided, when a distinct standstill has taken place, may resort be had to half-baths. With reference to the mode of application and the technic, the same statement is applicable as was made in this connection in the foregoing section.

DISEASES OF THE BRAIN AND ITS MEMBRANES

The therapeutic success that can in general be obtained in cerebral affections is quite small. The more noteworthy, therefore, are the reports by a number of writers of the results of the hydriatric management of certain diseases of the brain and its membranes. With reference to the treatment of **cerebrospinal meningitis,** Aufrecht [1] and others report excellent results from very hot baths—40° C. (104° F.)—of ten minutes' duration. The **mode of action** of these baths is not quite clear. Derivation of the blood from the brain and its meninges to the skin, increased secretion of sweat, and thereby elimination of toxins, no doubt play an important part. The baths are said, further, to exert an invigorating influence upon the action of the heart, and to exhibit an anodyne and sedative effect. In addition to the baths, provision should in any event be made for the application of a cold head compress, and cold applications to the nape of the neck, and the vertebral column.

Cooling apparatus of all kinds play an important part in the treatment of the disorders under consideration. In **acute cerebral leptomeningitis** they are almost the sole remedial measures at our command. Recovery, it is true, will not be brought about. The application of cold to the head is useful in relieving **irritation of the meninges,** in which the condition present is dependent upon circulatory disorders, or transitory intoxication, or reflex irritation.

Cerebral anemia is not an independent disease, but only a symptom of a number of diseases of varying character; nevertheless it occupies a far more prominent position from the therapeutic standpoint than a number of organic diseases of the brain, because it not rarely represents a prodromal stage of the latter, and yields to treat-

[1] "Therapeutische Monatshefte," 1894, No. 8.

ment, while the organic disease of the brain, developing out of the anemia, is often incurable. The **acute attack** of cerebral anemia requires generous sprinkling of the face and the chest with cold water. In addition, the disease underlying the anemia should be treated.

Cerebral hyperemia, also, is only a symptom, but one that must receive consideration as the cause of many subjective manifestations and as the point of origin of serious diseases. Under such circumstances all those measures are indicated that were mentioned in the discussion of sleeplessness. **Cerebral hemorrhage,** both during the apoplectic seizure, and immediately thereafter, is treated in the same way as cerebral hyperemia—namely, with the ice cap or cold coil, the trunk compress, sural compresses, and the like.

The treatment of the **paralysis** is begun after all irritative manifestations have subsided, and consists in partial ablutions and tepid half-baths (30° to 28° C.—86° to 82.4° F.). Good results are often obtained from these measures. The treatment of **embolism** varies with the cause. The treatment of the causative disease comprehends also the prophylaxis of hemorrhage and embolism. In the treatment of **psychoses,** hydriatric procedures can often be employed with the greatest utility. The sleeplessness, the states of fear, the maniacal excitement, the sexual excitement, the melancholia, indicate the employment of hydriatric measures; those appropriate in the various special conditions have already been discussed.

DISEASES OF THE JOINTS AND MUSCLES

With regard to the treatment of **acute rheumatic polyarthritis,** as well as **rheumatoid arthritis,** and **arthritis urica** (gout), the statements in previous sections may be referred to.

CHRONIC ARTICULAR RHEUMATISM

At this point some remarks may be made with reference to the simple form of **chronic rheumatic arthritis,** with or without villous formation; for although the pathogenesis is different from that of deforming arthritis, the treatment of this form of inflammation is quite the same as that of the latter disease. In this connection also general measures, particularly those stimulating the functions of the skin and the kidneys, are to be taken into consideration; especially wet packs, steam baths in various forms and of varying duration, followed by a cold rub; sheet baths; half-baths at a low temperature, and of three to five minutes' duration; shower-baths of alternating temperature and of varying duration, in accordance with the conditions present in the individual case. Likewise local stimulating compresses, particularly circular compresses, are employed. The latter are changed only every twelve or even twenty-four hours, and bring about marked improvement, inasmuch as they stimulate the local circulation and thereby absorption of the exudates, and greatly mitigate the severity of the pain. Max Schüller, of Berlin, speaks favorably of this method in the treatment of chronic rheumatic arthritis, and states that with its aid a mitigation of the pain and improvement in mobility can be brought about. Actual recovery occurs only when thickening of the capsule alone, without demonstrable villous formation, has taken place, or when the villi are still relatively small and not too numerous. Dense capsular thickening, as well as moderate villous formation, may undergo complete absorption. If the villi are more marked and more numerous, then the measures mentioned will have only a transitory influence, but in any event they relieve pain and render movement easier. Some cases may by this means be maintained for years in quite a tolerable condition.

In diseases that exhibit a tendency to **ankylosis,** and in which capsular shrinking exists, mobility may be restored by means of wet packs and Scotch douches. The hot-air apparatus recommended by Lindemann and Tallerman, the mode of application and uses of which are discussed elsewhere (see pages 126 and 272), should also be mentioned. Of great importance is the maintenance or the restoration of muscular activity. Especially in the disease under consideration should the greatest attention be given to **atrophy of the muscles.** In affections involving single joints, in cases of **monarthritis,** muscular atrophy is a marked feature. Under such circumstances the articular disease, as well as the muscular atrophy, may be treated by simple procedures, and especially with the Scotch douche. The powerful thermic and mechanical stimulation of this measure, the 'thermic contrast' effect, induces a better state of nutrition in the tissues, and, as a matter of fact, increased functional capacity is exhibited after their employment, as may be illustrated by dynamometric tests. The increased functional activity must, however, be maintained and increased, and accordingly the procedures must be repeated frequently. The application to the atrophied or atrophying muscles of a simple cold shower-bath, followed by a movable cold fan douche, both of exceedingly short duration, has an excellent effect in this condition. I may recall the experiments of Vinay and Maggiora, who demonstrated by ergographic means the usefulness of such measures. The wet packs are further lauded also, among Russian writers, by Stellmachovich and Tscherniavsky. These applications are doubly efficacious, as they influence favorably the articular disorder, and distinctly increase the muscular vigor. Massage is of great utility; it should, of course, be employed without giving pain, and only after the electrocutaneous sensibility has been diminished by the method of Drosdorff. A faradic current is passed through the joint for a period of from ten to fifteen minutes. This is followed by such marked lessening of the tenderness in the joints that massage can be employed.

ACUTE AND CHRONIC MUSCULAR RHEUMATISM

Of **diseases of the muscles**, the 'rheumatic' affections, **acute muscular rheumatism**, involving certain muscles or groups of muscles, should be mentioned. The muscles of the neck and of the lumbar region are specially predisposed to this disease, which accordingly appears most frequently in the form of **lumbago**, and of rheumatic **torticollis**. Nevertheless not all patients comprehended under this designation suffer from rheumatism. **Strain** and **laceration** of muscle-fibrils, and **muscular spasm**, are frequently confounded with muscular rheumatism. Fortunately, they disappear under the same procedures as the true rheumatic diseases.

With reference to the mode of origin or **pathogenesis** of these affections, which is practically the same as that of neuralgia, the same procedures should be employed that we have seen to be successful in the treatment of the latter. The underlying principle of the treatment is comprised in the formula, thermic contrasts. Procedures with alternating temperature in varying form, as has been repeatedly stated, are often attended with incredibly rapid success. The earlier the treatment is instituted, the more rapidly does recovery take place, and in cases of recent development, the symptoms may often be observed to disappear after a few applications.

In **chronic muscular rheumatism**, procedures with alternating temperature, which of course must be adapted to the indications in the individual case, will likewise yield good results.

CHAPTER IV

DISEASES OF THE RESPIRATORY ORGANS

Pulmonary Tuberculosis. Bronchitis. Pneumonia. Pleurisy.

PULMONARY TUBERCULOSIS

Hydrotherapy is capable of effecting much good at nearly all stages of pulmonary tuberculosis. It is of great prophylactic importance when a predisposition to tuberculosis exists; it may do excellent service in the treatment of the developing disease; and it sometimes brings about remarkable results in cases of the developed disease, even in those of florid tuberculosis. Suppression of the fever and of the night-sweats, increase in body-weight, diminution in cough and in expectoration, subsidence of the subjective symptoms, improvement in the local condition, are among the constant results of rationally directed hydrotherapy.

Prophylaxis

The question to be answered first is, What **indications** are to be met by hydrotherapy in the prophylaxis of pulmonary tuberculosis, and what **remedies** are available for this purpose? It is a fact, admitted by all writers at the present day, that the tubercle bacillus alone is not capable of causing tuberculosis, but that, in addition, there must be either a congenital or an acquired predisposition. The question as to what is really to be comprehended in **predisposition** is difficult of answer. If it be described as an enfeeblement of the vital processes, reduced activity of the organic functions, diminished resistance and so forth, little information is thereby imparted. It is not known upon what the enfeeblement of the vital processes depends, and we must be satisfied with the knowledge that certain indefinable alterations in circulatory and innervational conditions, in metabolism, in the cells and tissues, and in the state of the blood, exist. It is admitted by all writers that in cases of tuberculosis, and in individuals predisposed to this disease, there is a specially marked increase of reflex irritability in the peripheral terminations of the sensory nerves. It is further known that all persons included in these groups exhibit a blood-state resembling that of anemia or chlorosis. The reduction in the number of red blood-corpuscles, and in the percentage of hemoglobin is a constant feature in individuals predisposed to pulmonary tuberculosis. Likewise, lowered blood pressure and accelerated action of the heart are among the manifestations almost constantly observed. All of these factors must be taken into consideration in the institution of those prophylactic measures that occupy the first place in the treatment of pulmonary tuberculosis, and which may be comprehensively included under the term **hardening.** The purposes to be accomplished by this process are clearly indicated—namely, improvement in innervation and circulation, invigoration of the heart, and improvement in hemogenesis and in respiration; and it should always be a fundamental principle to avoid every unnecessary loss of heat. The hardening process thus corresponds with invigoration, and powerful thermic and mechanical measures and those of short duration are therefore best adapted for the purpose. This process should be begun in earliest youth. It is best, in the case of **infants** and **very young children,** to proceed as follows:

At the end of the first week cool water is added to the usual daily cleansing bath, and it is gradually reduced to a temperature of 30° C. (86° F.). At the conclusion of the bath, cooler water, at a temperature of about 24° C. (75° F.), is poured upon the trunk of the child. This is followed by vigorous friction with a dry towel. The bath should not be colder during the first year, although the temperature of the water employed for the affusion should gradually be lowered. Toward the end of the period of lactation a temperature of 20° C. (68° F.) may be reached. From the second year on, the affusion alone will suffice. This should be practised daily in the morning. The temperature of the water need not now be accurately determined. During the winter, also, water that has stood for several hours in a closed room will be suitable. Subsequently, still colder water should be employed.

A point that has already been mentioned, and that cannot be too strongly emphasized in this connection, is never to abstract heat. The bath or the affusion should be employed as the patient gets out of the warm bed, and should never be too protracted. It is to be remembered that the more vigorous and the shorter the thermic and mechanical stimulation, the more pronounced will be the reaction, and with slight loss of heat. If the person to be treated is a **delicate adult,** the cold rub, immersion baths, short cold vigorous shower-baths, and also partial rubs may be employed for the purpose of hardening. Some writers recommend after previous ablution or cold rub that the patient return to bed, in order to await restoration of the heat of the body. I do not consider this advantageous in general, although it may be indicated in the case of anemic individuals with impaired nutrition, or for those in whom the treatment is begun at an advanced age.

Treatment of Pulmonary Tuberculosis

We may now take up the treatment of fully developed pulmonary tuberculosis. The treatment of tuberculosis must be a potentized hygiene. The most favorable conditions for recovery will not be provided by any single curative factor, but by an intelligent combination of all physical methods of treatment. Let emphasis be given by repetition : All physical remedial measures and methods of treatment must be drawn upon in the treatment of pulmonary tuberculosis. Then, and not till then, will the physician have performed his whole duty in the management of his tuberculous patients.

The question has been asked repeatedly, whether the **indications from the bacterial standpoint** will be fulfilled by hydriatric measures. We can answer this question emphatically in the affirmative. Numerous investigators have made the curative process in the lungs dependent upon the active circulation of this organ, on the assumption that the active circulation of normal blood constitutes the best bactericidal agent. No form of treatment is capable of inducing active hyperemia, an increased flow of blood to and from the diseased parts, in such a degree as is hydrotherapy. One of the essential effects of this method is the strengthening of the circulation, the removal of the circulatory weakness in the lungs, of the obstruction in the lesser circulation, and the improvement in the flow of blood through the lungs. The simplest, and at the same time the most efficient measure for the attainment of this object is the use of the crossbinder. By means of this the best circulatory conditions in the lungs are established. The employment of the crossbinder for months brings about conditions that are inhibitory to the development of the bacilli, and induces **reactive inflammation,** limitation, destruction, elimination, and also **absorption** of the diseased tissues. A second and highly important measure for improving the circulation and for fulfilling all of the requirements present is the cold precordial coil. A strengthening of the action of the heart, an increase in vascular tone, an **induction of active hyperemia** in the diseased organs, will be certainly brought about by means of this application. Finally, general invigorating procedures involving the entire surface of the body will, in addition to the effects enumerated, render possible the invigoration of the organism as a whole.

Certain **individual symptoms** may likewise be successfully attacked.

Anorexia, upon which depends essentially the unfavorable outcome of the disease, may be combated by means of an abdominal binder, containing a rubber coil heated by water at a temperature of 40° C. (104° F.).

Cough and **difficult expectoration** are best relieved by means of the crossbinder.

Pulmonary hemorrhage is most efficaciously treated by means of small ice-bags placed in the supraclavicular fossa over the thinnest portion of the crossbinder, and covered with the dry portion of the latter. In this condition, also, the precordial coil renders good service. If, however, the pulmonary hemorrhage is of a **passive** character, as occurs frequently in cases of tuberculosis, invigorating measures are indicated.

Fever.—Hydrotherapy subserves an important function in the treatment of the fever. The requirements of any form of therapy in this condition are quite clearly defined ; they are evident from the origin of the fever. **Relief from heat-retention, prevention of excessive temperature, checking of sweating,** are the indications under such circumstances, and these are best fulfilled by means of partial ablutions or the cold rub. In this connection hydrotherapy is far superior to all other methods of treatment.

I would **summarize the plan of treatment** to be pursued in a case of pulmonary tuberculosis, as follows: In the **morning** immediately upon getting out of bed, a cold rub—10° to 12° C. (50° to 53.6° F.)—or a partial ablution with water of the same temperature, is practised. In the case of **febrile, bedridden patients,** this should be followed by the application of a crossbinder in which, in the course of the morning, the precordial coil is introduced for from half an hour to an hour. A febrile patient should lie down for the necessary period of time in the course of the morning, for the purpose of applying the precordial coil. In the **afternoon** the application of the precordial coil should be repeated, and on its removal, a very cold shower-bath—10° to 12° C. (50° to 53.6° F.)—of a quarter of a minute's duration be taken. Before going to bed a partial ablution or a cold rub should be given as in the morning, and this should be followed by the application of a crossbinder. Individual symptoms should be treated in accordance with the principles previously stated.

Aberg,[1] a distinguished Swiss physician, recommends a **special method** which is readily carried out, is really serviceable, and has also been highly praised by Winternitz. Three procedures represent, as it were, three different stages or grades of the treatment :

1. Sponging the neck, back, face, and chest, at first for only a short time and superficially, with an expressed sponge, followed immediately by thorough drying of the parts treated. At the beginning this is practised only in the morning, but later, both morning and evening, the sponge being less thoroughly expressed. Reaction is

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[1] "Reichs-Medicinal-Anzeiger," 1895.

permitted to take place in bed or in the open air. The temperature of the water should be 0° C. (32° F.).

2. As a measure of the second degree Aberg applies affusions to the head, neck, back, face, and chest, from a watering-pot. The application is repeated, and the subsequent treatment is the same as with the measure of the first degree. The temperature of the water is also 0° C. (32° F.).

3. The third degree of Aberg is the full bath of but momentary duration, the entire body being immersed, including the head. Thorough drying is practised as after the other procedures. The temperature of the water is from 7° to 12° C. (44.6° to 53.6° F.).

Aberg presents his method as the outcome of twenty-two years' experience, and gives the records of cases as an evidence of the extremely favorable results of his plan.

BRONCHITIS

The treatment of acute, chronic, and capillary bronchitis is based upon the same principles that have already been laid down. At this place especial attention need be directed only to certain factors. It should first of all be pointed out that **acute bronchitis** can be and is successfully **aborted** by means of artificially induced diaphoresis. For this purpose the wet pack of a duration of at least one and a half to two hours is most serviceable. This is followed by friction. Especial consideration should be given to **acute bronchitis in the aged**, particular attention being directed to the heart. Further, the **fever** should be counteracted as far as possible. The precordial coil, the crossbinder, partial ablution, with vigorous thermic and mechanical stimulation, frequently repeated, three or four times daily, are the most suitable measures. The trunk compress may, if necessary, be resorted to in the treatment of the disease. The same considerations are applicable also to the treatment of **emphysema.**

Capillary bronchitis is likewise treated by means of vigorous thermic stimulation. In this connection I would refer to the treatment of pneumonia in childhood (p. 139).

In the treatment of **chronic bronchitis** the cold rub and the crossbinder play the most important part.

PNEUMONIA

With regard to the treatment of pneumonia reference may be made to what has already been stated. In that connection pneumonia in childhood especially was discussed, but from such standpoints as are applicable as well to the treatment of pneumonia in adults. In adults also two factors must be taken into consideration: the **fever** and the **action of the heart.** With regard to the treatment of these symptoms reference may be made to the sections dealing with the infectious diseases in general. At this place I would direct especial attention also to the circulatory conditions in the **aged.** Here a double object is to be fulfilled—namely, the prevention of cardiac weakness, and correction of such weakness of the heart as has already developed. In **obese** patients, too, especial consideration should be given to the heart. In both instances temperatures of not too low a degree, with vigorous mechanical stimulation, are indicated. It is best to begin with partial ablutions, and then to pass on to moderately cool half-baths—25° to 23° or 22° C. (77° to 73.4° or 71.6° F.). When the patients are greatly debilitated, colder water should be employed, and the duration of the bath should be shortened; or the bath may be given at a higher temperature, at about 26° C. (78.8° F.), but with a copious affusion of cold water. The employment of the precordial coil plays an important part here also. "One who undertakes the treatment of pneumonia with cold baths will do well to administer wine as a stimulant for the heart before and after the bath." This advice of Jürgensen's can be fully indorsed. If **cardiac weakness** develop unexpectedly, tepid baths at the temperature of the body, with cold affusions, render good service in addition to the usual subcutaneous injections of medicinal substances. In drunkards, also, especial attention should be given to the heart. In America especially, following the suggestion of F. P. Henry, of Philadelphia, saline infusions are extensively used in cases of acute lobar pneumonia (see p. 294).

PLEURISY

The treatment of pleurisy is one of the most thoroughly investigated chapters in therapeutics. It is therefore the more remarkable that in few books can even a single word be found concerning the hydriatric treatment of this disease. Nevertheless hydrotherapy is most valuable in this connection.

In **dry pleurisy** the indication is the relief of the principal symptom, the stabbing pain upon the affected side of the chest, the resulting dyspnea, and dry cough. Under these circumstances a crossbinder containing a rubber coil, through which cold water is passed, renders remarkable service. The reduction in temperature, as has been shown by thermometric observations, extends to a sufficient depth to exert an **antiphlogistic** effect upon the disease-focus. An effect of this method of treatment that should not be underestimated is, further, the **relief of pain.** The patient becomes conscious of great amelioration immediately after the application. The usefulness of the cold water coil is further increased by the fact that the changing of compresses—so annoying and painful, when frequent—is omitted for a considerable time, this being done at most twice daily for the purpose of making other applications or of changing the cloths used for the compresses. Wet packs of one or two hours' duration, followed by friction, or a cool half-bath (22° to 20° C.—71.6° to 68° F.), are further successfully employed in the treatment of dry pleurisy. They exert a causal influence when the disease is dependent upon exposure to cold. Often the process subsides after a single application.

In the **after-treatment of simple dry pleurisy** it is advisable to practise daily in the morning a cold rub in a sheet dipped in very cold water—10° to 12° C. (30° to 33.6° F.)—and well wrung out. The cold rub fulfils the purpose of adequate respiratory gymnastics, and facilitates the correction or the prevention of extensive adhesions.

In the treatment of **exudative pleurisy** two phases must be distinguished. In the first stage **antiphlogistic** and **anodyne** measures occupy the first place, and those to be employed are naturally those that are used in the treatment of dry pleurisy. The control of the fever generally plays a subordinate rôle, inasmuch as the elevation of temperature is usually moderate. The wet packs, which have already been spoken of, may, however, be employed here, in case the fever is excessively high, in the form of alternating packs, for the moderation of the fever, and then as a pack of long duration, as in the treatment of dry pleurisy.

In the second phase of the treatment the principal object is to induce **absorption** of the exudate. Naturally, the discussion will apply only to serous exudates. Absorption can be hastened by increasing elimination. All measures that tend to increase diaphoresis and diuresis will lead to the desired result. Steam cabinet baths, or hot-air baths of ten to fifteen minutes' duration, followed by stimulating procedures, or wet packs of long duration, followed by similar measures, will bring about rapid absorption of the exudate. At the same time these measures will bring about a **general improvement,** and this is a matter of considerable importance in the presence of pleuritic exudates, which, in the majority of cases, develop upon a dyscrasic basis; or, if of long standing, cause a reduction in the resistance, and, as a result thereof, tuberculous disease of the lungs. A crossbinder changed every three hours supplements the treatment directed to the absorption of the exudate. An admirable method of stimulating sluggish absorption has been proposed by Fodor, of

Vienna. This consists in the application of a vigorous horizontal douche, with a divided or a concentrated stream, to the affected half of the chest for a period of several seconds. The procedure is believed to act as a sort of vigorous concussion in a manner similar to the method of vibrations practised by Swedish mechanotherapeutists for the purpose of hastening absorption of deeply situated exudates. The application of the local douche is made after a half-bath or after a rub.

In the **acute stage of pleurisy,** and in the presence of exudates occupying the entire pleural cavity and giving rise to symptoms of suffocation, vigorous procedures will naturally be avoided, and those sorbefacient measures resorted to that are applicable with the patient in a state of rest—such as packs and compresses. Subsequently, if necessary, the more radical remedial measures described may gradually be resorted to. If the pulse becomes frequent and small, an attempt should at once be made to avert the threatened cardiac weakness. The precordial coil is the cardinal remedy.

CHAPTER V

DISEASES OF THE CIRCULATORY APPARATUS

Acute and Chronic Endocarditis. Treatment of Cardiac Insufficiency. Pericarditis. Arteriosclerosis. Hemorrhoids.

ACUTE AND CHRONIC ENDOCARDITIS

In accordance with the course hitherto pursued, we shall first take up for consideration here the indications to be fulfilled, and the manner in which hydrotherapy meets the demands.

Therapeutic Indications.—The general indication in chronic cardiac disease is to favor the development of **compensatory hypertrophy,** which may require as special objects: (*a*) to stimulate the heart to increased activity, (*b*) to maintain the functional activity of the heart for so long a time as possible, or (*c*) to overcome the abnormal resistance in any given portion of the vascular system.

Stimulation.—As shown by the investigations recited in a previous chapter, there is not the slightest doubt that it is possible by means of hydriatric measures to stimulate the heart to increased activity—to bring about adequate and vigorous contractions and thereby a strengthening of the heart muscle with the development of compensatory hypertrophy. For this purpose we make use both of **local measures**—that is, applications to the precordium—and of **general applications** involving the entire surface of the body. Winternitz,[1] Pospischil,[2] Silva,[3] and many others have shown by means of sphygmographic and sphygmomanometric studies how greatly the local application of cold stimulates the action of the heart and strengthens the contractions. The invigoration of the heart muscle brought about through such measures is in many cases so persistent that the effect continues for a long time after the application has been withdrawn. General measures acting on the periphery of the entire body also exert a favorable effect in this connection. Every thermic stimulation affecting the surface of the body induces at first acceleration and invigoration of the action of the

[1] "Blätter f. klin. Hydrotherapie," 1891, Nos. 6 and 7.
[2] Ibid., 1894, No. 12; 1895, No. 4.
[3] "Riforma Medica," 1886, p. 253.

heart, acting upon the heart muscle in the manner of gymnastic exercises.

Without doubt a great danger resides in strain of the diseased heart and the resulting dilatation of its cavities. This danger must be the greater, the more pronounced is the resistance to be overcome by the heart.

Reduction of the Resistance.—The heart may become incapacitated in consequence of disease of the myocardium (absolute incapacity); or it may become incapacitated with reference to the existing resistance (relative incapacity). In both instances treatment is capable of accomplishing much good by removing or lessening abnormal resistance. Hydriatric measures cause especially, in sequence to temporary contraction, an active dilatation of the peripheral vessels—that is, dilatation of the vessels with preservation of their tone; provided, of course, that appropriate thermic and mechanical stimuli are employed. In this active dilatation of the cutaneous vessels resides the great value of our treatment. It can readily be understood that by means of a diminution of the resistance in a vascular system of such great extent and importance as that of the skin, the heart is relieved of much of its burden; but this is not the sole benefit afforded. The peripheral vessels are stimulated by the thermic irritation to an independent activity which assists in the propulsion of the blood, and by means of which the heart is additionally relieved.

In some instances, however, a **counterindication** to the employment of measures involving the entire surface of the body arises from an effect already mentioned—the primary contraction of the peripheral vessels. The cold rub, for instance, induces primarily powerful contraction of all of the cutaneous vessels affected. It increases, thereby, although only for a short time, the resistance in the peripheral circulation, which, in certain cases, is carefully to be avoided.

Increase of Nutrition.—A further favorable effect of hydriatric measures is **the prolongation** of the nutritional **rest-intervals** of the heart. The greater the interval between two systoles, the more vigorous will each be. Therefore the greatest importance has always been attached, in the treatment of diseases of the heart, to measures that tend to quiet the cardiac activity, and to lessen the frequency of contractions. The cold precordial coil, which in many other respects is comparable to digitalis in action, induces, like digitalis, slowing of the pulse, by prolongation of the diastole—the anabolic rest-interval—of the heart, and thereby a more vigorous systole with increased pressure in the arterial system.

The effect of hydriatric procedures in **deepening respiration** is of great importance; by this means a more rapid movement to the right heart, of the blood stagnating in the veins is inaugurated. The deepened breathing provides room for the entrance of blood into the lungs, favors better absorption of oxygen, and facilitates the discharge of blood from the lungs back to the left heart.

Dropsy.—Next to dyspnea, the most serious consequence of high degrees of general circulatory disturbance is **dropsy**, the lessening or the removal of which is accordingly one of the most important objects of treatment. The use of the precordial coil is calculated to fulfil this indication. In this connection also the precordial coil exhibits an action analogous to digitalis. The increased pressure in the aortic system induced thereby gives rise also to a change in secretion. It increases the latter, stimulates powerfully the absorption of transudates, and increases their elimination. For the attainment of this object those measures, further, are available that prepare the way for increased elimination of water through the skin. As has already been pointed out, the **insensible cutaneous transpiration** may be doubled or more greatly increased by simple friction with a dry cloth. If the mechanical stimulation be combined with thermic stimulation, the elimination of water will be still further increased. Partial ablutions completely fulfil this object; as do also wet packs to individual parts of the body, particularly the lower extremities. Circular compresses, about dependent parts, likewise increase the perspiration, and contribute materially to the removal of edema.

A favorite diaphoretic procedure consists in stimulating the secretion of sweat in the steam bath. Before the employment of the steam cabinet bath is decided upon, it is, however, advisable to bear in mind that the secondary effects of the steam bath consist in elevation of the body-temperature and acceleration of the action of the heart; effects that in the conditions under discussion are not only not desired, but which, on the contrary, must be counteracted. The only good effects of such procedures are the increase in transpiration and the stimulation of metabolism. We know how injurious, in acute febrile disease, is the influence exerted by the elevation of temperature upon the heart's action and the vascular tone, and for this reason great caution is advisable in the employment of the steam bath.

By means of the Winternitz steam tub bath the possibility is afforded of stimulating the secretion of sweat, while keeping in view the factors mentioned. The action of the heat is limited to the lower half of the body, or below the costal arch, inasmuch as the blanket is not closed about the neck, but beneath the arms. We combine with the steam bath prepared in this manner the application of the cool precordial coil, and in this way have provided a measure which will exert a useful effect in two directions with reference to the absorption of transudates and of edema, but in which the injurious effects are in part greatly diminished by restricting the application to the lower half of the body, and in part effectually neutralized by the simultaneous cooling application to the heart.

We have thus in the practice of hydrotherapy means by which to fulfil all of the indications presented by chronic cardiac disease. Invigoration of the action of the heart, now with coincident retardation, now with acceleration of its rate; enlargement of the volume of the pulse-wave; heightening of the tension and better filling of the arteries; lessening of the irregularity of heart or pulse; reduction or increase in the circulatory resistance; deepening of the respiration; improvement in secretion and in the elimination of exudates, are the requirements at different times; and these, as has been shown, we are able to meet by hydriatric procedures. The ultimate object of our treatment is the attainment of **increased power with diminished work**; and although it is also possible to attain this end by means of drug-giving, we must for many reasons give the preference to hydrotherapy.

Digitalis and Hydrotherapy.—A comparison may be made between the cardiac medicament most commonly employed—digitalis—and hydriatric methods of treatment. It should be stated here that the hydrotherapeutist cannot dispense with the use of digitalis, and has no wish to do so; but he employs it much less frequently than is customary in ordinary practice. That the effects of judiciously selected hydriatric measures are like those of digitalis, is evident from the foregoing description. They may, therefore, be used as a perfect substitute for this drug in those cases in which the employment of digitalis is, for the hydrotherapeutist, not yet indicated. For example, it is not necessary to resort to digitalis when the patient complains only of unpleasant sensations in the precordium, of palpitation, of shortness of breath, of irregularity in the action of the heart. One application of the precordial coil is sufficient to relieve these symptoms. Resort to digitalis is thus deferred; and, in consequence, its aid may prove effective at a time when those who had already begun its employment at the stage under consideration are no longer able to obtain results, because the muscular and nervous structures of the heart are no longer susceptible to the action of the drug.

Advantages of Hydrotherapy.—The advantage of hydrotherapy over treatment with drugs consists, therefore, first, in the fact that the susceptibility to the measures does not diminish by reason of their early or protracted employment. A second advantage consists in the fact that whereas the effects of digitalis are brought about in part by contraction of the peripheral blood-vessels, hydriatric measures raise the blood pressure through increase in muscular power; and thereby we avoid a contraction that heightens resistance and thus draws upon the final reserve power of the heart muscle. Further, an important advantage of hydriatric measures consists in the fact that it is possible through them to stimulate the heart to due activity at a time when this organ has become insusceptible to the action of the entire range of heart-tonics of the materia medica. In this way it is possible still further to improve the action of the heart, to change the quality of the pulse, and to render the heart muscle amenable to the influence of digitalis. Finally, the circumstance must be taken into consideration that the cumulative effect of digitalis does not appear when the precordial coil is employed. The precordial coil also plays the rôle of a prognostic aid. Should digitalis fail,—and this is the case when there is marked degeneration of the myocardium,—but the heart muscle still react to the precordial coil, the prognosis may, as an abundant experience has shown, be considered favorable, both with regard to the continuance of life, and to improvement, even though but temporary, of the condition. If the precordial coil fails to produce a good reaction, then the prognosis must be considered unfavorable.

It will not be difficult, from what has been said, to formulate the treatment in the individual case. The ends to be attained, and the mode of action of the available hydriatric procedures, are questions that must constantly be kept in mind, if the proper indications are to be laid down.

Acute Endocarditis

In **acute endocarditis** the indication for treatment is to quiet the heart. Any violence of cardiac action must be prevented on account of the danger of embolism. The precordial coil alone meets fully the indications present under such circumstances. It may be permitted to remain in place for hours, and even for days. Every other form of active treatment should be avoided on account of its uselessness. Only when cardiac weakness is threatened are stimulants indicated. During **convalescence,** gymnastic exercises for the myocardium are indicated. The heart muscle must be strengthened in order that it may attain at the earliest moment possible that measure of power that it will require permanently to overcome the circulatory obstruction. Partial ablutions and partial rubs are admirably adapted for this stage. As soon as the first signs of cardiac weakness appear that arouse fear of the development of disturbance of compensation, or when the beginnings of the latter have already made their appearance, then rest and cooling apparatus are again appropriate. The duration of each application of the precordial coil under such circumstances depends upon the factors present in the individual case. If the power of the heart is increased, if the quality of the pulse is improved, if the irregularities and the subjective symptoms are relieved, then the cooling apparatus has fulfilled its purpose. I do not mean by this to say that the coil should then be entirely abandoned as a remedial measure, as it should still be applied once or twice daily for from half an hour to an hour at a time with the object of invigorating the heart muscle. The occurrence of disturbance of compensation will thereby be prevented. Partial ablutions practised daily in the morning immediately on getting out of bed complete the plan of treatment. In addition to the necessary exercise of the heart muscle, they will induce active dilatation of the peripheral vessels, overcome circulatory resistance, and thus favor recovery.

Treatment of Derangement of Compensation

As soon as the familiar symptom-complex—edema, diminished secretion of urine, small, irregular pulse, dyspnea—has developed, the question will arise, What is the condition of the heart muscle? If the myocardium is insufficient because degenerative changes have taken place in it, then I generally proceed in the following manner: Partial ablutions are practised before the precordial coil is applied. Under such circumstances the peripheral circulatory resistance should, above all things, be overcome, the *vis a tergo* increased. Perhaps it may be possible by this means to stimulate the heart enough to enable it to perform the lessened amount of work thus prepared for it. It has already been mentioned that the primary contraction of the vessels attending partial ablutions constitutes a sort of gymnastic exercise for the heart. In order that the heart shall not be strained, I do not practise partial ablution of the entire body on the first day. I make a partial ablution of the lower extremities suffice. Not before the second day, or perhaps on the first day, but at a later hour, I extend the partial ablution to the trunk. On the following day the entire body is sponged, and now for the first time I apply the precordial coil. Success has never been wanting when this method has been pursued, and I have always secured the desired results from the two procedures at this stage of the disease.

Treatment of Cardiac Insufficiency

If the cardiac muscle be insufficient with reference to the existing circulatory obstruction then the indication is all the more urgent to employ general procedures; that is, such as involve the entire surface of the body. Under such circumstances also it is advisable to begin with partial ablutions, which, however, should later be extended to the entire body. Immediately after the partial ablution I apply the precordial coil for one or two hours daily. If necessary, the partial ablution may be practised twice daily. At this stage the application of a rubber coil to the nape of the neck also is indicated. This reinforces the action upon the heart of the partial ablution and of the precordial coil, through its effect upon the sympathetic and the vagus. The heart, which has become insufficient in the effort to overcome abnormal resistance, will most readily regain its contractile power as a result of this treatment. When the circulation is as completely restored as possible, the work of the heart may be progressively increased. In addition to massage and passive gymnastics, which are strongly indicated at this stage, the employment of half-baths, vigorous cool shower-baths of short duration (one-quarter of a minute), and cold rubs of one to two minutes' duration, are advisable. The degree to which an increase in the demands upon the heart appears permissible will always be best determined by observing whether or not the procedure gives rise to marked palpitation of the heart or dyspnea of considerable duration. If the cases are individualized carefully,—and this is absolutely necessary,—it will not rarely be found that patients with profound circulatory derangement regain their original functional ability. On the other hand, cases frequently occur in which, in consequence of premature or excessive use of applications involving at once the entire surface of the body, the cardiac insufficiency that has just been corrected immediately returns. Care is therefore demanded in the institution of the measures named.

Should the **edema** not subside under the treatment outlined, should **hypostatic manifestations and albuminuria** persist, cautious employment of the steam bath in the tub should be resorted to. As has already been mentioned, the application of the precordial coil should be conjoined with this procedure. Under such circumstances the treatment may so be carried out that the steam bath is preceded by the employment of the precordial coil, and that the latter remains in position throughout the duration of the bath and even for some time afterward. The duration of the steam bath is from five to ten minutes, that of the application of the precordial coil from thirty minutes to one hour. It may therefore be readily deduced from this statement how long before and how long after a steam bath the precordial coil should remain in place.

Circular compresses around the lower extremities, and trunk compresses changed every three hours, will contribute, as has been mentioned, to the stimulation of absorption and to the relief of the symptoms of stasis.

PERICARDITIS

In addition to the rest that will naturally be observed, it is from the precordial coil, cooled by the continuous flow of cold water, that the best results may be expected in the treatment of pericarditis. This measure plays the part of a powerful antiphlogistic, quieting the action of the heart and mitigating the severity of the pain. The application of cold is continued as long as necessary to bring about complete disappearance of the inflammatory manifestations. It may be continued for weeks without unpleasant or injurious secondary effects. If the application of cold becomes annoying to the patient, it may be suspended for a short time and be replaced by a stimulating compress.

In cases of **chronic pericarditis**, with the persistence of an effusion for a long time, unless tuberculosis be the cause of the pericarditis, diaphoretic procedures may be employed, naturally with the care that has been described as necessary in the use of diaphoretic procedures in the treatment of endocarditis. A wet pack in combination with the precordial coil, for a period of an hour to one and a half hours, is best borne by these patients. The **fever** may in this disease reach an unusually high level. Under such circumstances intense cold in the form of half-baths is indicated.

ARTERIOSCLEROSIS

The most important point in the treatment of arteriosclerosis is to lessen the resistance that is both the cause and the effect of the disease. In a **prophylactic** direction great service will be rendered by means of all measures that diminish circulatory resistance, increase the blood stream in the arterial system, and lower the blood pressure. The applications that may be employed under such circumstances consist, first, in the cold precordial coil and cold spinal coil. In addition to these, resort may be had to wet packs of three-quarters of an hour's duration, with subsequent cooling procedures; or to diaphoretic measures that do not greatly increase the circulatory activity, therefore in combination with the precordial coil; or steam baths, with subsequent cooling, may be employed. In the presence of **marked arteriosclerosis** the treatment is most advantageously begun with partial ablutions. After this procedure has been employed for a considerable time, resort may be had to the full cold rub, or to shower-baths at alternating temperatures. If there exists a tendency to congestions, running foot-baths, sural compresses, and trunk compresses are indicated. In all cases of arteriosclerosis especial provision should be made to prevent **hypostatic congestion** before the employment of any procedure. Neither arrhythmia nor albuminuria constitutes a counterindication to hydriatric measures. Collateral symptoms, such as **sleeplessness, asthma, angina pectoris, digestive disturbances, constipation,** and **bronchial catarrh,** should be treated in accordance with the principles already laid down.

DILATATION OF THE HEMORRHOIDAL VEINS

In the treatment of this disorder the etiology, with reference to possible disease of the liver, heart, or lungs, and constipation, should especially be taken into consideration. Cold sitzbaths of short duration are the most important procedures in the treatment of hemorrhoids. They are capable of relieving not alone the constipation, but also the venous stasis. A further most important aid is the use of Atzberger's rectal irrigator. **Inflamed venous nodules** and freely bleeding nodules are advantageously treated with cold sitzbaths of long duration. In **proctitis** and **periproctitis** following hemorrhoids, the cold sitzbath of long duration and the rectal cooling apparatus are indicated.

CHAPTER VI

DISEASES OF THE DIGESTIVE ORGANS

Diseases of the Stomach—Nervous Dyspepsia; Chronic Gastric Catarrh; Acute Gastric Catarrh; Ulcer of the Stomach; Atony and Dilatation. Diseases of the Intestine—Diarrhea; Intestinal Catarrh; Constipation; Acute Enteritis; Catarrhal Jaundice. Acute General Peritonitis and Perityphlitis. Diseases of the Biliary Passages and of the Liver—Cholelithiasis; Hyperemia of the Liver.

DISEASES OF THE STOMACH

Hydrotherapy plays in the domain of digestive diseases not alone the rôle of an auxiliary measure, but also that of a curative agency; and it is applicable almost unexceptionally, at least with some degree of success, in every form of gastric disease. Its influence upon motility, secretion, absorption, and sensibility is more marked than is observed from any other method of treatment. A most important influence is to be attributed to hydrotherapy in increasing the general strength and the functional power of the organism, while it powerfully stimulates the absorptive power and the utilization of the food.

Nervous Dyspepsia

The prototype of all chemical, motor, sensory, and secretory disorders of the functions of the stomach is presented by nervous dyspepsia.

In this disease hydrotherapy is of great service, both from the symptomatic standpoint and with relation to the general condition. The postulates that should be applied to a rational method of treatment are: Improvement of innervation, but no powerful stimulation; rapid restoration of warmth, but no abnormal elevation of temperature; invigoration, but with simultaneous consideration of the action of the heart; increase in the number of red corpuscles in the circulating blood; deepening and slowing of the respiration. In this sense—always, of course, making allowance for the conditions present in the individual case—good results will be obtained from a cold rub immediately on getting out of bed, in a sheet at a temperature of from 12° to 18° C. (53.6° to 64° F.), for a period of two or three minutes; the patient being permitted to lie in bed without being dried, with the windows open, particularly in the case of debilitated patients incapable of engaging in exercise for the purpose of bringing about successful reaction. Vigorous cold shower-baths of short duration, brief plunge baths, and rapidly applied cold affusions to the entire body—10° to 16° C. (50° to 60.4° F.)—will be equally successful. The amount of blood and the activity of the circulation in the gastric mucous membrane, and the tone of the muscular layer, are responsible for the secretion furnished by the glands of the stomach. By means of procedures, therefore, that increase or diminish the circulation, the innervation, and the tone of the stomach, it will be possible to exert an influence upon the secretion that is of great importance in the treatment of nervous dyspepsia. In this connection sitzbaths, by means of which, as is well known, it is possible almost arbitrarily to control innervation and circulation, play an important rôle. Cold sitzbaths of short or of long duration will be employed successfully in accordance with the indications present. Of equal importance is the abdominal binder; further, the combination trunk compress, with the hot rubber coil. The **cramp** and **peristaltic unrest** especially will be favorably influenced by the latter procedure. The **reflex irritability** of the stomach will be diminished. Such good results are obtained from this application that it is appropriately considered one of the most valued hydriatric measures in gastric cases, and, next to the abdominal binder, it has, of all the procedures of hydrotherapy, most rapidly found its way into general use. Its action in the presence of gastralgia of nervous origin, and of vomiting of nervous origin, is actually brilliant.

Chronic Gastric Catarrh

A similar course is pursued in the treatment of this disease. Independently of the cause to which the chronic gastric catarrh is to be attributed, the conditions to be dealt with consist especially in changes in the circulation in the gastric mucous membrane, which naturally exert an injurious effect upon the secretion of the gastric juice and the absorption of the contents of the stomach. The secretory disturbance soon becomes associated with **atony** of the muscular layer, with deficient peristalsis, which in turn may give rise to marked **dilatation.** Under such circumstances likewise it is desirable to improve innervation and circulation, both generally and locally, by means of general tonic measures. Further, the endeavor should be made to fulfil the indications presented by local symptoms by means of local treatment. These indications will be found in full measure in cases of chronic gastric catarrh. Sitzbaths, the abdominal binder, and Winternitz's combination compress constitute here also the cardinal remedies, after the general procedures; and even in neglected cases successful results will be obtained such as would fail to follow with equal promptitude upon the institution of other measures. In symptomatic catarrhal conditions rational dietetic regulation must, of course, be insisted on.

Acute Gastric Catarrh

Active intervention is rarely called for. All indications will generally be met by the application of an abdominal binder, which is changed every two or three hours. The elevation of temperature, like other febrile manifestations, has a tendency at times to attain a high degree. It then indicates the employment of those hydriatric procedures that were mentioned in the discussion of febrile diseases. Exceptionally, individual symptoms may render necessary special therapeutic measures. Particularly, **obstinate vomiting** and **persistent nausea** when the stomach is empty may require sedative measures. Small bits of ice administered internally or small amounts of ice-water given at long intervals, and the use of Winternitz's combination compress, will suffice to relieve these symptoms in most cases.

Ulcer of the Stomach

Two important **indications** must be fulfilled: In the first place, to avert the development of an ulcer; in the second place, after an ulcer has developed, to provide the most favorable conditions possible to bring about its healing.

In order to be able to avert a morbid process it is necessary to be familiar with the conditions underlying its development. With reference to ulcer of the stomach the circumstances are pretty clear. The predisposing factor is diminution in the alkalinity of the blood circulating in the gastric mucous membrane, and the secretion of an excessively acid gastric juice. A rational treatment will find its most important function of a causal nature, and for this purpose hydrotherapy is best adapted. The procedures that should be employed are especially those that have been mentioned as advantageous in the treatment of chlorosis—namely, applications with alternating temperature, by means of which improvement in the circulation in general, and an increase in the alkalinity of the blood, are probably with greatest certainty brought about. In addition, those measures are employed that improve the circulation locally; that is, in the wall of the stomach—namely, cold sitzbaths of short duration (from 10° to 12° C.,—50° to 53.6° F.,—and lasting from three to five minutes); stimulating compresses about the abdomen, trunk compresses, in combination with the hot stomach coil, which, however, should remain in place for only a short time.

A second important indication to be fulfilled in treatment consists in control of **hemorrhage**, of **vomiting** and of **cardialgia**. A powerful remedy for hematemesis is found in thermic influences.

Small ice-pills are often a source of disappointment. Small bits of ice introduced into the rectum exert a powerful effect. As Winternitz has shown, these are capable of influencing strongly the circulatory conditions in the stomach. The abdominal binder, in combination with the rubber coil cooled by a continuous flow of cold water, has an excellent effect in controlling the hemorrhage. It may remain in place for hours, or even for days. **Vomiting** and **cardialgia** will, by reason of their causative factor, have to be treated by means of Winternitz's combination compress. Only in the presence of gastric hemorrhage would I omit the use of this remedy.

Dilatation and Atony of the Stomach.—The primary enfeeblement of motor power and the state of functional debility constitute the points of attack for hydriatric procedures. Shower-baths of alternating temperature, in combination with brief movable cold fan douches to the abdomen; Scotch douches; a cold rub, immediately followed by a cold sitzbath of short duration; or half-baths with high abdominal affusions, act directly by stimulating the muscular layer of the stomach and the contractions of the abdominal muscles, and reflexly by their tonic effect on the entire nervous system.

DISEASES OF THE INTESTINE

It seems appropriate to discuss in this place two symptoms, diarrhea and constipation, as these occupy a prominent place in the symptomatology of all diseases of the intestine.

Diarrhea

This can be treated successfully, it matters not whether the cause reside in the abnormal character of the food and drink, producing simple increase in the intestinal secretion, excessive peristaltic activity, or some pathologic state of the intestinal mucous membrane; in morbid states of the intestinal mucous membrane, as acute and chronic catarrh, particularly of the large intestine; or in the secondary catarrh accompanying ulceration or other profound structural change. The diarrhea dependent upon the disturbances of innervation may also be favorably influenced by hydriatric measures.

With reference to the procedures to be employed under the circumstances in question, it will be understood that it is absolutely necessary for the indications to be laid down with precision; but, on the other hand, the statement is also applicable here that it is not any single measure that leads to the desired result. In all of the cases in which the abnormal character of the food and drink gives rise to diarrhea, it will be necessary to **accelerate peristaltic movement.** Apart from enemas and irrigations, it is especially cold sitzbaths—10° to 18° C. (50° to 64.4° F.), of one to five minutes' duration,—that will stimulate peristalsis both by reflex action and by inducing hyperemia of the intestine. The paradoxic diarrhea, or so-called **stercoral diarrhea,**—that is, the variety that is attended with fermentation and the generation of irritating matters in consequence of stagnation of the intestinal contents,—must be treated in the same manner.

Quite a different course must be pursued in cases of **diarrhea due to increased peristalsis,** caused principally by excessive irritability of the muscular layer of the bowel. Under such circumstances the peristaltic activity should be restrained. This may most advantageously be accomplished by means of the direct supply of heat or warming measures. Half-baths and sitzbaths at a temperature only a few degrees below that of the blood, and of considerable duration,—from half an hour to an hour,—wet packs in sheets well wrung out, for a period of one to two hours, followed by a moderately cool half-bath (28° to 26° C.—82.4° to 78.8° F.), and an abdominal binder until the body has become completely warm and dry, are examples of relaxing sedative measures of the character that will check peristaltic activity. I may additionally recommend the hot stomach coil, applied over a wet compress, as a useful remedial measure belonging in this category.

Intestinal Catarrh

The most important variety of diarrhea is that dependent upon catarrhal affections of the intestine. This includes the most obstinate and most dangerous cases. These are at the same time, however, the cases in which hydrotherapy is capable of exhibiting its specific effect. Reduction of the amount of blood in the intestine, reduction in the secretion of the intestinal mucous membrane, lessening of peristaltic activity, are the indications to be met in this connection. This will be accomplished by diverting the blood stream to the skin. Vigorous rubbing with a coarse sheet well wrung out of cold water is the most suitable procedure under such circumstances. This is followed by the sitzbath. Keeping constantly in mind the conditions present in the individual case, and the susceptibility of the patient to irritation, it will rarely be permissible to employ water at a temperature above 14° C. (57.2° F.), and it will often be necessary to resort to a temperature so low as 10° C. (50° F.). The duration will be from eight to ten minutes, and it will often have to be extended even to twenty or thirty minutes and more. The abdominal binder must also be considered as an additional measu a local derivative effect.

The **plan of treatment** will be as follows: A cold rub followed by a cold sitzbath of considerable duration. After the rub the patient, without being dried, enters the sitzbath, is thoroughly covered, and is directed to rub the abdomen vigorously. After the sitzbath the abdominal binder is applied, and this is changed after it has become completely dry. The same treatment is applicable also to **chronic** forms of diarrhea. Here especially hydrotherapy attains its best results. In cases of **nervous diarrhea,** the procedures directed against the neurotic state in general, particularly half-baths, will be appropriate.

Constipation

We may now take up the consideration of constipation. This condition may result from atony, as well as from spasm, of the intestine. The latter condition particularly has received far too little attention, although it is one of the most common causes of constipation. The spasmodic contraction of the intestinal musculature may give rise to marked stenosis of the lumen of the bowel, and even to complete occlusion, so that grave structural disease may be simulated. The treatment of constipation, which constitutes one of the most difficult problems presented to the physician, must accordingly be governed primarily by the causative factors. The condition of atony must be treated quite differently from one of spasm, and the failures so frequent in the treatment of constipation are principally attributable to the fact that far too little consideration is given to the differences indicated.

With both varieties irrigation plays an important rôle. In case of **atony,** cool irrigations and cold enemas are employed. Under these circumstances it is well to introduce at first small amounts of cold water—22° to 18° C. (71.6° to 64.4° F.)—in order to evacuate the lower portion of the intestine; and then to permit a somewhat larger amount—from one-third to one-half liter (quart)—of cold water to enter through an intestinal tube of considerable length. Retention of the injected water for as long a time as possible will then yield a satisfactory result. In the treatment of atony the cold rub followed by a cold sitzbath, of a maximum duration of five minutes, is further attended with admirable effects. Both procedures exert powerful stimulation. The friction improves the tone of all of the tissues; the short, cold sitzbath increases the flow of blood to the intestine, and stimulates peristaltic activity by heightening innervation. Moderately cool half-baths,—27° to 22° C. (80.6° to 71.6° F.),—with high abdominal affusions; and shower-baths, with a movable fan douche to the abdomen, exert a good effect.

In the **spastic** form of constipation it is the hot irrigations that will be attended with success. For purpose of irrigation, water at a temperature of 40° C. (104° F.) will suffice. Sodium chlorid may be added. The external use of warm applications is of great importance—namely, protracted warm baths, sitzbaths of considerable duration, warm abdominal compresses, steam compresses, the hot rubber coil in combination with a trunk compress, the thermophore, etc. Warm douches of short duration are likewise to be commended.

Acute Enteritis

First of all, the abnormal intestinal contents must be removed. Only after this indication has been fulfilled are such procedures to be employed as are capable of controlling the existing diarrhea. In cases of **chronic enteritis** also, persistent diarrhea or persistent constipation, or both in alternation, will require consideration. The treatment will be guided by the principles already laid down. **Mucous colic** is favorably influenced by the cold rub and cold sitzbaths of ten to fifteen minutes' duration.

Catarrhal Jaundice

Enteroclysis in the form of the so-called high irrigation, twice or thrice daily, with water at a temperature of 12° to 17° C. (53.6° to 62.6° F.), in amounts of one to two liters (quarts), is most suitable. Small retained enemas, which, like applications of ice within the rectum, exert a reflex influence upon the circulation in the uppermost portion of the intestine, are also of great value in this connection. Such enemas with about one-tenth of a liter (quart) of very cold water—10° to 12° C. (50° to 53.6° F.)—should be given twice or thrice daily. Cold sitzbaths, the duration of which will be governed by the presence of constipation or of diarrhea, may be employed additionally. The application of the abdominal binder will materially aid the action of the procedures mentioned. Of general measures, those of a stimulating character are indicated.

The treatment of **intestinal hemorrhage** is the same as that of hemorrhage from the stomach.

Nervous enteralgia requires general treatment such as has been laid down for cases of neurasthenia and hysteria. Hot applications are indicated for the relief of the attacks of pain.

ACUTE GENERAL PERITONITIS AND PERITYPHLITIS

The treatment of these affections with compresses in combination with cooling apparatus lessens the pain, as well as the

vomiting and the **meteorism.** Cold is at first not well borne by some patients. Under such circumstances stimulating compresses are first indicated. In cases of **perityphlitis,** operative intervention will often be averted by the timely institution of antiphlogistic treatment. It is quite often possible to place the intestine at rest and to relieve and remove **hiccough, vomiting,** and **pain** by means of trunk compresses with a cold abdominal coil. It is absolutely necessary to keep the apparatus in place for days at a time. The employment of irrigation should be avoided at first, but if it is absolutely necessary, it may be undertaken with the greatest care. Excessive pressure must, in any event, not be permitted.

DISEASES OF THE BILIARY PASSAGES AND OF THE LIVER

Cholelithiasis probably is amenable to hydrotherapy only during an attack of biliary colic. It is a fact to which Leichtenstern also has called attention that the antispasmodic and anodyne effect of morphin is materially increased, or, if the colic is of lesser severity, can be substituted, by a number of hydriatric measures. Particularly **heat** applied in various ways fulfils this object. I may mention here again the trunk compress with the hot rubber coil, steam compresses, the thermophore, and the like. The drinking of very hot water is of great utility. Although the water first swallowed is generally vomited, it is nevertheless advisable to continue giving it in small quantities. The hot water exerts a powerful antispasmodic influence; as does also a hot bath—40° C. (104° F.)—of considerable duration. Swift Walker recommends baths as hot as can be borne. I have seen no benefit from the use of the ice-bag as advised by Bricheteau.

The treatment of **jaundice** due to gall-stones is similar to that of **catarrhal jaundice,** which has already been described.

Hyperemia of the Liver

Of the disorders of the liver, only hyperemia will be considered. Venous hyperemia of the liver is most frequently brought about by disease of the lungs or of the heart. Its treatment is that of the cause. In arterial or **active hyperemia** of the liver, in addition to strict regulation of the diet, both quantitatively and qualitatively, hydriatric applications may be used with the hope of success. Very cold sitz-baths—8° to 10° C. (46.4° to 50° F.)—of ten to fifteen minutes' duration, administered daily, are especially to be recommended in this connection. Derivative procedures applied to the skin, particularly cold shower-baths, in combination with the movable cold fan douche, applied over the liver, also exert a good effect.

CHAPTER VII

DISEASES OF THE URINARY APPARATUS, OF THE FEMALE SEXUAL ORGANS, AND OF THE SKIN. VENEREAL DISEASES

Diseases of the Kidneys. Acute Nephritis. Uremia. Nocturnal Enuresis. Chronic Inflammatory Dermatoses. Ulcers and Burns. Eczema. Psoriasis. Syphilis. Gonorrhea. Cystitis. Prostatitis. Amenorrhea. Menorrhagia. Dysmenorrhea. Metritis and Endometritis.

DISEASES OF THE URINARY APPARATUS

DISEASES OF THE KIDNEYS

Acute Nephritis

The employment of **baths**, in conjunction with the dietetic and hygienic treatment of diseases of the kidneys, has always been most extensively practised. In cases of acute nephritis the bath is practically the only form of therapeusis available, and its good effects are generally admitted. The treatment is based upon the view that the skin and the kidneys bear functionally reciprocal relations, so that the skin to a certain degree may vicariously assume the work of the kidneys. It is true that the ability of the skin or of the sweat glands to take the place of the kidney has definite limitations; for although water in considerable amount can be eliminated through the sweat glands, the conditions are different with regard to the fixed elements of the urine. Even in case of the most profuse sweating, not more than one-tenth at most of the nitrogen eliminated through the urine in twenty-four hours escapes through the skin, as has been shown by Leube. That, therefore, diaphoretic methods of treatment are principally indicated for the purpose of stimulating the compensatory agencies that reside in the skin is clear, and is also generally known. Nor is much to be said with reference to the methods to be pursued. In cases of acute nephritis it is principally hot baths that are employed in order to bring about adequate diaphoresis. The temperature of the water is from 38° to 42° C. (say, 100° to 108° F.), and the duration of the bath from fifteen to thirty minutes. Excessively high temperatures, as well as excessive prolongation of th[illegible] exert an injurious rather than a favorable influence, as the invigorating effect of the hot bath may readily be converted into a debilitating effect if the application is too long continued. The conditions are analogous to those that obtain with the use of cold, which also exerts an invigorating effect within certain limits of time, beyond which it gives rise to excessive irritation. Excessive duration of the bath, or excessive diaphoresis, is attended with an additional serious disadvantage that should not be overlooked. The fact has already been pointed out, that even after the most profound sweating only a small portion of the solid constituents of the urine is eliminated; thus there is danger of hastening the development of profound uremic symptoms in consequence of retention and concentration of the excrementitious metabolic products in the tissues of the body. The endeavor should therefore be made to induce *gentle diaphoresis* by means of *warm baths*, in order to relieve the kidneys of a part of their function and to maintain elimination through the skin. The action of the bath may be aided by permitting the patient to *sweat subsequently* between woolen blankets; but forced sweating should, so far as possible, be avoided. There is no advantage in causing rapid disappearance of the edema or of the fluid in the serous cavities.

If I have not discussed the etiology of acute nephritis in the beginning of this analysis, it is because the treatment is so rarely governed by causal indications, but is pretty much the same in all cases. Special emphasis need not be placed upon the fact that consideration should be given to the danger of nephritis in cases of **infectious disease,** and particularly of **scarlet fever.** Should albuminuria, or even nephritis, develop in the course of an acute infectious disease, the withdrawal of hydriatric treatment would, as a matter of course, be not only useless, but even a mistake, inasmuch as by its continuance the morbid process might be restrained. The effects of extreme cold, however, should be avoided under such circumstances, and *moderately cool half-baths*—25° to 23° C. (77° to 73° F.)—be given. The vigorous friction pertaining to this measure takes the place of the thermic stimulation. It should be pointed out here that mechanical stimulation—dry friction—has been especially recommended by Semmola, because it increases elimination through the skin, as will be clear from previous considerations.

Chronic Nephritis

The treatment of chronic nephritis is based upon the same principles. Here, too, the most important point is to relieve and shield the diseased organ, and although actual cure cannot be brought about, as in cases of acute nephritis, it is at least possible to save a portion of the renal parenchyma, and to maintain the function of the organ at such a level that the patients may continue to live for years in comparative comfort. There are naturally other therapeutic indications in certain cases of chronic nephritis that do not exist in acute nephritis. These consist of diverse disturbances in the various organs, among which those connected with the circulatory and respiratory apparatus occupy the first place.

With reference to diaphoretic methods of treatment, after again emphasizing the importance of the two factors, duration and intensity, it may be mentioned that not only hot baths, but also a large number of other diaphoretic procedures, are available in this connection; Thus, wet and dry packs, steam cabinet baths, steam tub-baths, hot-air baths, electric light baths, and similar measures may be used. If the different effect of these procedures with reference to respiration and pulse frequency, and with reference to the action of the heart and innervation, be kept in mind, it will not be difficult to make a proper selection from among them. It should always be remembered that the wet and the dry pack exert a **sedative** influence upon innervation and cardiac action, and that they lower the blood pressure; hence the propriety of their employment in the treatment of chronic parenchymatous nephritis. It should further be borne in mind that marked acceleration of respiratory and pulse frequency, violent heart action, and elevation of blood temperature, take place in the steam bath, as well as in the hot-air bath and in the electric light cabinet. In making a selection from among these measures it is well to remember that much higher temperatures can be borne in a hot-air bath than in the steam cabinet. The consideration of the action of the heart, which is especially necessary, will in many cases indicate the precordial coil, which should be applied throughout the continuation of the heating procedures. The cold precordial coil plays an important rôle also in the treatment of the various forms of chronic nephritis, as it is often necessary to quiet and to strengthen the action of the heart, and to increase its vigor. In this way the symptomatic indication will be met. In consequence of the retention of urinary matters reactive irritation of the vascular nerves results, with increased blood pressure, and consecutive hypertrophy of the heart. All causes that lead to strain on the part of the heart are therefore to be avoided, and the measures that confine the activity of the heart within approximately normal limits are to be employed.

Treatment of Uremia.—The systematic application of the precordial coil is of great importance in the **prevention** of uremia, including under this term not only the profound morbid manifestations, such as convulsions, coma, or Cheyne-Stokes breathing, but also the headache, the vertigo, the asthma, the sleeplessness, and minor symptoms. The increased vigor of the heart that is brought about by this procedure causes a better flushing of the kidneys with arterial blood and a more abundant elimination of water and of toxic matters. With reference to the employment of hot baths in the treatment of uremia, attention may again be called to the danger of forced diaphoresis. One question further should be raised here—namely, What procedures should be employed after the diaphoretic measures? As the necessity has been made clear in several places for a cooling procedure following applications that supply heat or cause accumulation of heat, the reply to this question raises another—namely, May cold be employed at all in cases of nephritis? The fear of cold applications is almost universal, but their danger is by no means proportionate thereto. The principal desideratum of the hydrotherapeutist is to insure a good reaction. When this is attainable, cold applications in the form of shower-baths at a temperature of 16° C. (60.8° F.), or of cool half-baths (22° to 20° C.—71.6° to 68° F.), may be employed—always, however, in sequence to diaphoretic measures—in the most diverse forms of chronic nephritis. The favorable effect will be exhibited in increased diuresis, strengthening of the action of the heart, and improvement in the general condition.

Contracted Kidney

Hydriatric procedures—diaphoretic measures and others—are of great usefulness in the treatment of **contracted kidney,** particularly the variety dependent upon arteriosclerosis and the gouty diathesis. "The genuine contracted kidney, it may be stated incidentally, bears the same relation to acute infectious parenchymatous nephritis as does cirrhosis to acute yellow atrophy of the liver. In the one case, there occurs rapid destruction of the organ, immediately threatening life; and in the other case, slow progressive destruction, which may to a certain degree be rendered relatively uninjurious by means of compensatory processes in the organism. On the basis of this conviction we should interpose no objection to subjecting an individual with cirrhosis of the kidney to hydriatric procedures if demanded by certain symptoms constituting a part of the morbid process, or independently thereof, and if inflammatory processes in the kidney can be excluded." Thus writes Kraus [1] in summarizing an admirable study of the treatment of albuminuria with hydriatric measures, and with this opinion I am in entire accord. Moderately cool half-baths at a temperature of from 22° to 20° C. (say, 72° to 68° F.) will relieve many of the distressing symptoms attending contracted (sclerotic) kidney. Digestive disorders will be mitigated and bronchial catarrh improved. Cold ablutions also will render invaluable service. After their employment for some time the cold rub may be resorted to. Refer-

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[1] "Blätter f. klin. Hydrotherapie," 1897, No. 3.

ence has repeatedly been made to the beneficial influence of the cold or cool precordial coil.

Stasis in the kidneys in consequence of disorder of the **circulatory organs** should be treated according to the methods that have been described in the section dealing with diseases of the heart and vessels.

Diseases of the Bladder

A few words may be in place here with reference to **nocturnal enuresis.** The object to be attained in the treatment of this condition is invigoration of the vesical sphincter. General stimulating measures, cold rubs, cold brief shower-baths, cold plunges—16° to 18° C. (60.8° to 64.4° F.)—will aid in invigorating the entire organism of the debilitated individuals that, as a rule, suffer from the disorder under discussion. Under some circumstances cold sitzbaths of short duration, or, in the case of old persons, the employment of the psychrophore or of Atzberger's irrigator, which is directed to invigoration of the bladder through the rectum, will lead to the desired result. **Hyperesthesia, spasm,** and **paralysis of the bladder** may be improved, and eventually even cured, by means of measures that diminish sensibility in accordance with well-known laws—as cold applications of considerable duration in the form of sitzbaths; or by means of those that relax spasm—warm applications of considerable duration; or such as increase vigor and improve functional power—cold applications of short duration. **Cystitis** is mentioned elsewhere (p. 204).

DISEASES OF THE SKIN, SYPHILIS, AND VENEREAL DISEASES

DISEASES OF THE SKIN

It is a matter of course that a form of treatment whose point of attack and whose gate of entry into the complicated structure of the human organism is found in the skin should also be applied to this important organ itself; and it is, in fact, possible to induce therein local hyperemia and ischemia, active congestion, and passive stasis, in accordance with physical laws, and thereby to influence cutaneous pathologic processes at their seat in a powerful manner, that is possible with but few specifics.

In **acute inflammatory dermatoses,** cooling antiphlogistic compresses are employed, with or without cooling apparatus. By this means heat, pain, and exudative, hemorrhagic, and destructive processes are counteracted. In **chronic inflammatory dermatoses**, macerating procedures, such as the steam cabinet, wet packs, and the like, and, in addition, measures that stimulate and accelerate absorption and regeneration or cicatrization, such as stimulating compresses and circular compresses, are indicated. The latter render admirable service especially in **ulcerative and atonic processes**; **dense, unyielding exudates**; **burns of the third degree**; and **leg ulcers.**

In **secretory disorders** (seborrhea or universal hyperidrosis) general invigorating applications that restore normal circulatory and innervational conditions to the skin and the sudoriferous glands may be employed with good results.

Burns of the first degree may be treated antiphlogistically by means of cooling compresses; burns of the **second** and of the **third degree** by means of the permanent hot water bed (37° C.—98.6° F.), and with especially good results by means of circular compresses.

Acute eczema may be treated with cooling compresses, and finally with compresses in combination with cooling apparatus. In vesicular, pustular, and impetiginous eczema, circular compresses are useful locally, and general invigorating procedures assist the cure. In cases of squamous eczema, the softening and macerating procedures are employed.

In the treatment of ordinary **psoriasis,** two sets of indications are to be fulfilled. In the first place, the scales should be macerated and detached, and this is best brought about by means of prolonged tepid baths. In the second place, the causative factors should be combated by improving the chronic inflammatory state of the papillary layer, together with the hyperemia in the vascular loops. Under these circumstances, such procedures should be employed as will improve the vascular tone in a definite manner—namely, shower-baths of alternating temperature, the cold rub, sheet baths, wet packs, together with subsequent cold applications.

In the treatment of cutaneous **pruritus,** symptomatic and causal measures should be employed. In a symptomatic way tepid and warm high baths have long been in repute, as well as shower-baths of alternating temperature, and wet packs followed by half-baths. To remove possible causes, any digestive disturbance should be treated in accordance with the principles previously laid down.

SYPHILIS

In addition to systematic courses of treatment with mercury and iodin, tested and sanctioned by observations in thousands of cases, hydriatric procedures may at the same time find a useful place. The treatment is begun with a sort of **preliminary course,** which consists in the employment of vigorous mechanical and thermic stimulation. Thus, vigorous cold rubs, cold shower-baths, and half-baths are employed for from three to five days, being preceded, as a rule, by wet packs for thirty minutes to an hour, or steam cabinet baths. These are followed by the so-called **major procedures,** which influence metabolism in the most powerful manner and exhibit an active depurative and spoliative action. As a result of the disintegration of the body-proteid, the syphilitic virus, which probably is bound to this organic substance, is in successive quantities dislodged and thrown into the circulation, to be eliminated through the increased activity of all of the emunctories. All writers therefore recommend diaphoretic measures under these circumstances. As the most vigorous of these are appropriately considered the dry pack, which acts by causing accumulation of heat, and the steam cabinet bath, which acts by supplying heat. The natural fear that the absorption of mercury would be interfered with in consequence of hydriatric measures has not been substantiated.

GONORRHEA

In cases of **acute gonorrhea,** local applications of cold are indicated, in addition to the treatment usually employed. In cases of **chronic gonorrhea,** the psychrophore will find employment. This is generally introduced twice or thrice daily for a half hour at a time, and through it is passed cold water—12° to 16° C. (53.6° to 60.8° F.). Of the more important complications, **cystitis** may be mentioned. In the treatment of this condition, moderately warm sitzbaths,—30° to 35° C. (86° to 95° F.),—of from half an hour's to an hour's duration, yield admirable results. In complicating **prostatitis** Atzperger's irrigator is employed. If the condition be **acute,** a current of cold water—10° to 12° C. (50° to 53.6° F.)—is permitted to pass continuously through the instrument, while in cases of **chronic** prostatitis warm and cold water are employed alternately.

DISEASES OF THE FEMALE SEXUAL ORGANS

The utility of hydriatric applications is exhibited especially in the treatment of menstrual derangements. In all cases of **amenorrhea,** in addition to causal treatment, a generous flow of blood to the uterus must be brought about. For this purpose warm uterine douches, warm sitzbaths, stimulating compresses to the lower extremities, and cold movable fan douches to the inner surface of the thighs are available. **Menorrhagia** likewise requires both local and causal treatment, the object being, on the one hand, to stimulate contraction of the dilated uterine vessels and of the uterine musculature, and, on the other hand, to divert the blood from the congested genital apparatus to other portions of the body. With rare unanimity, both high degrees of heat through the vagina—two or three injections daily of a liter (quart) of water each time—and also cold vaginal irrigation—the injection of ice-water and introduction of bits of ice into the vagina—are advised. Protracted cold sitzbaths, as well as cold tubs and cold shower-baths, will aid the local measures. In cases of **passive menorrhagia** the tone of the genital vessels should be improved. Under such circumstances cold sitzbaths of short duration, five minutes at most, occupy the first place.

Dysmenorrhea should first of all receive causal treatment. The **spastic** variety will require avoidance of, or relief from, the spasm of the uterine musculature and of the vessels, and this it is possible to bring about by means of hot applications—sitzbaths, hot compresses, trunk compresses in combination with the hot water coil, and similar measures. Another variety of dysmenorrhea is that which is believed to depend upon disease of the **nervous system.** The treatment should be general, and be directed to improvement of the innervation. If the painful menstruation be due to rigidity of the tissues of the cervix, such as may remain after cervical metritis, the vaginal dilator may be used with water of any desired temperature.

The hydriatric management of **metritis, parametritis,** and **endometritis** enjoys general recognition. In view of the circumstance that the treatment of these disorders is based upon familiar principles already laid down, it is not necessary to consider them in detail again. In this connection also, the local and general measures previously mentioned are employed in accordance with the indications present.

Pregnancy and Hydriatric Measures

A few words may be devoted to the question whether or not the employment of hydriatric measures is permissible **during pregnancy.** It is impossible to lay down rules susceptible of general application; every case must be judged on its own merits. In the presence of a tendency to abortion, great care will obviously be necessary; as also in the first months of any pregnancy. Exceedingly high and exceedingly low temperatures, vigorous mechanical stimulation, and such measures as directly or reflexly excite contraction of the uterus or induce hyperemia of this organ, or diminish the amount of blood present in it, are **counterindicated** under all such circumstances. In an acute disease occurring during pregnancy the choice of a proper procedure will not be difficult. Chronic diseases during pregnancy should likewise be treated with due consideration of the latter.

Disorders resulting from pregnancy may briefly be mentioned here. In cases of **hyperemesis** of pregnancy, trunk compresses with the hot rubber coil at times render good service.

Eclampsia is most efficiently combated by means of hot baths of long duration (half an hour).

Puerperal fever is an infectious disease and should obviously be treated as such.

SUPPLEMENTAL CHAPTERS

HELIOTHERAPY, PHOTOTHERAPY, AND THERMOTHERAPY

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SALINE INFUSIONS AND IRRIGATIONS

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SUPPLEMENTAL CHAPTERS

HELIOTHERAPY, PHOTOTHERAPY, THERMOTHERAPY, AND SALINE INFUSIONS AND IRRIGATIONS

CHAPTER I

HELIOTHERAPY: GENERAL AND LOCAL USE OF SUNLIGHT[1]

Preliminary Considerations. Physiologic Effects of Light. Sunburn. Phototherapy. The Sun-bath—Technic; Physiologic Effects; Indications and Counterindications. Local Applications of Sunlight—Mode of Action and Effects; Indications.

Whatever may be the ultimate nature of light, it seems to be clearly proved that a so-called ray of sunlight, or white light, is in fact composed of several different kinds of rays. The existence of three different sorts of rays has been clearly demonstrated, and there are hints that others exist. Those well known have been designated as (*a*) **calorific** or **heat rays**; (*b*) **luminous** or **light rays**; (*c*) **actinic** or **chemical rays.** Very recent observations have demonstrated that, as Clark-Maxwell maintained on theoretic grounds, light exerts a measurable pressure.

The **heat rays** are for the most part invisible, as they do not stimulate the optic nerve, although they powerfully impress the nerves of the skin. Being the least refrangible, they are found in and below the red end of the spectrum. The **chemical rays** are found in the violet and ultra-violet portions of the spectrum. These also make slight impression on the eye, but stimulate the skin in a remarkable manner, making their presence known in other ways as well. The efflorescence of solutions of quinin, kerosene oil, and other substances is due to absorption and retention of the ultra-violet rays. It is by the

[1] Supplemental chapters I, II, III, and IV are by J. H. Kellogg, M.D., of Battle Creek, Mich.

aid of these rays that a photograph can be taken of writing in which a solution of quinin has been used in place of ink, the former being absolutely invisible. It is a curious fact that it has also been found possible to take a photograph of the eruption of smallpox before it appears. The **luminous rays** are centered in the yellow portion of the spectrum.

These several rays may be separated or filtered out from the compound ray of light by employing colored glass and other media. A solution of alum, for example, allows the luminous rays to pass readily, but excludes heat rays. A hollow convex lens, filled with a solution of iodin in carbon disulphid, permits the passage of the heat rays, but excludes the luminous and chemical rays.

Red and yellow rays allowed to fall upon a mixture of hydrogen and chlorin produce no effect, while the violet rays give rise to an explosion by inducing chemical combination of the gases. Godneff showed that silver chlorid in sealed tubes, placed under the skin of a naked animal, is blackened by the chemical rays, proving that the skin is readily penetrated by them. The phenomenon of translumination shows that the tissues are also permeable to the luminous rays. The abdominal wall may be made to glow by a very small lamp introduced into the stomach by the aid of a proper instrument. That the heat rays possess even greater penetrating power has been shown by various experiments.

These remarks are true of light in general, irrespective of its source; although compound light rays differ much in quality on account of the varying proportions in which the classes of rays mentioned are found in light from different sources.

The **electric arc light and sunlight** are very similar in character. The arc light is said to have a somewhat larger proportion of actinic rays as compared with sunlight, when beams having an equal luminosity are compared. The **incandescent electric light** contains a much larger proportion of heat rays and a much smaller proportion of actinic rays, as compared with the arc light.

Physiologic Effects

The physiologic effects of light are chiefly due to the actinic and calorific rays, the effects of which must be studied separately.

That light exercises a most potent influence upon life in all its higher manifestations, both animal and vegetable, is a fact of common observation. Plant growth seems especially to be influenced by the yellow rays. The ultra-violet rays increase flowering, while red light increases the aroma. Experiments made by Finsen and others tend to show that blue light retards growth. The phenomenon of heliotropism, the turning or bending of flowers, leaves, and even stems toward the sun, demonstrates most conclusively the powerful influence of light upon vegetable organisms; but intense light and continuous exposure to light may prove injurious to plants, which seem to require rest or the absence of sunlight at intervals, as do animals. Concentrated sunlight destroys plant cells, shriveling their protoplasm.

EFFECTS OF THE ACTINIC OR CHEMICAL LIGHT RAYS

A common illustration of the effect of light upon the healthy organism is to be found in the phenomenon commonly known as **sunburn,** more properly termed solar erythema. So long ago as 1859, Charcot suggested that sunburn might be due to the influence of the ultra-violet rays. Wilde made the assertion, of which Finsen has since furnished very positive proof, that so-called sunburn is not really a burn at all, but is an erythema set up by the irritative action of the ultraviolet, or fluorescent, rays upon the skin. White cows are subject to sunburn the same as white men, while red and black cows, as well as dark-skinned men, are protected by their color. The pigmentation of the skin that occurs in connection with sunburn guards against recurrence. The curious observation has been made that light-colored animals, especially cows, and even pigs, when exposed to the sun after having been fed on buckwheat, are especially subject to sunburn. This is supposed to be due to the development of a fluorescent element in the blood of these animals under the influence of light acting upon some peculiar constituent of the food. The pigmentation following exposure to the sun, commonly known as **tanning,** as well as that which follows solar erythema, has been attributed to destruction of the red blood-corpuscles occurring under the influence of intense light. Sunburn is more likely to occur in elevated regions, because of the greater intensity of the violet light rays at high altitudes.

The Influence of Light upon Metabolism

An animal eliminates more carbon dioxid under the influence of light than when confined in the dark. This has been found to be true of hibernating animals also. Starving animals lose less weight at night than during an equal number of hours of daylight, although kept equally quiet. Certain animals, as crabs, when painted with dark varnish, are quickly killed, although unaffected by transparent varnish (Heile). Eggs develop more rapidly when exposed to the influence of sunlight than when kept in the dark. This is also true of the larvæ of insects.

Metabolism is unquestionably stimulated by the reflex action set up by the light rays impinging upon the nerve-endings of the skin and retina. Oxidation of living tissues is increased by the action of sunlight (Quincke), while in human beings, as well as in animals, less carbon dioxid is eliminated at night than during the same number of hours of daylight, even though an equal degree of quiet be observed (Pettenkofer and Voit). Country children, who are more exposed to sunshine than those in the city, are much healthier in appearance and less subject to rickets, tuberculosis, and other grave disorders. Cretinism is most frequently found in deep valleys from which the direct rays of the sun are largely excluded. Eskimo women suffer from amenorrhea during the long polar night.

The Influence of Light upon the Nervous System

The powerful influence of light upon the nervous system is shown by many facts; as, for example, the effects of strong light in producing headache, giddiness, and even nausea, through the reflexes set up by overstimulation of the optic nerve. Similar effects are produced by prolonged exposure of the naked skin to the sun's rays, and especially by exposure of the head without ample protection. In Egypt, the natives habitually protect their heads from the powerful rays of the midday sun by wrapping them in shawls or scarfs, forming a huge mass, the heat of which would doubtless be intolerable were it not for the relief afforded by the exclusion of the exciting actinic rays.

Sunstroke affords a very forcible illustration of the pernicious effects of intense sunlight upon a human body not trained to tolerate it. Tolerance is established in a person exposed to the sun in part by habituation of the nerves to the peculiar stimulus of the sun's rays, and in part by pigmentation of the skin, which excludes some of the actinic rays. The natives of the South Sea Islands when obliged to expose their naked bodies for some time, protect themselves from the injurious effects of the sun's rays by blackening their skins. Although the accumulation of heat is increased by the color of their skin, its impenetrability by the actinic rays renders the dark-skinned races better able to endure exposure to the sun.

The Influence of Light upon the Functions of the Skin

Exposure to the sun's rays rapidly induces profuse perspiration, even though the temperature of the surrounding air may be considerably below that of the body. The activity of the sweat glands thus induced is probably due to the combined action of the actinic and of the calorific rays. It may be induced, however, by the heat rays alone, as is shown by the fact that very profuse perspiration follows exposure of the skin to the rays of the sun when protected in such a way as to exclude the chemical rays.

The coloration of the skin, consisting in tanning and freckles, produced by exposure to the sun is the result of stimulation of the pigment cells by the actinic rays. This coloration is a conservative reaction to shield the sensitive structures situated immediately beneath the skin and in its deeper layers.

The Action of Light upon Bacteria

Bacteria as well as most other low organisms of a parasitic character, including fungi, are sensitive to light and easily killed by it. Some bacteria which are not readily destroyed even by strong solutions of germicides, or by the action of steam, are quickly killed by exposure to light. Koch showed this to be true of the tubercle bacillus, and Kitasato made the same demonstration for the plague bacillus. Dieudonné showed that the ultra-violet rays are decidedly bactericidal. The germs of tetanus are killed more quickly by direct sunlight than by a 1 : 1000 solution of mercury bichlorid. The influence of sunlight upon bacteria accounts in part for the well-known and remarkably rapid purification of running water after contamination with sewage. Many bacteria are killed by exposure to diffused light, but for most positive effects the direct rays of the sun are required.

THE THERAPEUTIC USE OF LIGHT

Light is employed therapeutically in the following forms:

1. **Sunlight.**—The application of the rays of the sun is made to the uncovered or partially protected skin. For intense localized effect, the sun's rays are concentrated by means of convex lenses or concave mirrors. The solar rays are also modified by passing them through various media, more or less perfectly isolating the several different kinds.
2. The **incandescent electric light.**
3. The **arc light.**

Experiments have shown that the essential nature of light is the same, no matter what the source from which it may be obtained. The source of light, however, is a matter of considerable importance in relation to the convenience of application and the especial therapeutic results required, since there is a decided variation in the quality of light obtained from different sources. Sunlight contains very powerful luminous, calorific, and chemical or actinic rays, and hence is the most important and valuable of the various forms of light employed for therapeutic purposes. The light from incandescent electric lamps contains a large proportion (95 per cent.) of heat rays with a comparatively small proportion of luminous and chemical rays. The arc light, on the other hand, is fairly comparable to sunlight in luminosity and chemical activity, but is inferior to the incandescent light in the quantity of heat emitted when compared on the basis of equal candle-power.

THE SUN-BATH

Since the clothing, or at least a considerable part of it, must be removed, it is usually necessary that a special place or apartment should be prepared for the administration of this bath. To obtain the most complete effects, the sun's rays should fall upon the surface of the body, if possible, without passing through glass, for the reason that the ultra-violet rays, which are the most active in producing therapeutic effects, are to some extent excluded by ordinary glass. The sun-bath is best administered in an outdoor gymnasium, provided with suitable couches, a sand bank, and other appliances. Several patients of the same sex may be treated at once in such an inclosure, the demands of modesty being satisfied by the scantiest of bathing attire. Male patients commonly wear very small trunks, jock-bands, or narrow loin-cloths. A very convenient protective garment may be made of a small towel by attaching at each corner a tape twelve or sixteen inches long. The towel is passed between the thighs and each end is attached to the waist by tying the tapes together in front and behind. If white or light-colored garments are worn, a considerable amount of light will reach even the covered portions of the body. When it is desired to expose the entire skin surface,—and this is always an advantage,—tight screens may be placed about the patient in such a way as to protect him from observation while permitting the sun's rays to fall directly upon his uncovered body. Small, roofless cabinets may be arranged upon a flat roof. A very efficient sun-bath may be arranged in almost any sick-room which is so situated as to admit the sun's rays between 9 A. M. and 3 P. M., by taking out the window-sash and placing the patient naked on a bed or cot before the open window. In cold weather the patient may be placed before an unshaded window while the sun is shining.

Technic.—Either the whole surface or any desired portion of the body may be exposed to the action of the sun's rays. As a rule, it is best that the head should be protected. This may be accomplished by shading the head with a parasol, or by lightly covering it, first, with a moist towel, then with some dark-colored fabric. Exposure of the head often gives rise to nausea and other unpleasant symptoms through overexcitation of the brain and central nervous system, the natural result of the great penetrating power of the solar rays. This excitation is not necessarily due to overheating of the brain, but to the influence of the chemical or actinic ray, which is a powerful nerve stimulant.

When the whole surface of the body is to be exposed to the direct rays of the sun, it is sometimes well to protect the cerebral circulation still further by applying to the face, or to the neck and face, a cheese-cloth napkin wrung out of water at 60° to 65° F. (15.5° to 18.3° C.). In the case of children and men the whole hairy scalp may be moistened as well as the face. When the exposure is continued for more than a few minutes, the wet napkin should be renewed one or more times. After a person has become accustomed to the bath, this precaution is unnecessary, and it is not often required except in the case of feeble patients, and those who are very susceptible to the stimulating effects of the sun's rays.

In the treatment of various local affections which are especially amenable to phototherapy, it is seldom necessary to limit the action of the solar rays to the affected part, as great benefit may be nearly always derived from the general improvement in metabolism induced by the application of light to the entire cutaneous surface. When localized applications are considered necessary, however, the exposure may be confined to the affected parts. I have found it convenient,

FIG. 52.—INDOOR SUN-BATH.

in these cases, to employ white sheets or blankets as a protective, as this secures at least a partial exposure of all parts of the surface.

Feeble patients will necessarily recline during the application. More vigorous patients may walk about in an outdoor gymnasium or solarium, and may even engage in light gymnastics of some sort, or gymnastic games, with advantage, especially when it is desired to increase oxidation to as high a degree as possible, as in obesity, diabetes, and the lithemic diathesis.

The **duration** of the bath will vary considerably, according to the patient, the season of the year, and the condition of the atmosphere.

A feeble patient who has not been accustomed to the sun, should, at the first sittings, be exposed, at least to a very hot sun, for not more than three minutes; longer exposure is likely to produce headache, lassitude, insomnia, and depression. Such sensitive individuals are also very likely to be sunburned by a prolonged exposure. It is well to guard against this accident, for although no serious or permanent injury is likely to result, it is very disagreeable to the patient, and may discourage further efforts in a direction essential to recovery. The only treatment ordinarily required is the application of dry starch or a little zinc ointment; if there is considerable swelling, the cooling compress should be employed for a day or two. The sun-baths need not be interrupted; it is only necessary to cover the affected parts during the application.

In persons with light hair and blue eyes—blondes—the skin is always thin and very sensitive. The skin of persons with dark complexion and dark hair,—brunettes,—and of those who belong to the dark-skinned races, is much less susceptible to the influence of the actinic rays, and hence less likely to suffer from overdoses of sunlight. In such persons the exposure may be prolonged to half an hour or even an hour without detriment. After considerable training it is possible, in fact, for the patient to expose the greater portion of the body to the influence of the sun's rays for several hours daily, not only without ill result, but with great benefit.

When the bath is applied daily, the skin rapidly acquires a brownish tint through the increase of pigment. The protection afforded by this pigmentation not only permits a longer exposure without injury, but also seems to make a longer application necessary to insure the desired results. I have often seen patients in the outdoor gymnasium whose naturally white skins had become as dark as that of a mulatto, or a half-caste Hindoo, or South Sea Islander. This darkening of the skin indicates approximately the metabolic and therapeutic activity of the solar rays. The intensity of the sun's rays is very much greater in north temperate latitudes, during the three months from the middle of June to the middle of September, than in any other season of the year, increasing as the sun approaches the summer solstice and diminishing as it recedes.

A clear or rarefied atmosphere also increases the intensity of the sun's rays. This fact should be borne in mind in the application of the sun-bath in elevated regions. In the clear, rare atmosphere of a region elevated five thousand or more feet above the sea, the sun's rays are so intense that equal effects are obtained in half the time required at the sea-level. To produce the best results, the sun-bath should be taken daily, and the duration should rapidly be increased until the patient can bear exposure for from thirty to sixty minutes, at least once a day.

A finishing treatment of some sort is always required at the conclusion of a sun-bath. This will differ according to the patient. In general, it is best to make a tonic hydriatric application. The measures most serviceable in cooling and invigorating the skin, and in counteracting, by a general tonic impression, any depressing effect which may have been induced by superheating of the blood, are the following:

The Cooling Douche.—This may consist of a simple shower-bath or rain douche, a needle spray or circle douche, the horizontal rain douche or spray, or the horizontal jet. (See Fig. 15, p. 84.) The **vigor** of the application must depend upon the patient; a strong patient who is accustomed to cold water applications will be benefited by a full horizontal cold jet, while a feeble patient will require the broken jet, the spray, the shower, or even the fan douche. The **temperature** of the application may be from 70° to 45° F. (21° to 7° C.). For most patients, 60° F. (15.5° C.) is a suitable temperature. The higher the temperature, the more prolonged the application should be. When the temperature employed is so low as 50° to 45° F. (10° to 7° C.), the application should not last more than twenty to forty seconds. At 60° to 70° F. (15° to 21° C.) the duration may be forty to sixty seconds. A very good plan, which is adapted to the great majority of cases, is the application of the rain douche at 70° F. (21° C.) for forty seconds, the patient meanwhile rubbing himself well and the application terminating with the full jet or the percussion douche at 60° to 50° F. (15° to 10° C.) for fifteen seconds. In the application of the douche special attention should be given to the spine, which may receive the stream at full force, care being taken to avoid any sensitive points which may exist.

In the absence of a douching apparatus, a very useful substitute may be found in the pail douche. The patient sits in a full bath while water, previously prepared at a proper temperature, is dashed over him from a common water-pail. The temperature of the water should be the same as for the douche. It is well to have three pails filled with water at different temperatures. The first pailful should have a temperature of about 75° F. (24° C.), while the temperature of the second should be 10° F. (say, 5° C.) lower, and that of the third 5° to 10° F. (say, 3° to 5° C.) lower still.

Cold Wet Rub.—The patient is rubbed with a mitt of coarse cloth dipped in cold water or with a cold wet towel, or a wet sheet rub is administered.

In giving the cold towel rub, the towel is wrung out of water at 60° F. (say, 15° C.); it is then quickly applied to the patient's body and rubbed on the outside until warm. The patient assists in holding the towel in place. When the towel becomes warm, at the end of a quarter to half a minute, it should be removed, the parts should be rubbed dry, and the towel, freshly wrung out, applied to another part, the process being repeated until the whole surface of the body has been rapidly gone over.

The wet sheet rub is simply an extension of the towel rub. (See also pages 77 *et seq.*) A sheet wrung out of water at a temperature of 60° F. (say, 15° C.) is quickly wrapped about the patient while he stands erect. The sheet is fastened about the neck to prevent its slipping down; then two persons rub vigorously upon the outside of the sheet until it is warm, after which the sheet is removed and the patient is rubbed dry.

The Shallow Bath.—The patient sits in a tub containing four inches of water at a temperature of 75° to 65° F. (say, 24° to 18° C.). The head, face, and neck should be well cooled before he enters the bath, and while in the water he should be protected by a cheese-cloth napkin wrung out of water at 60° F. (say, 15° C.) and applied to the head and neck. During the bath he should be well—even vigorously—rubbed by an attendant, who, at intervals of half a minute or so, dips up water and pours it upon the spine. The patient assists by rubbing his own chest. The **duration** of the bath should be from about thirty seconds to a minute and a half.

The Swimming-bath.—The swimming-bath is one of the best of all hydriatric measures to be employed after the sun-bath. It is most conveniently utilized in connection with the outdoor gymnasium. The **temperature** of the swimming-bath should be 70° to 75° F. (say, 21° to 24° C.) for the average patient. Robust patients may endure a temperature of from 5° to 10° F. (say, 3° to 5° C.) lower. After some training, patients may advantageously alternate several times between the sun-bath and the swimming-bath, remaining in the sun until perspiration begins, then plunging into the swimming-bath for two to five minutes, then returning to the sun again, thus repeating three to five times.

The patient should drink freely, both before, during, and after the bath. The best drink which can be recommended is carbonated distilled water, with the addition of a little fruit juice of some sort, such as the juice of lemon, orange, raspberry, or grape, to enable the patient to drink a larger quantity. The carbonic acid gas promotes **absorption.** From two to four glasses of water should ordinarily be taken during the bath.

The Alcohol Rub.—In the case of feeble individuals, especially those subject to general neuralgic pains, very cold hydriatric applications are sometimes inadmissible. The necessary toning of the cutaneous vessels may be accomplished in these cases by means of the alcohol rub. Alcohol is applied to a small area, as an arm, or the front of the chest, in sufficient quantity to moisten the part well. Light friction is then applied by the hands until the alcohol has wholly evaporated. Another part is then treated in like manner until the whole body has been gone over. By this means the skin is cooled without chilling the patient or producing a general retrocession of blood by universal contraction of the cutaneous vessels.

Combined Sun-bath and Sand Bath.—The sun-bath may be advantageously combined with the sand bath for the reason that the sand being warmed by previous exposure to the sun, the whole surface is equally heated, so that perspiration, with the maximum effects of the bath, is more rapidly induced. This is particularly true in the treatment of rheumatic individuals, who are especially benefited by sun-bathing. Sufferers from chronic rheumatism, especially those whose joints are painful, should not receive a general cold application at the conclusion of the bath, but should be sponged with tepid water, placed in a sheet, lightly wrapped, and allowed to cool off gradually. Immediately after the sun-bath the joints should be wrapped in cotton or wool and covered with mackintosh to avoid chilling by evaporation.

Significance of Body-temperature.—The temperature of the patient should be taken before, during, and at the conclusion of the bath. The superheating which naturally results from an exposure sufficient to induce perspiration will be accompanied by an elevation of temperature amounting to one or two degrees F. (0.5° to 1° C.). At the beginning, in the treatment of feeble patients, the temperature should be taken every ten to fifteen minutes, and the patient should be withdrawn from the bath when the body-temperature reaches 100° F. (say, 38° C.).

The thermometer is a very good criterion of the effects of a bath. Patients who do not perspire readily, naturally show a higher temperature than those in whom perspiration is easily induced. Diabetics; chronic dyspeptics with dry, sallow skins; chlorotics; and persons in whom the alloxuric diathesis is strongly developed are especially subject to overheating, and hence require careful watching. Free drinking of water is a precaution that should be resorted to in these cases. There is little danger of overheating in the case of patients who perspire readily.

An ancient method of employing the sun-bath, which is now obsolete, consisted in wrapping the patient in the skin of an animal, and then exposing him to the intense heat of the sun's rays until vigorous perspiration was induced. A favorite place for making the application was the sandy beach of the seashore. After the bath, the patient was cooled by plunging him into the cold sea water.

Physiologic Effects of the Sun-bath.—The effects of the sun-bath include all those physiologic influences which have already been pointed out as characteristic of light. In sunlight the calorific, luminous, and actinic rays are all present in the highest degree of intensity, and the reactions induced represent the combined influence of these three powerful natural agencies. The **heat rays** give rise to an elevation of body-temperature, thus producing thermic effects practically identical with those induced by hot water, hot air, vapor, and all other means that increase the temperature of the blood, whether by causing an accumulation of heat within the body, or by preventing its escape through radiation and evaporation. The elevation of the body-temperature stimulates the heart, brain, and every other organ. Metabolic activity is increased. There is an increased production of carbonic acid, indicating an increased consumption of hydrocarbon and carbohydrates, which also occurs when the body is exposed to cold; and there is likewise an increased oxidation of proteid, one of the characteristic effects of all measures which raise the temperature of the blood. These physiologic effects have an exceedingly important bearing upon the therapeutic effects and indications of the sun bath.

As a result of the **thermic stimulation,** the cutaneous vessels are dilated, whereby, in conjunction with the increased activity of the heart, the movement of blood, and consequently metabolism throughout the whole body, are greatly accelerated; while the heating of the blood stimulates the activity of the sweat glands, giving rise to exceedingly active perspiration. The amount of sweat produced may be increased from the normal average of one and one-half ounces in an hour to as much as two or three pounds, and even more, in an hour, especially when the patient engages in active exercise.

The **overfilling of the cutaneous vessels** diverts from the interior of the body a considerable amount of blood, since, when filled, the vessels of the skin may contain one-half to two-thirds the total quantity of blood in the body. The natural result is a draining of all the viscera; a condition allied to collateral anemia is established in the brain, liver, kidneys, stomach, spleen, and other viscera. Cerebral anemia manifests itself in drowsiness, which often causes the patient to fall into a profound slumber. This is one of the characteristic and noticeable effects of the sun's rays on the nervous system.

While the thermic rays of the sun are producing these profound effects upon the circulatory system, the **chemical rays** are acting with equal intensity upon the nervous system. That this is a real and not a fancied influence has been thoroughly established by the observations of Finsen and others who have carefully studied the subject. The phenomena of sunstroke and sunburn are also indubitable evidences of these effects, as well as of the general influence of light upon animal and vegetable life, which has already been pointed out. That sunlight is one of the most powerful tonics that can be brought to bear upon the animal organism cannot, in the light of modern researches, be doubted.

Indications.—The sun-bath is applicable in all forms of disease accompanied by defective metabolism, especially in conditions characterized by deficient oxidation, as obesity, diabetes, and the uric acid diathesis. The dry, sallow, leathery skin of chronic dyspepsia—an evidence of the defective oxidation and profound autointoxication—rapidly becomes moist, lively, and velvety as the result of an hour's daily sunning. Neurasthenia, in all its forms, is materially influenced for good, the quality of the blood is improved, and all the tissue-building and energy-storing processes are stimulated. In anemia and chlorosis, the blood-making processes are encouraged, toxins are eliminated, and the spasm of the cutaneous vessels, which results in chronic visceral congestion, is rapidly relieved. In myxedema and exophthalmic goiter the sun-bath is of great value when employed with proper precautions. Care must be taken to guard the heart during hot baths of all sorts by placing an ice-bag or cold coil over the precordia. In Bright's disease, as in cirrhosis of the liver and in all other forms of visceral degeneration, patients often receive surprising benefit from this simple measure, when it is employed with proper adaptation to individual needs. In such affections great care must be taken in cooling the patient after the bath. The cold mitten friction, the cold towel rub, and the wet sheet rub are excellent means of toning the skin. The cold plunge, the shallow bath, and similar measures, are unsafe in the majority of cases. In chronic rheumatism, rheumatic gout, and even in tuberculous joint disease, the sun-bath often accomplishes wonders, always affording amelioration, and sometimes aiding the patient to recover in cases which seemed quite hopeless.

Winternitz has recently called attention to the great benefit that may be derived from exposing the skin to the sun in various cutaneous disorders, especially eczema. He covers the skin with a thin red cloth, and then exposes the parts thus protected to the influence of the full solar ray for some hours daily. Psoriasis also yields to this method. I have met with success in several cases of chronic acne of the face and shoulders.

Counterindications and Special Precautions.—The sun-bath is counterindicated in all febrile disorders, except in cases of chronic pulmonary disease with slight elevation of temperature. Decided febrile activity, however, should always be regarded as a counterindication to general sun-bathing, or as necessarily limiting the exposure to a very few minutes, never long enough to increase the elevation of temperature. It should be remembered that in cases of this sort the thermotactic functions of the body are disturbed, and an elevation of the temperature is very easily induced.

In eruptive fevers, especially in smallpox, the **chemical rays** should be excluded altogether. This may be accomplished by the use of red glass or translucent red paper in the windows of the sick-room, or by hanging heavy red curtains before them, as practised by John of Gadsden. Finsen and others have shown that this precaution prevents the formation of pustules, and shortens the course of the disease.

In cases of insomnia, great care must be taken to avoid overheating the head; the cold application following the bath should be carefully graduated, and at its conclusion a cold spray may be applied for ten or fifteen seconds to the legs and feet. In cases of rheumatism, gout, and rheumatoid arthritis, the cold application following the sun-bath must not be too intense or too prolonged. It is often better to cool a patient, especially at the beginning of a course of treatment, by a tepid shower or fan douche or the broken jet. The temperature should be from 85° to 75° F. (say, 30° to 24° C.), and the duration, twenty to sixty seconds. Care must be taken to avoid allowing the stream of cold water to fall directly upon the affected joints, as this will increase the pain. In cases of cardiac disease, in which there is marked evidence of failing compensation, prolonged exposure to the sun should be avoided, and the succeeding cold application should be very moderate in character, the temperature not being lower than 60° F. (say, 15° C.), and the duration from ten to twenty seconds. If the cold application is in the form of a douche, the precordial region should be avoided; the legs, the back, and the liver region receiving chief attention. In these cases, however, it is, as a rule, better to cool the patient by means of a cold towel rub or a wet sheet rub. When skin eruptions are present, very cold applications and friction must be avoided. The patient may be cooled by a prolonged rain douche at 85° to 78° F. (say, 30° to 25° C.) or a tepid bath at 90° to 85° F. (say, 32° to 30° C.) for two to six minutes. Reaction should in these cases be promoted by exercise after the bath rather than by friction.

LOCAL APPLICATIONS OF SUNLIGHT

Local applications of sunlight are commonly made with lenses or concave mirrors by which the sun's rays may be concentrated. I first employed the concentrated rays of the sun in this manner in the summer of 1883. The method was then successfully used in the treatment of a case of inveterate neuralgia of the posterior branches of the spinal nerves, and later in various other classes of cases. Experiments have shown that these concentrated rays have considerable penetrating power.

Mode of Action and Effects.—In these local applications of the concentrated solar rays, the **chemical ray** must be regarded as the active agent. The principal embarrassment which arises in the employment of concentrated light is the great intensity of the calorific rays, which renders the application intolerable after the first few seconds. Finsen first succeeded in overcoming this difficulty. He filtered out the calorific and luminous rays by passing the solar rays through a blue solution made by dissolving copper sulphate in dilute ammonia water. The strength of the solution may be varied to suit the intensity of the sun's rays at different seasons. It should be just sufficient to reduce the heat to a degree which the skin will tolerate when the rays of the sun are brought to a focus, the purpose being to obtain the highest degree of activity of the chemical rays while reducing the action of the heat rays to the point of tolerance.

FIG. 53.—FINSEN'S METHOD OF LOCALIZED HELIOTHERAPY.—(*From a Photograph loaned by Dr. H. W. Stelwagon.*)

The patient suffers no pain during the application, although there is sometimes intense itching. The surface under treatment reddens during the séance, and a few hours later the tissues may be slightly swollen. Twenty-four hours later a vesicle filled with clear serum usually appears. In a few days this is dry, leaving thin crusts, which are readily removed by means of dressings moistened with a solution of boracic acid. Sloughing never occurs. The effect is simply that of an intense sunburn.

Technic.—In order to increase the influence of the chemical rays

Finsen found it expedient to compress the tissues, thus emptying the blood-vessels and rendering the skin nearly transparent, experiments having shown that the opacity of the tissues is chiefly due to the presence of the red blood-corpuscles. This compression is accomplished by means of a hollow glass disc, which is made to act as a refrigerant of the tissues by means of a constant stream of cold water passing through it. It is thus possible to concentrate the sun's rays to a degree that would otherwise be intolerable. In an emergency, the same thing may be accomplished by a very simple though less practicable means. An ordinary lens about six inches in diameter is employed to concentrate the solar rays, which are allowed to fall upon the skin after passing through a thin disc of ice an inch or two in diameter, held

FIG. 54.—EFFECT OF HELIOTHERAPY.—(*Finsen.*)

upon the skin. The ice is pressed firmly upon the part and thus empties the blood-vessels, blanching and cooling the tissues. The cut on page 223 (Fig. 53) shows the devices employed by Finsen in the use of the solar rays.

The **duration** of the application is from an hour to an hour and a half. The application is confined to an area of one to three square centimeters, and is renewed daily, until the part is well cicatrized. Then another part is similarly treated.

There is no danger whatever in these local applications of the solar rays. The necessary apparatus is somewhat expensive; but the only inconvenience attending its use is the considerable length of time required.

Indications.—The actinic rays have been employed by Finsen and others in the treatment of various forms of lupus, epithelioma, and several varieties of acne, alopecia, and other maladies of the skin. The method has proved especially successful in lupus vulgaris.

The accompanying illustration (Fig. 54) shows the effect of treatment. When visiting the Light Institute of Copenhagen in 1899, I was informed that benefit had been derived in nearly all cases, and that failure had occurred only when the patient had not remained under treatment for a sufficient length of time. Note was also made of the interesting fact that better results were obtained during the summer season, when the patients were treated by the solar rays, than during the winter season, when the treatment was administered indoors by the aid of the arc light; this difference is probably due to the tonic effects of the general exposure to the sun.

The success obtained in the treatment of epithelioma of the skin was also highly encouraging, nine cures being obtained out of eighteen cases treated. Of twenty-nine cases of alopecia areata, twenty-two were cured. None of the rest were discharged as incurable, but some were obliged to discontinue treatment for various reasons.

The treatment of lupus by this method must be carried out with great perseverance. Finsen states that his patients remain under treatment, on an average, for about four and one-half months. In some cases two or three applications effect a cure, while in other cases in which the disease covers a considerable area a long time is required, since in many cases the applications must be repeatedly made to each part before a permanent cure is effected.

It is well to note that the cure is not effected by destruction of the tissues, but by destruction of the parasitic elements upon which the disease depends, and a quickening of the vital activities of the tissues, whereby their power of defense is increased.

CHAPTER II

ELECTROPHOTOTHERAPY

Physiologic Effects. Electric Sunstroke. The Arc Electric Light Bath—Description and Technic; Physiologic Effects; Indications. Local Applications of the Arc Electric Light. The Incandescent Electric Light—Technic; Physiologic Effects; Therapeutic Effects and Mode of Application; Indications.

THE THERAPY OF THE ELECTRIC LIGHT

Physiologic Effects.—Experiments for the purpose of determining the effects of the electric light upon vegetable life were first made by William Siemens in 1880. His conclusions may be summarized as follow:

1. That the electric light is efficacious in producing chlorophyl in the leaves of plants, and in promoting growth.

2. That an electric center of light equal to 1400 candles, placed at a distance of two meters from growing plants, appears to be equal in nutritional effect to average daylight in March, while greater effects may be attained by more powerful light centers.

3. That while under the influence of the electric light, plants can sustain increased stove heat without collapsing—a circumstance favorable to forcing by electric light, and showing the influence of light as a vital stimulant.

Hervé-Mangon,[1] Prillieux,[2] Sarat, and other later investigators confirmed the experiments of Siemens. Sarat showed that potatoes and tomatoes ripen sooner, and that hemp grows sixteen inches longer, under the influence of the electric light. Experiments conducted at the Cornell University Agricultural Station, in 1889 and 1890, showed that:

1. The electric light properly employed compares favorably with sunlight in its power to promote protoplasmic activity.

2. Electric light acts as a tonic to plants, enabling them to endure adverse conditions which they would not otherwise be able to resist; and acts as a true vital stimulus, the effect of its use at night to supplement the influence of daylight being practically identical with that of the prolonged solar day of the Arctic regions.

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[1] "Compt. Rend.," 53, 243.

[2] "Compt. Rend.," 60, 410.

Bacteria are killed in a few minutes by exposure to the concentrated rays of an electric arc lamp of 6000 candle-power.

Electric Sunstroke.—A condition which has been termed by the French 'electric sunstroke' affords convincing evidence that the physiologic effect of a powerful arc light is practically the same as that of sunlight of equal intensity. Electric sunstroke was carefully described by De Fontaine, who witnessed an experimental exposure of a surgeon (Maklakow) to a powerful electric arc light used for welding metals in a factory near Moscow. The result was a most pronounced erythema of the face, chemosis of the conjunctiva, coryza, lacrimation, photophobia, and intense burning of the skin. At the end of the second day the inflammation began to subside, and on the third day desquamation began. Pigmentation of the skin remained for some time.

The **effects of the electric light upon the skin** are the same as those induced by the sun—profuse perspiration, pigmentation, and erythema.

These effects indicate that the same powerful influence exercised by the sun's rays upon metabolism and the nervous system is likewise present in the light rays emitted by the electric arc.

THE ARC ELECTRIC LIGHT BATH

The electric light, as has been shown, possesses properties identical with those of the sun's rays; in the arc light the luminous and chemical rays predominate, in the incandescent light the heat rays.

The difference in form between the arc lamp and the incandescent lamp, and the decided difference in the quality of the light obtained from these two sources, naturally divide the devices by which these two forms of light are utilized therapeutically into two distinct classes —arc light baths and incandescent light baths. In the earliest forms of the arc light bath, a single arc lamp was employed and a reflector was placed behind it in such a position as to focus the rays upon the patient's back. Baths of this sort were employed empirically in the United States more than twenty years ago. In 1891 I had constructed various forms of electric light apparatus, employing for the first time incandescent lamps; later I constructed cabinets with both arc and incandescent lamps, with which exact observations were attempted.

Description and Technic.—The arc light, while emitting much more powerful rays, has not thus far proved to be so useful for general purposes as the incandescent light. Its bulk, the expense attending its installation, and the numerous inconveniences attending its employment are perhaps sufficient reasons why its use has thus far been quite limited. For general application I have found most convenient a square cabinet of such shape and height as to permit the patient's head to be excluded from the bath while he sits erect upon a stool in the center of the cabinet, a recess being provided at each corner in which is placed a powerful arc light arranged in such

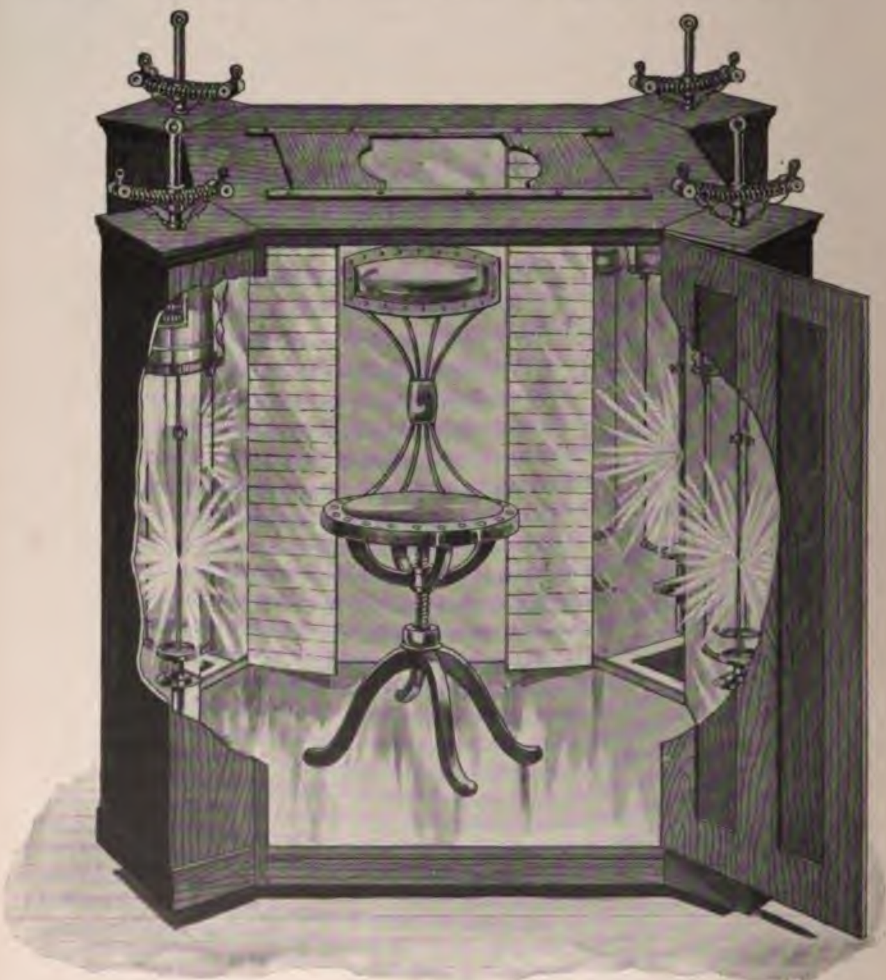

FIG. 55.—ARC LIGHT CABINET.

a manner that it may be adjusted to any level. Its construction is imperfectly shown in figure 55. The cabinet is lined with aluminum, nickel-plated copper, or silvered glass, so as to direct the rays toward the center. Mounted glass screens attached by hinges at either side of the recess are so arranged that either a red or a blue screen can be interposed at will between the lamp and the patient. By this means it is possible to employ the unfiltered rays or either the chemical or the calorific rays alone. When the chemical rays are required, it is only necessary to interpose the blue screen; while the red screen allows the passage of heat rays only.

The recess containing the lamp is open at top and bottom, so that, by a free circulation of air, the heating of the glass screen, and consequently the heating of the air of the cabinet, may be, so far as possible, prevented. The cabinet itself is also freely ventilated, so that the effects of the bath are practically confined to the direct influence of the radiant energy emitted by the electric light.

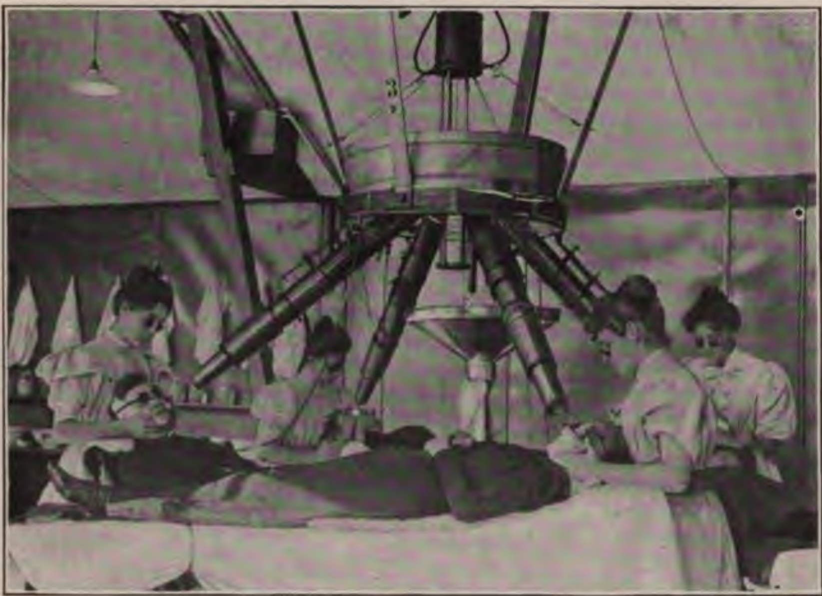

FIG. 56.—APPARATUS FOR LOCALIZED ELECTROPHOTOTHERAPY.—(*Finsen.*)

Physiologic Effects.—The results obtained by the employment of this bath are essentially the same as those obtained from the sun-bath. Patients, however, begin to perspire more quickly than when exposed to an ordinary sun-bath. This may perhaps be due to the greater number of actinic rays in the arc light, which exercise a powerfully stimulating effect upon the sweat glands. A **short application** of the bath is highly tonic in its effects. A **prolonged application** produces depressing effects similar to those observed from the prolonged sun-bath. The **duration** of the bath may be from five to twenty minutes.

Indications.—These are precisely the same as those for the sun-bath. The measures described as suitable for **after-treatment** in connection with the sun-bath are equally applicable in connection with the arc light; and the **precautions** and **counterindications** are the same for both procedures.

Our knowledge respecting the value of the arc light as a **local therapeutic measure,** and the methods of application, are almost wholly due to the inventions and observations of Finsen, who, after demonstrating the value of the actinic rays of the sun in the treatment of lupus and various other maladies of the skin, showed that the same results may be obtained by the employment of the arc light by the aid of suitable apparatus.

The general directions for the use of the arc light in the treatment of lupus are the same as have already been given for the use of sunlight for the same purpose (see page 225).

The Lortet-Genoud Lupus Lamp.—This recent improvement of Finsen's original apparatus has practically brought the treatment of skin lesions by electric light within the reach of all. With an ordinary arc lamp of 10 to 15 ampères the patient can be brought close to the light, and the action on the skin in this way is increased so that the time of exposure can be reduced from one hour to fifteen minutes, while the cost of installation and current is considerably reduced. Although with the Lortet-Genoud lamp it is possible to treat only four patients with one lamp in one hour,—that is, thirty-two patients in an eight-hour day,—yet these thirty-two patients require only one attendant to look after them instead of four. The chief feature is that the use of a condenser is dispensed with. In doing this it becomes necessary, first, to make use of the chemical rays as near as possible to their origin before dispersion, since the degree of concentration increases directly with the proximity to the luminous source; and, second, to protect the patient from the action of the heat rays. These indications are met by the apparatus in question (Fig. 57) in the following way: Between the light and the patient there is interposed a screen consisting of a metallic vessel in which a constant circulation of water is kept up to obviate heating. This vessel has a central orifice which allows the light to pass through, the orifice being in its turn closed by a hollow obturator, the two faces of which consist of quartz lenses. One of the faces of the obturator is in close contact with the skin and exercises compression, hence it is also known as the compressor. As it also has a constant circulation of cold water, the tissues with which it is in contact are subjected to constant refrigeration. The luminous rays from the electric arc fall upon the surface to be treated only about 3 or 4 cm. from their source, having undergone no concentration. Thus the available luminous zone is of considerable extent, instead of being about the size of a shilling, as in the ordinary method. The lamp is a continuous-current arc, taking a current of 12 to 15 ampères and from 55 to 65 volts.

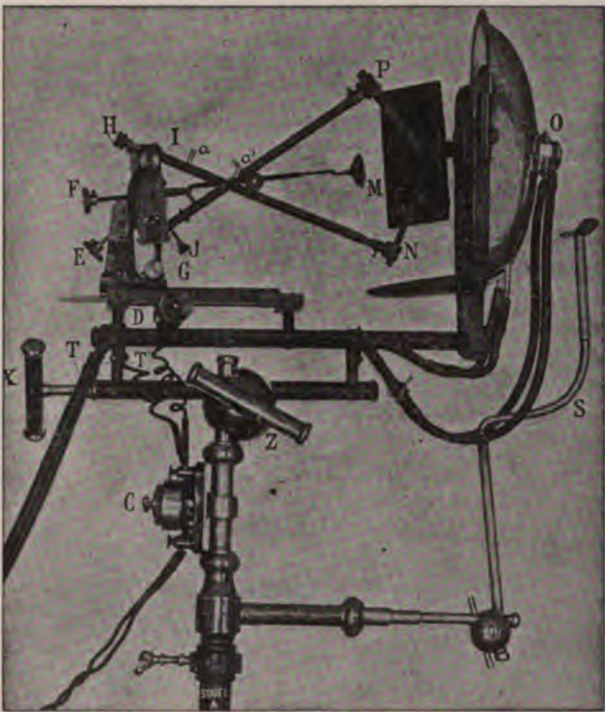

FIG. 57.—LORTET-GENOUD LUPUS LAMP.

THE INCANDESCENT ELECTRIC LIGHT

After the sun-bath, the incandescent electric light is the most useful and generally serviceable measure employed in phototherapy. Various appliances have been devised for both general and local applications of the incandescent electric light. The first of these were constructed for me in 1891, and consisted of a number of simple devices for applying the electric light to small areas. The very first consisted of a cone of polished metal, about a foot in length, and ten to twelve inches in diameter at the base. In the apex was fixed a single electric light socket, in which could be placed a lamp of any candle-power required. The cone was placed over the abdomen, the chest, the back, a joint, or any other part to which it was desired to make an application. The results obtained were so excellent that other de vices for applying the light to special parts, as the spine, the trunk, the feet, and the joints, as well as apparatus for applying the light to the whole body, were rapidly constructed.

The first **general incandescent light bath** consisted of a frame about two feet in width and six feet in length, upon which were supported a metal reflector and twenty to thirty incandescent lamps. This frame was attached by hinges to a support in such a way that it could be raised and lowered. A couch was placed beneath it, on which the patient lay during the treatment. After the application had been made to one side of the body for a sufficient length of time, the patient turned over and received the light upon the opposite side.

FIG. 58.—AUTHOR'S INCANDESCENT ELECTRIC LIGHT APPARATUS FOR SPINE AND FEET.

A little later **cabinets** were constructed—first a vertical, and then a horizontal one. Other cabinets of various forms and sizes have since been constructed by those who have interested themselves in the development of this therapeutic measure, particularly Winternitz. The **horizontal cabinet** employed by me is shown in figure 59. In this cabinet the patient lies upon a movable couch, mounted on wheels, and easily run in and out. The couch is provided with a thick glass top, beneath which a number of electric lights are placed so that the lower as well as the upper surface of the body is exposed to the influence of the light, making it unnecessary for the patient to change his position in order to secure exposure of the whole surface. The small vertical cabinet, constructed with the head excluded, requires twenty to forty lamps. The horizontal cabinet contains ninety lamps of sixteen candle-power each.

Other devices permit applications to the spine, trunk, joints, and other parts of the body. (See Fig. 58 and Fig. 60.)

FIG. 59.—AUTHOR'S HORIZONTAL INCANDESCENT ELECTRIC LIGHT CABINET.

Portable apparatus for making local applications of the incandescent electric light have also been constructed.

Technic.—For the application of the general incandescent electric light bath the patient's clothing is removed just as he enters the bath, care being taken that the feet are warm, and the head, face, and neck cooled in preparation for the bath. The intensity of the bath is regulated by means of suitable switches, which render it possible to increase or diminish, at will, the number of lights. A rheostat may be used for the same purpose, leaving all the lights in operation all the time, but controlling the intensity of the light by increasing or decreasing the resistance.

The **duration** of the bath must be determined by the effect desired. If tonic effects alone are required, the duration will be three to ten minutes, or until the skin becomes slightly moist. If it is desired to heat the skin thoroughly, then the patient remains in the bath until free perspiration is established. If eliminative effects are desired, the patient remains in the bath until vigorous perspiration has been continued for the time desired, say from fifteen to forty minutes. In cases in which the application is considerably prolonged, an ice-bag or the cold precordial coil should be placed over the heart, and a cold wet napkin should be wrapped about the head, or the head and throat, and this should be renewed as often as it becomes warm.

FIG. 60.—AUTHOR'S ELECTRIC LIGHT CABINET FOR JOINTS.

The **temperature** of the bath may range anywhere from 150° F. (65.5° C.) to the highest temperature tolerable. It should be remembered that in this bath the heat is not derived from the air, as in the hot-air bath, but is communicated to the body by means of the heat rays or radiant energy thrown off by the incandescent filaments within the lamps. These rays pass through the air surrounding the patient without heating it to any very considerable degree. As the rays enter the body, they come in contact with various opaque structures, the resistance afforded by which converts the radiant energy into heat. It is apparent, then, that the temperature of the air surrounding the patient is a matter of very little consequence. It is important that the bath should be **well ventilated,** so that the moisture arising from the patient's body may be carried off rapidly. The dryer the air, the higher the temperature the patient will be able to bear. Some French observers report the employment of temperatures ranging from 400° to 500° F. (say, 200° to 315° C.). These authorities employ, in taking the temperature of the bath, a thermometer whose bulb has been covered with lamp-black, and which is fully exposed to the light, being usually placed upon the patient's body. Superheating of the air about the patient may be practised, when desirable, by simply restricting the air space within the cabinet. It is thus possible to combine the hot-air bath with the light bath. In cases in which patients are rather intolerant of heat, the temperature may gradually be raised by connecting only a part of the lamps at the beginning of the bath, and bringing into use additional groups as the patient becomes able to bear a higher temperature.

Care should be taken in the treatment of patients whose eyes are sensitive to bright light, to protect the eyes by means of a napkin laid across the face, or by glasses suitably colored.

The **after-treatment** to be employed in connection with the incandescent electric light or radiant heat bath is precisely the same as that employed after the arc light bath or the sun-bath. A cold application should be made in almost all cases. The only exceptions are those in which cold is counterindicated. General applications must be made after the general bath; and after local applications, cold in some form should be applied to the parts which have been exposed to the action of the light and heat. For local applications, the douche and the cold towel rub are most satisfactory and efficient measures.

Physiologic Effects.—My observations may be summarized as follow:

1. The most important property of the electric light bath is that of a superior **heating agent.**

2. An intense or a considerably prolonged application of the incandescent electric-light bath, whether local or general, produces intense **reddening of the skin,** with **dilatation of the superficial vessels.** Its effect, in this respect, is comparable with that of a vapor or a hot-air bath. When the application is repeated many times, the parts become **pigmented,** or brownish in color, just as when the surface is exposed to the sun's rays.

It is proper to call attention here to the interesting observations of Conrad Klar respecting the rate at which heat is eliminated from the surface of the body when fully exposed to a temperature below that of the body. He found that the rate, during the first five minutes, was ten times the normal, or eighteen calories per minute; in the second five minutes the amount of heat eliminated was only twice as great, the diminution being due to the contraction of the blood-vessels, resulting from the contact with cold air. In an electric light bath the radiant heat maintains continuous relaxation of the superficial veswithout heating the air about the patient to any appreciable degree, if free circulation is maintained. It is thus possible to maintain continuously, for a considerable length of time, conditions most favorable for heat-elimination, while at the same time heat-production is being stimulated by the thermic impression made, and the elevation of the temperature of the blood through exposure to the action of the heat rays in the widely distended vessels of the skin. This especial characteristic of the electric light bath unquestionably accounts for the increased production of carbon dioxid, which is a proof of the powerful influence of the bath upon metabolism, and of its remarkable alterative and reconstructive effects.

3. **General perspiration** is induced more quickly by the incandescent electric-light bath than by any other known procedure, generally appearing within three to five minutes after the patient enters the bath, and quite regardless of the temperature of the air about the patient. This observation has been confirmed by Winternitz and others. Winternitz reports having seen perspiration appear within a very short time, at a temperature not above 85° F. (30° C.); the time required to produce perspiration in the Turkish or hot-air bath is generally much longer.

Cutaneous activity is considerably greater in the electric light bath than under the influence of any other sweating procedure. That the sweating is caused by the radiant energy and not by the contact of hot air with the body is shown by the fact that vigorous perspiration may be induced in a small area of the body, as in an arm or a leg, by subjecting the part to the influence of the light rays without confining it. Winternitz has observed that perspiration in the electric light bath begins first on the outer surfaces of the thighs, which are most exposed to the influence of the light. The profuse perspiration induced by an incandescent electric-light bath is doubtless due, in large part at least, to the stimulating effects of the light rays upon the nerve-endings in the skin.

4. There is a quite rapid **rise in the body-temperature** in the electric light bath. I have noted an elevation amounting to four or five degrees above normal in from fifteen to twenty minutes. This fact renders the bath of special value in the treatment of rheumatism, gout, and other phases of the uric acid or alloxuric diathesis.

5. Study of the respiration products shows a decided **increase in the elimination of carbon dioxid**, an evidence of the active oxidation and tissue changes set up by this procedure. In my observations made in 1894, the average percentage of carbon dioxid eliminated during an electric light bath of thirty minutes was found to be 5.13 per cent. in a patient who, previous to the bath, was eliminating 3.60 per cent.—an increase of 44 per cent. In a Russian bath the same subject eliminated an average of 3.00 per cent., an increase of 10 per

cent.; while in a Turkish bath of thirty minutes the average elimination was 4.1 per cent., an increase of 11 per cent. The acceleration of oxidation indicated by the increased elimination of carbon dioxid was thus four times as great in the light bath as in the Turkish bath, and the difference was still greater as compared with the Russian bath. It should be noted also that respiration is free and without embarrassment, though somewhat quickened, contrasting widely with the distressed breathing often observed in the Turkish and Russian baths.

6. The **blood-count,** especially of the red cells, is increased to a marked degree (10 to 20 per cent.) by the electric light bath, followed by the usual cold bath; the increase appears within half an hour, and continues for a longer time, and in cases of marked anemia, the increase is usually permanent, provided the application is repeated daily.

7. Under the influence of the incandescent electric-light bath, the **pulse** is at first slowed, but later is quickened.

8. The **blood pressure** is at first increased, later diminished.

The **therapeutic effects and modes of application** of the incandescent light bath may be summarized briefly as follows:

1. It is one of the most effective of all means of producing general and local revulsive effects, by dilating the cutaneous vessels. The reddening of the skin begins within a very few moments after the influence of the light is brought to bear, and becomes more and more intense as the application is continued. The permanency of the effects produced may be greatly increased by a short cold application following the light bath. The effect of such an application is to fix the blood in the skin by converting the passive venous congestion into an active arterial hyperemia, in which the 'peripheral heart' is brought into active play.

2. The incandescent electric-light bath certainly has no equal among therapeutic means as a sudorific measure; it induces perspiration more quickly and more vigorously than any other agent, and with the least amount of inconvenience and discomfort to the patient. When employed for this purpose, especially when the bath is considerably prolonged, care must be taken to protect the heart and the head by means of cold compresses. The patient should be made to drink water very copiously, both to encourage diaphoresis and to maintain the normal blood volume.

3. The incandescent electric-light bath is a most effective means of promoting the absorption of exudates. For this purpose both general and local applications are valuable. In France the general electric light bath has been used successfully in promoting the absorption of exudates in the cornea of the eye, vitreous opacities,

and other pathologic products of a similar nature. I have used it with most gratifying success in promoting absorption of exudates from the pleural and peritoneal cavities, and in and about the joints. There is no known means by which the absorption of exudates in the joints may more rapidly be induced than by general applications of the electric light bath, combined with local applications of the light to the affected parts, and suitable hydriatric measures.

Care should be taken to administer a **cooling bath** after general applications, and the **alternate spray** or douche after local application to the joints, this to be followed by the application of a **heating compress,** consisting of a linen towel wrung as dry as possible out of cold water and wrapped about the part, then covered with mackintosh and the whole covered with several layers of dry flannel so as to retain the heat.

The **local** application of light should be made at least twice daily, the **general** application once a day. The **heating compress** should be changed at least twice daily. Massage and, in some instances, electric applications to the parts, and especially to the adjacent muscles, are important adjuvants.

4. For tonic effects no other means excels short applications of the incandescent electric light (three to eight minutes). A sensation of well-being, similar to that experienced by one who stands before a glowing fire, is most pronounced, and when followed by a proper hydriatric application, the stimulation to nutrition is of the highest possible degree. This statement is not made at random, but after ample experience.

Indications.—In the treatment of the **alloxuric diathesis** in all its forms, and especially **rheumatism, gout, lithiasis, and neurasthenia due to alloxuremia,** the increase of oxidation and general improvement in metabolism aid in the burning up of the nitrogenized waste matters and in the elimination of toxic elements. In cases of this sort, the bath should be applied **two or three times weekly** to the extent of producing vigorous perspiration and elevation of the body-temperature two or three degrees. Copious water-drinking, an antilithemic diet, and abundant exercise out-of-doors, must support the phototherapeutic measures.

Diabetes and **obesity** are benefited by the electric light bath through its potent influence upon carbon dioxid formation by the stimulation of the oxidation processes within the body. Fat diabetics are especially likely to be benefited by the electric light bath. The inactive skin is caused to sweat freely under the powerful stimulus of the light bath. The increased oxidation lessens the excretion of sugar. The alkalinity of the blood is increased, and the organism is thereby better prepared to correct the disorder to which this malady or symptom-complex is due.

Obesity is in a high degree amenable to the powerful influence of the electric light. The incandescent light bath does not, like most other sweat baths, simply extract a considerable amount of water by increasing the activity of the skin. In addition, owing to the penetrating power of the light rays, much more is accomplished: the deeper structures of the skin are excited to activity; the heat-making processes, by which fat may be consumed, are stimulated to an unusual degree, as shown by an increased elimination of carbon dioxid. When it is recollected that at least three-fourths of the energy of the body is consumed in heat-production, it is apparent that an increase of tissue consumption, amounting to much more than forty per cent., as shown by the author's experiments, is a matter of the highest importance. Suppose this increase to be continued for the space of one hour only, as the result of a general electric light bath; this alone would represent a considerable loss of fat. But, as Conrad Klar has shown, the heat-elimination may be increased to more than ten times the normal amount, and this may be continued, not for a few minutes only, but for a considerable length of time, when the temperature of the air surrounding the patient is below the temperature of the body, provided the blood-vessels are maintained in a state of active dilatation, as is possible in the electric light bath, but in no other heating procedure.

Sciatica, intercostal **neuralgia**, vague neuralgic pains, and **myalgia** yield readily, in the majority of cases, to the use, daily or thrice weekly, of the incandescent electric-light bath, especially when combined with carefully administered tonic hydriatric measures, massage, a proper dietary, and an outdoor life.

Autointoxication and **chronic metallic poisoning** find in the incandescent electric-light bath a most efficient remedy. The enormous elimination of water through the skin secures the ingestion of water in abundant amount, and at the same time promotes absorption through the mucous surface, thereby subjecting the tissues to a veritable water bath and cleansing them of accumulated wastes and other toxic agents, which disturb metabolism and interfere with normal tissue activity.

In **chlorosis** and **anemia** the most excellent results are obtained by the systematic employment of the incandescent light bath. There is no more efficient means of dilating the cutaneous vessels, to whose contraction is due the pallor characteristic of these disorders, thus relieving the visceral congestion necessarily present. This prompt balancing of the circulation establishes the primary condition essential to aid the recuperative powers of the body in their effort to re-establish normal blood-making processes.

In **nephritis** the electric light bath, by diverting half to two-thirds of all the blood in the body into the skin, affords prompt relief of the congested and inflamed parts. In this condition, perspiration may be prolonged for many hours if necessary, care being taken to refresh the patient at intervals by a very brief energetic cold rub with a friction mitt, by an ice-bag over the heart, and by protection of the head with cold compresses. Great care should be taken to avoid chilling the patient. A very slight chill, such as might result from momentary exposure of the body to the influence of evaporation from a moist surface, might be sufficient to cause contraction of the cutaneous vessels, and counteract the good effects of the bath. Imimediately after the administration of the bath, the patient should be wrapped in flannels. This process should be repeated at intervals of four to six hours, and perspiration should be maintained from twenty-four to thirty-six hours, or until the renal function is established.

According to Rieder, the incandescent electric-light bath affords good results in **syphilis**, in **chronic bronchitis**, and in **bronchial asthma.** The same author also obtained good results from the use of this bath in **cardiac hypertrophy**, and in **cardiac dropsy.** In these conditions, however, according to my experience, the bath must be used with a considerable degree of caution. The temperature should be low at first, and very gradually increased, always avoiding excessively high temperatures. The heart must be guarded by an ice-bag or cold precordial coil placed over it before the heat is turned on, and the application should be brief, barely sufficient to induce gentle perspiration. Cold mitten friction should be applied immediately afterward, and great care should be exercised that the patient does not become chilled by exposure following the bath. The cutaneous activity induced by the procedure, with the precautions suggested, greatly relieves the overburdened heart by diminishing the distention of the right ventricle, by lessening the resistance in the peripheral vessels, and by setting at work the 'skin-heart,' which is often most inactive in this condition.

Chronic tuberculous or **inflammatory disease of bones, chronic leg ulcers, paralysis,** and **trophic disorders,** may be benefited by exposure of the parts to the full sunlight, and by the application of the concentrated solar or electric light rays.

It might almost be said in conclusion that to mention all the conditions for the treatment of which the incandescent electric-light bath has been recommended with more or less reason, would involve the discussion of almost every important chronic affection known to medical science. The procedure is certainly a most effective means of bringing into activity and maintaining in operation those natural recuperative forces by means of which all actual curative processes must be instituted and carried forward.

The **hygienic value of the electric light bath** can scarcely be overestimated. In cities, where the sun-bath is available to only a limited degree at any season of the year, and during the winter, when the sun's rays are of little intensity, and are for a large part of the time obscured by clouds, the electric light bath affords a capital substitute for sunlight. The exposure of the naked body to the influence of the active radiant energy of the incandescent electric light during a period of from five to ten minutes daily or thrice weekly, is a measure certain to afford ample compensation for the trouble and expense involved. Care should be taken, however, to follow the bath by a short plunge at a temperature of 65° to 75° F. (say, 18.5° to 24° C.), or a vigorous application of the douche at a temperature of 60° to 50° F. (15.5° to 10° C.). The cool half-bath, or even the cold sheet rub, is a less vigorous but an effective substitute for the douche or the plunge when these are not available.

CHAPTER III

PRINCIPLES OF THERMOTHERAPY

Definitions. General Physiologic Effects—Effect of Heat on Skin; Muscles; Nervous System; Circulation; Blood; Respiration; Body-temperature; and on the Viscera. Anatomic Basis. Cutaneous Reflex Areas; Correlated Vascular Areas. The Practice of Thermotherapy—General Indications; Modes of Application.

THERMOTHERAPY

Definitions

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespective of the nature of the media through which the application is made. Properly speaking, hydriatric applications of all sorts, both hot and cold, vapor baths, hot- and cold-air baths, and even light baths, are **thermic applications,** and they are so spoken of in preceding chapters. Here, however, attention will be confined to the consideration of such applications as are capable of directly **communicating heat** to the body; hence, cold applications of all sorts will be excluded. Vapor and Russian baths, which may properly be termed thermic applications, are also omitted from this chapter, having received consideration elsewhere.

Media of any sort having a temperature above that of the body are said to be hot. Temperatures above 104° F. (40° C.) are termed very hot. Temperatures near that of the skin are termed warm. These terms, with others relating to temperature, are commonly used rather loosely. To secure accuracy in prescription it is better to indicate the exact temperature. When ordinary terms are employed, they may be understood as expressing approximately the following temperature values: Very cold, 32° to 55° F. (say, 0° to 12.5° C.); cold, 55° to 65° F. (say, 12.5° to 18° C.); cool, 65° to 80° F. (say, 18° to 27° C.); tepid, 80° to 92° F. (say, 27° to 33.5° C.); warm, 92° to 98° F. (say, 33.5° to 37° C.); neutral, 92° to 95° F. (say, 33° to 35° C.); hot, 98° to 104° F. (37° to 40° C.); very hot, 104° F. (40° C.) and above.

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, as set forth in Part I of this volume. The limitation of space will here permit only a brief statement of the physiologic effects resulting from warm and hot applications, general and local, which will be followed by a description of the technic of hot applications and a summary of their therapeutic uses. For convenience in discussion some of the facts and principles already set forth may be repeated on occasion.

GENERAL PHYSIOLOGIC EFFECTS OF HEAT

The **primary effects** of heat are those of an excitant or a physiologic stimulant. Within physiologic limits, the application of heat to living cells increases the activity of their protoplasm, an effect easily recognized in the quickened movements of the amebæ, leukocytes, and other minute animal forms, when placed upon a warming stage under the microscope. Heat is thus one of the most powerful of all vital stimulants, exciting the function of all tissues upon which it may be brought to bear—glands, nerves, nerve-centers, and the like.

These effects, however, are temporary, and are followed by **secondary effects** of an opposite character,—depression,—a sort of negative or atonic reaction after the withdrawal of the hot application. To these secondary depressant or atonic effects are attributable the weakening or exhausting effects of thermic measures when improperly managed or inappropriately applied.

These mixed effects are due to the different functions of the various structures which are directly excited by the elevation of temperature following the immediate contact with a heated medium. Elevation of temperature of the sweat-glands and nerve structures heightens their activity. If the application of heat is continued for a sufficient length of time to raise the temperature of the blood, all the vital activities of the body are accelerated. At the same time, however, there is set in operation a series of inhibitory effects which result from the stimulation of the heat-nerves, the tendency of which is to lessen heat-production and lower blood pressure, and diminish the disposition to and the capacity for mental and muscular activity. Cold acts in precisely the opposite way. In lowering the temperature of the structures of the skin, it acts as a depressant, diminishing the activity of the sweat-glands and other structures. If continued long enough to lower the temperature of the blood, heat-production and other forms of vital activity are lessened. Cold acts, however, as an excitant to the cold-nerves of the temperature sense. (These nerves as well as others may be paralyzed by an intense or prolonged application of cold.) Stimulation of the cold-nerves reflexly produces strong excitation of almost every bodily function. The force of the heart contraction is augmented, the blood pressure is raised, heat-production increased, metabolic activity quickened, and the disposition to and the capacity for mental and muscular activity heightened. The effects of heat are, then, directly excitant, indirectly depressant; while the effects of cold are directly depressant and indirectly excitant. These mixed effects afford opportunity for an infinite number of variations in the form and intensity of hydric and thermic applications, and in therapeutic effects.

The actual effects of a thermic application depend (*a*) upon its temperature, duration, and form; and also (*b*) upon the condition of the patient.

A **prolonged application at a high temperature** is at first excitant, and then decidedly depressant. The excitation is the natural result of the elevation of the temperature of the blood. The depressing effects appear to result from the lowering of the nerve tone and the exhaustion of nervous energy by overstimulation.

A **very brief application at a high temperature** is strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A **less intense** and **moderately prolonged** thermic application is excitant to a moderate degree at first, depressant effects appearing later, after the conclusion of the application.

A very complete statement of the physiologic effects of thermic applications upon the various bodily organs and functions has been given elsewhere in this volume, by Professor Winternitz (see pages 18 to 38) in a discussion of hydrotherapy. As the principles of thermotherapy rest upon the same foundation, it will be necessary to discuss here only such points as relate specifically to hot applications, and especially those which require somewhat fuller elucidation.

Effects of Heat upon the Skin

A very brief and very hot application produces a goose-flesh appearance from contraction of the smooth muscle-fibers of the skin.

Heat contracts the yellow elastic tissue, but relaxes the white fibrous tissue that constitutes the chief element of ligaments and tendons.

Heat may cause increase in perspiration to more than twenty times the ordinary amount.

Tactile sensibility increases at 98° F. (36.7° C.); decreases at 113° F. (45° C.); and disappears at 130° F. (54.4° C.), when painful sensations are experienced.

Momentary pallor occurs when the temperature is high (110° F. —say, 43° C.—and upward), and is quickly followed by reaction, with reddening of the skin from dilatation of the vessels. Lower temperatures produce immediate reddening of the skin with dilatation of the small blood-vessels, especially the veins. Contraction of the cutaneous vessels, with pallor, occurs some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

Following a hot application there is increased heat-elimination, which is the result of the quickened movement of blood through the skin, dilatation of the surface vessels, increased conductivity of the skin, and the more active evaporation occasioned by the great amount of moisture thrown upon the surface by the sweat-glands.

Effects of Heat upon the Muscles

The energy of the striated muscles is increased by short, hot applications.

Prolonged warm or hot applications lessen the excitability and the energy of voluntary muscles. It is thus that heat becomes of service in relieving muscular cramp. Cold produces the opposite effect.

Very hot applications—104° to 130° F. (40° to 54.5° C.)—increase the excitability of smooth or involuntary muscles.

Effects of Heat upon the Nervous System

Very short hot applications excite the brain, nerves, and nerve-centers through the impressions made upon the skin.

Prolonged general hot applications may give rise to pronounced exhaustion of the brain and spinal cord. Warm and hot applications lessen general nervous sensibility to a remarkable degree. This is especially true of very hot applications. The effect may be due in part to the absorption of moisture by the terminal nerve filaments in the skin; or it may be brought about by the stimulation of the temperature nerves. It is well known that the skin is much more sensitive to thermic impressions than to any other form of stimulus that it is capable of recognizing.

Applications of heat to the skin generally produce an agreeable sense of comfort and well-being. If the application is continued too long, languor, lassitude, and depression result.

Very hot applications of short duration, like brief cold applications, have both a direct and a reflex excitant effect.

Effects of Heat upon the Circulation

Heart.—In general, heat applied over the heart tends to quicken the systole, while cold produces the opposite effect.

General hot applications at first slow the pulse, then increase its frequency. Cold produces exactly the opposite effect.

Blood-vessels.—Very hot applications at first cause the blood-vessels to contract, then to relax.

Under the influence of heat the **skin** quickly assumes a dusky red hue from slowing of the cutaneous circulation. The vascular activity accompanying the reaction which follows a cold application concerns the arteries especially, and gives the skin a bright red hue. The vascular dilatation due to heat is passive, while that due to cold is active.

Large arterial trunks are dilated by hot applications prolonged sufficiently to heat the intervening tissues, or made at points at which large vessels lie near the surface, as in the groin, the axilla, the neck, the bend of the elbow, and the popliteal space.

The principle of **derivation or revulsion,** which furnishes the foundation for one of the most important therapeutic uses of heat, depends upon the fact that, when the vessels of one portion of the peripheral area supplied by an arterial trunk are in a state of dilatation, the vessels of the remaining portion or portions are contracted. In other words, the local hyperemia induced by an application of heat gives rise to a compensatory or collateral anemia in correlated vascular areas. This explains the relief afforded by an application of heat about a rheumatic joint, or over an inflamed or congested nerve or muscle. The same fact likewise affords an explanation of the relief of visceral pain which results from a general hot application.

Blood Pressure.—Cold raises blood pressure, while general hot applications lower blood pressure, though the blood-vessels may be dilated in both cases.

The dilatation which is part of the reaction following a cold application does not lower blood pressure, being accompanied by increased vigor of the heart's action resulting from reflex stimulation and increased activity of the small vessels—termed by some writers the 'skin heart,' but for which I prefer the name of the 'peripheral heart,' because the arterioles of the muscles and of various internal organs are influenced as well as those of the skin. A **very hot** application may raise blood pressure by reflex excitation of the heart, producing a quick, strong pulse; but, in general, **hot** applications lower the blood pressure by dilating the cutaneous vessels and thereby lessening peripheral resistance. The skin is capable of holding from one-half to two-thirds of all the blood in the body. Hence a general hot application, by dilating the surface vessels, and especially the veins of the skin, withdraws a large amount of blood from the internal circulation. The pressure in the ventricles of the heart is reduced, and the cardiac contractions are lessened in force.

A **hot douche** produces an elevation of blood pressure, at the same time dilating the surface vessels to the fullest degree by its strong mechanical or percutient effect.

The **tension of the tissues,** as well as that of the blood-vessels, is diminished by the mechanical influence of heat upon the connective-tissue and muscular elements which form the framework of the tissues, and upon the unstriped muscle-fibers found in the skin and in most of the viscera.

The Effects of Heat upon the Blood

General hot applications diminish the number of red cells. Local applications of heat, either moist or dry, produce a very marked increase in the number of leukocytes, although reducing the number of red cells. Heat also lessens the alkalinity of the blood, thus diminishing vital resistance, as has been shown by Charrin. This fact emphasizes the importance of concluding every general hot application with a general cold application of some sort, the effect of cold serving to maintain the normal alkalinity of the blood, and thus to increase vital resistance. When profuse sweating is induced, the volume of the blood is diminished, unless the loss is made good by the ingestion of water.

Effects of Heat upon Respiration

Heat and dryness of the air hinder the gaseous exchanges in the lungs, and render respiration more frequent and superficial. Heat and moisture to the point of saturation interfere with elimination through the lungs.

A **general hot bath** increases the rate and frequency of respiration. The depth of respiration is at first diminished; but if the bath is continued sufficiently long to raise the temperature of the blood, and increase carbon dioxid production, the respiratory movements are augmented.

A frog breathes with its skin; a dog sweats with its lungs; man not only sweats with his skin, and breathes with his lungs, but, like the frog, to some extent, breathes with his skin, and, like the dog, sweats with his lungs. Hot baths promote not only the perspiratory activity of the skin, but also the elimination of moisture through the lungs, thus aiding the escape of those toxic substances which, as Charrin has pointed out, are probably eliminated through the bronchial mucous membrane.

The Effects of Heat upon Body-temperature

A **general hot bath** at a temperature above that of the body causes elevation of the temperature of the blood by interference with heat-elimination. For example, in a series of experiments in my laboratory, the temperature of a young man weighing 108 pounds was increased 3.2° F. (1.8° C.) in thirty minutes, representing an accumulation of 88.2 calories, by a bath at 100° F. (say, 38° C.). A bath at the temperature of the body (98.4° F.—say, 37° C.) caused a rise of 0.6° F. (0.3° C.). Baths at a neutral temperature of 92° to 96° F. (33° to 35° C.) did not elevate the body-temperature. A Russian bath of twenty-five minutes' duration raised the temperature 2.1° F. (1.16° C.). An elevation of the same amount was observed as the result of an electric light bath lasting twenty-three minutes. A rise of 1.7° F. (0.94° C.) resulted from a Turkish bath of one hour at 146° to 158° F. (63° to 70° C.). The increase of body-temperature induced by prolonged hot baths is not wholly due to diminished heat-elimination, since it has been shown that in dogs exposed to a temperature of 104° F. (40° C.) heat-production is augmented to three and one-half times the normal.

A **short application of heat** is followed by a fall of temperature, the result of increased heat-elimination through dilatation of the surface vessels, and a diminution of heat-production through the reflex influence of the thermic nerves upon the thermogenic processes.

The General Effects of Heat upon the Abdominal Viscera

As already observed, heat lowers the tone of voluntary muscles, while cold raises it. In other words, heat relaxes muscles, while cold contracts them. This effect is particularly marked when applications are made to the muscles of the abdominal wall, a fact which has long been taken advantage of in the treatment of strangulated hernia, and more recently in the practice of examining the pelvic and abdominal viscera while the patient lies in a hot bath.

The **tension of the abdominal muscles** is a matter of no small importance in relation to respiration, and especially to the blood movement in all the viscera lying below the diaphragm. With relaxation of the abdominal muscles intra-abdominal tension is diminished, and the portal vessels become engorged with blood. All the viscera are congested. The stomach and intestines become distended with gas and their walls yield to the tension, resulting in dilatation, with stasis in the stomach and colon, and gastric indigestion and constipation, accompanied by fermentations and putrefactive processes that lead to autointoxication and various disturbances of nutrition.

Cold, when applied to the abdominal wall, contracts not only the external voluntary muscles, but the internal, involuntary muscles of the stomach and intestines, urinary bladder, and gall-bladder, together with the muscular structures found in the spleen and liver, and the muscular walls of the blood-vessels. **Hot** applications to the abdominal walls produce the opposite effect. It is apparent that hot applications of this sort are therapeutically valuable for the relief of conditions of muscular spasm, either in the external voluntary muscles, or the internal involuntary muscular structures, as, for example, in intestinal or renal colic, and gall-stones.

Long-continued warm applications to the abdominal surface appear to lead to concentration of blood in the portal circulation, doubtless by relaxing the visceral vessels.

Very hot applications divert blood from the internal viscera by widely dilating the surface vessels. This effect is made possible by the anatomic connection that exists between the cutaneous vessels and those of the viscera, and which will be mentioned in detail a little later.

By the alternate application of heat and cold, the **blood move-**

ment through any internal viscus may readily and almost perfectly be controlled. Cold contracts the visceral vessels by reflex action through the thermic nerves, while heat produces the opposite effect. By the alternation of these effects a veritable pumping action may be instituted, whereby functional activity may be heightened, and morbid processes profoundly influenced.

Very hot water, when brought in direct contact with the gastric mucous membrane, excites both motor and secretory activity, producing also a very decided stimulating effect upon the heart. **Cold applications** to the epigastrium, as well as cold applications to the general surface, increase the peristaltic movement of the stomach and stimulate the secretion of gastric juice. **Very hot applications,** either general or local, unless greatly prolonged, produce similar effects. It should be noted, however, that when the general hot application is prolonged until profuse perspiration has been induced, the secretion of gastric juice is greatly diminished. Puschkin has asserted from experimental observation that the amount of the gastric juice and its digestive activity are greatly increased by the application of heat to the epigastrium after eating. Results observed during more than a score of years, in the large use of this measure as a means of promoting digestion, enable me to say that Puschkin's claims are fully corroborated by clinical experience. Applications, to be beneficial in this way, must be very hot. Warm applications doubtless tend to diminish the secretory activity of the stomach and to lessen activity.

The Effects of Heat on the Liver and the Spleen

According to the exact observations of Kowalski, **hot applications** over the region of the **liver,** followed by cold applications, increase the secretion of bile. This effect is doubtless produced by the increased movement of blood through the organ induced by an application of this sort, the rationale of which has previously been explained. The beneficial results obtained in hydriatric practice by the employment of fomentations over the liver, followed by the heating compress, fully corroborate Kowalski's conclusions. For more than a hundred years this measure has been employed, largely empirically, but nevertheless successfully, in the treatment of hepatic affections, especially catarrhal jaundice, so that it cannot be doubted that the liver may be influenced powerfully by this means.

The effect of **thermic applications**—hot, cold, or alternately hot and cold—over the **spleen** is clearly shown in the rapid diminution in size which may thus be brought about in cases of splenic enlargement from malarial infection and allied conditions, when not involving definite structural changes in the organ.

The Effects of Heat upon Renal Activity

General hot baths promote renal activity, and increase the amount of urine when the temperature is sufficiently high to increase blood pressure—104° to 110° F. (40° to 43° C.). Renal secretion is diminished, however, when a general hot application is prolonged sufficiently to induce profuse perspiration. The powerful influence of general hot applications upon the kidneys is shown by the remarkably beneficial results obtained by the employment of the hot bath and other general hot applications in the treatment of acute nephritis.

The Effects of Heat upon Metabolism

General applications of heat, if sufficiently prolonged to elevate the temperature of the blood, increase carbon dioxid production. Nitrogen oxidation appears also to be particularly favored by the elevation of temperature induced by general hot applications.

Experiments show that the elevation of temperature induced by general hot applications aids the body in the formation of alexins and antitoxins. Animals suffering from infectious diseases live longer when subjected to the influence of moderate heat. The recognition of this fact has led to the revival of the dictum of Hippocrates, that the elevation of temperature that occurs in connection with most acute infectious diseases is, within limits, remedial in purpose and effect. By parallel reasoning, we are led to the conclusion that a slight degree of pyrexia artificially induced by a general hot application may be beneficial in aiding resistance to infection, especially when followed by a short cold bath.

Local applications of heat in many instances operate beneficially by increasing the blood supply of the affected parts as well as by greatly increasing the proportion of leukocytes.

THE ANATOMIC BASIS OF THERMOTHERAPY

The physiologic effects of thermotherapy are determined experimentally. The therapeutic applications are suggested by inference, or determined by clinical experience. For a full understanding of the rationale of both physiologic and therapeutic effects, it is necessary to bear in mind a few anatomic facts of special interest in this connection. This is more particularly true in relation to **local thermic applications.**

The **effects** of thermic applications to the surface depend upon:

1. The elevation of the temperature of the parts to which the application is made, and of the general body-temperature;
2. The changes induced in more or less remote parts through nervous reflex influence; and

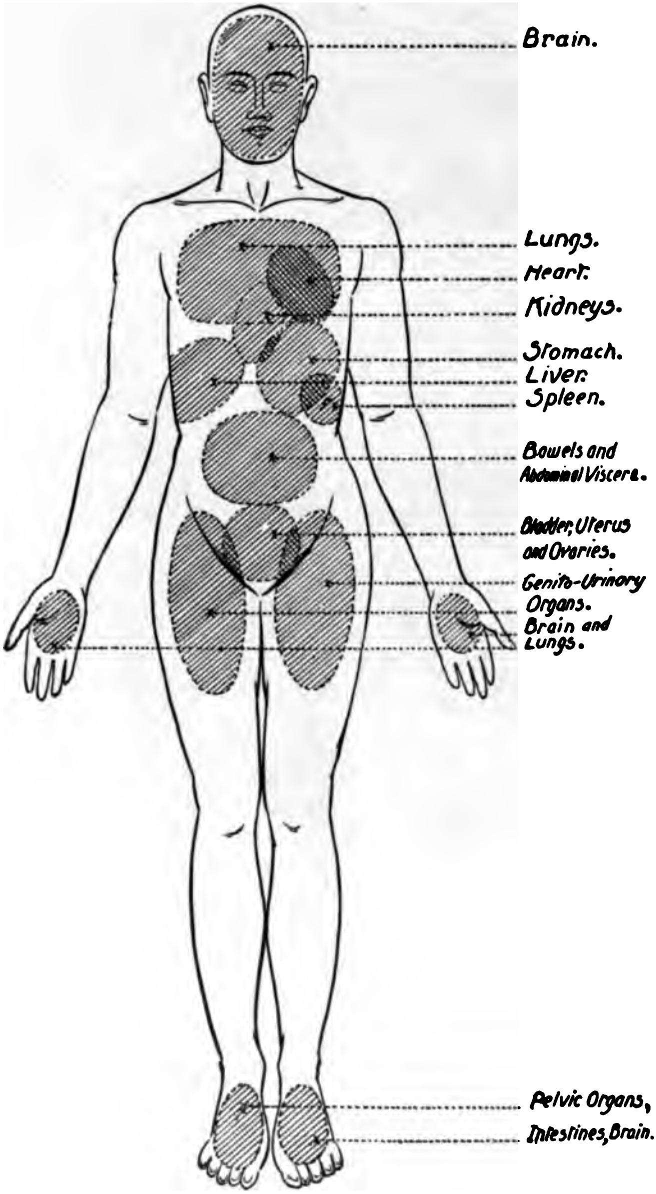

FIG. 61.—ANTERIOR CUTANEOUS AREAS REFLEXLY ASSOCIATED WITH INTERNAL PARTS.

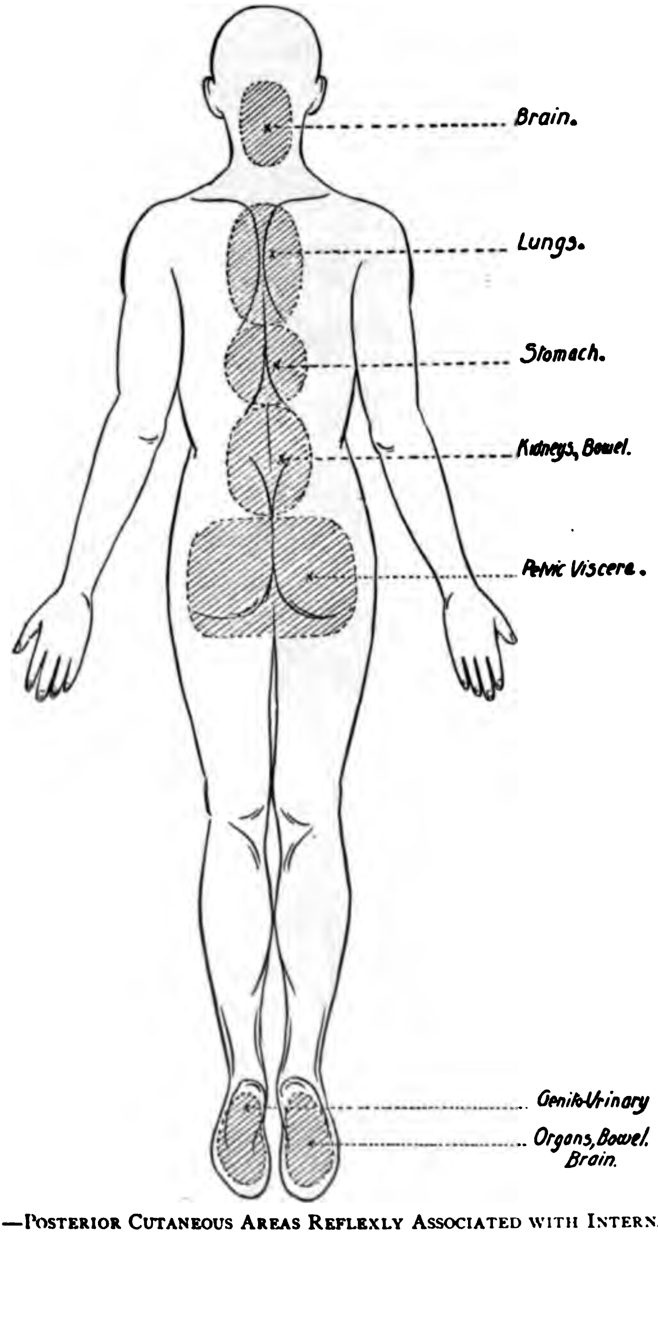

FIG. 62.—POSTERIOR CUTANEOUS AREAS REFLEXLY ASSOCIATED WITH INTERNAL PARTS.

3. The vascular relations existing between different organs and regions.

Cutaneous Reflex Areas.—The effects depending upon reflex nervous action are the result of the association, through nerve-trunks and centers, of the internal viscera with clearly defined cutaneous areas. Each viscus has its own area from which the most intense reflex impressions are received, while at the same time it is more remotely related with all portions of the surface. These cutaneous reflex areas, in general, overlie the individual viscera. The accompanying cuts (Figs. 61 and 62) show diagrammatically the principal cutaneous areas that have been definitely worked out, and that are clinically important.

Correlated Vascular Areas.—Careful anatomic studies have shown that there is an equally intimate and more direct relation between the blood-vessels of deeply seated organs and overlying or adjacent cutaneous vessels.

The **vessels of the brain** are freely connected with those of the scalp and of the nose through the parietal foramen, the foramen cæcum, the mastoid foramen, the posterior condyloid foramen, the foramen of Vesalius, the foramen ovale, the foramen lacerum medium, the carotid canal, the anterior condyloid foramen, as well as through the diploë of the cranial bones.

The **meningorachidian veins,** which form dense plexuses in the spinal canal, are freely associated with the cutaneous veins of the back, and with the dorsospinal veins through the anastomosing veins which issue from the canal through the intervertebral foramina, and unite with the intercostal, vertebral, lumbar, and sacral veins.

The blood supply of the eyelids and of the skin covering the eyebrows and adjacent portions of the forehead is collaterally related with branches of the internal carotid which supply the **eyeball.**

The circulation of the **middle ear** is collaterally related with the circulation of the skin of the face and head of the same side through the common carotid. The circulation of the **internal ear,** on the other hand, is associated with the skin of the back of the neck, being derived from the vertebral arteries.

The vessels of the mucous membrane of the **nose and pharynx** are associated with those of the face and the sides of the head through the common carotid.

The circulation of the **lungs** is collaterally related with that of the skin covering the arms, the chest, and the upper part of the back. The **pericardium** and the parietal **pleura** of the anterior portion of the chest are collaterally related with the skin covering the anterior portion of the chest-wall, through the internal mammary artery.

The parietal **pleura** of the posterior portion of the chest and the visceral pleura are collaterally related with the intercostal vessels. A collateral relation also exists between the **bronchial arteries**—the nutrient arteries of the lungs—and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian artery. There also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessels of the skin and of the lungs is still further extended by the connection of the bronchial veins with the azygos veins of the right side, and with the superior intercostal or the azygos veins of the left side. It is in the highest degree interesting to note these extensive communications between the pulmonary circulation and that of the cutaneous surface, all of which are of high therapeutic interest.

The **kidneys** are associated with the skin covering the loins, through the renal branches of the lumbar arteries.

The vessels of the **prostate** in man, the **uterus** and **ovaries** in woman, and the **bladder** in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, and the suprapubic region, these parts being chiefly supplied by branches of the internal iliac artery. These parts are also associated with the skin of the leg through the common iliac artery.

The **rectum** is similarly associated with the skin covering the anal region and the perineum and that of the lower extremities.

There is a collateral relationship, both venous and arterial, between the **stomach, liver, spleen, intestines,** and even the **pancreas,** and the skin of the trunk which overlies those deeply seated organs.

The **portal circulation** communicates with the systemic circulation, thus establishing a collateral relationship with the cutaneous vessels at half a dozen or more points, especially the following: the hemorrhoidal plexus, the esophageal veins, the left renal vein, the phrenic vein at the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac vein (Treves, Schiff).

In a similar way, it may be stated that the **upper half** of the body is collaterally related with the **lower half**; a fact of which constant use is made when the lower extremities are warmed to divert blood from the head.

The cutaneous vascular areas connected with the several viscera are roughly indicated in the accompanying diagram (Figs. 63 and 64). It should be remembered, however, that every portion of the cutaneous surface is vascularly related, at least remotely, to every internal part. It is also interesting to note that the vascular areas con-

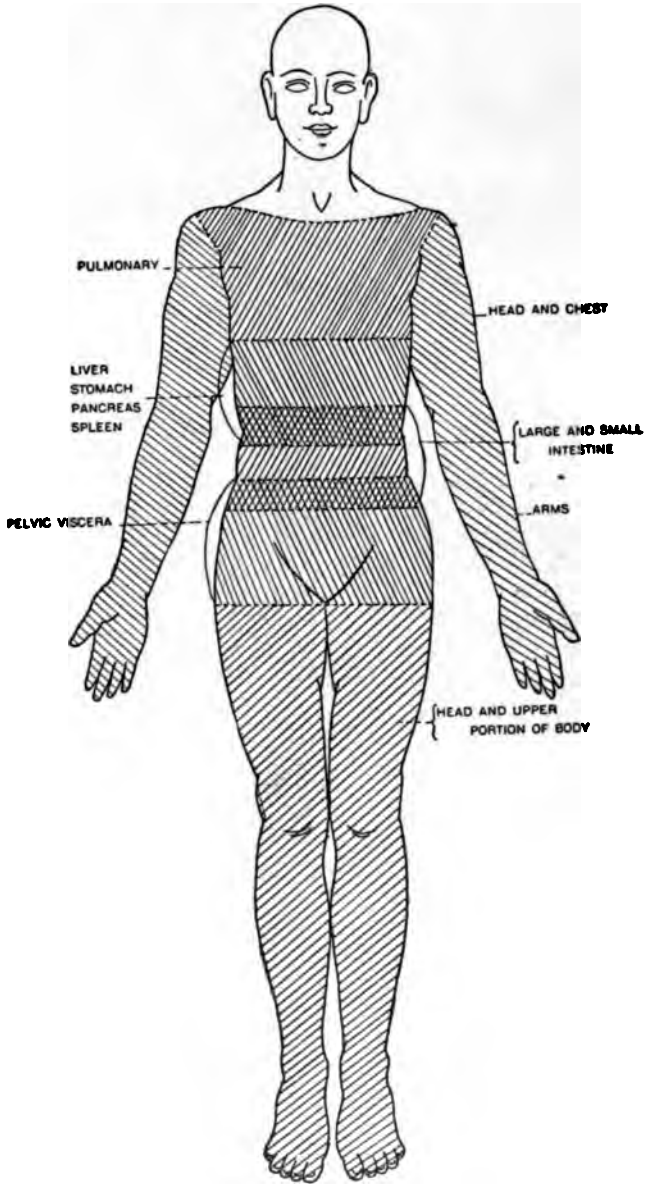

FIG. 63.—CUTANEOUS VASCULAR AREAS COLLATERALLY RELATED WITH THE VESSELS OF THE VISCERA (FRONT VIEW).

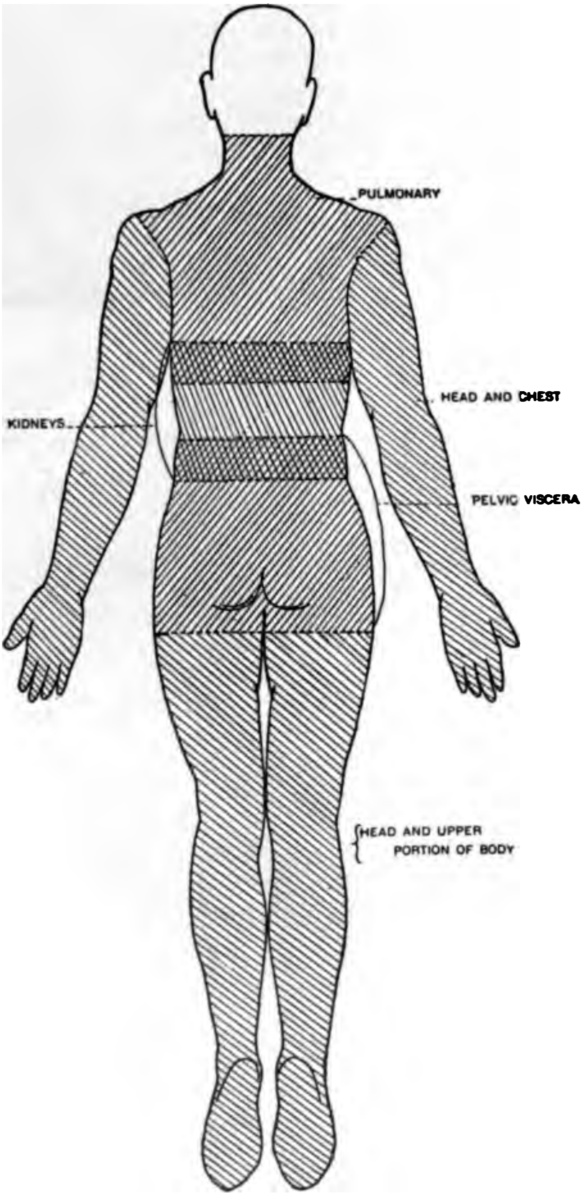

FIG. 64.—CUTANEOUS VASCULAR AREAS COLLATERALLY RELATED WITH THE VESSELS OF THE VISCERA (BACK VIEW).

nected with the several internal viscera do not altogether correspond to the reflex cutaneous areas connected with the same parts, although in the main the reflex areas and vascular areas are practically identical. For example, the skin covering the front of the chest is of greatest importance as a means of reflexly influencing the pulmonary circulation; whereas, the cutaneous vessels of the skin covering the back of the chest are more intimately related with the vessels of the lungs than are those of the anterior surface. A most important reflex relation exists between the skin covering the lower portion of the sternum and the kidneys, whereas the principal vascular relation exists between the kidneys and the skin covering the loins.

The portion of the body below the umbilicus is collaterally related with the head, the arms, and the upper half of the trunk; and the legs are likewise in collateral relation with all parts of the body above them, especially those which occupy the pelvic cavity.

These relationships render it possible to employ the **reflex** and the **fluxion methods** at one and the same time, a cold application of small extent being made over the center of greatest reflex activity, while a hot application or heating compress is applied over the area which is in closest vascular relation with the interested part. When the vascular cutaneous areas and the reflex areas concerned are identical, the cold application is made to the reflex area, while the hot application is made to the feet, legs, or lower half of the body, or even to the entire cutaneous surface when the largest possible effect is desired.

Understanding these interesting anatomic relations, it is readily seen that the volume of blood in any internal viscus, no matter how remote from the surface, may be diminished either by a **general hot application** to the surface, whereby one-half of all the blood in the body may be diverted into the skin; or to a lesser degree by **local applications.**

Thus, by means of heat suitably applied, the vessels of different portions of the **brain** may be drained into the communicating areas of the skin. The longitudinal sinus is drained by means of applications to the sides of the head; the lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the back of the neck. Congestion of the **spinal cord** may be relieved by hot applications to the back from the base of the cranium down. Congestion of the **eyeball** may be relieved by hot applications made over the eye and the forehead above, not extending below the eye. Congestion of the **middle ear** is relieved by hot applications over the sides of the head and face; of the **internal ear** by hot applications to the arms and legs; of the **nasal cavity** and the **pharynx** by a hot application to the face and sides of the head; of the **larynx** by hot applications to the front of the neck, the arms, the back, the upper part of the chest, and the legs; of the **lungs** by an application over the whole thoracic cage and the arms, an additional advantage being gained by a hot application to the legs; of the **kidneys** by general hot applications to the whole surface, or local hot applications over the lumbar region; of the **pelvic organs** by hot applications to the hips and legs; of the **stomach and other viscera** by hot applications over the interested part, or, better, to the entire trunk, or trunk and legs.

As Treves very well remarks, these facts give "an anatomical demonstration of the value of counterirritants in inflammatory affections of certain of the viscera, and also a scientific basis to the ancient practice of poulticing the loin and the iliac region in nephritis and in inflammations about the cæcum."

PRACTICE OF THERMOTHERAPY

As is the case with all physiatric measures, the therapeutic action of heat is clearly foreshadowed in its physiologic effects.

General Indications.—The **general excitant effects** of heat render highest service in most conditions of extreme exhaustion, as in surgical collapse, extreme fatigue from violent exertion, the collapse of typhoid and other infectious fevers; in certain cases of poisoning; and in acute autointoxications.

Thermotherapeutic measures are of value in all cases in which active **diaphoresis** is called for, as after taking cold, in acute rheumatism, in certain forms of chronic rheumatism, some cases of pneumonia and other acute infectious febrile disorders, and as an **alterative** or **spoliative** measure in obesity and other diathetic maladies.

General applications of heat serve an extremely useful purpose in modifying metabolism. **Short applications** lessen heat-production and oxidation, and encourage heat-elimination; while **prolonged applications** raise the body-temperature by preventing heat-elimination, and by communicating heat to the body. The increase of oxidation which accompanies a prolonged hot bath renders applications of this sort of the highest value in cases of obesity, in diabetes, and in the uric acid diathesis. Their effectiveness in increasing the oxidation of proteid wastes renders general hot applications of some sort almost indispensable in the treatment of spinal sclerosis, tabes dorsalis, and many other affections accompanied by organic change, in all of which some form of autointoxication is probably of causative importance.

General hot applications are indicated in all forms of chronic visceral congestion, including chronic bronchial catarrh, chronic gastritis, intestinal catarrh, chronic inflammation of the pelvic viscera, and chronic cerebral congestion. The skin being capable of holding one-half to two-thirds of all the blood in the body, the filling of this immense vascular area—comprising a surface of more than ten thousand square feet, if we include the capillary network distributed in the walls of the tubules of the sweat-glands—relieves visceral congestion by diverting the blood to the surface, and accomplishes a therapeutic purpose which cannot be so satisfactorily achieved in any other way. To make permanent the effects thus obtained, the hot application must be followed by a short cold application, whereby strong reaction effects are produced, with accompanying dilatation of the small arteries and an increased rhythmic activity of the 'peripheral heart.'

Still another important indication for general hot applications is the **preparation of the skin for the cold douche,** the shallow bath, wet-sheet rub, wet-sheet pack, or any other hydriatric application of a temperature below that of the body. This preparation is especially important in feeble patients. It may be advantageously employed in all cases. The application should be of brief duration, ordinarily from three to five minutes, or only sufficiently long to heat the skin thoroughly. The maximum effect desirable is obtained when the skin becomes slightly moistened by perspiration.

General hot applications are of service as a means of **intensifying the effects of cold hydriatric procedures.** When employed for this purpose, the hot and the cold applications are made in alternation. A hot application of two of three minutes may be followed by a brief cold application of five to twenty seconds. Such an application is strongly excitant to the circulatory system, and produces profound revulsive effects. Short applications of equal duration,—ten to twenty seconds,—the so-called **alternate applications,** are powerfully excitant; they are generally made by means of the alternating general douche, for which the horizontal jet or the circle or needle douche may be employed. The vapor douche and a cold-air douche may be thus employed in alternation, or the patient may be exposed alternately to the heat of the vapor bath, the electric light bath, or the hot-air bath, and to the refrigerant effects of the cold horizontal jet, the shower, or the plunge.

Finally, hot applications are of value as a means of inducing tolerance to cold applications which could not otherwise be borne, as in the **simultaneous hot and cold bath.** Various combinations may be made; as, for example, a hot shower-bath combined with a cold douche to the spine, or to the hepatic, gastric, lumbar, or hypogastric region, or to the extremities, as may be desired; or a cold douche may be administered to any part of the body while the patient is enveloped in hot vapor in a Russian bath or warmed by means of the vapor douche. The ideal application of this sort is to combine the cold douche and the incandescent light bath. The patient stands in a recess, surrounded on three sides by incandescent lights, closely placed in front of a reflecting surface, by which the skin is strongly heated, while at the same time a jet of cold water is made to play upon any part of the surface that it is desired to impress in this way.

Modes of Application

General thermic procedures include the Turkish bath, the hot-air bath, the Russian bath, the vapor bath, the incandescent light bath, the sand bath, the mud-bath, the hot immersion bath, the hot blanket pack, and the dry pack.

Local thermic applications are made either by limiting the foregoing measures or by the use of heated objects, such as jugs, bottles, or rubber bags filled with water, the cotton poultice, the electrotherm,—a dry compress containing metallic objects affording resistance, through which a current is passed,—or the thermophore (a rubber bag containing a chemical solution capable of giving off heat for a long time during the process of crystallization) or the Japanese 'hand stove' (a little cloth-covered, perforated, metallic receptacle, containing sticks of a slow-burning compound). The last-named is specially useful for domestic practice.

Deep-seated inflammations may be controlled by either general or localized applications to the appropriate cutaneous surface. This is well illustrated in pelvic inflammation, for example, by the great relief to pain afforded by the hot hip-and-leg pack, the hot hip pack, the general hot blanket pack, the hot immersion bath, or any other hot application. This use of heat is suggested by the natural instinct which leads one to protect any painful part, such as an aching tooth, eye, or ear, by the application of the warm hand, and is further shown in the drawing up of the legs when abdominal pain is present, an instinct possessed by the lower animals in common with man.

In **ovarian inflammation**, an ice-bag should be applied over the ovary simultaneously with the use of the hot hip-and-leg pack. After the hot application is removed, the ice-bag should remain in place, the limbs being kept warm by hot bags and wrappings. By the cold application the vessels of the inflamed part are made to contract reflexly, while the hot application, acting derivatively, empties the vessels of the part, thus securing the complete co-operation of two important therapeutic principles at one time and place. This principle is illustrated in the common employment of the very hot foot-bath, in association with a cold compress to the head for the relief of cerebral congestion. The same principle may be extended to the treatment of congestions and inflammations of any deep-seated organ.

Thus in a combined hydriatric application for relief of a congested kidney, an ice-bag applied over the lower third of the sternum causes reflex contraction of the renal vessels, as shown by Beni-Barde, while an application of heat made to the lumbar region relieves the congested organ by diverting blood from its arteries and veins into the overlying muscular structures. In simultaneous application of heat and cold for relief of congestion of the pelvic viscera, the ice-bag applied to the hypogastrium and to the groins causes contraction of the branches of the internal iliac, which supplies the uterus and ovaries; while the hot hip-and-leg pack, by dilating the cutaneous vessels, diverts a large volume of blood into the external branches of the internal iliac and the cutaneous branches of the external iliac.

In conclusion, attention should again be called to the fact that thermotherapeutic measures of all sorts, whether general or local, should, almost without exception, **be followed by a cool or cold hydriatric application,** so as to restore the tone of the surface vessels and to fix the blood in the skin, thus rendering permanent the temporary benefit derived from the hot application. When the hot application has been prolonged sufficiently to cause an elevation of the body-temperature, the temperature of the cooling procedure should be moderate, ordinarily 90° to 75° F. (32.2° to 23.8° C.), and sufficiently prolonged to restore the thermic equilibrium of the body. The time required ordinarily should be one to three minutes. The duration should never be sufficient to produce chilliness, and the application should be made with sufficient vigor to maintain the dilatation of the surface vessels. When applications of heat have been limited to small areas or have been of short duration, the cooling application should be at a lower temperature and of shorter duration (60° to 45° F.,—15.5° to 7.2° C.,—three to fifteen seconds).

CHAPTER IV

GENERAL AND LOCAL APPLICATIONS OF HEAT

The Turkish Bath—Description; Physiologic Effects; Indications; Counter-indications and Precautions. The Hot-air Bath—Description and Technic; Indications. The Local Hot-air Bath—Description and Technic; Apparatus; Special Precautions; Indications. The Dry Pack—Technic; Mode of Action; Indications. Rubber Bags; Hot Water Bottles or Jugs; Heated Sand-bags, Bricks, Blocks of Wood, and Other Objects. The Heating or Stimulating Compress.

THE TURKISH BATH

Description.—A scientifically arranged Turkish bath establishment consists of a series of rooms which provide, besides dressing-rooms and a cooling room furnished with couches on which patients may recline after a bath, at least the following separate compartments:

1. A room heated to a temperature of 110° to 130° F. (44° to 54° C.), the 'tepidarium' of the ancients.

2. A hot room, heated to the temperature of 150° to 200° F. (65° to 93° C.), the 'calidarium.' In some establishments another small room is provided, in which a temperature of 230° to 300° F. (110° to 148° C.) may be obtained.

3. An adjacent room, conveniently furnished with marble slabs and hot and cold water with other necessary paraphernalia, provides for the shampoo.

Close at hand must be found a well-arranged douche apparatus, and in a well-equipped establishment there will be also a plunge or swimming bath containing water at a temperature of 60° to 70° F. (15° to 21° C.). In some European establishments the temperature of the plunge is so low as 45° F. (7.3° C.); but 60° F. (15.5° C.) is low enough to secure all essential therapeutic results, and is safer for the average patient than a lower temperature. Any intensity of effect desired may be attained by increasing the duration of the bath.

The hot room may be heated by steam coils, or by hot air provided by a furnace, or an indirect steam heater. When direct radiation from steam pipes is employed, the air is generally very impure, by reason of the absence of adequate provision for ventilation. When, however, hot-air heating is employed, the ventilation is easily made ample, air change being essential as a means of maintaining the temperature of the room. The foul air outlet must be near the bottom of the room, and must communicate with a ventilating shaft. The opening for the inlet of warm air may be either at the floor or the ceiling; it is perhaps best located at a point about two or three feet above the level of the floor.

Technic.—The patient disrobes, places a loin cloth about his body, drinks a glass of water, either hot or cold, enters the warm room, and lies down upon a couch. Usually, by the end of ten to fifteen minutes, and sometimes sooner, the skin becomes slightly moistened, and a little later the subject finds himself in a state of profuse perspiration. In cases in which perspiration does not promptly appear, the activity of the cutaneous glands may be encouraged by superficial massage, or friction of the skin by an attendant. The native shampooers of Cairo and Constantinople rub the bather with mitts made of coarse fabric somewhat resembling haircloth. A very hot foot-bath or a short, hot spray, or full bath, is also an effective means of encouraging perspiration. In the case of patients who cannot drink freely, a hot enema (110° F.), administered just before the bath, will aid in inducing prompt sweating. In extreme cases the patient may be sponged with hot water.

If he does not perspire either with or without the aid of the measures mentioned, he should not be allowed to remain in the bath for any considerable length of time, as serious injury may possibly result from a long exposure of the body to intense heat without the protecting influence of evaporation.

After the patient begins to perspire, he may, if he desires, enter the second hot room, to remain but a few minutes, until very vigorous perspiration is induced; or if more moderate cutaneous activity is desired, he may remain in the warm room.

When perspiration has been maintained as long as it is desirable, the patient is conducted to the shampooing room, where he is first rubbed with the bare hands or with Turkish mitts from head to foot, beginning with the head, and in such a manner as to remove every particle of the superficial layers of the epidermis that has been loosened by the profuse perspiration.

Finally the patient is shampooed with soap, the lather being well rubbed upon the skin, either by a thoroughly aseptic brush, the Egyptian 'loofa,' or a properly arranged mass of flax, manila, or other fibrous material. Great care must be taken, in the employment of shampoo brushes, to avoid conveying infection of any sort from one patient to another. The only safe precaution when a common brush is used—a practice which is certainly not to be commended—is to drop the brush for five minutes into boiling water each time it is used, after thoroughly rinsing the soapsuds out of it. There is an advantage in the use of manila and other fibers; the material is so cheap that it may be thrown away and a new supply provided for each patient, and at each bath. The brush or mass of fiber or horsehair is applied at first to the upper part of the neck and chest, then to the arms, then to the lower parts of the body. The shampooing and rubbing should be continued until the whole surface feels like polished marble. After the shampooing the patient is conducted to the douche. If he is still quite warm, a cold douche may be administered at once. If he has become slightly chilled, he should be thoroughly warmed up by a warm shower or rain douche before the cold application is made. The bath should end with a douche of cold water at a temperature of 60° F. (15° C.) or less. If the patient is inclined to perspire freely after the bath, a graduated rain douche at a temperature of 84° to 76° F. (29° to 24.5° C.) should be given for one to three minutes before the final cold application.

After the douche, which serves the double purpose of removing the soap and counteracting any depressing effects from the prolonged exposure to heat, the patient may enter the plunge or the swimming bath, or may wrap a sheet around him, and lie down upon a couch until the skin becomes perfectly dry, and the pulse returns to its normal rate. Massage or joint movements, or both measures, may be advantageously employed in many cases. This practice is a decided aid to reaction in feeble patients.

To feeble subjects the Turkish bath should not be administered more than one to three times weekly. The ordinary patient may take a short Turkish bath daily, and when the bath is employed for reduction of weight, it may often be administered twice a day, provided the exposure in the hot room is not longer than thirty to forty minutes.

It is not usually necessary to apply cold to the head of the patient during the bath, as perspiration of the face and scalp begins early, and this prevents overheating of the head. For persons who are unaccustomed to the bath, the application of a dry towel or napkin over the face and forehead will usually be sufficient. The distention of the surface vessels diverts the blood from the brain, and thus obviates any danger from cerebral congestion. The only exceptions are those cases in which the heart is unduly excited and the brain congested by the elevated temperature of the blood.

Physiologic Effects.—The physiologic effects of the Turkish bath are essentially the same as those of other general hot applications. There are, however, certain characteristic differences which it may be well to note.

The exposure of the entire body to a superheated atmosphere, and especially the inhalation of dry hot air, excites the pulmonary mucous membrane, as well as the skin. The great extent of this membrane—about 2000 square feet—gives importance to this fact. The great dryness of the air, and the excitation of the mucous surface with which it comes in contact, unquestionably facilitate the elimination of those volatile toxins which find exit through the pulmonary mucous membrane (Charrin).

Shortly after the patient enters the bath, the **pulse** is found considerably accelerated, and tension increased. The higher the temperature of the bath, the more rapid the pulse. During this period of increased blood tension, the patient experiences a sense of fullness in the head, some respiratory distress, and general discomfort. As soon, however, as the skin becomes reddened and moistened with perspiration, the pulse-rate diminishes, tension is lowered, respiration becomes easy, and uncomfortable sensations disappear. The breathing is usually thoracic in character.

The **sweat glands** are powerfully stimulated. The amount of secretion may be increased from one and a half ounces in an hour to fifteen or twenty times this amount. I have often seen patients lose two pounds or more in weight as the result of an hour's sweating in the hot room of a Turkish bath. This rapid loss of fluid indicates the importance of copious water drinking during the bath, as the heart's action may be lessened in power, and various other functions interfered with as the result of so considerable a reduction of the blood volume. The profuse discharge from the skin, moreover, promotes absorption from the alimentary canal. As a result, patients who are taking Turkish baths daily are likely to suffer from **constipation,** unless this tendency is counteracted by copious water drinking. The activity of the sweat glands excited during the bath continues in a modified degree for some hours after the bath as the result of the improved cutaneous circulation. Hence, water drinking must be practised after, as well as before and during, the bath.

The intense **congestion of the skin** induced by the Turkish bath withdraws an enormous amount of blood from the liver, spleen, stomach, intestines, brain, and other internal organs. The decongestion of these deep-lying vascular areas is one of the most important results obtained by this procedure, although one which seems to have been very little appreciated by many of those who have written upon this subject.

While it is not probable that any considerable amount of heat is communicated to the body from the heated atmosphere of the bath, heat-production is increased to such a degree that a very decided **elevation of temperature** may generally be noted when the patient remains in the bath for half an hour or more. Experiments with the dog have shown that exposure to an atmosphere of a few degrees above the temperature of the body may increase heat-production as much as 350 per cent. At this rate, the heat-production during an hour's exposure in the Turkish bath might amount to nearly 400 calories, or nearly one-sixth the daily output of energy, representing more than an ounce and a half of fat, or three ounces of carbohydrate. Heat-elimination also must be greatly increased, for the rise in body-temperature is comparatively slight.

In the treatment of **obese persons**, it must be remembered that these patients have a much smaller skin surface in proportion to their weight than have smaller persons, and hence that heat-elimination is greatly hindered. For example, a person weighing three hundred pounds has a skin area of only thirteen and a half square inches to the pound, while a person weighing 120 pounds has a cooling cutaneous surface of eighteen square inches for each pound of weight, or nearly fifty per cent. more. The obese person labors under a further disadvantage in that the surface vessels are in large part buried in fat, so that they do not come near the surface, whereas in a thin person the close approach of the ten thousand square feet of capillary network to the surface secures a rapid cooling of the blood.

Indications.—The Turkish bath renders valuable service in the treatment of obesity, alone or combined with diabetes; in the autointoxication so commonly present in chronic dyspeptics; in the uric acid diathesis; and in many cases of neurasthenia, hypochondria, and melancholia. Most forms of chronic nervous disease, even cases of locomotor ataxia, chronic myelitis, paresis, paralysis, neuritis, and other equally obstinate maladies, are materially helped by the judicious use of the Turkish bath, even though a radical cure may be, in the majority of cases, impossible. In all forms of anemia and chlorosis the Turkish bath is an admirable measure, promoting blood formation and relieving visceral congestion. Care must be taken, however, to avoid extreme temperatures and prolonged exposure in these cases, on account of the degeneration of the blood-vessels, which is sometimes present.

As a **hygienic measure**, the Turkish bath has long justly held a high place in the confidence of the laity, as well as of the profession. The thorough cleansing of the skin which it secures is alone an advantage of no small consideration, yet its highest value is due to the fact that the combined hot and cold applications which it involves, in the highest degree promote vital activity and the building up of the powers of resistance to disease, thus counteracting to some degree the evil consequences of the artificial conditions imposed by civilized life, and affording a considerable degree of protection against various infective agents.

The Turkish bath affords an opportunity to produce the most pronounced effect possible upon the circulation of any internal viscus that it may be desired to influence. For example, in cases of chronic gastritis or chronic intestinal catarrh, chronic spinal congestion, cerebral hyperemia, or renal congestion, the general effect of the bath in relieving visceral congestion may be intensified by a suitably placed cold application, consisting of an ice-bag, a cold compress, or a cooling coil. In cerebral congestion an ice-bag may be applied to the head, or an ice collar may be fitted about the neck. A towel wrung out of ice-water may be applied to the face and ears. In renal congestion an ice bag may be applied over the lower third of the sternum. In uterine and ovarian congestion, or the so-called chronic inflammation of these organs, an ice-bag may be applied to the groins and the hypogastrium. In chronic inflammation of the stomach or intestines, or congestion of the spleen or liver, a cold application should be made over the parts indicated. The application of cold in the manner suggested, especially to the head, renders a higher temperature tolerable, and may permit of a longer duration of the bath.

Counterindications and Precautions.—The Turkish bath is counterindicated in cases of cardiac dilatation, tachycardia, and arteriosclerosis; in exophthalmic goiter; in organic affections of the heart in which there is evidence of deficient or failing compensation; in irritable skin affections and all febrile disorders; and for apoplectic subjects. The bath must be used with great care in all forms of nephritis, and is counterindicated in advanced stages of renal disorder.

The **pulse** should be watched carefully, especially during the first séances, and the first few moments after the patient enters the bath. Undue cardiac excitation may generally be relieved by the application of cold over the heart. If the effect desired is not readily induced, the patient should be removed from the bath, and the incandescent electric light bath or some other unobjectionable heating procedure adopted.

THE HOT-AIR BATH

This bath resembles the Turkish bath, the essential difference being that the head is excluded from contact with the heated air, so that the patient is able to breathe air at the ordinary temperature, while the entire body, with the exception of the head, is exposed to dry superheated air.

Description and Technic.—The hot-air cabinet may be a permanent structure of wood, zinc lined (Fig. 65), or it may consist of a portable cabinet of rubber cloth, or other impervious materia the absence of a specially constructed cabinet, a substitute can easily be improvised by placing the patient in a chair, and covering him with a rubber blanket or with ordinary blankets, between the folds of which newspapers have been placed. Various sources of heat may be employed, as a small kerosene stove, a large kerosene lamp or an alcohol lamp, a small gas stove, or even heated stones or bricks. For a permanent arrangement, a steam coil is most convenient.

FIG. 65.—AUTHOR'S HOT-AIR CABINET.

Figure 66 shows a convenient arrangement for a domestic hot-air bath. In all such contrivances the greatest care must be taken to **avoid burning the patient.** Lives have been lost by carelessness in this regard. When an alcohol lamp is used as the source of heat, it should be placed in a vessel of water. The lamp should be lighted before the patient enters the bath. If the flame goes out, the patient should be removed from the bath before it is relighted. The same precaution should be taken if gasoline or kerosene is used as the means of heating. When the patient is not able to sit erect, the bath may be administered in bed, either by means of a special device or by an arrangement which may easily be improvised. It is only necessary to provide a space about the patient by means of a proper framework, covered first with rubber cloth, then with ordinary blankets. Heat is supplied by means of a tin pipe, which can be made by any tinner at a small expense, so arranged that one end can be slipped over the top of an ordinary lamp chimney, while the other enters the inclosed space about the patient.

In **preparation for the bath,** the patient should remove all his clothing in a warm room, and should be wrapped in a Turkish sheet or woolen blanket while passing from the dressing-room to the bath cabinet. He should drink a glass of water or lemonade, either hot or cold as preferred, before entering the bath. Carbonated water is the best. Perspiration may be promoted by repeated water drinking during the bath. It is also important that before the patient enters the bath, the head or the face and neck, and, in the case of men, the scalp also, should be well cooled by wetting with water at 60° F. Towels should be applied to the face and neck in treating women, and to the head and face of men (Fig. 65).

The **temperature** may vary from 150° F. to 250° F. A still higher temperature may be tolerated if the air is perfectly dry, but offers no advantage.

The **duration** of the bath may be six minutes to an hour, according to the effect desired. When administered to feeble persons, and when the purpose of the bath is simply to heat the skin in preparation for a cold application, the duration should be brief—not more than six to twelve minutes. When prolonged sweating is desired for eliminative effects, the duration may be twenty to sixty minutes. Ordinarily, however, the bath need not be employed for more than thirty to forty minutes to secure the maximum beneficial effects.

After the bath a cooling procedure of some sort should be employed. The rain douche, horizontal douche, wet-sheet rub, shallow bath, and pail douche are the most generally useful measures. For feeble persons the cold towel rub and the cold mitten friction are preferable, and should be employed at the beginning of a course of treatment. Later, when the patient has, by systematic training, acquired greater ability to react, more vigorous cooling measures may be applied. In certain cases, sudden cooling of the skin is not desirable. This is especially the case with chronic rheumatics when suffering from an acute exacerbation, with more or less elevation of temperature, and much pain and tenderness in the joints. In such cases, the patient, on removal from the bath cabinet, should be quickly wrapped in warm blankets. If it is desirable to continue the per-

FIG. 66.—DOMESTIC HOT-AIR CABINET.

spiration, he is warmly covered, and made to drink freely. If, however, prolonged perspiration is not desirable, he is more lightly covered, and the face is from time to time bathed with a little cool or tepid water until sweating has ceased spontaneously and the usual pulse-rate has been re-established. The wrappings are then carefully removed, uncovering small areas at a time, as an arm, the chest, or a leg, and an alcohol rub is administered.

Indications.—The therapeutic applications of the hot-air bath and the counterindications therefor are essentially the same as those of the Turkish bath. It should be mentioned, however, that the hot-air bath may be employed in cases in which the Turkish bath is inadmissible on account of the embarrassment experienced by the patient in the inhalation of hot, dry air. Indeed, in most cases all the therapeutic advantages of the Turkish bath may be obtained by the proper employment of the hot-air bath.

THE LOCAL HOT-AIR BATH

Hot air may be applied to any circumscribed portion of the body, either by means of a current of superheated air, directed upon the part, or by inclosing the part in a chamber the air of which is superheated. The hot-air douche was employed by me some eighteen years ago, but was not found to possess advantages over the simpler methods of making local applications of heat.

Description and Technic.—Recently, various excellent devices have been offered for local applications of hot air, especially to the joints. None of these, however, is greatly superior to a simple device that can readily be constructed by any tinner (Fig. 67). It consists of a tin box, so arranged that it may easily be opened while the limb is being placed in position. The limb must be protected from contact with the metallic portions of the box. This is easily accomplished by making the end pieces of wood. Arrangement must be made to permit the entrance of air and escape of vapor to avoid scalding the patient by his own sweat. The box is so placed that a large kerosene lamp may be set beneath it, with just sufficient space between the chimney and the bottom of the box to secure a clear flame. In a short time the air within the box will become sufficiently heated to secure the effect desired. With dry air, a temperature of 300° to 400° F. (148° to 205° C.) is tolerated. The **effect** of this application is to produce powerful revulsion by dilatation of the surface vessels. It is possible that certain trophic effects may also be induced by the impression made upon the thermic nerves.

At the conclusion of the application the parts should be quickly rubbed with the hands dipped in cold water, or, if the parts are painful, a towel wrung quite dry out of cold water may be applied for ten or fifteen seconds. The parts are then quickly and carefully dried or bathed with alcohol and covered first with dry cotton, then with mackintosh, and finally with flannel, so that the effect obtained by the application may be continued. In cases in which an active inflammation is present, as indicated by elevation of temperature and pain, the heating compress should be applied instead of the cotton poultice. This consists of a single thickness of linen cloth, or three or four folds

FIG. 67.—SIMPLE HOT-AIR BOX FOR THE LIMBS.

of cheese-cloth, wrung quite dry out of water at 60° F. (150° C.), smoothly wrapped about the part, and covered with flannel and mackintosh. The compress should warm up at once. If it remains cold, injury will result. Great care should be taken to extend the mackintosh sufficiently above and below the flannel wrappings to leave no opening through which air can enter or evaporation take place.

Apparatus.—The **Tallerman-Sheffield local hot-air bath**

apparatus consists of a cylinder of copper, of shape and size adapted to the part to be inclosed. One end of this cylinder is closed by a cap attached in such a way that the opening can be completely or partially closed. The limb to be treated is introduced at the other end, air being excluded by means of a rubber sleeve, one end of which is attached to the cylinder, the other being gathered closely about the limb. Several openings on the upper side of the cylinder provide for additional ventilation, thus avoiding the accumulation of moisture. The cylinder is heated by gas burners placed beneath. The temperature is indicated by a thermometer supported in the top of the cylinder.

The **apparatus of Lentz** (Fig. 68) is an improvement upon that of Tallerman-Sheffield. It consists of a copper cylinder of similar construction, to the bottom of which is attached a fire-box of Russian iron in which is placed a Bunsen burner, consisting of two tubes, in each of which there is a row of small flames similar to those employed in heating an ordinary gas oven. The cylinder is lined with sheet asbestos, the lower third of the lining being separated from the cylinder a distance of one and one-half inches and supported by iron bars running the whole length of the cylinder. On the cradle of this frame rests a thick piece of magnesium, an excellent non-conducting material. This forms a safe and suitable bed upon which the limb may rest without danger of burning. The remaining arrangements are practically the same as those in the Tallerman-Sheffield apparatus.

FIG. 68.—HOT-AIR CHAMBER FOR THE LIMBS.

The **temperature** employed in the Tallerman-Sheffield apparatus is 240° to 260° F. (115° to 126° C.). The Lentz apparatus produces a higher temperature, ranging from 300° to 350° F. (148° to 176° C.), in from ten to fifteen minutes after the limb is introduced. The temperature may be controlled by the cap or door at the closed end of the apparatus. On opening this, the temperature very quickly falls.

By regulating the size of the opening, the amount of air passing through the apparatus can be regulated and the temperature adapted to any individual case.

The **duration** of the treatment may be from twenty to forty minutes, or even longer.

Effects.—The effect of the local hot-air bath is to produce the most powerful local diaphoresis and intense cutaneous congestion. If the application is continued for some time, general diaphoresis is also produced. This effect renders necessary some general cooling procedure at the conclusion of the application as well as the local cooling which has before been referred to. It should be remembered that the hot-air treatment produces relaxation and lowered tone of the vessels and tissues of the parts brought under its influence. A short local cold application is necessary to produce a tonic reaction by which the blood is fixed in the skin and the activity and tone of the surface vessels increased. This will prevent subsequent injury from slow cooling by evaporation. A general cooling application is necessary for the same purpose. If this is neglected, the patient is liable to be chilled by the evaporation of moisture from the skin, and all the possible good effects of the application will thereby be neutralized and the disease may possibly be aggravated. Local and general thermic and hydriatric applications are often brought into discredit by a neglect to employ the proper means to prevent these untoward effects of hot applications. The best general applications for most cases are the cold mitten friction, the cold towel rub, and the alcohol rub. The latter is especially indicated for feeble persons and for those whose joints are the seat of much pain and tenderness.

Special Precautions.—In order that the patient may readily receive this general treatment and to prevent moistening of the clothing, all the clothing should be removed (underclothing as well as outer garments) in preparation for the local treatment, although the part to be treated may be only a single joint, as the wrist, elbow, or ankle. This precaution involves some little trouble and inconvenience, but its observance is necessary in order to secure uniformly satisfactory results. Great care must be taken to avoid burning the patient, not only because of immediate ill effects, but because burns are very slow to heal in chronic rheumatics, and thus necessarily interrupt treatment for a considerable length of time. Wrappings about the part exposed to the hot air increase the dangers of fire and scalding.

The flame should always be lighted for a few minutes before the limb is introduced, so that the instrument may be warmed, and also to avoid the possibility of injury to the patient from explosion of gas if too large an amount should escape before the application of the match in lighting. If for any reason the flame should go out during the application, the limb should be removed while the burner is being relighted. The increase of heat must be gradual, and proportioned to the individual reaction.

Indications.—This procedure has proved of most extraordinary service in subacute and chronic articular rheumatism, gout, traumatic arthritis, synovitis, tenosynovitis, fibrous ankylosis, rheumatoid arthritis, chronic leg ulcer, joint tuberculosis, and sprain. Decided benefit has also been derived in cases of acute gout and rheumatism, although the method is less readily applicable in these cases because of the great pain involved in moving the limb. Local hot-air baths have been found especially beneficial in removing the stiffness, swelling, and pain left behind as a result of gonorrheal and other infectious forms of rheumatism. The benefit derived from these applications is in part due to the general effect as well as to the heating of the affected parts. This is demonstrated by the fact that when applications have been confined to a single joint in cases where a number of joints have been affected, all the joints have been improved; evidently as a result of the increased oxidation and elimination of waste, as in the general hot-air and vapor baths. In chronic cases improvement may generally be hastened by judicious **massage** following the hot-air bath, or on alternate days.

THE DRY PACK

Technic.—This is a very effective, but rather inconvenient, mode of bringing the body as a whole under the influence of heat. The patient is closely wrapped in blankets (Fig. 69), with hot water bottles or bags to the feet, thighs, and back. Care must be taken to tuck the covers in closely about the neck, and to bring the wrappings closely in contact with the body everywhere, so as to prevent the slightest movement of air about the body. This will prevent evaporation and consequent cooling.

Mode of Action.—In this procedure the source of heat is the body itself. Heat elimination is favored by the warm coverings, so that there is a gradual accumulation of body-heat, which after a time results in a sufficient increase in the body-temperature to produce perspiration and all the other effects of a general hot application.

This measure accomplishes all that can be accomplished by any other sweating procedure. The chief inconvenience lies in the length of time required to produce active sweating, which sometimes amounts to several hours, and the considerable degree of discomfort which the patient experiences during the heating period before perspiration begins.

The **indications and counterindications** for this procedure are the same as for other general hot applications to produce sweating. The special uses of the dry pack are the induction of perspiration in cases where other general thermic applications are not readily available; especially when for any reason the application of water is not deemed advisable—as when a chill from malarial infection or pyemia is anticipated, in most cases of surgical shock, and in some cases of acute and chronic rheumatism. **Local applications** of the dry pack are often required in surgical cases, in cases of paralysis

FIG. 69.—DRY PACK.

of the limbs, after the ligation of arteries, in threatened senile gangrene, and in neuralgic affections.

OTHER LOCAL APPLICATIONS OF HEAT

The fomentation and the heating compress, perhaps the most useful of all the local measures known to thermotherapy, have been elsewhere described in connection with other hydriatric procedures.

Dry hot applications may be made by a variety of means, of which we need mention only a few. For example, the application of dry heat, like that of cold, as already described, may be made by means of the **coil** of rubber or aluminum, through which a stream of water at the required temperature is made to flow continuously. The temperature of the coil is easily regulated by a tube compressor, which controls the outflow. A rubber bag with an opening at each end may be employed in place of the coil, but is somewhat less convenient. To avoid the inconvenience of emptying the water which is passed through the coil and refilling the heating reservoir, I have arranged a tank heated by a gas jet, from the top of which a pipe carries the water to the coil, while a return pipe enters the tank at the bottom. The rate of flow is regulated by a stop-cock.

Rubber bags, bottles, or **jugs** may be filled with hot water; **sand-bags, salt-bags, bran-bags, bricks, blocks of wood, stove lids, Japanese hand stoves,** and other objects may be heated and employed for localized applications. These should be properly wrapped to avoid blistering the patient, an accident that has been known to occur through a nurse's carelessness. **Thermic massage,** which is especially useful in myalgias (as lumbago and torticollis), is accomplished by stroking and pressing the affected part with a heated object. The use of the **flat-iron** is familiar. Goldscheider employs a special **thermophore**—a hollow metallic roller or rocker containing chemicals that give off heat upon the addition of water. It is usually advisable to protect the skin with a piece of thin, dry flannel.

Effects and Mode of Action.—Localized applications of heat are among the most useful of all means of relieving pain. The rationale of the effect produced differs in different cases. In neuralgia, for example, the relief may in some cases be due to the simple relaxation of the nutrient vessels of the nerve-trunks. Du Bois-Raymond has shown that the pain of neuralgia may be due to pressure upon the nerve filaments by spasm of their nutrient vessels, as well as by compression of the nerve-trunks by the overfilling of the blood-vessels in contiguous areas. It is evident that in the latter case the neuralgic pain may be relieved by simple revulsion, or diversion of the blood, to some other part, adjacent or remote. It is important to bear in mind that the therapeutic effect desired can be obtained only by a long continuation of the improved conditions induced by the application. An application lasting from ten to twenty seconds may, for example, give perfect relief for the time being; but, as a rule, the pain, unless due to some transient cause, will return, and often with very discouraging promptness. The disappointment thus occasioned frequently leads the physician to resort to an opiate when a more skilful application would wholly obviate the necessity for an anodyne of any sort. Cases are extremely rare in which pain even of a most excruciating sort cannot be very promptly relieved by thermic measures, or at least mitigated to such a degree that tolerance is easily possible until the cause of the pain can be removed by natural or artificial means.

Duration.—It would be an error to suppose that the best results are always to be obtained by very prolonged hot applications. If the object of the application is to divert blood from a part to some remote part, as when a hot application is made to the feet and legs for the relief of cerebral congestion, or to aid in controlling a pleuritic pain or an acute bronchitis, the application may be continued for one hour, or even longer; but it should be remembered that the application of heat to so extended an area as the legs may after a time elevate the general temperature, especially when febrile activity is already present, and the heat-regulating power of the body thus lessened. In general, the hot applications should be at least briefly interrupted at the end of fifteen to twenty, or, at the longest, thirty minutes. This is especially true when heat is applied directly over the affected part, for the reason that a long-continued hot application under such circumstances leads to an overaccumulation of heat in the part and dilatation of the deep-lying vessels, thus diminishing the derivative or revulsive action. On withdrawing the hot application, a well-wrung cool compress should be applied to the parts for one or two minutes, so as to restore the tone of the vessels and remove the heat which has been stored in the skin.

The Heating or Stimulating Compress.—The duration of the heating process and of the derivative effect induced by the hot application may be prolonged by the use of a heating compress. This consists of one thickness of a linen towel, or of three or four thicknesses of cheese-cloth, wrung out of water at 60° F. (15° C.) and applied over the same area to which the hot application has been made, the wet cloth being covered with mackintosh extending an inch beyond the moist cloth in all directions, and all being finally covered by several thicknesses of flannel bound firmly in place so as to prevent access of air to the moist cloth. If air is admitted, evaporation will take place, and chilling will result. The cold cloth should be applied the instant the hot application is removed, and should be warmed up within a few seconds. Prolonged chilling will counteract the beneficial effects of the hot application. The latter may be renewed at the end of two or three hours, or at shorter or longer intervals, as may be required. By this means the affected part may be kept continuously under the influence of the thermal agents employed, and definite results may be obtained. In many cases the application of a cotton poultice, consisting of dry cotton closely covered with mackintosh and flannel, affords the most convenient means of maintaining the effect obtained, until another application is made. Lamb's wool (the 'carded wool' of the dry-goods shops) is even better for a chest-jacket, as in pleurisy and pneumonia.

CHAPTER V

SALINE IRRIGATIONS AND INFUSIONS[1]

Introduction

As a result of physiologic experimentation, it was first demonstrated by Kronecker and Sander, little more than twenty years ago, that dogs which previously had been bled from an open artery to the point of death could, by a subsequent infusion of so-called physiologic salt solution (0.6 per cent. sodium chlorid), be restored to life. Control animals brought to a corresponding degree of acute anemia and untreated, invariably died.

The way had been paved for these investigations by Goltz, who in his oft-quoted paper had established the principle that under circumstances of profuse hemorrhage, cardiac action ceases, not from the loss of any specific constituents of the blood, but for mechanical reasons alone.

As a natural sequence of these revolutionizing experiments the infusion of **sodium chlorid solutions** as a therapeutic measure immediately stepped in to supplant in all cases of hemorrhage the dangerous and uncertain methods of direct blood transfusion, at the time much in vogue, but which, for many reasons better understood to-day, never could have found permanent favor. That the establishment of these fundamental principles should subsequently have led to the advocacy of similar therapeutic procedures for the treatment of most diverse conditions of disease is again a matter of natural sequence: procedures, however, both rational and otherwise, but in the majority of which entirely new physiologic principles are involved—of the saline combinations in the body-fluids, of osmotic pressure and glandular activities, of solubilities of toxins, and the like; a discussion of which is hardly appropriate at this place. Needless to say, they are far removed from the simple principle concerned in hemorrhage—namely, that of refilling 'die leere Pumpe' of Goltz.

[1] By Dr. Harvey Cushing. The writer makes no attempt in this brief sketch to give the usual bibliographic references to the results of investigation or clinical experiences embodied therein. The literature of the subject within a few years has assumed large proportions. An excellent "Sammelreferat" by Laufer, containing two hundred and eighty-six references to the more important contributions up to the year 1900, will be found in the "Centralblatt für die Grenzgebiete der Medizin und Chirurgie," Bd. III, S. 422 *et seq*, 1900.

As a matter of fact, the rapid progress, that has been made in recent years by physiologic chemistry and physics toward a better understanding of the parts played in organic activities by the inorganic salts of the body-fluids and tissues, gives us but an indication of the line of development along which saline infusion as a therapeutic measure must proceed. At the present time, unfortunately, this method of treatment, though firmly established along certain lines, must nevertheless in others be regarded as still tentative or formative; and in only a few isolated conditions can we as yet make an intelligent attempt to vary the constituent saline percentages of our infusion solutions for the purpose of combating existing abnormal states of the body-fluids.

The conditions in general for which artificial serum treatment is recommended, appropriately or otherwise, may be classified roughly into a few large groups.

Primarily, and of greatest importance, stands the great division of cases suffering from the effects of **direct loss of blood** from an open vessel. Here the therapeutic indication from first principles is plain. A second large group of conditions comprises those which are associated with a **depletion of the body-fluids,** usually by way of the alimentary canal, such as accompany persistent vomiting, diarrhea, and the like. The associated concentration of the blood and dehydration of the tissues gives here, as well, an evident therapeutic indication. In a third group may be included the various **intoxications,** whether bacterial in origin or otherwise, the **infectious diseases** and **septicemias, poisonings** from mineral or organic substances,—indeed, all the diseases for the relief of which the procedure aptly termed by the French writers 'lavage du sang' has been advocated. Here the treatment is more or less empirical and the exact clinical indications for its employment are far less clear. Lastly, in a fourth group may be placed a multiplicity of conditions—certain **specific diseases** and numberless **special symptoms** of others, for which saline infusion has without much reason been recommended.

It is in these two latter groups that not only the method of administration, but, above all, the **percentages and varieties of the saline constituents** which go to make up the solutions employed, become matters of the greatest moment. Although the future promises much, in the present state of our knowledge the infusion therapy for these conditions must be regarded as being in a larval state.

METHODS OF ADMINISTRATION

Fortunately, several methods of introduction of the saline solutions present themselves. Unfortunately, however, those which are unattended by risk or by difficulties of administration are subject in their application to distinct limitations. Primarily among these may be mentioned the introduction of the solution by way of the rectum or large bowel, termed enteroclysis.

Enteroclysis

Rectal injections are naturally to be preferred to all other methods, both from the ease of administration as well as from the simplicity of preparation of the solutions. It is unnecessary that the latter be sterile; their saline percentages need not be calculated to a nicety. In cases of acute secondary anemia the rapidity with which ordinary salt solution is absorbed from the large bowel demonstrates the efficacy of the treatment. It has been claimed by some that so much as one or two liters (quarts) may thus be absorbed in very few minutes—four and a half minutes, according to Warmann. On one occasion in my own experience, after an emergency operation in the country for ruptured tubal pregnancy, other methods of infusion at the time being precluded, two quarts of saline solution were slowly introduced into the rectum and were apparently absorbed as though sucked up by a sponge.

After the high introduction of the rectal tube or catheter,—preferably one of sufficient caliber and thickness to avoid kinking or turning backward,—or, if nothing other is at hand, of the rubber tubing attached to an ordinary douche bag, the fluid, at or slightly above the body-temperature, should be allowed to enter the bowel slowly. Reflex efforts at evacuation, such as follow a low administration of the fluid, are thus avoided. The patient, meanwhile, should be placed in the left lateral Sims's position, or else should have the pelvis raised on pillows or the foot of the bed should be elevated. The Trendelenburg position is a most favorable one for the administration of a rectal infusion. Many gynecologists take advantage of the fact, and as a routine at the end of an operation and before recovery from the anesthetic introduce a saline enema. For purposes of enteroclysis, an emergency solution may readily be made by adding a teaspoonful of table-salt to a pint of warm water. This form of infusion of course has its limitations, especially so, since in a very large group of conditions in which infusion is called for there is attendant disease of the intestine; here other methods must be employed.

Enemas of salt solution containing a **hyperisotonic percentage** of sodium chlorid have been recommended in ascites and anasarca; for the purpose, however, of abstracting fluid from the body rather than of administering it. For purposes also of cleanliness, to remove secretions and products of bacterial growth, saline solutions are frequently employed as **rectal irrigations.** When there is present ulceration of the bowel, the greatest care must be taken even in this apparently simple form of treatment. In a case of amebic dysentery, in which the customary quinin irrigation had been administered, I have seen perforation of the bowel occur as a result of the procedure.

In view of its simplicity, it is unfortunate that enteroclysis is **counterindicated** in diseases of the intestine, in which circumstances so often arise demanding saline infusion therapy. For these conditions one of the more elaborate methods must be employed.

Subcutaneous Infusion

Previous to its general introduction, in 1881, or thereabouts, this form of infusion had been recommended by Cantoni as a treatment for Asiatic cholera, and had been called **hypodermoclysis.**

At the present time it doubtless represents the most useful and widely applicable of all methods proposed for the administration of artificial sera. In view both of its simplicity and of its efficacy as a therapeutic measure for most diverse conditions, it is difficult to understand why its employment as yet has not been more widely popularized, but remains almost limited to its use in hospitals. Every apothecary should have sterilized and ready for immediate use an infusion needle and a flask with the proper saline solution, and every physician as well who is likely to be called to an emergency case of hemorrhage should be similarly prepared.

Apparatus.—In its simplest form, all the apparatus that is necessary is an ordinary douche bag with rubber tube attachment, four to six feet in length, and a hollow aspirating needle at the open extremity of the latter. Indeed, an ordinary hypodermic needle may be used, though it is desirable to have one of somewhat larger bore. Preferable, of course, to the rubber bag, is a graduated glass flask with an opening at the bottom to which the rubber tubing may be attached; and a glass joint in the course of the delivery tube is also an advantage. In this way the quantity infused and the rapidity of flow may more readily be estimated. The very elaborate forms of apparatus which are described, especially by the Germans, are unnecessary.

Precautions.—Cleanliness—*i. e.*, surgical cleanliness—naturally is indispensable. The fluid used for the infusion must have been filtered, to remove all foreign particles, and must have been sterilized. It may conveniently be kept in narrow-necked flasks of glass which endure high temperatures, like Florentine flasks, holding one to two liters (quarts), and which have been stoppered by cotton plugs in the same manner as culture-tubes. When once sterilized, such solutions may be kept indefinitely as stock solutions, requiring only to be warmed to the necessary temperature when desired for use. The apparatus destined to hold the fluid during administration, together with the needle, should be boiled before using, or else sterilized after being pinned up in a towel, in which original cover it may be left until there is demand for its use.

Preparation.—The skin of the patient, at the area selected, should be cleansed carefully with green soap, alcohol, and sublimate solution. The sterilized fluid, warmed to a few degrees above the body-temperature, should be poured into the infusion bag or bottle, and before the insertion of the needle under the skin the fluid should be running from it freely and without air-bubbles. The infusion receptacle may then be raised or lowered to the desired height, the static pressure of the fluid being sufficient to cause it to enter the tissues.

The **place selected for the infusion** is largely a matter of personal choice. Some prefer to infuse directly into the belly of a muscle like the gluteus maximus, but the majority prefer the loose subcutaneous connective tissue of one or another region. Slight distention in such localities is less painful, and there is less danger of shutting off the circulation of the part, through the tension of the infusion-holding tissue. I greatly prefer to infuse in the loose tissues at the anterior border of the axilla; that is, at the posterior edge of the pectoral muscle, the needle lying almost parallel with the muscle edge and pointing toward the axilla. The region is not sensitive; there is no danger of doing injury; the tissues are lax; the lymphatics are abundant; and absorption is rapid. In the female, possibly the place of election is in the loose tissue between the mammary gland and the chest-wall. The breast should be lifted and the needle introduced from the outer side, care being taken that it does not enter the gland tissue itself. In one instance of which I have cognizance, when this accident occurred, a painful nodule persisted for months after the infusion. The retro-mammary tissue may easily take a liter of fluid in a short space of time, and large amounts are likewise accommodated in the loose tissue of the axillary or supraclavicular region without the production of undue distention. However, it is not well to force the infusion under any circumstances, and it should never be allowed to enter the tissues much faster than absorption takes place. The rapid introduction of the fluid either through static pressure due to considerable elevation of the solution-flask above the patient's level, or by forcing it into the tissues through the agency of a pump or syringe (injection method), as I have seen practised in foreign clinics, should for many reasons, aside from its uselessness, be avoided. The tumor that results from such a local distention is painful, and, together with the massage that is often practised as an aid to the absorption, gives an insult to the tissues sufficient to encourage the localization of a chance infection at this point; furthermore, it leaves a tender and painful area, preventing the utilization of the same region for subsequent infusion. Such a repetition of the infusion may be called for. If the infusion is given slowly, large amounts may be introduced in the same area without the production of painful distention. In this way I have introduced 2500 c.c. (2½ quarts) of salt solution at the pectoral margin with no appreciable swelling; the fluid meanwhile was allowed to enter slowly from a static pressure of 40 to 60 centimeters (one to two feet) and in a constant flow, during a period of twelve hours, of about 200 c.c. (6½ ounces) an hour. In many conditions, as in anuria, some forms of septicemia, and intoxications, such a slow prolongation of the infusion is distinctly more beneficial than the rapid administration of a large amount of fluid, so often attempted.

As suitable for infusion, many localities other than the two that have been mentioned are highly recommended by various writers: such are the lumbar region; the buttock; the abdominal wall; the outer side of the thigh; at the posterior border of the scapula, etc. Where, however, tissues are somewhat tense and the blood supply is not especially abundant, great care must be exercised. I have seen an area of gangrene as large as the open hand follow an emergency infusion given under considerable force in the outer side of the thigh. The accident was due, no doubt, to the shutting-off of capillary circulation from the part in consequence of the local tension.

Peritoneal infusion may be mentioned as a modified form of hypodermoclysis. The saline solution may be introduced into the peritoneal cavity after puncturing the abdominal wall with the infusion needle—a procedure, however, attended with some risk. The more common practice, which is only applicable in cases of abdominal operation, is to pour the fluid directly into the peritoneal cavity during or at the end of the operation, before closure of the abdominal wound. Thus, as in the conditions described above, the fluid enters primarily a space of the lymphatic system, passing thence by way of the lymph-vessels, and always through glands, before entering the blood. This fact precludes many sources of danger to the individual which, as we shall see, accompany direct intravenous infusions.

Solutions are thus administered intraperitoneally with one of two objects in view: either for the sake of **adding a fluid** to the economy,—as in cases of shock with hemorrhage; for the purpose of preventing post-operative thirst; to stimulate the kidneys to action, etc.,—or else for the sake of **flushing out septic material.** The propriety of the latter procedure, as well as that of irrigation of an infected peritoneum under any circumstances, is the occasion of much discussion. It is a question whose decision must rest with the operator in relation to the individual case. The same thing is true as regards the **position** into which the patient should be put **after the treatment**—whether with elevated or lowered head and shoulders.

Doubtless both forms of treatment and of posture have in certain instances their justification.

Intravenous Infusion

Of all forms of infusion this represents the most difficult of application, the most dangerous, the most uncertain in its effects, and yet, at the same time, one most essential for certain special emergencies. Although, as a form of treatment in general, it possesses at the present time many limitations, doubtless the day will come when a great number of the intoxications, of septicemias, of poisonings of one sort or another, may intelligently be combated in this way with antitoxic substances.

The Method of Procedure.—The fluid selected, the infusion apparatus with flask, rubber tubing, and cannula should be sterilized and prepared as described in connection with subcutaneous infusions. Any convenient superficial vein of sufficient size may be chosen. A vessel at the bend of the elbow, the radial vein as it crosses the 'anatomist's snuff-box,' or the saphenous vein, are favorite ones. A bandage snugly applied to the extremity, proximal to the point selected for the infusion, usually suffices to bring the vein into prominence. The part should be cleansed scrupulously, as for an operation. One of two methods may be used for the introduction of the fluid—a **closed** or an **open** method. The former, more simple but less certain, consists in the introduction obliquely into the lumen of the prominent vessel of a small, sharp, hollow needle; a simple puncture of the skin being made, as in hypodermoclysis. In the latter—the method usually employed, and preferable for many reasons—the vein is exposed by a longitudinal incision through the skin and carefully isolated for a length of two or three centimeters (say, one inch). Local anesthesia should be employed. The vein should be handled as little as possible during this procedure, for such an isolated vessel contracts markedly under manipulation. A simple ligature should be placed under each end of the freed portion of vein and, unless it is desired to remove a quantity of blood prior to the infusion, the distal ligature should be tied. Otherwise the vein should be opened first, as in the ordinary procedure of blood-letting. In opening the vessel, a small oblique cut should be made with a sharp-pointed pair of scissors; and through this, into the proximal portion of the vein, the needle or cannula with the infusion fluid meanwhile flowing from it to prevent the entry of air, should be introduced and the proximal ligature tied in a single knot over it. It is convenient to have a blunt-pointed slightly curved glass or metal cannula especially constructed for this purpose. An ordinary hollow aspirating needle may, however, suffice; though it is more difficult to introduce and may injure the vessel wall. The loose bandage tourniquet is then removed and the fluid allowed to enter the vessel. After the infusion has been given, the needle is withdrawn as the single knot of the proximal ligature is tied down, and the wound is closed.

As will be emphasized under "Special Indications," there are certain particular conditions in which this form of infusion is demanded, but, under all circumstances, its dangers and uncertainties are such that, in consideration of the efficacy of the less heroic methods, there must always be some hesitation in its employment. This is especially the case, since in the light of our present knowledge we cannot be absolutely certain of utilizing the proper saline combination or percentage in our solution ; one of too great saline percentage (hyperisotonicity) may produce a most marked toxic effect, whereas one too weak in saline content (of hypisotonicity) is likely to have a solvent effect on the red blood-corpuscles.[1] Infusion fluids, on the other hand, which have entered by way of the lymphatics, unless in too great amount, may be supposed to acquire from the tissues, by osmosis, saline percentages which render them innocuous by the time they have reached the blood current. Thus, pure water is harmless when injected in the tissues, but may be fatal when introduced into a blood-vessel.

Furthermore, there are always **certain dangers,** as of an embolus from injury of the vessel wall, as well as from the accidental introduction of some fine particle in suspension in the fluid. There is some liability to air embolism, though this, it must be admitted, is usually exaggerated. It is difficult to estimate the correct temperature, a matter which is of much less importance in the subcutaneous method. There is considerable risk, also, that the wound will not heal kindly, since in individuals who are in such general condition that there is a reasonable necessity for intravenous infusion, such a wound is apt to break down, especially when situated in one of the flexures, as at the elbow, where movements are difficult to restrict. In addition to these disadvantages, assistance is almost indispensable, the operative preparations must be more or less elaborate, and the same region cannot be used for a subsequent infusion. I remember to have seen a patient who had been so infused in both basilic veins for the treatment of traumatic shock and hemorrhage, following the amputation of a leg for septic gangrene. Doubtless a general infection was already present to encourage the localization of a wound infection. The patient

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[1] It is in the experience of all who have employed this intravenous method of infusion extensively to have seen unpleasant symptoms occasionally follow soon after the administration of any large quantity of fluid. These symptoms resemble very closely those of a malarial paroxysm with a severe chill and rise in temperature, a rapid pulse, and quickened respiration. It seems to me not impossible that this may be, as in malaria, in some way associated with the breaking up of red blood-corpuscles ; here, of course, the destruction being caused by the hemolytic effect of a hypisotonic solution.

recovered, but with a suppurating wound and venous phlebitis of each arm.

Intra-arterial Injections

This method of infusion, at one time quite widely employed and highly recommended, consists in the introduction of the infusion fluid centripetally into a peripheral artery. Certain special advantages were supposed to accrue from the direct mechanical effect exerted on the heart by an injection so administered. Many accidents, however, resulted therefrom, and the method is mentioned merely to be dismissed.

CONCERNING INFUSION SOLUTIONS

It is a matter of no little historic interest that so called 'normal' or 'physiologic' salt solution was first used by the anatomists as a means of preserving fresh tissues for histologic examination, its superiority over pure water having been recognized. Its subsequent adoption by physiologists to preserve the normal irritability of isolated tissue preparations undergoing investigation, and its wide employment in the physiologic laboratory in practically the same saline concentration as that which was originally recommended,— a 0.6 per cent. solution of sodium chlorid,—has led to the general acceptance to-day of the belief that such a solution is the normal physiologic salt solution. As a matter of fact, this is a most misleading designation, if we mean to imply by the term a fluid which is isotonic with the body-fluids, and thus one that may be used with impunity in large amounts to replace directly in the circulatory system the loss of normal blood-serum. A 0.6 per cent. salt solution is, in the first place, sufficiently hypisotonic to lake the corpuscles perceptibly if used in sufficient quantity, and, furthermore, the recent observations of Loeb and his pupils have demonstrated the actual toxicity toward cellular activities of the pure sodium chlorid solution, that is to say, when uncombined with other salts. In spite of these facts, I presume that nine out of every ten individuals who infuse intravenously still use the 0.6 per cent. solution. This statement holds true as well for the practice in the majority of hospitals.

Sidney Ringer, some twenty years ago, through an accidental observation, discovered the fact that minute doses of calcium and of potassium salts, when used in combination with the usual percentage of the sodium salt, made a solution possessing a much more beneficial effect in conserving the activity of an isolated heart than the sodium solution when used alone. Thus for the first time was pointed out the antagonizing action of small amounts of calcium and potassium toward the toxicity possessed by the single sodium ion, and thereby was given the first indication of the necessity of combining salines in order to obtain a more perfect infusion solution. For such solutions, therefore, as contain the proper proportions of saline elements, or, in other words, in which the injurious effects toward tissue protoplasm possessed by any individual salt, are counterbalanced by the presence of others, Loeb has introduced the term 'physiologically balanced solutions.' The entire subject is comparatively young at present, and until the relationship of the inorganic salts and the body-fluids are better understood, so that infusion solutions of varying percentage can be adapted to different pathologic conditions, we can do little more than accept the foregoing few facts as a basis for the selection of proper solutions for purposes of infusion.

From what has been hinted at in the section on intravenous infusion, it may be understood that the extreme precautions laid down, in so far as they concern saline percentages, are applicable chiefly to the procedure in which the fluid is directly introduced into the vessels. Solutions administered in other ways will probably have acquired, by osmosis from the storehouse of inorganic salts of the tissues, characteristics that will render them harmless to blood-corpuscles, nerve-cells, and other constitutents of the tissues, by the time they have reached the blood stream. This presumably is especially true of infusions given by the rectum. Here water itself, aside from its irritability to the mucosa, answers the purpose, in large degree, of a physiologically balanced solution.

For similar reasons, the usual 'salt solution' of 0.6 per cent. sodium chlorid, provided it has been filtered and is sterile, may with propriety be used for hypodermoclysis, and the same may be said for peritoneal infusions, though a solution of higher percentage (0.75 per cent. to 0.9 per cent.), which corresponds more closely to the molecular concentration of the tissue fluids, is far preferable.

When, however, we come to the introduction of fluid intravenously, we are confronted by a more complex problem. The very fact that numberless fluids with most variable combinations and percentages of saline constitutents have been advocated gives evidence of the uncertainty in which the matter rests. Solutions containing no sodium chlorid whatever, or else this really essential constituent in proportions all the way from 0.4 per cent. (Cantoni) to 1.0 per cent. (Malassez), are recommended with or without auxiliary sodium salts—the carbonate and bicarbonate, sulphate or phosphate; also calcium, potassium, or magnesium salts in one form or another; sugar solutions (Landerer, Schücking); and many others. Queirel has recommended, as a proper solution, sea water in the proportion of 83 parts to 190 parts of distilled water, in order to obtain 'ready-made' a proper proportion of salines.

There can be no doubt that the pure sodium chlorid solution alone may in certain ways be injurious from its toxic effects; that, furthermore, a solution of the single salt, as weak as the 0.6 per cent. commonly employed, has a hemolytic effect upon the red corpuscles. The desirability, therefore, of administering a fluid which shall not only be nontoxic, but which shall be as nearly as possible isotonic with the blood,—that is, shall have a molecular concentration corresponding to that of the liquor sanguinis,—is evident. This isotonicity of the blood naturally varies considerably under different clinical conditions, and at the present time we have no way of determining it for the individual case. Under normal conditions, Hamburger, by a test which depended on the determination of that percentage of saline which failed to lake the red corpuscles, and von Koranyi, who established the molecular concentration by determination of the freezing-point, have shown that the proper proportion of salt in a sodium chlorid solution varies from 0.9 to 1.3 per cent. A nine-tenths per cent. solution may therefore be considered safe and proper to employ for human beings under ordinary circumstances; and as a modification of Ringer's solution a combination such as the following:

Sodium chlorid ($NaCl$),	0.9
Calcium chlorid ($CaCl$),	0.026
Potassium chlorid (KCl),	0.01
Distilled water (H_2O),	99.064
	100.0

may, in the present state of our knowledge, be recognized as the most nearly perfect solution to be applied for the generality of cases.[1]

SOME OF THE SPECIAL INDICATIONS

The Acute Anemia of Hemorrhage

The entire therapy of saline infusions, as has already been indicated, is the outcome of its original successful employment as a means of combating the acute primary anemia from loss of blood. It is unnecessary to pass in review the circumstances of hemorrhage that might lead to the demand for this form of treatment. The

[1] Such a solution is employed as the routine infusion fluid in several hospitals where attention has been given to the subject. When great quantities are employed, it is convenient to have a concentrated solution of the saline carefully made by the apothecary, a certain number of cubic centimeters of which, necessary to make the desired percentage, can be added to a liter of distilled water when it is made up for sterilization. Thus the tedium and errors incidental to the weighing out of the salts for each separate flask of solution are avoided. [This may be termed 'clinical saline solution.' Certain manufacturing chemists have placed upon the market somewhat similar solutions, presumably prepared with due care, in sealed vials containing each the correct quantity for one liter (or quart) of water.—ED.]

clinician meets them chiefly in hemorrhages from the esophagus, stomach, intestinal canal, and lungs; the surgeon in traumatic cases with or without associated shock and either with concealed or external bleeding; the gynecologist in the ruptures of tubal pregnancy, in hemorrhages from uterine tumors; the obstetrician in many complications of labor; the condition, in fact, of acute primary anemia may be encountered by any and every practitioner of medicine. When encountered, however, there are more things to be taken into consideration than the fact of a great loss of blood for which we may desire to compensate by replacing it with an artificial serum. Among the questions which arise is, Shall the infusion be given before the open vessel or vessels are secured or the bleeding has ceased spontaneously? As a general rule, it is safe to answer in the negative, since clinical experience shows that the associated rise in blood pressure is apt to increase the loss of blood, or even to start up afresh the oozing from vessels that previously were dry. There is, however, something to be said on the other side, and, paradoxic as it may seem, the infusion, even though it increases the blood volume, may in certain cases actually check the hemorrhage. This *hemostatic effect* has been demonstrated experimentally by numerous French investigators, who have shown, however, that it follows the administration of comparatively small quantities of saline solution. Provided, therefore, that the bleeding point has not been controlled,—as in many cases of internal hemorrhage it cannot be,—the infusion may be indicated; but in these cases particular care should be exercised lest it be carried too far—namely, to the point of relaxation of vascular tone. Such a condition often results from the infusion of a large amount of fluid. In the case of an adult, from 200 to 250 c.c. (say, 6 to 8 fluidounces) will often suffice to improve the general condition and to check the bleeding. Later, when the vessels have become securely thrombosed, a larger quantity of infusion may be introduced with safety (Haeberlin). The rationale of the administration of a moderate quantity of saline solution as a *preliminary to an operation* which promises to be bloody can thus be seen to exist. The proposition has been made to use larger quantities of calcium chlorid, and even to add gelatin, for hemostatic effect under such circumstances.

The **method to be employed**, whether intravenous or otherwise, depends largely upon the degree of anemia reached. Some authors have attempted on experimental grounds to subdivide the condition of profound hemorrhage into stages which depend [illegible] the amount of blood lost, each having a more or less definite symptom-complex. For example, there is a **first stage**, with a loss of [illegible] grams (one to two quarts) of blood, causing [illegible] compressible pulse having a rate of [illegible]; a **second stage**, when something over 2000 grams (two quarts) have been lost, producing cold extremities, an almost indistinguishable pulse, fainting, and precordial anxiety; a **third stage,** when the loss exceeds 3000 grams (three quarts), manifested by relaxation of sphincters, imperceptible pulse, fibrillar twitching of the muscles, and similarly grave phenomena that accompany an unavoidable exitus (Cholmogoroff).

In desperate conditions, as represented by these later stages, an **intravenous** or even **intra-arterial infusion** is absolutely necessary for the saving of life. It is practically only in hospitals, where materials are in sufficient readiness, that the exigencies of such extreme states may be met successfully. In the earlier stages, **subcutaneous infusions,** or, when the symptoms are comparatively mild, **rectal injections,** meet fully the therapeutic requirements.

The **rapidity** with which the fluid should be given, as well as the **quantity** to be infused, must remain a matter of personal judgment in the individual case. In my estimation, not only are too copious infusions apt to be introduced at one sitting, but they are, as a rule, introduced with much too great speed. Within reasonable limits, the more slowly the infusion proceeds, the better. Continuous observations should meanwhile be made on the volume and rapidity of the pulse and on the blood pressure. The latter may be estimated roughly by the palpating finger, or, still better, by some form of measuring apparatus, such as that described by Riva-Rocci. If an appreciable improvement has ensued on the administration of 500 c.c. (one pint), more or less, it is well to discontinue the infusion temporarily. It is a rule too often followed that because a small amount is good, more must be better; and, in consequence, patients are often deluged with saline solution, to the extent of 1500 or 2000 c.c. (3 to 4 pints)—a procedure which of itself may occasion collapse, profuse sweating, flabby pulse, and the low blood pressure of splanchnic dilatation, from which there may be no recovery.

These warnings are especially applicable to the conditions of **shock with hemorrhage**; states in the treatment of which infusion is indicated, but in which it must be given with the greatest care. In cases of pure **traumatic shock** without loss of blood, I have never seen the treatment do more than temporarily to improve the pulse. If this condition be due, as is generally supposed, to a relaxation of the great splanchnic vascular area, the therapeutic indication is to furnish these vessels with some artificial support or to improve their tonicity. The former object may be attained in a measure by abdominal bandaging and by posture. The infusion of a physiologic salt solution will not improve the local vascular tone; indeed, in large amounts it tends to lower this still more. Howell has suggested, on experimental evidence, the possibility that small amounts of sodium bicarbonate, when added to the usual infusion fluid, have some direct local influence in contracting the splanchnic area in shock. I know of no clinical observation as yet in corroboration of the statement, but if it shall prove true, it will be a most valuable addition to the infusion therapy.

The treatment, nevertheless, of traumatic shock by the routine administration of saline infusions has its warm adherents, and its employment is wide-spread.

Conditions of Abnormal Loss of Fluid from the Tissues

The indications here are to replace in the body the watery elements that have been withdrawn from the tissues by morbid processes. As a noteworthy example of the beneficial effects of infusion in meeting such conditions may be mentioned its use in **Asiatic cholera.** Michael's statistics have shown that 40 per cent. of the cases so treated in a particular epidemic recovered, in contrast with 22 per cent. of the cases not infused. The drying out of the tissues and concentration of the blood, due to the excessive loss of fluid by the bowel, is doubtless provocative of many of the serious symptoms of the disease—symptoms which are largely counteracted by the artificial serum.

The same therapeutic principle holds good for all diseases in which there is an abundant loss of serum from the tissues, as in **dysentery, typhus**, or **profuse diarrhea** from any intestinal infection. In the **summer diarrheas of children** especially is it a most valuable therapeutic measure. It is almost like a resurrection to see an infant, emaciated and in the profound collapse accompanying those conditions, brought back to life by the infusion under the skin of a few hundred cubic centimeters of salt solution. Similarly, in cases of uncontrollable vomiting, whether of a toxic or a nervous origin, but in which there is great loss of fluid from the body, correspondingly beneficial results may be seen.

Analogous conditions are those in which the individual is suffering from the need of fluid, not because it is rapidly withdrawn, but because it cannot be taken in the natural way; in obstructive processes of the upper portion of the alimentary tract—**esophageal** or **pyloric stricture**, for example. Here the daily administration by h y p o d e r m o c l y s i s of 300 to 500 cc. (10 to 16 ounces) of a saline solution will completely remove that most unbearable symptom, thirst. Inasmuch as rectal feeding must oftentimes be instituted, under extreme circumstances of this kind, the bulk of the nutritive enemas may thus be greatly reduced by giving the watery elements demanded by the patient in large part under the skin. The procedure of feeding by the rectum may in this way, by sparing the lower bowel, be continued over a much longer period than otherwise.

There are many other occasions of a similar sort when, as symptomatic treatment, infusions may be called for to alleviate symptoms due to a deficiency of fluids which cannot be taken in sufficient quantity by the mouth. Especially is this so during the hours of **post-operative nausea,** when thirst and diminished renal activity may be prominent and annoying symptoms, owing their presence partly to the direct influence of the anesthetic and partly to some loss of blood and the abundant perspiration which often has accompanied the state of narcosis. In consequence, many operators administer a few hundred cubic centimeters of sodium chlorid solution by the rectum or under the skin as a routine, **after a general anesthetic** has been employed. The indication is plain and the results most satisfactory. Comparative statistics (Clark) have shown the efficiency of the procedure in increasing renal activity after operations and in controlling thirst. For similar purposes, after abdominal operations, the fluid may conveniently be left in the peritoneal cavity, from which its rapid absorption takes place.

In the Various Intoxications, Infectious Diseases, etc.

The possibility of using infusions as a means of washing out from the blood stream ('lavage du sang') toxic products of one sort or another had its first advocates in Dastre and Loye. These authors by experimental evidence furnished a scientific basis for this form of treatment. Such a **lavage of the blood** may be carried out in one of two ways: either by preliminary extraction of blood and a subsequent intravenous infusion to take its place; or, on the other hand, as a **perfusion,** by a slow continuous administration of the saline solution, which is found to be productive of a diuresis sufficient to carry off the fluid as rapidly as it is introduced. These authors demonstrated in animals that four times the volume of the blood may thus slowly be given, and that a corresponding quantity of fluid will in the same time be passed through the renal epithelium. Such an actual perfusion naturally has the tendency to wash away and dilute toxic products; at all events, those which are soluble. An immense field of therapeutic possibilities was thus opened by these investigators, and the experimental observations have been in a degree corroborated by clinical experience.

However, as has been stated earlier in this paper, it is in the treatment of conditions of this sort that the proper saline percentages of complex saline solutions become matters of moment; and inasmuch as at present no fixed rule can be laid down for their selection, the treatment must be considered to be decidedly in its probationary stage. It remains for institutions in which large groups of cases are treated to determine the appropriateness of the treatment in special diseases, and for the experimentalists to determine the solutions best fitted to combat the varying conditions of toxicity. These criticisms, however, which I wish to make concerning the usage of saline infusions in this group of cases, apply especially to its intravenous introduction. If therapeutists would confine themselves for the present, or until appropriate and safe solutions can be determined upon, to the method of subcutaneous infusion, the dangers of the treatment would be reduced to a minimum and the results, in so far as they are due to the principle of perfusion, be almost equally good.

A great number of the **acute infectious diseases** have been so treated, usually with the so-called 'normal salt solution' (0.6 per cent. sodium chlorid), and by one method or another of infusion. In **typhoid fever** (Landouzy) it has been compared favorably with the bath treatment. The method was inaugurated by Sahli, and it is said to be effectual as an antipyretic and diuretic, and to be especially useful in cases in the typhoid state which are suffering from an intoxication or bacterial septicemia.

In **pneumonia** also, especially as a cardiac stimulant, has infusion been warmly recommended by numerous writers, following F. P. Henry. Cases of **tetanus** have been so treated; also **erysipelas** and the great variety of traumatic or so-called **surgical infections**; and it has been found useful in **sepsis**, of whatever bacterial origin. If treatment with saline solution is instituted for conditions of this sort, unless there is some especial emergency indicating the need of intravenous infusion, it is much safer to limit the procedure to the subcutaneous method. In prolonged febrile diseases of the typhoid type the daily administration of from 200 to 300 c.c. (say 6 to 10 fluidounces) has been advocated. Much larger doses, however, are sometimes given. Lenhartz reports a remarkable instance in which a patient suffering from a severe case of typhoid was given twenty-three liters in seventeen days, a distinctly beneficial effect on the vascular tone and general condition having been appreciable after each administration.

In a great number of **autointoxications** from disease, especially in cases associated with renal insufficiency, infusions may be, from their diuretic effect, most helpful. In the **uremia** of **chronic nephritis** it often has a most favorable influence; sometimes, in the presence of acute symptoms, it is associated with blood-letting. When subcutaneous infusion has produced a good effect, it may be maintained by rectal injections. The latter, indeed, systematically given, are often useful as a prophylactic measure, against the severe symptoms of uremia (Cohen). Sahli has claimed that the presence of anasarca is ordinarily no counterindication to a subcutaneous infusion, since by the infusion an unusually free lymph circulation in the edematous part may be established. In the condition of **coma**, a combined blood-letting and direct intravenous infusion have been recommended.

Similarly, in **eclampsia** many cases have been reported with recovery following the extraction of a few hundred cubic centimeters of blood and subsequent infusion. For another profound intoxication, that producing **diabetic coma**, the saline infusion is the most approved therapeutic measure. Stadelman's demonstration of the fact that these symptoms of coma were due to a form of acid intoxication has led to the introduction of an alkaline infusion, as much as 0.3 to 0.4 per cent. of sodium bicarbonate or chemically pure sodium carbonate being added to the sodium chlorid solution. This neutralizing treatment in diabetic coma is one of the few instances in which known abnormal chemical conditions of the blood give a definite indication for the saline constitution of the clinical infusion.

For the intoxication associated with extensive **superficial burns**, saline infusion is the most efficacious treatment we possess. Tommasolli has shown experimentally that infusion will save a certain percentage of animals that have been extensively burned, while those not treated all die; also that the serum of dogs that have suffered from extensive burns is fatal when injected into normal animals, but that a following infusion may keep them alive.

In many **forms of poisoning** other than these intoxications has the treatment been recommended, with or without preliminary or coincident venesection, according to the special indications of toxic agent and individual patient; thus, in **phosphorus** poisoning, in **mercurialism** (Sahli), in **iodoform** intoxication, in acute **alcoholism** (Cohen), in **chloral, chloroform** and **carbolic acid** poisoning, in the various putrid **meat intoxications**, in poisoning from **carbon monoxid**, from **carbon dioxid**, from **illuminating gas** and many other agents. In morphin and strychnin poisoning no successful result has as yet been recorded, which is presumably due to the marked tissue fixation of these drugs; whereas in the various forms of autointoxication mentioned, as well as in the toxemias of febrile diseases, and of poisons such as alcohol, the greater or less value of the treatment depends presumably on the degree of solubility, or the ready loosening from tissue combinations of the poison, which, owing to the induced renal activity, is carried off with the urine.

Lastly, we come to a **miscellaneous group of diseases** in the treatment of each of which there are certain therapeutists who champion the cause of saline treatment. On the ground that the various **psychoses** are of toxic origin, lavage of the blood with salt solution has been recommended (Boeck), and favorable results reported in cases of **mania, neurasthenia**, and **hysteria**. It has been advocated as a treatment in certain forms of malignant **syphilis**, in **mycosis fungoides**, in **eczema**; as a local measure in numerous diseases of the eye in the form of subconjunctival infusions; as a means of stimulating local lymphagogic action in the neighborhood of chronic local processes, as ulcers, glandular swellings, and the like; and so the list might be indefinitely increased.

Summary

After the foregoing brief review of infusion therapy, it may in summary be stated that this form of treatment, although its employment has extended over but a score of years, has firmly established itself as one of the most useful of remedial measures; that for certain conditions, especially those associated with the loss of blood and its concentration from dehydration of the tissues, no other efficacious form of treatment is available; that in a great number of intoxications and infections the infusion, chiefly by inducing an associated renal activity, plays the part of diluting and washing out the toxic products; that the method of **hypodermoclysis** is the method of choice for almost all conditions, whereas the intravenous method possesses many dangerous features owing to the present insufficiency of our knowledge regarding the proper makeup and percentage of the saline constituents of the infusion solutions.

BALNEOLOGY AND CROUNOTHERAPY

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BALNEOLOGY AND CROUNOTHERAPY

INTRODUCTION

THE CLASSIFICATION OF MINERAL WATERS

WITH ESPECIAL REFERENCE TO THE

CHARACTERISTICS AND GEOGRAPHIC DISTRIBUTION OF THE MEDICINAL SPRINGS OF THE UNITED STATES

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Definition of Mineral Waters

Water being an inorganic body—a compound of definite composition—hydrogen monoxid—is itself a mineral; moreover, as it is a universal solvent, absolutely pure water is a product of the laboratory alone. From a strictly scientific standpoint, therefore, all waters should be considered as mineral waters. Even glass is to a certain extent soluble in pure water; and rain-water, the purest natural water, in its passage through the atmosphere acquires small quantities of solid organic and inorganic matters as well as of ammonia, carbonic acid, and other gases. The definition of a mineral water will thus depend largely upon the point of view; that of the chemist differing from that of the physician or that of the layman. In common usage the term mineral water has been applied to waters containing appreciable quantities of foreign matters; some of the definitions restricting it to such waters as contain an unusual amount of matter in solution, or have a decided taste or a particularly high temperature. Many writers consider as mineral waters only those used in the treatment of disease; that is, that are utilized solely for medicinal purposes—a definition too narrow for practical use. These writers go to one extreme, while the chemist may possibly go to the other. The definition given long ago by Daubeny perhaps covers the ground as well as any other. He says [1]: "The term mineral water in its most extended sense comprises

[1] "Sixth Report, British Association for the Advancement of Science, 1836," p. 1.

every modification existing in nature of that universally diffused fluid, whether considered with reference to its sensible properties or to its action upon life."

From the therapeutic standpoint, a mineral water is any water that may alter in any way the physiologic functioning of the human system, no matter how feebly mineralized the water may be; that is, it is any water that possesses medicinal virtues, whether they be due to the presence of organic or inorganic, solid or gaseous contents, or to temperature. This is practically the definition found in most works on mineral springs. Under it would be included many waters that from a chemical standpoint might be considered comparatively pure—the chemically indifferent waters of some classifications. Many of them are less highly mineralized than the ordinary potable waters of most localities; yet the fact that they have some specific effect, from the therapeutic point of view, entitles them to consideration under this definition Small quantities of some constituents are often more effective as remedial agents than larger quantities of others. The medicinal effect of weakly mineralized waters may therefore be due to the presence of some substance effective in small quantities; or it may depend upon the purity of the water, permitting large quantities of fluid to be used.

Classification

That a systematic arrangement of the various mineral waters is not only desirable, but important, is a proposition from which no one dissents, and various schemes have been outlined. Unfortunately almost every one who has written on the subject has presented a classification differing in some respects from all others. It is a matter attended with much difficulty, from whatever standpoint it may be approached. Any classification must be to a certain extent arbitrary, as we find that the various waters shade imperceptibly into each other in respect to their various ingredients; the principal ones must therefore be emphasized in main classes, the minor ones determining subordinate groupings; and in some cases this may be a matter of individual judgment. Classifications may be made from a **geographic**, a **geologic**, a **therapeutic**, or a **chemical** standpoint; the first two, in view of the general uses of mineral waters, being of little value except for special scientific study. We are practically confined to a choice between the therapeutic and the chemical classification.

The universal use of water for drinking purposes led at first to the division into **potable and nonpotable** (or drinkable and nondrinkable) waters; but mineral waters were very early differentiated and divided into classes according to their predominant character or the qualities which appealed most strongly to the senses of taste and smell. In the time of Aristotle they were classified according to the vapors or gases they contained. Pliny divided them into acidulous, sulphurous, saline, nitrous, aluminous, and bituminous; and many of our classifications of to-day have advanced but little beyond this early scheme. If existing classifications are in any sense chemical, they are generally based upon properties that are not analogous; terms denoting gaseous contents being given equal value with those referring to the solid constituents. Usually, however, there is a mixture of classes based on chemical and therapeutic qualities with classes based on characteristics referable to physical sensations; the various properties being considered in these schemes as coordinate. Thus, in most classifications, the terms 'alkaline,' 'purgative,' 'thermal,' and 'sulphur,' as applied to waters, are found of equal rank.

The ideal scheme of classification from the standpoint of the medical practitioner, who is perhaps more largely interested in the subject than any one else, is a **therapeutic** one, which should be based on careful and thorough clinical study. The conditions at present, in the United States especially, are such as to render this impossible; there are few, if any, of our springs whose waters have been studied so thoroughly from the clinical viewpoint as to give us accurate knowledge of their effects upon correctly diagnosticated diseases. We are therefore restricted to a **chemical classification** based upon the predominance of one or more of the ingredients. In the absence of complete therapeutic data, we can rely with a reasonable degree of certainty upon the chemical composition, and may expect certain effects from the probable combinations indicated by the analyses. We may be guided, moreover, by analogies based upon recorded experience with well-known springs in Europe, where the subject has been accorded a prominence which it will no doubt eventually receive in this country. A chemical classification is furthermore necessary as a preliminary to the construction of one based upon the application of the waters in the treatment of disease. It presents some inherent difficulties, and is further embarrassed by the great variations in the methods of stating results used by different analysts. Thus, an inspection of some thousand analyses of American mineral waters revealed forty-two different methods of statement. On the whole, however, a chemical classification is preferable, especially if it can be made broad enough to include all mineral waters already analyzed or to be analyzed hereafter.

The scheme that follows is applicable not only to American waters, but to all others. The designation of a mineral water according to this system gives at once a definite idea of its general chemical composition and affords a clue to its probable therapeutic effect. Thus it becomes feasible to pick out certain waters as probably suitable for a certain class of cases; after which, a more careful study of the analysis of a given spring will permit one to determine whether or not it is likely to meet all the requirements of the individual patient.

AUTHOR'S SCHEME OF CLASSIFICATION[1]

Group:	*Class:*				
(A) THERMAL or (B) NONTHERMAL	I. ALKALINE			(1) Sodic (2) Lithic (3) Potassic (4) Calcic (5) Magnesic (6) Chalybeate (7) Aluminous	(1) Nongaseous (free from gas) (2) Carbonated (containing carbonic acid gas) (3) Sulphureted (containing hydrogen sulphid) (4) Azotized (containing nitrogen gas) (5) Carbureted (having carbureted hydrogen) (6) Oxygenated (containing oxygen)
	II. ALKALINE-SALINE	Sulphated-muriated; Borated			
	III. SALINE	Sulphated-muriated; Borated			
	IV. ACID	Sulphated-muriated; Silicious . .	Sulphated; Muriated		

In the first place, all waters are characterized by their **temperature**; they are cold, tepid, warm, or hot. In the foregoing table, therefore, the first column divides them into two great groups: (A) **Thermal** and (B) **Nonthermal**, and the two groups are treated precisely alike so far as their solid constituents are concerned. Each contains four main classes: **Alkaline**; **Alkaline-Saline**; **Saline**; and **Acid.** An alkaline, a saline, or an acid spring may be either thermal or nonthermal. A thermal water may belong to any one of the subordinate classes or their subdivisions, and the nonthermal water may duplicate the thermal in any or all particulars except that of temperature.

In CLASS I, **alkaline waters,** are included all waters containing the alkaline carbonates, whether they are of the alkalies, or the alkaline earths, and carbonates of manganese, iron, etc. Usually the iron carbonate is associated with the alkaline carbonates. Generally these waters are characterized by the presence of free carbonic acid gas (carbonated)—the 'acidulous waters' of some classifications.

CLASS III, **saline waters,** includes all those characterized by a predominance of sulphates or chlorids; they are subdivided, according to the predominance of one or the other, into sulphated and muriated, or when these two classes of salts are present in about equal amounts, the term sulphated-muriated may be employed; when sodium biborate is present as the predominent ingredient, the waters are termed borated.

CLASS II, **alkaline-saline waters,** is intermediate between Classes I and III, and contains all those waters in which there is a mixture of carbonates with sulphates or chlorids, and may be subdivided into sulphated, muriated, and borated.

[1] This scheme was first outlined by the writer before the American Climatological Association in 1887. See "The Transactions of the Amer. Climat. Assoc.," 1887, p. 156.

CLASS IV, **acid waters,** includes all those characterized by the presence of free sulphuric acid; free hydrochloric acid; or free silicic acid. The subdivision into sulphated and muriated waters holds here according to the presence of sulphates or chlorids, as it does for the saline and alkaline-saline classes. It might be argued that waters containing free carbonic acid (carbon dioxid) should also be included here; but as the latter exists in a gaseous state, such waters may be found in any one of the four classes. Thus, we can have a carbonated alkaline water, a carbonated saline water, or a carbonated acid water.

These four classes are further **subdivided** according to their predominant basic solid constituents. When sodium carbonate, sodium sulphate, or sodium chlorid predominates, the water is known as **sodic, sodic sulphated,** or **sodic muriated** respectively, and similar designations are applied to waters characterized by **potassium, calcium, lithium,** or any other predominant basic constituent.

If iron is present in great quantity, the water is known as a **chalybeate.** It may be an alkaline chalybeate; an alkaline-saline sulphated or muriated chalybeate; a saline sulphated or muriated chalybeate; or an acid sulphated or muriated chalybeate. An iron spring, therefore, may belong to any one of the four classes. The fact that waters contain iron should not relegate them all to one class, any more than the presence of sodium should cause waters characterized by a predominance of sodium bicarbonate to be placed in the same group with those containing sodium sulphate as their principal ingredient.

Any other ingredient, such as manganese or arsenic, if found in sufficient quantity, can be indicated by designating the water as manganic or arsenic, etc. The terms in the fourth column of the table can thus be extended indefinitely to include any kind of mineral water. Frequently there is a **combination** of the various constituents, in which case the character of the water can be expressed by a combination of terms, as sodic-magnesic; calcic-magnesic; sodic-chalybeate; calcic-chalybeate; etc.

Lastly, any water belonging to any subdivision of the four classes in our table may be characterized, according to the absence or presence of its **gaseous constituents,** as follows:

1. Free from gases: **Nongaseous.**
2. Containing carbonic acid gas: **Carbonated.**
3. Containing hydrogen sulphid: **Sulphureted.**
4. Containing nitrogen gas: **Azotized.**
5. Containing carbureted hydrogen: **Carbureted.**
6. Containing oxygen gas: **Oxygenated.**

These gaseous constituents are expressed by the terms in the fifth and last column of the table. When more than one gas occurs in a water, this fact can be indicated by combining two or more terms; thus, a water may be sulphocarbonated—containing both free carbon dioxid and free hydrogen sulphid. The term carbonated is used in preference to 'acidulous,' as we may have a carbonated acid sulphated water (*i. e.*, a water with free carbonic acid, free sulphuric acid, and sulphates), and in such a case, the term 'acidulous acid water' would be awkward.

In the scheme just outlined the term 'indifferent' or 'chemically indifferent' is not used; as it is one upon the application of which agreement would be impossible. The spring-owner would perhaps draw his line of indifference at one place, the physician who prescribes the water might draw it at another, and the chemist at still a third point. The various analyses can be arranged in order according to the proportion of the classifying ingredient; beginning with the least highly mineralized water or with the one containing the largest quantity of solid contents. The waters sometimes called 'neutral' or 'chemically indifferent' are not always therapeutically indifferent. For instance, in the POLAND spring-water the total solid contents amount to less than four grains to the gallon (0.06 gram to the liter); and at the HOT SPRINGS of **Arkansas** some of the waters contain less than ten grains to the gallon (0.15 gram to the liter). Many other waters from widely separated localities might be cited, but these are well known and will suffice to prove the point.

Illustrations

Three cases will suffice to illustrate the **applicability** of the scheme:

The High Rock Spring and most of the other springs at SARATOGA would be described as **carbonated sodic-muriated alkaline-saline** springs; *i. e.*, the water contains free carbonic acid gas, its predominant solid constituent is sodium chlorid, but it also contains alkaline carbonates. It belongs to Group A, as no temperature is given, it being a cold spring.

The water of the GILROY HOT SPRINGS of **California** would be described as a **hot sulphocarbonated sodic-muriated saline** water; *i. e.*, it contains both free carbonic acid gas and free sulphureted hydrogen, and its principal solid constituent is sodium chlorid. It belongs to Group B, as it is a hot water.

A third example is the HOT SPRINGS of **Virginia.** The water of the Boiler Spring, one of its many springs, may be described as a **hot carbonated calcic alkaline** water; *i. e.*, it contains free carbonic acid gas, the principal solid ingredient is calcium carbonate, and it belongs to Group B (thermal waters).

COMPARISON OF CLASSIFICATION SCHEMES

Owing to the fact that so many different schemes of classification have been proposed there has been more or less confusion in their application. In order that consideration of the subject may be somewhat simplified, an attempt is made here to correlate them. Although differing in details, these various schemes may nearly all be reduced to one or the other of four typical schemes, which can conveniently be designated as the German, French, English, and American. In the tables that follow, these are briefly summarized and each is compared with the scheme outlined by the author; while their relations are described and briefly discussed. It is not purposed to criticize these various schemes except in so far as it facilitates their comparison and is necessary in order to correlate them with that of the author. Each undoubtedly has certain merits; but all, being more or less artificial and arbitrary, must to some extent be unsatisfactory. It remains, as a prelude to uniformity, to reconcile differences so far as possible; and a careful comparison should throw more light on the whole subject and lead to practical results. In the last column of each of the following tables is given the equivalent of each division in accordance with the author's scheme already outlined.

GERMAN CLASSIFICATION

		Correlation with Author's Scheme
I. ALKALINE,	1. Simple carbonated or acidulous. 2. Alkaline or acidulous alkaline.	**Carbonated alkaline and alkaline.**
	3. Alkaline with common salt or alkaline hydrochloric (or muriated) acidulous.	**Muriated alkaline-saline.**
II. GLAUBER'S SALT,		**Sodic sulphated saline.**
III. IRON (Chalybeate),	1. Pure or simple.	**Alkaline chalybeate.**
	2. Alkaline and saline.	**Alkaline-saline chalybeate.**
	3. Earthy and saline.	**Alkaline-saline or saline chalybeate.**
IV. COMMON SALT, OR SODIUM CHLORID,	1. Simple sodium chlorid. 2. Concentrated sodium chlorid or brine (Soolen).	**Muriated saline.**
	3. Sodium chlorid with bromin and iodin.	**Iodobromic muriated saline.**
V. EPSOM SALT,		**Magnesic sulphated saline.**
VI. SULPHUR,		**Sulphureted waters of** any class.
VII. EARTHY AND CALCAREOUS,		**Calcic alkaline** and **calcic sulphated alkaline-saline** or **saline.**
VIII. INDIFFERENT,		Waters that may be of any class, whether thermal or nonthermal.

The scheme outlined above is the one used, with slight modifications, by practically all German writers on mineral waters. Dr. Kisch in his scheme (as detailed in this volume, page 416) places the waters containing large amounts of sodium sulphate and magnesium sulphate under one head, designated '**bitter waters**,'—a plan followed likewise by many other German writers. Instead of the term carbonated, Kisch uses '**acidulous**,' and for the indifferent waters of elevated temperature he employs the term '**acratothermal**' or 'indifferent thermal' waters. He also arranges his groups in a somewhat different order from that of the table, putting the '**sulphur waters**' ahead of the '**iron waters**' and the '**bitter waters**' between the '**sodium chlorid**' and '**sulphur waters.**' In agreement with nearly all schemes, the '**alkaline waters**' here include those characterized by the preponderance of carbon dioxid and the alkaline carbonates. He divides them into four sub-groups—'acidulous waters,' 'alkaline acidulous waters,' 'alkaline hydrochloric (or muriated) acidulous waters,' and 'alkaline-saline acidulous waters.' This is to all intents and purposes Division I of the table page 305.

Division II, '**Glauber's Salt waters**' of the German classification, includes the waters characterized by the presence of sodium sulphate, occurring usually in large amount; this is one subdivision of the '**bitter waters.**'

Division III, '**iron waters,**' includes all the chalybeates. Kisch defines them as "containing iron in notable amounts, without the sum-total of their constituents being large"; and divides them into carbonated or '**steel waters,**' sulphated or '**vitriol waters,**' and '**iron and arsenic waters.**'

Division IV, the '**common salt,**' or 'sodium chlorid waters,' contains common salt as the characteristic ingredient. They are subdivided into 'simple,' 'concentrated' or 'brines,' and those containing bromin and iodin.

Division V, '**Epsom Salt waters,**' includes waters in which magnesium sulphate predominates; this is the second subdivision of the '**bitter waters.**'

Division VI, '**sulphur waters,**' includes all waters containing hydrogen sulphid or some other binary sulphur compound.

Division VII, '**earthy or calcareous waters,**' includes the waters characterized mainly by the presence of calcium sulphate or carbonate.

Division VIII, '**indifferent waters,**' includes the waters that contain no especial solid or gaseous ingredient in large amount. Kisch includes this division in his scheme only in so far as "they are characterized by their high temperature"; that is, only the thermal waters ('**acratothermal**') of this class.

Some objections to the German classification are evident. In the first place, the terms are based on properties that are not analogous. Sulphur waters are characterized by the presence of a gas—hydrogen sulphid. If, however, the gas is carbon dioxid, the water is placed under a sub-group of the alkaline division. The iron waters are divided into pure, alkaline and saline, and earthy and saline; and yet alkaline waters also constitute one of the principal divisions of the scheme, being made coordinate with the iron, sulphur, and common salt divisions. The subdivision of the common salt or muriated waters is based mainly on the amount of sodium chlorid contained, a difference in degree that can just as well be shown by arranging the waters according to their strength under the head of muriated saline waters. Another objection to this scheme is that many of the thermal springs would be included under the head of 'indifferent waters,' whereas it would seem that they should be distributed among the various classes in accordance with their predominant solid constituents.

FRENCH CLASSIFICATION

		Correlation with Author's Scheme
Sulphur Waters, . . .	With salts of sodium.	Sulphureted sodic-muriated saline.
	With salts of lime.	Sulphureted calcic-muriated saline.
Sodium Chlorid Waters,	Simple.	Sodic muriated saline.
	With bicarbonates.	Sodic muriated alkaline-saline.
	Sulphureted.	Sulphureted sodic-muriated saline.
Bicarbonated Waters, .	Sodium bicarbonate.	Carbonated sodic alkaline.
	Calcium bicarbonate.	Carbonated calcic alkaline.
	Mixed bicarbonates.	Carbonated sodic-calcic, calcic-magnesic, sodic-chalybeate, etc., alkaline.
Sulphated Waters, . .	Sodium sulphate.	Sodic sulphated saline.
	Calcium sulphate.	Calcic sulphated saline.
	Magnesium sulphate.	Magnesic sulphated saline.
	Mixed sulphates.	Sodic-calcic-magnesic saline, or alkaline-saline, etc.
Ferruginous Waters, .	Bicarbonated.	Carbonated chalybeate alkaline.
	Sulphated.	Sodic chalybeate, calcic chalybeate, or alumino-chalybeate sulphated saline.
	With salts of manganese.	Manganic chalybeate alkaline or saline.

The French classification given above is a mixed scheme; waters characterized by their gases being placed on a line with those in which a solid constituent—iron, or sodium chlorid—is the classifying ingredient, while two of the divisions are made, not in accordance with the predominant chemical bases, but from the fact that these exist in the waters in the form of bicarbonates or of sulphates, respectively. Saline waters are found under all the divisions except one. The 'ferruginous' or chalybeate waters are separated from the saline and alkaline divisions and have a subdivision to include the waters which contain both iron and manganese.

The term 'thermal' as a class designation does not appear in this scheme of classification; probably for the very good reason that a water referable to any one of the divisions of this scheme may be a thermal water or a nonthermal water. There have been many other classifications of the French mineral waters; but the one given here is probably the one that has been most widely used, most of the others differing only in unimportant details. Some of them employ the term 'saline' for the sodium chlorid waters, and 'alkaline (sodaic)' for the bicarbonated waters.

ENGLISH CLASSIFICATION

		Correlation with Author's Scheme
Simple or Indifferent Thermal Waters,		Thermal waters of any class.
Common Salt or Muriated Waters,		Sodic muriated saline or alkaline-saline.
Alkaline Waters,	(*a*) Simple alkaline waters	Alkaline.
	(*b*) Muriated alkaline waters.	Muriated alkaline-saline.
	(*c*) Sulphated alkaline waters.	Sulphated alkaline-saline.
Iron or Chalybeate Waters,		Carbonated or sulphureted chalybeate-alkaline or saline, etc.
Arsenical Waters,		Arsenical muriated saline, chalybeate sulphated saline, etc.
Sulphur Waters,		Sulphureted waters of any class.
Earthy or Calcareous Waters,		Calcic sulphated saline, alkaline-saline, etc.
Table Waters and Other very Weakly Mineralized Cold Waters,		May include waters of any class of the nonthermal group.

Weber's classification,[1] which may be considered the typical English system, as outlined in the preceding table, places those thermal waters which are also designated as simple or indifferent, on a line with muriated waters, alkaline waters, sulphur waters, etc.; and, in addition, has one division devoted to 'table waters and other weakly mineralized cold waters.' Thus, there are two divisions of 'indifferent waters,' one at the beginning and the

[1] "The Mineral Waters and Health Resorts of Europe," by Hermann Weber, M.D., and F. Parkes Weber, M.D., London, 1898.

other at the end of the tabulated scheme. The first of these two divisions contains what Weber, following the Germans, calls 'the **acratothermal** waters'—thermal waters which "are poor in solid and gaseous substances, of low specific gravity, almost tasteless, of great transparency and softness, and of temperatures between 80° F. and 150° F." Some, he says, also "contain an unusual amount of oxygen, some of nitrogen; argon and helium have also been found in this group." Other thermal waters are found distributed throughout the other classes of the scheme, as shown in his detailed descriptions, although not indicated in the table. The names of the other classes sufficiently indicate in a general way the characters of the waters grouped under them.

WALTON'S AMERICAN CLASSIFICATION

		Correlation with Author's Scheme
ALKALINE WATERS, . . .	1. Pure.	**Alkaline.**
	2. Acidulous (carbonic acid).	**Carbonated alkaline.**
	3. Muriated (chlorid of sodium).	**Muriated alkaline-saline.**
SALINE WATERS (CHLORID OF SODIUM), ...	1. Pure.	**Muriated saline.**
	2. Alkaline.	**Muriated alkaline-saline.**
	3. Iodobromated.	**Iodobromic muriated saline.**
SULPHUR WATERS, . . .	1. Alkaline.	**Sulphureted alkaline-saline.**
	2. Saline (chlorid of sodium).	**Sulphureted muriated saline.**
	3. Calcic.	**Sulphureted calcic alkaline-saline.**
CHALYBEATE WATERS, .	1. Pure. 2. Alkaline.	**Alkaline chalybeate.**
	3. Saline (chlorid of sodium).	**Muriated chalybeate saline.**
	4. Calcic.	**Calcic-chalybeate alkaline.**
	5. Aluminous.	**Alumino-chalybeate, Sulphated saline, or Sulphated acid.**
PURGATIVE WATERS, . .	1. Epsom salt (sulphate of magnesia).	**Magnesic sulphated saline.**
	2. Glauber salt (sulphate of soda).	**Sodic sulphated saline.**
	3. Alkaline.	**Sulphated alkaline-saline.**
CALCIC WATERS, ...	1. Limestone (carbonate of lime).	**Calcic alkaline.**
	2. Gypsum (sulphate of lime).	**Calcic sulphated-saline.**
THERMAL WATERS, . . .	1. Pure. 2. Alkaline.	**Thermal alkaline.**
	3. Saline (chlorid of sodium).	**Thermal muriated saline.**
	4. Sulphur.	**Thermal sulphureted.**
	5. Calcic.	**Thermal calcic alkaline**

In Walton's scheme,[1] which may perhaps be considered a typical American classification, three systems are combined in one. The term **thermal** is based on a physical sensation; **purgative** refers to a therapeutic effect, and the **other terms** are based on chemical composition. **Alkaline, saline, chalybeate,** and **calcic** waters are named respectively from their predominant solid contents. **Sulphur** waters, being so named from the presence of a gas,—hydrogen sulphid,—are given a coordinate place with the principal divisions, while the presence of another gas—carbon dioxid—places the water in a subdivision of the alkaline class. Walton's classification is, therefore, the most mixed of all; he himself says that his scheme "partakes both of the chemical system and the therapeutic system," and that "the class Thermal Waters may embrace waters which, as for their chemical constituents, belong to one of the other classes." He follows other writers in saying that "it is rare, however, for thermal waters to contain a large proportion of mineral ingredient," a statement which, as pointed out on page 314, requires some modification.

Dr. J. K. Crook[2] in the main adopts the scheme of the writer, but modifies it by bringing all the **chalybeates,** whether alkaline chalybeate, saline chalybeate, or acid chalybeate, into one class, which he substitutes for the writer's Class IV, of **acid waters.** He also adds a fifth class, to include what he calls **neutral or indifferent** waters.

Crook's reasons for the substitution of a class of chalybeate waters for acid waters are as follow: "(1) An examination of the various analyses will show that springs containing free acids are by no means common in the United States; (2) all those containing such acids also contain iron in considerable quantities; (3) iron springs are among the most common as well as the most valuable in our country; (4) iron is of more importance in mineral waters than free acids." If, however, there existed but one acid spring, it would be a good and sufficient reason for the erection of a class to contain it. Iron springs, of course, are valuable even if common, but that is scarcely a valid reason for including them in one class in the scheme which we have outlined. Crook himself speaks of muriated chalybeates, sulphated chalybeates, alkaline chalybeates, and acid chalybeates. As to the comparative importance of iron and free acids, this will depend somewhat upon the point of view and the use to which the water is to be put. His **neutral** or indifferent waters, in which category he includes the POLAND SPRINGS of Maine, the GLEN SUMMIT SPRINGS of Pennsylvania, and the STAFFORD SPRINGS of Mississippi, are, he adds, by no means neutral in a therapeutic sense.

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1 "The Mineral Springs of the United States and Canada," by George E. Walton, M.D., third edition, New York, 1883.

2 "The Mineral Waters of the United States and Their Therapeutic Uses," 1899.

COMPARATIVE CLASSIFICATION OF EUROPEAN WATERS

In the following table a number of well-known European waters are designated according to the different schemes of classification just described, and this comparison will probably give a better idea of the differences among them. The enumeration might be extended to include the entire list of well-known foreign and American waters, but that is unnecessary in this place. Of course, it must be remembered that in many cases the various springs at one locality differ much in the composition of their waters; and, again, that a water may be classified according to its predominant constituents and yet be additionally referable to some other class on account of some strong ingredient that, in small quantity, has or may have a different effect therapeutically from that of the classifying constituents. The springs compared in the following table are those best known at the various localities mentioned.

Water	Character (Author's scheme)	German Classification	English Classification	French Classification	American Classification
Apollinaris, ...	Carbonated sodic **alkaline.**	Simple acidulous alkaline.	Gaseous or table.	Bicarbonated (sodic).	Acidulous alkaline.
Vichy, ...	THERMAL carbonated sodic **alkaline.**	Thermal acidulous.	Simple alkaline gaseous thermal.	Bicarbonated (sodic).	Acidulous alkaline.
Wildungen, ...	Calcic-magnesic **alkaline.**	Earthy.	Earthy or calcareous.	Bicarbonated (calcic).	Calcic.
Spa, ...	Carbonated sodic-chalybeate **alkaline.**	Carbonated iron (Steel).	Gaseous iron or chalybeate.	Bicarbonated ferruginous.	Chalybeate.
Schwalbach, . . .	Carbonated magnesic-chalybeate **alkaline.**	Carbonated iron (Steel).	Gaseous iron or chalybeate.	Bicarbonated ferruginous.	Chalybeate.
St. Moritz, ...	Carbonated calcic-chalybeate **alkaline.**	Carbonated iron (Steel).	Gaseous iron or chalybeate.	Bicarbonated ferruginous.	Chalybeate.
Pyrmont, ...	Carbonated calcic-chalybeate **alkaline.**	Carbonated iron (Steel).	Gaseous iron or chalybeate.	Bicarbonated ferruginous.	Chalybeate.
Carlsbad, ...	THERMAL carbonated sodic sulphated **alkaline-saline.**	Alkaline-saline.	Gaseous sulphated alkaline.	Sodic sulphated.	Alkaline-purgative.
Marienbad, ...	Sulphated sodic chalybeate **alkaline-saline.**	Alkaline-saline and iron.	Sulphated alkaline.	Sodic sulphated.	Purgative.
Franzensbad, . .	Sulphated sodic **alkaline-saline.**	Alkaline-saline.	Sulphated alkaline.	Sodic sulphated.	Purgative.
Contrexéville, . . .	Sulphated calcic **alkaline-saline.**	Earthy.	Earthy or calcareous.	Calcic sulphated.	Calcic.
Leuk, ...	THERMAL sulphated calcic **alkaline-saline.**	Earthy.	Simple thermal.	Calcic sulphated.	Calcic.

WATER.	CHARACTER (Author's scheme)	GERMAN CLASSIFICATION	ENGLISH CLASSIFICATION	FRENCH CLASSIFICATION	AMERICAN CLASSIFICATION
Assmanshausen, .	THERMAL carbonated muriated calcic-sodic **alkaline-saline.**	Acidulous alkaline muriated.	Gaseous muriated alkaline thermal.	Bicarbonated sodic chlorid.	Acidulous saline.
Gleichenberg, . . .	Carbonated muriated sodic **alkaline-saline.**	Acidulous alkaline muriated.	Gaseous muriated alkaline.	Bicarbonated sodic chlorid.	Acidulous saline.
Royat, ...	Carbonated muriated sodic **alkaline-saline.**	Acidulous alkaline muriated.	Gaseous muriated alkaline.	Bicarbonated sodic chlorid.	Saline.
Ems, ...	THERMAL carbonated muriated sodic **alkaline-saline.**	Acidulous alkaline muriated.	Gaseous muriated alkaline thermal.	Bicarbonated sodic chlorid.	Acidulous saline.
Toeplitz, ...	THERMAL muriated calcic-sodic **alkaline-saline.**	Alkaline muriated.	Simple thermal.	Sodic chlorid.	Thermal.
Aix-les-Bains, . . .	THERMAL azotized sulphated sodic **alkaline-saline.**	Bitter or sulphur.	Sulphurous thermal.	Sodic sulphur.	Sulphur.
La Bourboule, . . .	THERMAL sodic muriated **alkaline-saline.**	Alkaline muriated.	Arsenical thermal.	Bicarbonated sodic chlorid.	Saline.
Pullna, ...	Sulphated sodic-magnesic **saline.**	Bitter.	Sulphated and muriated sulphated.	Sodic sulphated.	Purgative.
Friedrichschall, . .	Sulphated magnesic-sodic **saline.**	Bitter.	Muriated sulphated.	Sodic sulphated.	Purgative.
Gastein, ...	THERMAL sulphated sodic **saline.**	Bitter.	Simple thermal.	Sodic sulphated.	Thermal.
Plombières, . . .	THERMAL sulphated sodic **saline.**	Bitter.	Simple thermal.	Sodic sulphated.	Thermal.
Bagnères de Bigorre, ...	THERMAL sulphated calcic-sodic **saline.**	Bitter or earthy.	Earthy or calcareous thermal.	Sodic sulphated.	Calcic.
Schlangenbad, . .	THERMAL muriated sodic **saline.**	Sodium chlorid.	Simple thermal.	Sodium chlorid.	Thermal.
Aix-la-Chapelle, . .	THERMAL sulphocarbonated sodic muriated **saline.**	Sulphur.	Gaseous sulphurous thermal.	Sodic sulphur.	Sulphur.
Bourbonne-les-Bains, ...	THERMAL sodic muriated **saline.**	Alkaline muriated.	Muriated thermal.	Sodium chlorid.	Saline.
Selters, ...	Carbonated sodic muriated **saline.**	Acidulous alkaline muriated.	Table.	Bicarbonated sodic chlorid.	Saline.
Kissingen, ...	Carbonated sodic muriated **saline.**	Simple sodium chlorid.	Gaseous muriated or common salt.	Bicarbonated sodic chlorid.	Saline.
Wiesbaden, ...	THERMAL carbonated sodic muriated **saline.**	Simple sodium chlorid.	Gaseous muriated or common salt thermal.	Bicarbonated sodic chlorid.	Saline.
Homburg, ...	Carbonated sodic muriated **saline.**	Acidulous sodium chlorid.	Gaseous muriated or common salt.	Bicarbonated sodic chlorid.	Saline.

Water	Character (Author's scheme)	German Classification	English Classification	French Classification	American Classification
Kreuznach, ...	Sodic-calcic muriated saline.	Sodium chlorid with iodin.	Muriated or common salt.	Sodic chlorid.	Saline.
Nauheim, ...	Carbonated sodic muriated saline.	Simple sodium chlorid.	Gaseous muriated or common salt.	Bicarbonated sodic chlorid.	Saline.
Nenndorf, ...	Sulphocarbonated sodic-calcic sulphated saline.	Sulphur.	Sulphurous.	Bicarbonated mixed.	Sulphur.
Meinberg, ...	Sulphocarbonated sodic-calcic sulphated saline.	Sulphur.	Sulphurous.	Bicarbonated mixed sulphated.	Sulphur.
Barèges, ...	Sodic-magnesic muriated saline.	Sodium chlorid.	Sulphurous.	Sodic chlorid.	Sulphur.

The different classes of waters, according to the author's scheme, may now be considered.

THERMAL WATERS

Strictly considered, all springs whose mean annual temperatures are above the mean annual temperatures of their respective localities (no matter in how small a degree) are thermal springs. There is a variation, therefore, according to geographic position. Thus, in Alaska or Siberia, where the ground is constantly frozen to the depth of several hundred feet, springs that have temperatures between 32° and 42° F. (0° and 5.5° C.), and never freeze, are warm springs; while in the East or West Indies or under the equator, springs of the same degree of heat would be termed cold. For practical purposes we must draw an arbitrary line, and it has been found most convenient to consider all springs with temperatures above 70° F. (say 21° C.) as **thermal springs**; those whose waters have temperatures between 70° and 98° F. (say, 21° and 36.7° C.) are called tepid or warm; and all over the latter temperature are designated as hot. All the thermal waters (Group A of the classification) are subdivided, as are all nonthermal waters (Group B). They may be carbonated, sulphureted, etc., and alkaline, saline, alkaline-saline, or acid; that is, they may belong to any class and be characterized by the presence of any gas found in nonthermal waters.

It has generally been supposed and frequently stated that thermal waters are less highly mineralized than nonthermal waters. *À priori*, hot water is a better solvent than cold water, and if sometimes a thermal water is less highly mineralized, it is probably because it comes from a greater depth, where the rocks are of such a character as to be less readily acted upon. Other things being equal, there is no reason why a thermal water should not contain the same ingredients that a nonthermal water has. The fact that waters are thermal is dependent largely upon the geologic position, as already indicated. The rocks in which they originate are usually not so readily disintegrated as are the more soluble sedimentaries. Where springs of the two groups occur in the same geologic position, we find little, if any, difference in regard to the quantity of solid contents found upon chemical analyses; or if there is, it is in favor of the thermal waters. At the HOT SPRINGS of **Virginia** one of the springs, with a temperature of 78° F., has 18.09 grains of solid contents in a gallon, while another, with a temperature of 110° F., has 33.36 grains in a gallon. At the BATH ALUM SPRINGS, in the same region, with a temperature of 60° F., the total solid contents are found to be 45.44 grains in a gallon (Spring No. 1), which does not differ materially from the results noted at the Hot Springs. At the CALIFORNIA GEYSERS the coldest spring, with a temperature of 70° F., has 7.12 grains in a gallon, while the hottest, at 212° F., contains 296.4 grains in a gallon. It is probable that the statement as to the weak mineralization of thermal waters was correctly made in the first place with reference to some well-known spring, and was afterward erroneously extended to cover all thermal waters. This error was probably copied from one work to another, and thus was perpetuated.

The **cause of the heat** of the thermal springs is to be found in their proximity to, or their source in, rocks of volcanic or igneous origin; in their occurrence in areas of mountain corrugation or of profound dislocations; or, if they come from great depths, in the normal downward increase of the temperature of the globe. Chemical action as a source of heat plays little, if any, part as a cause. The downward increase of heat, however, is not the same at all places, and is due partly to the character of the rocks, so that the depth of a spring cannot be told with any certainty from its temperature. The question as to the permanency of the heat is interesting; usually it is very persistent, especially where due to the temperature of the earth itself. Professor Forbes, in his study of the hot springs of the **Pyrenees** in 1835, compared his observations with those taken at intervals for nearly one hundred years previously, and in many cases found a remarkable uniformity in the temperatures recorded at different times throughout this period. In regions where earthquakes and active volcanic manifestations occur, fluctuations of temperature in springs have, however, been common. In the case of American springs, the data are insufficient for careful comparisons in respect to changes of temperature. In one case, however,—that of the hot springs of SALT LAKE CITY,—a considerable variation has been noted. Ordinarily these springs have a temperature of 122° F. (50° C.), but in 1889, for one month (June to July), and at irregular intervals in preceding years, the springs became so cold as 50° F. (10° C.). The cause of this variation has not been determined. Observations comparing recent temperatures of the thermal springs of **Virginia, North Carolina,** and **Arkansas,** with those taken years ago, show no differences beyond what are due to variations in the instruments employed. The most recent observations on the deep well at WHEELING, West Virginia, by Dr. Wm. Hallock, state that down to 3200 feet the gradient is 1° F. for every 81.5 feet (equivalent to 1° C. for 44.72 meters); whereas the last few hundred feet show an increase of 1° F. for about every 60 feet (equivalent to 1° C. for 32.92 meters). Different authorities state the downward increase of temperature as from 1° F. in 23 feet (7.012 meters) descent, to 1° F. in 68 feet (20.731 meters). However, as already stated, the geologic structure and the character of the rocks should be considered.

Distribution of Thermal Waters in the United States

In the United States, thermal springs are found mainly in the **Rocky Mountain region** and in the **Pacific Coast States.** The few springs of this character that are found in the eastern part of the country occur in connection with the faults and anticlinal axes of the **Appalachian** uplift. They are the hot and warm springs of **Virginia,** and the warm springs of **North Carolina** and **Georgia.** There is one spring in **Pennsylvania** (PERRY COUNTY SPRINGS) that comes very near to being a thermal spring, having a temperature of 72° F., and also one in **New York** (LEBANON, 73° F.), and a tepid spring at WILLIAMSTOWN, **Massachusetts.** The HOT SPRINGS of **Arkansas,** which deservedly occupy a high place among the thermal waters of the country, occur in connection with the **Ozark Mountain** uplift. Attention was long ago called to the hydrothermal contrast between the eastern and western States, which is in accord with the geologic conditions.

In the **Rocky Mountain** region, in addition to the mountainous uplifts, which are of recent origin compared with the Appalachian uplift, there are extensive areas of volcanic rocks also due to comparatively recent disturbances, and therefore thermal springs are found in a great many localities in **Colorado, New Mexico, Arizona, Utah, Idaho, Montana,** and **Wyoming**; these States containing thermal springs of many varieties. The YELLOWSTONE NATIONAL PARK, however, stands at the head of the list for thermal waters in this country.

The Yellowstone Park is the greatest resort in the United States, and deservedly so, not only on account of its geysers and the great number of its thermal springs, but also because of the great variety of the waters, which, when they are better known, will undoubtedly be more highly prized for their medicinal virtues. Although there are nearly four thousand springs and one hundred geysers in the National Park, less than one hundred of the waters have been analyzed carefully. The springs are nearly all thermal, and may be classed under three heads: viz., (1) **calcic waters**, which are generally carbonated to a slight degree, and sometimes are sulphureted; (2) **silicious waters** that are acid, carrying free acid in solution; and (3) **silicious waters** that have an alkaline reaction. Nearly all the springs carry arsenic, varying in quantity from 0.02 to 0.41 per cent. of the mineral matter in solution. The waters of one locality in the Park (Joseph's Coat Springs) are comparable to the arsenical waters of the famous resort of La Bourboule in France, which has achieved a wide reputation for the efficacy of its water in nervous diseases.

In the **Great Basin** and the **Plateau** region—regions intermediate between the Rocky Mountains and the Pacific Coast States—mountain corrugation is subordinate to the dislocation of strata, due to profound faulting. With these faults are associated numerous hot springs, and a map of them would be to a great extent a map of the displacements; just as a map of the hot springs of the world would be a very good map of the lines of volcanic disturbances of the globe. With the faults of the Great Basin are associated also frequent occurrences of volcanic rocks, the result of outpourings of lava in time not far past, geologically considered. This association gives perfect conditions for the occurrence of thermal springs.

The conditions in the **Pacific Coast States** are similar to those of the Rocky Mountains, these States being largely mountainous in character and of geologically recent uplift, besides being also well supplied with rocks of volcanic origin. **California** is *par excellence* the thermal-spring State of the Union. The geysers of California were known long before the Yellowstone Park reservation was set aside, and among their springs a great variety of thermal waters is found. **Alaska** is also a hot spring region, but little is known of the waters at present, beyond the fact that they are very numerous.

As already stated, the **divisions of the thermal group** of waters follow exactly the same order as those of the nonthermal waters, and therefore the individual thermal springs of this country will be noted further on, when the waters of the different classes are enumerated. A list of their temperatures would be of little value here, and of course would be of no use in their classification. They are used mainly for bathing, and when very hot must be cooled before they can be used; as also is necessary when they are to be utilized for drinking.

ALKALINE WATERS

As already defined, the alkaline waters are [illegible] by the presence of [illegible] the various schemes of classification [illegible] head than under any of the others [illegible] and almost universally used [illegible] the schemes agree in placing under [illegible] carbonate. In the French scheme [illegible] of bicarbonated waters [illegible] characterized by the presence of [illegible] The German scheme [illegible] containing calcium [illegible] and the English [illegible] adopts this plan, placing the [illegible] waters under the head of [illegible] the English scheme are of course confined mainly to those containing sodium carbonate. The [illegible] waters of the French classification also are largely equivalent to the [illegible] calcareous waters of the English and German schemes, although some of them, in which sodium carbonate predominates over the other constituents, may be referred to the simple alkaline waters. The English scheme subdivides the alkaline waters into simple alkaline, muriated alkaline, and sulphated alkaline—thus including waters that have saline constituents. It seems preferable, therefore, to transfer all of these to the **alkaline-saline** class (Class II of the writer), and to keep under the head of the **alkaline waters** (Class I of the writer) all the waters containing alkaline carbonates, whether they are earthy or not. This is done, not because they would give an alkaline reaction, which nearly all mineral waters do, but because they contain the alkaline carbonates—carbonates of the alkalis or alkaline earths—and carbonates of iron, manganese, etc.

In many classifications the chalybeates are brought together under one head, whether they are associated with the alkaline carbonates, with saline constituents, or with free acids. However, they should not be placed on a line with alkaline, saline, or acid spring-waters, but should rather be subdivisions of these classes in accordance with the particular form in which the iron exists; as their effects differ widely according to their particular constitution. A large number of the chalybeates, however, naturally fall under the head of alkaline waters; the iron salts appearing mostly in combination with the alkaline carbonates. Dr. Crook in his modification of the writer's scheme brings all the chalybeates together, but the example which he gives of a 'pure chalybeate water,' upon the examination of the analysis, should be referred to the muriated sodic [illegible]lines; more than half of the solid contents being made up of sodium and magnesium chlorids with only 5.13 grains of iron carbonate in the 20.87 grains to the gallon.

Perhaps the best-known European water falling under the head of alkaline waters is that from the Grande Grille of VICHY in France. The spring is thermal, and would be designated as a thermal carbonated sodic-alkaline water. The Apollinaris water, placed by Weber in his class of '**table waters**,' also falls under this head. The waters from VALS in Ardèche, France, which are cold waters stronger in sodium carbonate than are the hot waters of Vichy, also belong to this class. Other localities are given by Dr. Kisch in this volume, and therefore need not be enumerated here. FACHINGEN, in Germany, may be considered a typical German water of this class.

Distribution of Alkaline Waters in the United States

Alkaline springs are found in all sections of the United States, from Maine to California and from Florida to Oregon. Some of them are **thermal**, but the majority are **nonthermal**, and a large proportion of them fall under the head of carbonated waters. Many of the waters usually called indifferent are also included here. The geologic formations which seem to give origin to most of these waters are those of the older rocks, and we find them well exposed in **New England**; in the **Appalachian** region of the **Middle** and **Southern Atlantic States**; in the northern part of the **North Central States**; in the **Rocky Mountains**; and on the **Pacific Coast.**

The alkaline waters may be divided primarily into five **subdivisions**: viz., sodic, potassic, calcic, magnesic, and chalybeate; in which the carbonates of sodium, potassium, calcium, magnesium, and iron respectively predominate. In many cases there will be a combination of terms, as sodic-calcic; calcic-magnesic; sodic-chalybeate; calcic-chalybeate; etc., and the waters in each of these subdivisions may be non-gaseous; or carbonated, or sulphureted, etc. Nearly one-half of the alkaline springs are **calcic-alkaline**—that is, with calcium carbonate, or bicarbonate, predominating; and the **calcic-chalybeates** probably come next in number, although the **sodic-** and **magnesic-alkalines** are numerous. This is easily accounted for by the fact that limestones are found so widely spread in the United States in all the geologic sedimentary formations, through which the waters frequently pass after originating in the underlying feldspathic rocks. In the following enumeration some of the principal alkaline waters of the United States are given in accordance with the various subdivisions of the scheme of classification:

ALKALINE SPRINGS IN THE UNITED STATES

	Alkaline Carbonates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:		
Bladen Springs, Alabama,	43.99	48.88
Magnesia Spring, Kane Co., Illinois,	36.61	38.92
Pence Spring, West Virginia (azotized),	17.86	22.23
Hunter's Hot Springs, Montana (thermal),	9.34	16.85
Pavilion Spring, Wernersville, Pennsylvania,	0.68	1.98
Paradise Spring, South Poland, Maine,	0.51	0.99
Sodic-calcic:		
Manitou Springs (Navajo Spring), Colorado (carbonated),	128.58	182.23
Manitou Springs (Manitou Spring), Colorado (carbonated),	127.13	174.47
Ponce de Leon Spring, Meadville, Pennsylvania,	19.09	20.86
Corry Artesian Mineral Well, Pennsylvania (azotized-oxygenated),	15.03	20.58
Thompson's Bromine and Arsenic Spring, North Carolina,	2.62	5.45
Glenola (Wayland) Springs, Virginia (carbonated),	1.55	5.08
Commonwealth Spring, Massachusetts (carbonated),	1.13	2.45
Sodic-magnesic:		
Adams Spring, California (carbonated),	183.99	201.19
Mill Creek Apollinaris Spring, Montana (carbonated),	128.27	216.84
Sodic-borated:		
Skaggs Hot Springs, California (thermal carbonated),	174.49	216.35
Sodic-calcic-magnesic:		
Blodgett Springs, California (sulphocarbonated),	24.35	44.13
Indian Medical Spring, Minnesota (sulphocarbonated),	8.64	11.51
Magnesic-sodic:		
Duncan Springs, California (carbonated),	108.12	118.11
Calcic:		
Bartlett Springs, California (carbonated),	38.25	43.35
Soda Spring, Hot Springs, Virginia (thermal),	20.16	32.88
Spring No. 2 (sulphur spring), Stribling Springs, Virginia,	18.62	21.28
Kickapoo Magnetic Springs, Indiana,	17.73	24.42
Mt. Clemens (Victory) Spring, Michigan,	17.34	19.80
Hacket's Spring, Wisconsin,	15.45	17.70
Clarendon Springs, Vermont (carbonated),	13.09	14.26
Roanoke Red Sulphur Springs, Virginia (sulphocarbonated),	12.39	21.70
Seneca Spring, Glen Springs, New York,	12.00	12.66
Capon Springs, West Virginia,	10.35	12.15
Magnesia Spring, Hot Springs of Arkansas (thermal carbonated),	8.09	11.75
Hot Springs of Arkansas (thermal carbonated),	8.32[1]	11.92[1]
Chattolanee Springs, Maryland,	6.43	8.29
Galbraith Springs, Tennessee,	4.31	6.84
Clear Creek Springs, Kentucky,	3.91	6.34
Massasoit Spring, Massachusetts,	2.22	3.43
Stark Mineral Spring, Connecticut,	1.96	3.38
Poland Spring, Maine,	1.76	3.75
Beacon Mountain Spring, New Jersey,	1.55	3.55
Nobscot Mountain Spring, Massachusetts,	1.36	3.21
Chippewa Spring, Wisconsin,	1.28	2.11

[1] The averages of the analyses of seven springs.

ALKALINE SPRINGS IN THE UNITED STATES—(*Continued*)

	Alkaline Carbonates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic:		
ROSSCOMMON SPRING, Pennsylvania (**carbonated**),	0.49	1.21
POWNAL SPRING, Maine,	0.48	1.15
SHEEP ROCK SPRING, Massachusetts,	0.25	0.81
Calcic-magnesic:		
IDAN-HA SPRING, Idaho (**carbonated**),	129.05	152.14
ALLOUEZ (Magnesia) MINERAL SPRING, Wisconsin,	52.22	62.38
OHIO MAGNETIC SPRINGS, Ohio (**carbonated**),	36.81	44.90
GLEN FLORA SPRING, Illinois,	33.22	36.41
PERRY SPRINGS, Illinois (No. 1),	32.90	38.24
White Rock Mineral Spring, WAUKESHA, Wisconsin,	32.13	37.06
Hygeia Spring, WAUKESHA, Wisconsin,	32.13	36.21
Clysmic Spring, WAUKESHA, Wisconsin,	30.86	35.46
SILOAM SPRINGS, Iowa,	30.83	32.35
Bethesda Spring, WAUKESHA, Wisconsin,	30.67	35.71
Vesta Mineral Spring, WAUKESHA, Wisconsin,	24.63	26.46
PALMYRA SPRINGS, Wisconsin,	23.17	25.92
ARCTIC SPRINGS, Wisconsin,	23.49	25.03
OSCEOLA SPRINGS, Virginia (**carbonated-azotized**),	21.92	34.73
Spout Bath Spring, HOT SPRINGS, Virginia (**thermal**),	20.98	34.09
No-che-mo Springs, REED CITY, Michigan,	20.35	22.07
Silurian Spring, WAUKESHA, Wisconsin,	16.90	18.68
WHITE MINERAL SPRINGS, Minnesota,	16.78	18.64
WELCOME ISLAND LITHIA SPRING, Michigan,	13.91	16.48
SHEALTIEL MINERAL SPRINGS, Wisconsin,	13.57	14.65
EASTMAN SPRINGS (Silver King), Michigan (**carbonated**),	13.35	13.57
ASTORG SPRINGS, California,	12.39	15.99
ZONIAN SPRINGS, Illinois,	12.20	15.69
ALL HEALING SPRINGS, North Carolina,	4.83	6.83
GREAT BEAR SPRING, New York,	4.75	5.94
EQUINOX SPRING, Vermont,	3.26	4.16
PINE LAWN SPRING, New Jersey,	2.76	5.29
BENTLEY SPRINGS, Maryland,	0.97	2.18
Calcic-sodic:		
CALIFORNIA SELTZER SPRING, California (**carbonated**),	170.00	187.15
SABATTUS MINERAL SPRING, Maine,	4.67	6.82
FONTICELLO LITHIA SPRING, Virginia (**carbonated**),	1.07	2.66
Lithic-sodic:		
PACK MONADNOCK LITHIA SPRING, New Hampshire,	22.03	24.06

ALKALINE CHALYBEATE SPRINGS IN THE UNITED STATES

	Iron Salts, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic Chalybeate:			
OJO CALIENTE, New Mexico (**thermal**),	5.90	95.32	135.54
Iron Ute Springs, MANITOU, Colorado (**carbonated**),	3.37	81.03	123.17
PANACEA SPRINGS, North Carolina (**carbonated**),	2.18	3.54	9 70

ALKALINE CHALYBEATE SPRINGS IN THE UNITED STATES—(*Continued*)

	IRON SALTS, GRAINS IN ONE U. S. GALLON	ALKALINE CARBONATES GRAINS IN ONE U. S. GALLON	TOTAL SOLID CONTENTS, GRAINS IN ONE U. S. GALLON
Sodic-calcic Chalybeate:			
ST. LOUIS SPRING, Michigan (**carbonated**),	1.00	161.07	227.14
MONTEBELLO SPRING, Vermont, ...	0.40	18.24	37.60
ARRINGTON SPRINGS, Kansas (**carbonated**),	2.01	13.42	19.05
CAMP SPRINGS, Georgia (**sulphocarbonated**), ...	2.38	0.30	3.44
Calcic Chalybeate:			
REED'S MINERAL SPRINGS, Missouri (**carbonated**), ...	3.29	17.46	26.38
MASSANETTA SPRINGS, Virginia, ...	3.12	18.31	24.40
YELLOW SPRINGS, Ohio, ...	0.39	19.57	23.17
STAFFORD MINERAL SPRINGS, Mississippi, .	0.24	15.07	19.80
NYE CHALYBEATE SPRING, Virginia, . . .	1.33	16.66	18.65
MARDELA SPRING, Maryland, ...	11.50	1.39	15.32
BERKLEY SPRING, West Virginia (**azotized carbonated**), ...	0.89	5.00	10.88
Chalybeate (No. 3), STRIBLING SPRINGS, Virginia (**carbonated**), ...	0.11	3.79	7.79
BLUE HILL SPRINGS, Maine, ...	0.59	2.02	4.78
RAWLEY SPRINGS, Virginia (**carbonated azotized**), ...	1.09	1.59	3.17
Calcic-magnesic Chalybeate:			
OWOSSO WELL, Michigan, ...	15.92	44.76	63.40
BRONSON-VITALIS SPRING, Minnesota (**carbonated**), ...	10.52	28.73	43.75
LESLIE WELL, Michigan (**carbonated**), . .	2.27	51.27	63.01
SALVATOR MINERAL SPRINGS, Wisconsin, .	1.30	38.90	41.80
HIGHLAND SELTZER SPRING, California (**carbonated**), ...	1.43	100.98	110.46
MIDDLETOWN SPRINGS, Vermont, ...	1.11	6.53	10.07
SOUTH FARM MANGANO-CHALYBEATE WELL, Connecticut, ...	0.70	4.67	7.82
CRUM MINERAL SPRINGS, Ohio, ...	0.59	7.25	9.78
HUBBARDSTON MAGNETIC SPRING, Michigan,	0.15	23.89	24.17
BIRCHDALE SPRINGS, New Hampshire, . .	0.37	3.12	5.92
ADDISON MINERAL SPRINGS, Maine, . . .	1.65	4.21	8.14
Sodic-magnesic Chalybeate:			
NAPA SODA SPRINGS (Iron Spring), California (**carbonated**), ...	7.84	50.07	66.17
GEYSER SPA, California (**carbonated**), . .	2.09	40.06	58.57
COOKS SPRINGS, California, ...	1.04	296.69	304.40
Magnesic Chalybeate:			
WAGNER SPRING, Oregon (**carbonated**), .	. .	. .	163.87
Pagoda Spring, NAPA SODA SPRINGS, California (**carbonated**), ...	7.90	35.13	67.15
CHEROKEE MAGNETIC SPRING, Iowa, . .	11.26		27.93
SPARTA MAGNETIC SPRING, Wisconsin, . .	11.94	3.85	19.25
HIGHLAND SPRING, Maine, ...	1.41	2.06	4.78
ROANOKE RED SULPHUR (Chalybeate Spring), Virginia (**carbonated**), . . .	2.09	1.84	5.17
Lithiated Chalybeate:			
BALLARDVALE LITHIA SPRING, Massachusetts, ...	0.70	22.01	24.51

Comparison of American with European Alkaline Waters

Owing to the almost infinite variety in the composition of mineral waters it is impossible to find any two that are exactly alike, although they may closely approach each other in the character of their solid constituents, while there is a great difference in the contained amounts. In the following table only a few of the American alkaline waters are compared with some of the well-known European waters of the same class. The few that are cited will be sufficient to indicate in a general way the resemblance of our waters to these typical foreign alkaline waters, and may serve as a guide to the use of our own waters. A reference to the lists in the preceding portion of this article will make more apparent the fact that we have many alkaline waters, especially among the carbonated group, that are comparable with waters that may be said to have become famous in their class.

	Sodium Carbonate, Grains in One U. S. Gallon	Calcium Carbonate, Grains in One U. S. Gallon	Total Alkaline Carbonates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon	Free Carbon Dioxid, Cubic Inches in One U. S. Gallon
Apollinaris Spring, Neuenahr, Prussia (carbonated sodic alkaline),	177.20	3.60	107.92	157.76	376.32
Bilin, Bohemia (carbonated sodic alkaline),	184.85	24.71	218.34	304.49	120.74
Vichy (Grande Grille), France (thermal carbonated sodic alkaline),	319.44	28.52	390.73	427.68	117.92
Adams Spring, California (carbonated sodic alkaline),	58.77	27.95	182.26	201.19	265.76
California Seltzer Spring, California (carbonated calcic-sodic alkaline),	53.00	72.40	170.00	187.15	18.00
Duncan Springs, California (carbonated magnesic-sodic alkaline),	90.11	15.64	108.12	118.11	36.57
Idan-ha Spring, Idaho (carbonated calcic-magnesic alkaline),	69.74[1]	57.96	129.05	152.14	In excess[2]
Medical Lake, Washington (sodic alkaline),	63.54	0.19	63.95	101.46	——
Mill Creek, Apollinaris Spring, Montana (carbonated sodic-calcic alkaline),	57.55	54.14	128.27	216.84	In excess[2]
Manitou Spring, Colorado (carbonated sodic-calcic alkaline),	40.66	69.08	127.13	174.47	In excess[2]

[1] Sodium and magnesium carbonates. [2] No accurate estimate has been made.

ALKALINE-SALINE WATERS

The waters referred to the alkaline-saline class include all those in which there is a mixture of the alkaline carbonates with either the sulphates or the chlorids, or with both. These waters may grade by imperceptible degrees from the alkaline waters to the saline —that is, the alkaline carbonates may be in excess or the saline constituents may predominate; and between these two extremes the two groups of salts may coexist in almost any proportion. The lines, therefore, at either end of the scale are anything but hard and fast. The class is subdivided primarily into **sulphated** and **muriated waters** according to the predominance of either the sulphates or chlorids; and a third subdivision into **borates** may be made, to include the few springs, found especially in California, in which sodium biborate predominates. These **borated waters** are of interest mainly from a commercial standpoint; their therapeutic usefulness up to the present time has not been demonstrated, except to a limited extent for local applications. The sub-groups of alkaline-saline waters may be divided still further, exactly as are the alkaline waters, into sodic, potassic, magnesic, chalybeate, etc., according to the base of the contained salts; and they may also be nongaseous, or carbonated or sulphureted, etc.

Comparative Classification

As already noted in the different classification schemes referred to in this article, the alkaline-saline waters are distributed under many different heads. In the **German** classification we find them under the third division of the alkaline waters, in the second and third divisions of the iron waters, under the 'Glauber's' and 'Epsom salt' divisions, and under the sulphur waters. In the **French** classification also we find them much scattered, and in the **English** classification they are found under all the principal divisions of the scheme. The same remarks apply with even more force to the scheme outlined by Walton. The waters referred to the earthy or calcareous divisions of the various schemes also come under this head.

The celebrated CARLSBAD water of Bohemia represents the **thermal sulphated alkaline-saline class**; and MARIENBAD, also in Bohemia, the **cold** waters of the same division. The thermal waters of EMS in Germany and ROYAT in France, and the nonthermal waters of SELTERS and LUHATSCHOWITZ, of Prussia and Moravia respectively, may perhaps be considered as representing typical European **muriated alkaline-saline** waters.

Distribution of Alkaline-saline Waters in the United States

In the United States the alkaline-saline waters are about one-t[illegible] as numerous as those of the saline class; unless we include under t[illegible] all the waters containing even the most minute quantity of the alkaline carbonates, in which case it would be hard to tell which class is the more numerous.

Alkaline-saline waters are not confined to any one section of the country, but are perhaps more frequently found in **New England**, the **Middle States**, and the northern part of the **North Central States**. In these sections, metamorphic rocks form a large portion of the surface or are not far below the surface, and the waters that come through them are, as a rule, not very highly mineralized, especially in New England. Many of these waters are, of course, alkaline; but others, as we approach the areas in which the sedimentary formations rest upon the older rocks, contain considerable proportions of saline constituents. SARATOGA, which is the prototype of all other mineral spring resorts throughout the Union, may perhaps be placed at the head of our alkaline-saline spring localities. The waters here are **carbonated sodic-muriated alkaline-saline**—*i. e.*, they contain free carbonic acid gas, while sodium chlorid predominates among the solid constituents, which include also alkaline carbonates.

ALKALINE-SALINE SPRINGS OF THE UNITED STATES

DIVISION I.—SULPHATED

	Alkaline Carbonates, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:			
ROYAL GORGE HOT SPRINGS, Colorado (**thermal carbonated**),	119.50	79.30	217.00
PAGOSA SPRINGS, Colorado (**thermal**),	70.76	150.21	351.09
WHITE SULPHUR SPRINGS, Montana (**thermal sulphureted**),	42.52	26.07	90.78
AGUA DE VIDA (Upper Spring), California (**sulphureted**),	17.36	30.55	53.93
AGUA DE VIDA (Lower Spring), California (**carbonated**),	12.15	15.29	46.00
DOXTATTER'S MINERAL WELL, New York (**sulphureted**),	11.84	55.92	119.92
Ponemah Spring, MILFORD, New Hampshire (**carbonated**),	0.58	0.64	3.03
Sodic-magnesic:			
IDAHO HOT SPRINGS, Colorado (**thermal**),	43.20	51.52	107.00
PIEDMONT WHITE SULPHUR SPRINGS, California (**sulphocarbonated**),	22.85	24.89	62.61
FARMVILLE LITHIA SPRINGS, Virginia (**carbonated**),	7.80	5.58	26.38
Sodic-magnesic-calcic:			
GORDON SPRINGS, California (**thermal carbonated**),	21.22	43.01	90.80

ALKALINE-SALINE SPRINGS OF THE UNITED STATES—DIVISION I.—SULPHATED—(*Continued*)

	Alkaline Carbonates, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic:			
BUFFALO LITHIA SPRINGS (No. 2), Virginia (sulphocarbonated), ...	46.51	43.03	98.38
PARIS SPRINGS (Williams's Spring), Missouri (carbonated), ...	18.92	28.85	64.20
SUWANEE SULPHUR SPRING, Florida (sulphureted), ...	15.46	2.38	21.61
WASHINGTON SPRINGS (Sulphur Spring), Virginia (sulphureted), ...	3.71	6.47	10.41
ALLANDALE SPRING, Massachusetts, . . .	1.15	0.52	3.30
Calcic-sodic:			
Shoshone Spring, MANITOU, Colorado (carbonated), ...	115.06	49.06	164.71
Little Chief Spring, MANITOU, Colorado (carbonated), ...	61.91	60.16	122.66
SALT SULPHUR SPRINGS (Iodine Spring), West Virginia (sulphocarbonated), . .	53.13	112.00	172.48
ESTILL SPRING, Kentucky (sulphocarbonated), ...	17.46	15.73	41.34
Magnetic Spring, COLFAX, Iowa, . . .	25.49	119.96	150.79
RED SULPHUR SPRINGS, West Virginia (sulphocarbonated), ...	10.06	4.69	23.96
HARRIS LITHIA SPRING, South Carolina, .	7.78	84.47	111.68
WEST SPRINGS, South Carolina, ...	7.42	20.37	30.88
MILLBORO SPRINGS, Virginia (sulphocarbonated), ...	6.86	5.00	13.43
WARM SPRINGS, Georgia (thermal carbonated), ...	6.20	1.75	10.70
Toof's Artesian Well, CONCORD, New Hampshire, ...	4.45	2.00	7.45
AMBLER MINERAL SPRINGS, South Carolina,	3.60	0.69	6.46
MONATIQUOT SPRING, Massachusetts, . . .	1.97	0.50	3.71
Calcic-potassic:			
BUFFALO LITHIA SPRINGS (No. 2), Virginia (carbonated), ...	48.26	43.01	98.36
JORDAN'S WHITE SULPHUR SPRINGS, Virginia (sulphureted), ...	12.59	7.22	21.63
OCHEE SPRINGS, Rhode Island, ...	4.33	1.73	8.98
Calcic-magnesic:			
GENEVA, Red Cross Lithia Spring, New York, ...	72.86	119.97	210.01
CROCKER SPRING, Tennessee, ...	35.42	52.16	94.08
RICHFIELD White Sulphur Spring, New York (sulphureted), ...	31.74	117.49	154.28
OLD SWEET SPRING, Virginia (carbonated),	30.85	28.85	60.62
CHERRY VALLEY SPRING, New York (sulphureted), ...	27.23	93.32	140.71
VICTORIA MINERAL SPRINGS, Nebraska, .	26.90	33.94	62.18
HOT SPRINGS (Boiler Spring), Virginia (thermal), ...	26.10	12.85	43.33
SHARON White Sulphur Spring, New York (sulphureted), ...	24.00	119.40	149.10
CLIFTON SPRINGS, New York (sulphureted),	22.80	93.44	133.68

Alkaline-saline Springs of the United States—Division I.—Sulphated—(*Continued*)

	Alkaline Carbonates, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic-magnesic:			
Chittenango White Sulphur Spring (**sulphureted**),	22.10	83.58	107.36
Healing Springs (New Spring), Virginia (**azotized**),	20.68	11.41	38.00
Healing Springs (Old Spring), Virginia,	19.38	11.19	35.86
Colemansville Mineral Springs, Virginia,	13.45	2.36	19.41
Grayson Springs, Kentucky,	11.07	54.20	67.59
Storm Lake Springs, Iowa (**carbonated**),	10.75	44.76	59.46
Hot Springs, North Carolina (**thermal**),	9.12	28.86	42.86
Red Boiling Springs (Red Spring), Tennessee (**sulphureted**),	7.75	9.53	23.80
Crockett Arsenic Lithia Springs, Virginia,	7.24	6.58	18.35
Faywood Hot Springs, New Mexico (**thermal**),	7.07	13.55	24.94
Lebanon Thermal Spring, New York (**thermal azotized oxygenated**),	6.45	2.10	24.38
Gettysburg, Katalysine Spring, Pennsylvania,	5.57	8.07	16.38
White Sulphur Springs, Oklahoma Territory (**sulphureted**),	9.04	7.75	20.35

Chalybeate Sulphated

	Iron Salts, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic Chalybeate:				
Stafford Spring, Connecticut (**Carbonated**),	0.67	0.90	1.17	7.10
Sodic-magnesic Chalybeate:				
Young's Natural Gas Well, California (**carbureted**),	4.95	53.60	50.78	124.39
Newsom's Arroyo-Grande Spring, California (**sulphocarbonated**),	3.98	16.56	10.05	37.30
Witter's Mineral Spring, California (**sulphocarbonated**),	1.17	16.21	32.12	76.94
Potassic-calcic Chalybeate:				
Londonderry Lithia Spring, New Hampshire (**carbonated**),	1.85	40.40	30.48	74.85
Calcic Chalybeate:				
Eaton Rapids Springs (Bodine Spring), Michigan,	2.25	56.92	57.50	120.17
Bedford, Chalybeate Spring, Pennsylvania (**carbonated**),	0.44	11.10	2.74	20.29

ALKALINE-SALINE SPRINGS OF THE UNITED STATES—DIVISION I.—SULPHATED – (*Continued*)

	Iron Salts, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic Chalybeate:				
BUFFALO LITHIA SPRINGS (No. 3), Virginia (sulphocarbonated),	3.77	4.37	5.54	14.47
Calcic-sodic Chalybeate:				
TOPEKA MINERAL WELL, Kansas,	28.06	58.09	23.56	147.45
SPRINGDALE SELTZER SPRING, Colorado,	3.99	49.51	107.55	171.27
ELDORADO SPRINGS (No. 1), Missouri (carbonated),	7.25	15.31	4.56	32.55
ROCKCASTLE SPRINGS, Kentucky (carbonated),	0.84	3.44	3.38	8.55
HARBIN HOT SULPHUR SPRING, California (thermal sulphocarbonated),	1.75	22.44	36.76	88.63
FARMVILLE LITHIA SPRINGS, Virginia (carbonated lithiated),	1.26	7.80	5.58	26.38
Calcic-sodic-magnesic Alumino-chalybeate:				
WEST BADEN SPRINGS (No. 3), Indiana (carbonated azotized),	3.00	34.36	168.00	301.87
WILBUR SPRINGS, California (sulphureted),	4.16	16.94	69.71	76.94
WASHINGTON SPRINGS, Virginia,	1.95	13.66	8.49	27.78
PARK'S SPRING, North Carolina,	3.50	4.80	2.98	14.93
Calcic-potassic Chalybeate:				
CHALYBEATE SPRINGS, Georgia,	0.79	1.09	0.56	5.30
Calcic-magnesic Alumino-chalybeate:				
INDIAN SPRINGS, Indiana (carbonated azotized),	20.23	58.00	41.63	163.67
ADIRONDACK MINERAL SPRING, New York,	5.04	45.64	11.13	76.89
FULTON WELLS, California (sulphocarbonated),	11.75	30.08	24.36	81.13
GENEVA LITHIA SPRING, New York,	2.15	26.03	132.37	234.33
MONTVALE SPRINGS, Tennessee,	2.40	13.26	90.72	108.84
CATOOSA SPRINGS (No. 4), Georgia (carbonated),	0.19	11.65	74.22	91.46
CLOVERDALE LITHIA SPRINGS, Pennsylvania (carbonated azotized),	0.75	7.26	1.60	10.70
SCHOOLEY'S MOUNTAIN SPRING, New Jersey,	0.58	3.60	1.68	7.17
MIN-NI-YAN SPRING, Illinois,	5.80	14.91	3.62	24.91
HARBIN SPRINGS (Iron Spring), California (thermal carbonated),	1.90	23.63	11.36	46.53
MIDWAY WARM SPRINGS, Utah (thermal carbonated),	1.05	65.04	13.61	102.74
YELLOW SULPHUR SPRINGS, Virginia (carbonated),	0.62	10.64	88.73	107.67
FAUQUIER WHITE SULPHUR SPRINGS, Virginia (sulphocarbonated),	2.14	10.35	5.02	22.00
WARM SPRINGS, Virginia (thermal sulphocarbonated),	2.50	5.22	16.27	32.63
COLD SULPHUR SPRINGS, Virginia (sulphureted),	1.22	3.63	6.59	13.67
GREEN SPRINGS, Oak Ridge Spring, Ohio,	3.00	63.71	64.36	174.72

ALKALINE-SALINE SPRINGS OF THE UNITED STATES—(*Continued*)

DIVISION II.—MURIATED

	Alkaline Carbonates, Grains in One U. S. Gallon	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:			
Castalian Mineral Springs, California,	1724.11	1973.02	4422.25
Lansing Magnetic Well, Michigan (carbonated),	242.70	320.22	613.77
Dixie Mineral Springs, Tennessee,	161.81	110.89	313.74
Borland Mineral Well, West Virginia (sulphureted),	128.51	240.07	432.28
Glen Alpine Springs, California (thermal carbonated),	88.40	21.17	118.80
Ætna Soda Springs, California (thermal carbonated),	86.34	28.75	134.05
Cumberland Mineral Spring, Illinois,	75 95	113.31	184.95
Hot Sulphur Springs, Colorado (thermal sulphureted),	75.22	14.61	101.75
Charleston Artesian Well, South Carolina (thermal),	71.20	63.38	135.37
Medical Lake, Washington,	63.95	25.61	101.45
El Paso de Robles (Sulphur Spring), California (sulphocarbonated),	54.24	27.30	101.47
Howard Springs (Excelsior Spring), California (thermal carbonated),	45.56	111.15	156.84
Santa Ysabel (Sulphur Springs), California (thermal sulphocarbonated),	45.39	18.10	81.43
Des Chutes Hot Springs, Oregon (thermal carbonated),	34.50	23.63	77.61
Rose Hill (Hart Well), Willow Island, West Virginia,	16.21	30.44	54.77
Aguas Calientes, California (sulphureted),	8.30	31.00	39 30
Gilroy Hot Springs, California (thermal sulphocarbonated),	4.13	40.25	62.86
Hailey Hot Springs, Idaho (thermal carbonated),	5.40	4.70	18 00
Cresson Magnesia Spring, Pennsylvania,	2.07	3.09	6.86
Sodic-calcic:			
White Sulphur Springs, Iowa,	67.94	149 61	307.04
Hartford Cold Spring, Maine,	23.27	14.43	44.68
Salutaris Spring, St. Clair, Michigan,	13.88	83.02	97.47
Calcic-sodic:			
Saratoga Springs, New York (carbonated):			
Lafayette Spring,	818.05	463.80	1290.52
Champion Spring,	742.69	446.97	1195.59
Geyser Spring,	586.73	400.02	991.55
Saratoga A or Alum Spring,	565.67	84.11	656.92
Hathorn Spring,	511.59	304.11	820.85
Pavilion Spring,	467.58	210.59	687.28
Favorite Spring,	454.34	258.01	719.28
Carlsbad Spring,	400.66	715 72	1121.50
Congress Spring,	305.21	577.00	893.97

Alkaline-saline Springs of the United States—Division II.—Muriated—(*Continued*)

	Alkaline Carbonates, Grains in One U. S. Gallon	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic-sodic:			
Saratoga Springs, New York (**carbonated**) (*Continued*):			
Hamilton Spring,	297.30	154.64	460.33
Royal Spring,	236.97	274.37	518.27
Patterson Spring,	233.20	281.84	518.18
Union Spring,	227.72	462.03	696.17
Vichy Spring,	222.29	142.81	315.18
High Rock Spring,	221.56	399.10	628.04
Peerless Spring,	212.37	201.85	419.62
Putnam Spring,	213.21	196.85	416.75
Victoria Spring,	202.35	227.30	424.33
Washington Spring,	182.74	158.57	350.23
Empire Spring,	163.82	510.94	680.44
Imperial Spring,	140.53	127.67	269.20
Magnetic Spring,	138.12	77.07	216.05
Columbian Spring,	130.11	267.00	408.30
Excelsior Spring,	124.34	377.65	514.75
Kissengen or Arondack Spring,	193.49	152.49	350.59
United States Spring,	176.43	150.51	331.84
Star Spring,	186.14	145.91	337.18
Seltzer Spring,	160.54	135.64	302.02
Red Spring,	159.94	90.40	255.68
Eureka Spring,	79.43	166.82	258.38
Springboro Mineral Spring, Pennsylvania (**carbonated azotized**),	7.85	33.81	42.98
Panacea Spring, Florida,	12.81	157.57	198.12
Iron Duke Spring (Cañon City), Colorado (**thermal carbonated**),	124.40	83.00	219.54
Tolenas Springs, California (**carbonated**),	114.76	200.63	340.18
Little Ute Spring (Cañon City), Colorado (**thermal carbonated**),	112.90	118.00	243.00
Fountain Park Magnetic Springs, Ohio,	37.65	19.98	61.03
Cincinnati Sulpho-saline Well, Ohio (**sulphureted**),	28.47	578.18	642.16
Coronado Springs, California,	6.49	11.08	26.29
Artesian Mineral Well, Harrison Valley, Pennsylvania,	16.20	8.09	28.89
Saegerstown Mineral Springs, Pennsylvania,	6.11	7.46	18.89
Glen Summit Springs, Pennsylvania,	0.20	0.23	1.16
Wurtzel Mineral Well, Michigan,	34.15	168.70	224.00
Sanicula Spring, Illinois (**carbonated**),	15.32	139.64	170.77
Whann Alkaline Lithia Mineral Springs, Pennsylvania,	3.85	7.39	13.69
Sodic-magnesic:			
Azule Springs, California (**carbonated**),	143.25	115.05	261.68
Allen Springs, California (**carbonated**),	54.47	88.06	142.86
Bowden Lithia Springs, Georgia,	40.56	133.71	200.94
Alum Rock Spring, California (**carbonated**),	35.87	17.37	62.21
Fort Crawford Mineral Well, Wisconsin,	11.59	94.00	138.63

ALKALINE-SALINE SPRINGS OF THE UNITED STATES—DIVISION II.—MURIATED—(*Continued*)

	Alkaline Carbonates, Grains in One U. S. Gallon	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic-magnesic-sodic:			
BALLSTON SPA (Artesian Lithia), New York (carbonated),	439.31	783.31	1233.25
RIVES MINERAL SPRING, South Carolina,	11.13	9.32	24.72
HIGH ISLAND MINERAL SPRINGS, Texas (sulphureted),	47.04	61.72	117.26
Calcic-potassic:			
MT. VERNON SPRINGS, North Carolina,	2.24	1.03	11.57

CHALYBEATE MURIATED

	Iron Salts, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic-chalybeate:				
UKIAH VICHY SPRINGS, California (carbonated),	18.14	215.36	28.60	268.45
PACIFIC CONGRESS SPRINGS, California (carbonated),	13.87	164.85	44.21	334.27
SUMMIT SODA SPRINGS, California (sulphocarbonated),	2.70	60.21	26.18	92.16
BYRON HOT SPRINGS (White Sulphur), California (carbonated),	3.00	18.94	12.81	36.06
Sodic-alumino-Chalybeate:				
BINGHAMTON MOUNTAIN VICHY SPRING, New York (carbonated),	1.50	34.79	120.15	221.34
Calcic-sodic chalybeate:				
AMERICANUS MINERAL WELL, Michigan (carbonated),	3.06	346.51	183.84	503.90
LITTON SELTZER SPRING, California (carbonated),	5.03	111.14	79.34	223.46
PLYMOUTH ROCK WELL, Michigan,	1.73	15.37	14.38	33.64
SIZER MINERAL SPRING, Pennsylvania,	3.05	19.65	50.28	74.60
Magnesic-sodic Chalybeate:				
WILHOITS SODA SPRING, Oregon (carbonated),	6.00	205.12	201.00	421.97
BLOUNT MINERAL SPRINGS (No. 4), Alabama (sulphocarbonated),	3.19	16.03	25.25	55.55
BOULDER HOT SPRINGS, Montana (thermal sulphureted),	2.90	7.50	4.70	24.20
HARBIN SPRINGS (Arsenic Spring), California (thermal sulphocarbonated),	0.92	31.30	10.86	52.16

Comparison of American with European Alkaline-saline Waters

A few of the best-known alkaline-saline waters of Europe have been selected for the table on page 331, and with them are compared some of the American waters from the various divisions of the same class. The presence of the alkaline carbonates in these waters, especially in those falling under the sulphated divisions, very considerably modifies the effects of the saline constituents, as, for instance, in the case of the CARLSBAD and MARIENBAD waters,—and as these effects are perhaps due largely to sodium carbonate, the amount of that salt is indicated in one of the columns, and the calcium carbonate in another. Under the head of the **calcic sulphated waters** many of the '**earthy waters**' of other classifications would be included.

	Sodic Carbonate, Grains in One U.S. Gallon	Calcic Carbonate, Grains in One U.S. Gallon	Iron Salts, Grains in One U. S. Gallon	Total Alkaline Carbonates, Grains in One U. S. Gallon	Total Chlorids, Grains in One U.S. Gallon	Total Sulphates, Grains in One U.S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sulphated Alkaline-saline:							
CARLSBAD (Sprudel), Bohemia (thermal carbonated sodic),	72.49	16.02	0.25	91.95		162.64	334.66
PAGOSA SPRINGS, Colorado (thermal sodic),	83.27	41.76	0.16	70.76		150.21	351.09
ROYAL GORGE SPRINGS, Colorado (thermal carbonated sodic),	73.20	33.50	Trace	119.50		79.30	217.00
CONTREXÉVILLE, France (carbonated calcic-sodic),	11.50	39.42	0.52	64.30		75.84	171.75
Little Chief Spring, MANITOU, Colorado (carbonated calcic-sodic),	8.76	43.81	1.05	61.91		60.16	122.66
Sulphated Chalybeate Alkaline-saline:							
MARIENBAD, Bohemia (carbonated sodic chalybeate),	68.75	36.84	2.80	63.45		293.75	523.88
WITTER'S MINERAL SPRING, California (sulphocarbonated sodic magnesic chalybeate),	5.96		1.17	32.12		16.21	76.94
Muriated Alkaline-saline:							
EMS, Germany (thermal carbonated calcic-sodic),	80.30	10.07	0.16	97.36	62.16		169.75
ÆTNA SODA SPRING, California (thermal carbonated calcic-sodic),	73.06	8.94	0.05	86.34	28.75		134.17
LUHATSCHOWITZ, Moravia (carbonated sodic),	186.10	34.47	0.88	228.85	202.58		438.05
LANSING Magnetic Well, Michigan (carbonated sodic),	112.08	107.59	1.88	242.70	320.22		613.77
SELTERS SPRING, Germany (carbonated calcic-sodic),	54.22	14.82	0.63	81.80	140.13		228.15
Seltzer Spring, SARATOGA, New York (carbonated calcic-sodic),	29.43	89.87	1.71	160.54	135.64		302.02

SALINE WATERS

Under the head of **saline waters** are included those in which sulphates and chlorids are in greatest quantity, and, in accordance with the presence of the predominant salt, the class is subdivided into **sulphated** and **muriated**, with an intermediate group, **sulphated-muriated**, in which the sulphates and chlorids are present in nea equal quantity. A fourth subdivision may be made, to include borated waters, although the borates are usually present in connec with the sulphates or chlorids. The sulphates may be sodium sulphate, magnesium sulphate, calcium sulphate, potassium sulphate, or iron sulphate, or a combination of any two or three of these salts; and thus we may have a **sodic, calcic,** or **chalybeate sulphated saline spring,** or a **sodic-calcic, sodic-magnesic, calcic-chalybeate, magnesic-chalybeate** water, etc. The same statements apply to the **muriated** waters, whether the contained chlorid is that of sodium—common salt—or a chlorid of any other base, as magnesium, potassium, calcium, or iron. In most of the classifications, as already outlined, the word '**saline**' is used in the ordinary or common nonscientific sense to designate waters in which common salt is the predominant ingredient, and this use frequently leads to confusion in terms. The use of saline in this sense is still further objectionable, as any chemical salt in the water strictly entitles it to be called saline. It is preferable, therefore, to separate those waters containing the chlorids from those characterized by the presence of sulphates, prefixing in each subdivision the words sodic, calcic, chalybeate, etc., as indicated above.

In the **German** classification the common salt waters are divided first into simple and concentrated, with a third division containing the waters in which bromin and iodin occur in connection with the common salt. The 'Glauber's salt' and 'Epsom salt' waters, or bitter waters of the German classification, fall in our scheme under the heads, respectively, of the **sodic sulphated saline,** and **magnesic sulphated saline** waters.

In the **French** classification the sodium chlorid waters are divided into the simple, or what we should call **sodic muriated saline** waters, and those associated with bicarbonates, which are really **alkaline-saline** waters. The sulphureted sodium chlorid waters of this scheme correspond with our **sulphureted sodic-muriated saline** waters. Waters characterized by the presence of sulphates, with the exception of those containing iron sulphate, are placed in a class by themselves in the French scheme; the iron sulphate waters being included with other chalybeate waters under the head of ferruginous waters.

In **Walton's** scheme, under the head of saline waters we find our **alkaline** waters; and some of our **saline** waters are found under the head of sulphur waters and also under the heads of chalybeate, purgative, calcic, and thermal waters.

Almost all the springs usually classified as purgative or aperient saline would fall under the head of **sulphated salines,** although some of them would be included in similar divisions of the **alkaline-salines.** Thus, a **sodic sulphated** water or a **magnesic sulphated** water could hardly be mistaken for anything else than a pur-
e water. Under the head of **muriated salines,** all the 'brines'

would fall, as they are characterized by the presence of sodium chlorid in large quantity. In this class, therefore, fall the 'Soolen' and 'Soolbäder,' or brines and brine baths, of Germany and other countries.

The **sodic muriated** springs constitute nearly ninety per cent. of the muriated saline waters of the **United States,** and are largely used for commercial purposes.

About one-quarter of the American **sulphated saline** waters are **calcic.** Possibly in arranging these waters the proportions of the other sulphates ought also to be given, as the calcic sulphate is by some authors supposed to be inert, medicinally. On the other hand, some of the European waters with large reputation for the treatment of gout and diabetes—as, for example, Contrexéville, which, however, for reasons given, has been assigned to the alkaline-saline class—are distinctly calcic sulphated waters. Under the **chalybeate sulphated** waters a large number of the alum waters fall; those with free sulphuric acid, however, belong to the **acid** class. Waters of the saline class may be characterized by their gaseous constituents, exactly as are the alkaline-saline waters. Although naturally hydrogen sulphid is most frequently found in them, many are carbonated, and a very large proportion is sulphocarbonated, containing both hydrogen sulphid and carbon dioxid. Carbureted hydrogen is sometimes found, but is rather rare. When carbon dioxid occurs, it is likely that a very strict classification would make the waters alkaline-saline.

The waters of KREUZNACH, of Rhenish Prussia, in Germany, which are said to have been the first waters of the kind to be medicinally employed in that country, present a typical example of a **muriated saline** water. This water can be designated as a nonthermal sodic-muriated saline water. The same description will apply to the Kurbrunnen of NAUHEIM, in Germany, with the exception that it is carbonated and is also a thermal water. Other saline waters, not quite so strong, are found at KISSINGEN and WIESBADEN, in Germany; at BOURBONNE, in France; and in many other European localities.

SAINT-GERVAIS, in France, has waters which may stand for those that are typical of the **sodic-muriated-sulphated** saline waters; that is, those in which the sulphates and chlorids are mixed, occurring in about equal proportions. The Hungarian waters—Franz Joseph, Hunyadi Janos, and Apenta—are among the best-known **sulphated salines.** The water from GRAN, in Hungary, is a strong **magnesic sulphated saline,** and that from RUBINAT, in Spain, is a **sodic sulphated saline.** The waters of FRIEDRICHSHALL, known a- strong 'bitter waters,' are **sodic-magnesic muriated** and **so sulphated.**

Distribution of Saline Waters in the United States

In the United States the saline waters are probably nearly one-third more numerous than the alkaline waters, and outnumber the alkaline-saline in the proportion of three to one, although but a small proportion is as yet utilized for medicinal purposes. If very small quantities of alkaline carbonates in some waters are disregarded, this proportion would be increased. In the **south central States,** which include Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Indian Territory, Arkansas, and Oklahoma, saline springs outnumber all others; this being due to the fact that in these States large areas are covered with rocks of carboniferous age, which are usually prolific in saline mineral waters. In the **north central section,** which includes the States from Ohio westward to the Missouri River and the State of Nebraska, and northward from the Ohio River to the Canadian line, the geologic conditions are similar to those in the south central States, and in both sections saline chalybeate and calcic waters are abundant, many of them being highly sulphureted. In Ohio, calcic springs probably predominate. The springs of Indiana and Illinois are much the same as those of Ohio. Missouri is a State rich in mineral waters, the SWEET SPRINGS of Saline County being perhaps the best known. The mineral waters of Kansas are drawn mainly from artesian borings, as are those of Michigan. In both States the waters are well mineralized, sulphureted saline springs predominating.

Saline springs are also found in other sections of the country, especially in **Virginia** and **West Virginia,** and in the western parts of **Pennsylvania,** in the **Rocky Mountain** States, and in **California,** where some very strong muriated saline waters occur. The area lying between the Appalachians and the Rocky Mountains is one of saline waters. In this area the States of Ohio, Michigan, and Missouri may possibly be considered typical. In all of them strong salt waters or brines are found. Salt wells extend from New York and Pennsylvania westward. In Ohio there is a belt of black Devonian shales reaching from Lake Erie to the Ohio valley, and springs issuing from it carry iron and sulphur almost everywhere. There are also considerable areas in which a bed of bog iron ore underlies the drift, and waters passing through this are chalybeate. The strong salt wells enter largely into the economic resources of the State. This is true also of Michigan, a very large proportion of the salt product of the United States being credited to this State. The original soluble constituents have been largely retained in the strata, and hence nearly all artesian waters of the State are mineralized. Saline and sulphureted springs predominate. Wells from the beds above the Marshall series of the carboniferous are generally stronger in the sulphates, those in the series are muriated saline, and those from below are generally sulphureted. In Missouri as we pass westward there are purer beds of underlying sodium chlorid and the waters become freer from accompanying salts.

SALINE SPRINGS OF THE UNITED STATES

DIVISION I.—SULPHATED

	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:		
Gibson Mineral Well, Texas (carbonated),	256.60	329.65
Lineville Mineral Springs, Missouri,	187.12	202.58
Palo Pinto Well, Texas,	175.44	226.23
California Geysers (Witch's Caldron), California (thermal sulphureted),	58.46	63.53
San Bernardino Hot Springs, California (thermal),	48.97	74.61
Arrowhead Hot Springs, California (thermal sulphureted),	47.82	36.39
Santa Barbara Hot Springs, California (thermal sulpho-carbonated),	31.60	36.69
Walley's Hot Springs, Nevada (thermal carbonated),	15.27	25.41
Sodic-magnesic:		
American Carlsbad Springs, Illinois (carbonated),	222.50	259.90
Duke Bitter Well, Palo Pinto, Texas,	31.84	32.24
Black Barren Spring, Pennsylvania,	4.44	5.75
Magnesic:		
B. B. Springs, Bowling Green, Missouri,	552.32	596.46
Crab Orchard Epsom Spring, Kentucky,	285.65	401.43
Harrodsburg Springs, Kentucky,	217.76	245.52
Santa Rosa White Sulphur Springs, California (sulpho-carbonated),	17.37	28.75
Magnesic-aluminic:		
Cuyahoga Lithia and Magnesia Springs, Ohio,	750.74	791.58
Calcic-magnesic:		
Alleghany Springs, Virginia (carbonated),	171.49	183.06
Wright's Epsom Lithia Well, Tennessee,	157.47	250.49
Bedford Magnesia Spring, Pennsylvania,	149.40	150.29
Blue Ridge Springs, Virginia,	148.16	157.57
Greenbrier White Sulphur Springs, West Virginia (sulphureted),	113.17	129.66
Mineral Park Bitter Spring, Arizona,	106.24	109.38
Butterworth's Magnetic Mineral Spring, Michigan,	75.15	167.20
Rawlin's Sulphur Springs, Wyoming (sulphureted),	53.76	76.09
Sulphur Mountain Spring, California,	39.17	54.32
Red Boiling Springs (No. 2), Tennessee,	23.33	47.82
Calcic-sodic-magnesic:		
Abana Mineral Springs, Illinois (carbonated),	410.13	510.78
Salt Sulphur Springs (Old Spring), West Virginia (sulphocarbonated),	125.47	150.28
Avon Sulphur Springs (Upper Spring), New York (sulphocarbonated),	110.00	136.40
Hot Springs (Minnekatah Spring), South Dakota (thermal),	42.26	62.57
Calcic-sodic:		
Berry Hill Spring, Virginia,	150.04	164.40
Vade Mecum Spring, Stokes County, North Carolina (carbonated),	102.00	118.24
Hot Springs (Mammoth Spring), South Dakota (thermal),	65.00	92.71
Shocco Springs, North Carolina,	55.80	68.06
Fernvale Springs, Tennessee (sulphureted),	50.83	73.84
Calcic:		
French Lick Springs (Proserpine Spring), Indiana (sulphocarbonated),	207.05	350.52

SALINE SPRINGS OF THE UNITED STATES—DIVISION I.—SULPHATED—(*Continued*)

	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Calcic:		
Daniel's Spring, Georgia,	94.78	108 61
Glenn Spring, South Carolina,	91.50	97.55
Hughes' Mineral Well, Georgia,	73.68	86.43
Chick's Springs, South Carolina (carbonated),	35.57	40.48
Calcic-alumino-manganous:		
Irondale Spring, West Virginia,	74.62	96.76

CHALYBEATE SULPHATED

	Iron Salts, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic Chalybeate:			
Matchless Mineral Water, Alabama,	1050.06	1233.31	1564.00
Milford Mineral Spring, Texas,	1.26	431.64	493.74
Sodic-magnesic Chalybeate:			
Austin's Springs, Tennessee,	14.60	24.80	46.00
Vermont Mineral Spring, Vermont,	1.01	1.98	3.80
Calcic-magnesic Chalybeate:			
Rock Enon Springs, Virginia,	14.25	16.45	40.43
Arkansas Lithia Springs, Arkansas,	12.34	23.79	73.21
Sweet Chalybeate Springs (Red Spring), Virginia (carbonated),	0.73	43.29	48.40
Tate Epsom Spring, Tennessee (carbonated),	4.46	202.61	271.88
Calcic-magnesic Alumino-chalybeate:			
Church Hill Alum Springs, Virginia,	158.79	409.20	426.69
Cresson Springs (Alum Spring), Pennsylvania,	44.64	90.28	145.46
Cresson Springs (Iron Spring), Pennsylvania,	28.52	75.06	108.39
Kittanning Mineral Spring, Pennsylvania,	24.49	127.63	145.86
Versailles Medical Springs (Alum Spring), Missouri,	22.42	167.82	192.93
Crystal Spring, Lamonte, Missouri,	7.89	56.33	67.33
Castalian Springs, Mississippi (sulphocarbonated),	4.84	61.09	77.04
California Geysers (Iron Spring), California,	0.12	5.84	7.12
Calcic-sodic Chalybeate:			
Eldorado Springs (Park Spring), Missouri (carbonated),	3.39	3.12	10.47
Calcic Chalybeate:			
Powder Springs, Georgia (sulphocarbonated),	2.00	1.00	4.50
Sharon Springs, Chalybeate Spring, New York,	1.40	77.09	114.53
Anderson Mineral Springs (Iron Spring), California (carbonated),	1.18	22.82	31.45
Oxford Mineral Spring, Connecticut,	0.91	2.27	6.18

SALINE SPRINGS OF THE UNITED STATES—(*Continued*)

DIVISION II.—SULPHATED AND MURIATED.

	Iron Salts, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:				
Waconda Spring, Kansas (carbonated), ...		268.88	765.76	1120.65
Beck's Hot Sulphur Springs, Utah (sulphocarbonated), ...	0.46	178.44	620.58	848.45
St. Helena White Sulphur Springs, California (sulphureted), ...	5.56	14.46	15.66	40.04
Sodic-calcic:				
Ohlon's Mineral Well, Baldwinsville, New York, . .		122.24	218.18	421.35
Upper Blue Lick Springs, Kentucky (sulphocarbonated), ...	1.96	57.00	567.22	660.14
Massena Springs, New York (sulphureted), ...	0.49	60.53	107.23	191.88
Dalby Springs, Great Red Spring, Texas, ...	0.78	2.70	3.75	13.82
Sodic-calcic-magnesic:				
Clark's Riverside Mineral Springs, Michigan (sulphureted), ...		2873.00	4268.68	7318.97
Sodic-magnesic:				
Louisville Artesian Well, Kentucky (sulphocarbonated), ...	0.35	546.63	707.44	915.47
Gypsum Spring, Detrital Valley, Arizona, ...		206.61	239.95	446.05
Lower Blue Lick Springs, Kentucky (sulphocarbonated), ...	0.36	42.96	546.63	634.03
Sodic-potassic:				
Midland Mineral Springs, Michigan, ...		58.73	41.11	110.20
Alburgh Springs, Vermont, ...		16.61	18.59	38.00
Magnesic-sodic:				
Blue Lick Springs, Sweet Spring, Missouri, . . .		17.60	220.17	300.00
Blue Lick Springs, White Sulphur Spring, Missouri (sulphureted), ...		15.52	185.10	245.46
Swinehead's Arsenic Lithia Springs, Virginia, ...	0.02	0.37	0.50	1.64
Calcic-magnesic Sodic:				
Cuyahoga Lithia Well, Ohió, ...	0.82	245.47	242.60	515.82
Blue Lick Springs, Red Sulphur Spring, Missouri (sulphureted), ...		107.65	1512.79	1708.16
Glasgow Mineral Spring, Missouri (sulphureted), .		71.13	968.30	1048.63
Belcher's Artesian Well, St. Louis, Missouri (sulphureted), ...	0.06	50.18	496.01	550.25
Randolph Springs, Missouri (sulphureted), ...		43.05	920.59	1058.63
McAlister Springs, Black Sulphur Spring, Missouri (sulphureted), ...		40.30	745.42	848.53

DIVISION III.—MURIATED

	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:		
Byron Hot Springs, Surprise Spring, California, . . .	18,699.28	18,773.73
Mt. Clemens Mineral Well, Michigan (sulphocarbonated),	13,482.98	13,654.33
Port Huron Mineral Bath, Michigan (sulphureted), . .	4,712.23	5,791.41
Ypsilanti, Moorman Mineral Wells, Michigan (sulphureted), ...	1,845.06	2,256.26
Eureka Springs, California (sulphureted), ...	1,504.00	1,800.27
Young's Medicinal Well, Missouri (sulphocarbonated), .	1,470.81	1,584.00
Utah Hot Springs, near Ogden, Utah (thermal carbonated),	1,321.77	1,354.55
Magneso-saline Mineral Springs, Missouri (carbonated),	1,267.67	1,374.33
Glenwood Springs, Yampa Spring, Colorado (thermal sulphocarbonated), ...	1,102.92	1,26[illegible]

SALINE SPRINGS OF THE UNITED STATES—DIVISION III.—MURIATED—(*Continued*)

	Chlorids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sodic:		
Geuda Springs (No. 1), Kansas (carbonated),	1,074.88	1,280.29
Akesion Spring, Sweet Springs, Missouri,	1,062.83	1,171.55
Liver and Kidney Spring, Byron Hot Springs, California (carbonated),	745.10	769.05
Lodi Artesian Well, Indiana (sulphureted),	605.93	672.45
Excelsior Spring, New York,	592.22	668.24
Spring Lake Well, Michigan,	559.44	628.37
Cincinnati Artesian Well, Ohio (sulphocarbonated),	563.27	617.32
Blue Lick Springs, Missouri (sulphocarbonated),	504.82	610.30
Montesano Springs, Montesano Spring, Missouri (sulphocarbonated,	417.43	538.57
Byron Hot Springs, Black Sulphur Spring, California, (thermal sulphocarbonated),	395.00	461.97
Addison Sulphur Springs, West Virginia (sulphureted),	377.32	467.30
Magnetic Mineral Springs, Indiana (sulphocarbonated),	365.62	429.36
Lithium Springs, Attica, Indiana,	364.83	390.66
Livingston Artesian Well, New York,	300.58	312.55
Wasatka Mineral Springs, Utah,	267.47	332.50
Alpena Magnetic Spring, Michigan (sulphureted),	222.11	534.35
Sweet Springs, Sweet Spring, Missouri,	131.84	166.14
Monegaw Springs, Old Black Sulphur Spring, Missouri,	123.69	167.09
Mercy Medicinal Spring, California,	122.66	131.95
Oak Grove Spring, Michigan,	102.58	143.87
Clinton Artesian Well, Missouri,	68.59	106.25
Bayport Mineral Well, Michigan,	59.79	100.47
Macbeth Mineral Well, New Mexico,	34.57	45.00
Calistoga Hot Springs, California (thermal sulphureted),	26.27	41.89
Salt Lake City Warm Springs, Utah (thermal),	24.61	33.88
Sodic-calcic:		
Glen Springs, Neptune Spring, New York (iodobromic),	10,503.08	10,503.08
Fruitport Well, Michigan (carbonated),	622.38	703.13
Grand Haven Mineral Spring, Michigan,	527.54	608.89
Sodic-calcic-magnesic:		
Clark's Red Cross Well, Michigan,	17,700.55	17,825.27
St. Clair Mineral Spring, Michigan (sulphureted),	16,514.40	17,904.60
Mt. Clemens, Clementine Spring, Michigan,	10,797.71	10,874.53
Parker Mineral Spring, Pennsylvania,	614.31	627.59
Webster Salt Sulphur Spring, West Virginia,	409.24	414.20
Tioga Mineral Wells, Texas (carbonated),	175.21	238.52
Sodic-potassic:		
Deep Rock Spring, New York (carbonated),	467.51	559.18
Sodic-magnesic:		
Mt. Clemens, Medea Spring, Michigan (sulphureted),	7,742.08	12,014.80
Calcic:		
Hot Springs, Rio San Francisco, Arizona (thermal),	364.36	388.26
Belknap Hot Medical Spring, Oregon (thermal),	126.71	145.51
Maryland Strontia Spring, Maryland (carbonated),	23.08	43.54
Magnesic:		
Olympian Springs, Kentucky (sulphocarbonated),	221.40	332.84
Magnesic-sodic:		
Sheboygan Mineral Wells, Wisconsin,	404.26	436.49

SALINE SPRINGS OF THE UNITED STATES—DIVISION III.—MURIATED—(*Continued*)

CHALYBEATE MURIATED

	IRON SALTS, GRAINS IN ONE U. S. GALLON	CHLORIDS, GRAINS IN ONE U. S. GALLON	TOTAL SOLID CONTENTS, GRAINS IN ONE U. S. GALLON
Sodic Chalybeate:			
ERCKENBRECKER'S SALT WELL, Ohio, . .	54.46	5,628.75	5,738.10
GODBOLD MINERAL WELL, Mississippi, .	12.24	1.73	13.99
YPSILANTI MINERAL WELL, Michigan (iodobromic), ...	17.50	9,931.45	10,476.60
ALBANY ARTESIAN WELL, New York, . .	8.00	504.00	600.00
AURORA SPRINGS, Round Spring, Missouri,	6.06	10.96	20.87
OCEAN SPRINGS, Mississippi (sulphureted),	4.71	56.62	61.33
ROYAL OAK SPRING, Michigan (carbonated), ...	4.06	19.29	56.00
Magnesic-sodic:			
SCHOOLEY'S MOUNTAIN, Heath House Spring, New Jersey, ...	4.00	48.00	91.00
Calcic-sodic Alumino-chalybeate:			
BROMO HYGEIA SPRING, Michigan (bromic), ...	14.95	13,238.46	13,412.83

DIVISION IV.—BORATED

	BORATES, GRAINS IN ONE U. S. GALLON	TOTAL SOLID CONTENTS, GRAINS IN ONE U. S. GALLON
Sodic:		
HOT BORATE SPRING, California (thermal carbonated), . .	201.75	483.95
SKAGGS'S HOT SPRINGS, California (thermal carbonated), .	24.19	214.80
GEYSERS, Hot Sulphur Spring, California (sulphureted),	23.93	38.12
MONO LAKE, California (sulphocarbonated), ...	19.75	2915.16
TOLENAS SPRINGS, California (carbonated), ...	19.13	340.18
LITTON SELTZER SPRINGS, California (carbonated), ...	4.43	223.26
PIEDMONT WHITE SULPHUR SPRING, California (carbonated),	5.23	43.20

Comparison of American with European Saline Waters

To reproduce in many of our waters the exact conditions found in analogous foreign saline waters it would be necessary to concentrate some, while others would have to be diluted—a statement applicable as well to many of the alkaline and alkaline-saline waters. Still, many of them correspond quite closely, and the lists might be extended to include many others that have their counterparts among the foreign salines. Only a few well-known European waters have been taken for the table on page 331, and, likewise, of those American waters most closely corresponding, only a small number has been selected.

	Sodium Sulphate, Grains in One U. S. Gallon	Magnesium Sulphate, Grains in One U. S. Gallon	Calcium Sulphate, Grains in One U. S. Gallon	Total Chlorids, Grains in One U. S. Gallon	Total Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Sulphated Saline:						
Pullna, Bohemia (**sodic-magnesic**),	990.40	744.69	6.16		1794.29	2010.46
Gibson Mineral Well, Texas (**carbonated sodic**),	256.60				256.60	399.65
American Carlsbad Spring, Illinois (**carbonated sodic-magnesic**),	53.00	103.70	65.8		222.50	259.90
Sulphated and Muriated Saline:						
Friedrichschall, Germany (**carbonated magnesic-sodic**),	333.84	316.40	89.92	787.60	750.32	1559.92
Louisville Artesian Well, Kentucky (**sulphocarbonated sodic**),	72.29	77.33	29.43	707.44	546.63	915.47
Waconda Spring, Kansas (**carbonated sodic**),	183.60	85.28		765.76	268.88	1120.65
Plombières, France (**thermal sodic**),	5.02			4.40	5.02	18.29
St. Helena, White Sulphur Spring, California (**thermal sulphureted sodic**),	12.84			15.16	14.46	40.04
	Sodium Chlorid	Magnesium Chlorid	Calcium Chlorid			
Muriated saline:						
Kreuznach (Elisenquelle), Germany (**sodic-calcic**),	543.06	32.59	107.11	640.42		750.76
Spring Lake Well, Michigan (**sodic-calcic**),	405.53	36.20	113.42	559.44		628.37
Akesion Spring, Sweet Springs, Missouri (**sodic**),	882.78	89.51	85.21	1062.83		1171.55
Schlangenbad, Germany (**thermal sodic**),	14.60			14 63		20.46
Calistoga Hot Springs, California (**thermal sulphureted sodic**),	20.76		5.57	26.27		41.89
Warm Springs, Salt Lake City, Utah (**thermal sodic**),	19.54	0.54	4.53	24.61		33.88

IODOBROMIC WATERS

Inasmuch as small quantities of **iodin** in water are considered to be therapeutically effective, some space should be devoted to these waters. Usually the iodin occurs associated with **bromin**, and generally as **sodium iodid** with **sodium bromid**, although **potassium** and **magnesium** iodids and bromids are also found. They usually occur in the strong brines. Bromin is so widely distributed as to justify the statement that wherever compounds of chlorin are found, compounds of bromin also occur. Iodin is found with bromin in nearly all **salt wells**, especially in those of **Ohio, West Virginia, Michigan,** and **New York,** although in the waters of the latter State only traces, as a rule, are found. In Ohio and West Virginia the mother-liquor from salt is worked over for bromin. In many other waters both iodin and bromin are found, as, for instance, in those of Saratoga, where so much as 4.68 grains of sodium iodid in the gallon occurs in one of the springs, although the amount in most of the spring-waters is very much less, falling usually below one grain. Sodium bromid also occurs, and in most cases in larger amount than the iodid. This is the case also as to the Michigan waters.

In a number of **California** waters and at HOT SPRINGS, **Arkansas**, iodin and bromin occur, usually, however, as traces; the amounts, with few exceptions, not being large enough to determine by chemical analysis. Usually when iodin and bromin occur, their percentage, when compared with the total solid contents, is found to be very small. Traces of bromin are also found in the thermal waters of the YELLOWSTONE NATIONAL PARK, but without iodin. The following table presents a number of these waters that occur in the United States, and although the list is not intended to be complete, it will give an idea of the distribution of such waters:

IODOBROMIC WATERS OF THE UNITED STATES

	Iodids, Grains in One U. S. Gallon	Bromids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Eureka Spring, SARATOGA SPRINGS, New York (**calcic-sodic muriated alkaline-saline**)	4.68		258.38
Excelsior Spring, SARATOGA SPRINGS, New York (**calcic-sodic muriated alkaline-saline**)	4.24		719.28
Hamilton Spring, SARATOGA SPRINGS, New York (**calcic-sodic muriated alkaline-saline**)	3.00		460.33
Columbian Spring, SARATOGA SPRINGS, New York (**calcic-sodic muriated alkaline-saline**)	2.56		408.30
Washington Spring, SARATOGA SPRINGS, New York (**calcic-sodic muriated alkaline-saline**)	2.25		350.23
TOLENAS SPRINGS, California (**calcic-sodic muriated saline**)	1.75		340.18
PARKERSBURG MINERAL WELL, West Virginia (**sodic muriated and sulphated saline**)	1.00		84.00
CALISTOGA HOT SPRINGS, California (**sodic muriated saline**)	0.94		41.98
YOUNG'S GAS WELL, California (**sodic-magnesic sulphated chalybeate**)	0.78		140.62
WILBUR SPRINGS, California	0.75		124.39
JORDAN ALUM SPRINGS, Virginia (**alumino-chalybeate acid**)	0.70		84.64
WACONDA SPRING, Kansas (**sodic muriated and sulphated saline**)	0.23		1,120.63
SKAGGS'S HOT SPRINGS, California (**thermal borated saline**)	0.13		216.35
PORT HURON MINERAL BATH, Michigan (**sodic muriated saline**)	21.99	721.82	4,712.23
KANE GEYSER WELL, Pennsylvania (**calcic-sodic muriated saline**)	0.88	73 94	10,016.94
BOWDEN LITHIA SPRING, Lower Spring, Georgia (**sodic-magnesic muriated alkaline-saline**)	0.73	15.23	173.36
EUREKA SPRING, California (**sodic muriated saline**)	Trace	14.00	1,800.27
BROM-MAGNESIA WELL, Kansas (**sodic muriated saline**)	0.09	13.71	4,303.82
YPSILANTI MINERAL WELL, Michigan (**sodic chalybeate muriated saline**)	5.00	12.60	10,476.60
Congress Spring, SARATOGA SPRINGS, New York (**calcic-sodic muriated alkaline-saline**)	0.25	9.66	[illegible]

IODOBROMIC WATERS OF THE UNITED STATES—(*Continued*)

	Iodids, Grains in One U. S. Gallon	Bromids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Upper Blue Lick Spring, Kentucky (sodic-calcic muriated and sulphated saline),	0.15	3.80	660.14
Lafayette Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	1.72	3.75	1,290.52
Hathorn Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.12	3.65	820.85
Champion Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.03	3.58	1,195.59
Geyser Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.25	2.22	991.55
Bowden Lithia Spring (Upper Spring) (sodic-magnesic muriated alkaline-saline), Georgia,	Traces	1.69	200.94
Union Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline,	0.04	1.40	696.17
Putnam Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.09	1.28	416.75
Carlsbad Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.03	1.23	1,121.50
Peerless Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.01	1.22	419.63
Pavilion Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.08	0.99	687.28
High Rock Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.09	0.74	628.04
Patterson Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.16	0.68	518.19
Iodin Spring, Salt Sulphur Springs, West Virginia (calcic sodic-magnesic sulphated saline),	0.63	0.65	172.48
Deer Lick Spring, Glen Springs, New York (sodic chalybeate muriated saline),	0.04	0.59	180.45
Cascade Springs, Tennessee (sodic muriated and sulphated saline),	0.05	0.56	59.88
Paroquet Springs, Kentucky (sodic muriated saline),	0.40	0.48	442.41
Louisville Artesian Well, Kentucky (sodic muriated saline),	0.35	0.47	915.57
Royal Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.02	0.34	518.27
Empire Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	0.01	0.27	680.44
Borland Mineral Well, West Virginia (sodic muriated saline),	0.02	0.28	39.25
Lower Blue Lick Springs, Kentucky (sodic-magnesic muriated saline),	0.25	0.24	634.03
Grand Haven Mineral Spring, Michigan (calcic-sodic muriated saline),	0.05	0.17	608.89
Blount Mineral Springs (No. 4), Alabama (sodic muriated saline),	0.14	0.16	55.55
Black Sulphur Spring, Byron Springs, California (sodic muriated saline),	0.74	0.16	461.97
Iron Pipe Spring, Byron Springs, California (sodic muriated saline),	0.13	0.07	668.14

IODOBROMIC WATERS OF THE UNITED STATES—(*Continued*)

	Iodids, Grains in One U. S. Gallon	Bromids, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Surprise Spring, Byron Springs, California (sodic muriated saline),	0.13	0.06	18,773.73
Thompson's Bromine-Arsenic Spring, North Carolina (sodic potassic sulphated alkaline-saline),	Traces	0.04	5.45
Liver and Kidney Spring, Byron Springs, California (sodic muriated saline),	0.79	Trace	769.05
Iron Spring, Byron Springs, California (sodic muriated saline),	0.04	Trace	765.64
Hot Salt Spring, Byron Springs, California (sodic muriated saline),	0.03	Trace	706.94
Sand Beach Mineral Water, Michigan (sodic-calcic muriated saline),		1,738.80	21,812.00
Bromo-Hygeia Spring, Michigan (calcic-sodic alumino-chalybeate saline),		101.00	13,412.83
Excelsior Mineral Spring, Michigan (sodic-calcic muriated saline),		46.72	8,938.00
Erckenbrecker's Salt Well, Ohio (sodic chalybeate muriated saline),		28.21	5,738.10
Climax Springs, Missouri (sodic chalybeate muriated saline),		18.18	71.12
Green Mineral Spring, Ohio (calcic sulphated saline),		16.76	216.49
Favorite Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),		4.32	719.28
Belcher's Artesian Well, Missouri (calcic-magnesic-sodic muriated and sulphated saline),		3.06	550.25
Montesano Springs, Missouri (sodic muriated saline),		2.29	496.98
Spring Lakewell, Michigan (sodic muriated saline),		2.17	628.02
Council Spring, Montesano Springs, Jefferson County, Missouri (sodic muriated saline),		1.91	466.72
Afton Spring, Montesano Springs, Jefferson County, Missouri (sodic muriated saline),		1.73	369.26
Catoosa Springs (No. 2), Georgia (calcic-magnesic sulphated saline),		1.70	93.94
Lodi Artesian Well, Indiana (sodic muriated saline),		0.88	672.45
Fruitport Well, Michigan (sodic calcic muriated saline),		0.77	703.13
Star Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),		0.37	337.18
Vichy Spring, Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),		0.10	367.32

ACID WATERS

Acid waters, which form the fourth and last class of our sch-
have been neglected in all previous classifications. This class t
all waters in which free sulphuric acid, free hydrocl

acid, or free silicic acid occur. Waters of the latter division are included here largely for the sake of convenience; if the free silicic acid were eliminated, a few of the waters might fall under the head of the alkaline-saline waters, although the majority would be considered as saline. Of course, other acids than those enumerated occur in mineral waters, but they are usually in a state of combination with various bases. Carbonic acid frequently occurs uncombined, but it is naturally in its gaseous state, and is therefore disregarded here as a classifying agent.

Free **sulphuric acid** is present in many spring-waters as a distinguishing ingredient, and is usually found in connection with sulphates. The presence of free **hydrochloric acid** characterizes a fewer number of spring-waters, and when this ingredient does occur, it is usually in connection with chlorids. Free **silicic acid** is more commonly found in mineral waters than are free sulphuric and free hydrochloric acids. We have, therefore, as subdivisions of the class of acid waters, **sulphated, muriated,** and **siliceous.**

Siliceous waters may be subdivided into sulphated and muriated, according to the presence of the sulphates or chlorids occurring in connection with the silicic acid.

So far as known, free acids have not been determined in European waters, but a considerable number of such waters have been found among the springs of the **New Zealand** geyser region, where free hydrochloric acid particularly occurs, in many cases, in connection with chlorids. **Canada** has an acid spring in the TUSCARORA Sour Spring.

Distribution of Acid Waters in the United States

In the United States, sulphated acid waters have been found in **Pennsylvania, New York, Alabama, Mississippi, Kansas, Texas, South Dakota,** and **California**; and a few springs of the same character are found in the YELLOWSTONE NATIONAL PARK. The OAK ORCHARD SPRINGS, of New York, are among the most celebrated acid springs in the country, and one of these springs is remarkable for its large quantity of sulphuric acid, amounting to over 40 per cent. of its total contents. The **Texas** Sour Springs are also widely known, and there are many sulphated acid waters found at the CALIFORNIA GEYSERS.

Muriated acid springs, so far as shown by all accessible analyses, are with one exception confined in this country to the YELLOWSTONE NATIONAL PARK. The exception is the Lemonade Spring at the GEYSERS in **California**, which has 1.10 grains of free hydrochloric acid with the 31.82 grains of free sulphuric acid to the gallon. The percentage of free hydrochloric acid in the Yellowstone Park waters ranges from a mere trace to nearly 14 per cent.

Waters characterized by free silicic acid are found at a number of localities in the United States, but of course are most numerous in the YELLOWSTONE NATIONAL PARK. The amount of free silica ranges from 11 per cent. to over 50 per cent.; the average, however, is about 24 per cent. Many of the springs contain comparatively small amounts of free silica, and therefore belong to the other classes. In those springs of the Yellowstone Park that have been referred to the sulphated acid and muriated acid classes on account of the presence of the free sulphuric and hydrochloric acids, there is also usually a large proportion of free silicic acid. One of these springs, the Bench Spring of the Upper Geyser Basin, has 50.88 per cent. of silicic acid, while the sulphuric acid exists only in traces. This spring is a sodic-sulphated acid spring, and were it not for the presence of sulphuric acid, would be referred to the siliceous division of the acid class. It frequently happens, however, that a small amount of the classifying agent is of importance, as in the case of lithiated waters, and this spring is therefore kept with the sulphated acid waters.

Sulphated Acid Waters

Acid sulphated waters are those characterized by the presence of free sulphuric acid occurring in connection with sulphates of various bases. In the following enumeration such waters of this class as occur in the United States are divided in accordance with the author's scheme of classification.

	Free Sulphuric Acid, Grains in One U. S. Gallon	Iron Salts, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon
Alumino-chalybeate:				
Alum Spring, STRIBLING SPRINGS, Virginia,	9.09	12.13	55.86	40.38
Alumino-chalybeate (carbonated):				
WALLAWHATOOLA ALUM SPRINGS, Virginia,	33.82	5.69	135.28	97.28
ROCKBRIDGE ALUM SPRINGS (No. 7), Virginia,	4.84	2.07	116.27	108.31
Sodic-calcic:				
MUSH-POT SPRING, Pelican Creek, Yellowstone National Park,	4.04	Trace	64.13	45.64
Sodic-magnesic alumino-chalybeate (thermal):				
Lemonade Spring, CALIFORNIA GEYSERS,	31.82	12.25	195.05	146.44
Sodic-alumino-magnesic (thermal):				
Devil's Tea-kettle, CALIFORNIA GEYSERS,	110.64		296.24	172.77

	Free Sulphuric Acid, Grains in One U. S. Gallon	Iron Salts, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon
Calcic-magnesic:				
Manhattan Artesian Wells (No. 1), Kansas,	61.36	0.19	117.94	83 37
Catoosa Springs (No. 10), Georgia,	0.13	0.27	99.27	84.67
Calcic-alumino-chalybeate:				
Overall Mineral Wells, Texas,	Traces	144.90	235.01	223.67
Calcic-magnesic alumino-chalybeate:				
Texas Sour Springs, Caldwell, Texas,	7.26	7.58	448.98	248 84
Oak Orchard Acid Spring, New York,	134.73	28.62	314.42	172.66
Brown's Wells, Mississippi,	40.88	36.52	263.23	196.88
Gaylord and Gulick Mineral Spring, Blossburg, Pennsylvania,	5.64	31.65	85.20	76.98
Aquæ Vitæ Spring, Illinois,	2.57	55.38	258.04	223.66
Pate Sour Well, Texas,	1.32	69.19	188.98	167.60
Iowa Acid Spring, Iowa,	408.99[1]	97.30	816.39	156.26
Alumino-magnesic (thermal sulphureted):				
Mud Indian Spring, California Geysers,	32.30		150.20	105.65
Magnesic-chalybeate (thermal sulphureted):				
Lane Mineral Spring, California,	15.24	122.00	251.97	29.76
Magnesic-alumino-chalybeate:				
Alum Spring, California Geysers (sulphureted),	6.45	7.34	138.11	117.60
Sour Lake Springs (No. 7), Texas,	16.67	17.20	82.02	65.35
Hunter's Pulaski Alum Springs, Virginia,	1.94	108.75	137.96	134.04
Sour Spring, Anderson Springs, California,		0.63	20.28	13 86
Alumino-ammoniated (thermal):				
Devil's Ink-pot, Yellowstone National Park,	2.33		197.05	181.89
Calcic-magnesic alumino-chalybeate (carbonated):				
Bath Alum Springs, Virginia,	5.81	14.52	45.44	6.62
Calcic-magnesic alumino-chalybeate (carbonated and azotized):				
Bedford Alum Springs, Virginia,	19.98	23.46	92.17	72.19
Magnesic-alumino-chalybeate (carbonated):				
Iron Lithia Springs, Virginia,	0.51	5.08	23.55	20.76

Muriated Acid Waters

As just stated, the muriated acid waters include those containing free hydrochloric acid, together with various chlorids, and in this country, so far as known, they occur only in the Yellowstone

[1] Some of this is probably combined with aluminum.

NATIONAL PARK. They are all thermal, and usually contain free carbonic acid gas, with traces of sulphureted hydrogen in a few of them. They are waters from the following springs:

	Temperature in Degrees Fahrenheit	Total Solid Contents, Grains in One U. S. Gallon	Percentage of Silica in Total Solid Contents	Percentage of Free Hydrochloric Acid	Percentage of Chlorids
Sodic Muriated:					
Coral Spring (Gibbon Geyser Basin), . .	163.4	111.35	31.77	0.76	61.21
Schlamkessel (Norris Geyser Basin), . . .	195.8	98.52	27.04	4.12	55.72
Echinus Spring (Norris Geyser Basin), .	195.8	48.38	30.46	3.31	20.47
Sodic Muriated and Sulphated:					
Constant Geyser (Norris Geyser Basin),	197.6	94.44	28.88	1.77	56.93
Alum Creek (Hayden Valley), ...		71.12	17.83	13.81	6.18
Bench Spring (Upper Geyser Basin), . . .	191.4	27.40	50.88	Trace	

Siliceous Waters

The siliceous division of the acid waters includes those which, in addition to other ingredients, carry a considerable proportion of free silicic acid. Waters of this class are especially characteristic of the various **geyser regions** of the world, as in **Iceland, New Zealand,** and our own YELLOWSTONE NATIONAL PARK, where there are large areas of siliceous deposits left upon the evaporation of the waters poured out by the numerous springs and geysers. There are also many other springs in the United States whose waters carry free silicic acid. Among them are the geysers of **California.** As these waters also contain free sulphuric acid, they have been noted under the head of sulphated acid waters; but they are largely silicic also, and some of them are enumerated therefore in the following table, the contents being expressed in grains to the gallon:

	Grains of Silica in One Gallon	Total Solid Contents	Temperature in Degrees Fahrenheit
Lemonade Spring, ...	16.50	195.95	103
Acid Spring, ...	21.11	319.22	140
Alum Spring, ...	17.26	138.11	136
Mud Indian Spring, ...	12.25	150.20	100
Devil's Tea-kettle, ...	12.83	296.24	212

Of the several thousand springs within the limits of the Yellowstone National Park, less than fifty have been subjected to complete analysis. Most of the waters are of exceedingly high temperature, that of the geysers being at the boiling-point, which is here a little less than 200° F., on account of the high altitude—the geyser basins ranging from 7200 to 7500 feet above sea-level. The waters are quite heavily mineralized and nearly all contain arsenic in limited quantities, while many of them are strongly lithiated. Free carbonic acid and sulphureted hydrogen characterize many of the springs, although not present in great quantity except at a few localities.

The siliceous waters may be divided into sulphated and muriated, as are other acid waters; and if the free silica were eliminated, most of them would fall under the head of saline or alkaline-saline waters. In the following enumeration, which is far from complete, the percentage of silica is stated and the temperature and total solid contents are given.

	Percentage of Silica	Total Solid Contents, Grains in One U. S. Gallon	Temperature in Degrees Fahrenheit	Percentage of Sulphates
Sodic-calcic-magnesic sulphated:				
Cleopatra Spring (Mammoth Hot Springs),	2.48	121.64	159.8	33.79
Orange Spring (Mammoth Hot Springs),	2.94	101.54	145.4	41.81
Sodic-calcic sulphated and muriated:				
Hunter's Hot Spring, Montana,	4.52	16.85	168.0	0.04
Calcic-magnesic-sodic sulphated:				
Ferris Hot Springs, Montana,	4.61	34.34	122.0	0.34

	Percentage of Silica	Total Solid Contents, Grains in One U. S. Gallon	Temperature in Degrees Fahrenheit	Percentage of Chlorids
Sodic Muriated:				
Giantess Geyser (Upper Geyser Basin),	27.62	82.20	199.8	51.48
Fearless Geyser (Norris Geyser Basin),	25.60	95.02	191.4	67.55
Bee Hive Geyser (Upper Geyser Basin),	25.12	70.54	199.8	52.55
Asta Spring (Hillside Group),	24.40	39.05	187.2	23.49
Great Fountain Geyser (Lower Geyser Basin),	24.19	76.37	199.8	43.96
Fountain Geyser (Lower Geyser Basin),	23.69	81.03	179.6	39.85
Turban and Grand Geyser (Upper Geyser Basin),	21.83	81.03	195.8	44.53
Artemisia Geyser (Upper Geyser Basin),	18.40	86.28	192.0	32.55
Grotto Geyser (Upper Geyser Basin),	18.15	82.78	199.8	36.13
Splendid Geyser (Upper Geyser Basin),	18.14	95.02	199.8	32.72
Excelsior Geyser (Midway Basin),	15.04	85.70	197.6	31.85
Chrome Spring (Crater Hill),	13.05	166.32	197.6	60.22
Taurus Geyser (Shoshone Basin),	3.72	74.62	196.6	25.30
Sodic Potassic Muriated:				
Old Faithful Geyser (Upper Geyser Basin),	26.54	81.03	191.4	51.85
Hygeia Spring (Lower Geyser Basin),	20.98	68.79	109.4	34.63
Madison Spring (Gibbon River Basin),	11.37	76.65	140.0	9.97

CHALYBEATE WATERS

Chalybeate or **iron waters** may exist in connection with alkaline carbonates, sulphates, chlorids, or acids. Therefore they will be found under any of the four classes, according as the predominant form is a carbonate, a sulphate, or a chlorid. They may be thermal or nonthermal and also may occur under any one of the subdivisions depending on the gaseous constituent.

Chalybeate waters have a separate place in all the classifications cited in this article, but the reasons for not following these schemes have already been stated. An absolutely pure chalybeate water does not exist. The so-called pure chalybeates are really alkaline chalybeates. SPA, in Belgium, which may be considered a typical **alkaline chalybeate,** contains more sodic carbonate than iron carbonate, although the two are very nearly equal in quantity and are found in connection with larger quantities of magnesium and calcium carbonates. Other European chalybeate waters are SCHWALBACH, which is an **alkaline calcic-magnesic chalybeate,** and PYRMONT, which is an **alkaline-saline calcic-magnesic sulphated chalybeate,** and ST. MORITZ, which is a **saline calcic-sodic sulphated** water.

Distribution of Chalybeate Waters in the United States

In the United States chalybeate waters are found in nearly every state, as enumerated in previous pages. Alkaline chalybeates are found all along the **Atlantic border** of the country, frequently, as in the case of the chalybeate waters of **Massachusetts,** occurring in low grounds in connection with beds of bog iron ore. The iron is usually held in solution as a bicarbonate in connection with sodium bicarbonate. When this salt occurs in smaller quantity or is partly replaced by sulphates, we have the **alkaline-saline chalybeate,** or if it disappears entirely and only sulphates and chlorids occur, then we have a **saline chalybeate.** As we leave the coast and enter the region of the **Appalachians,** these waters become more frequent, and especially is this so in the vast area stretching from the Appalachians to the Rocky Mountains. Of course, even here chalybeate waters are found in connection with bog iron, especially in the Drift Beds, as **in Ohio**; but the primary seat of these waters is in the beds of pyritiferous shales that characterize the coal-bearing rocks that underlie so large a part of this region. Ferrous sulphate is formed in these shales by the action of oxygen and moisture, and this, with free sulphuric acid, which is also frequently found, acts upon the clay. In these changes we have the source of the chalybeate and alumino-chalybeate waters of this portion of the country. The remarks made in reference to the regions indicated apply also to the **Rocky Mountains** and other western areas of the country. As m of these chalybeate waters have already been enumerated, only a few of each class will be mentioned again and a comparison made with a few of the European chalybeates. Such comparisons, however, can be made only in a general way, as there are so many different ingredients in the waters and no two waters are exactly alike. Iron, to be effective medicinally, should exist in a quantity of at least one-half of a grain to the gallon.

	Salts of Iron, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Total Contents, Grains in One U. S. Gallon
Alkaline Chalybeates:			
Ojo Caliente, New Mexico (**thermal sodic chalybeate**), ...	5.90	95.32	135.54
Mardela Spring, Maryland (**calcic chalybeate**), ...	11.50	1.10	15.32
Massanetta Springs, Virginia (**calcic chalybeate**), ...	3.12	18.31	24.40
Napa Soda Springs (Pagoda Spring), California (**carbonated magnesic chalybeate**), ...	7.90	35.13	67.15
Sparta Magnetic Spring, Wisconsin (**magnesic chalybeate**), ...	11.94	3.85	19.25
Owosso Chalybeate Spring, Michigan (**calcic magnesic chalybeate**), . . .	15.92	44.76	63.40
Spa, Belgium (carbonated magnesic calcic chalybeate), ...	4.57	39.56	52.06
Schwalbach, Prussia (carbonated calcic magnesic chalybeate), ...	5.44	31.21	39 70

	Iron Salts, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Chlorids or Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Alkaline-saline Chalybeates (Sulphated):				
Buffalo Lithia Springs (No. 3), Virginia (**sulphated calcic chalybeate sulphocarbonated**), ...	3.77	4.37	5.54	14.47
Topeka Mineral Well, Kansas (**sulphated calcic-sodic chalybeate**), .	28.06	58.09	23.56	147.45
West Baden Springs, Indiana (**sulphated calcic-sodic magnesic alumino-chalybeate**), ...	3.00	34.36	168.00	301.87
Fulton Wells, California (**sulphocarbonated sulphated calcic-magnesic chalybeate**), ...	11.75	30.08	24.36	81.13
Green Spring, Oak Ridge, Ohio (**sulphated calcic-magnesic alumino-chalybeate**), ...	3.00	63.71	64.36	174.72
Pyrmont, Germany (**carbonated sulphated calcic-magnesic chalybeate**), ...	5.00	74.53	76.18	167.30

	Iron Salts, Grains in One U. S. Gallon	Alkaline Carbonates, Grains in One U. S. Gallon	Chlorids or Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Alkaline-saline Chalybeates (Muriated):				
Ukiah Vichy Springs, California (carbonated muriated sodic chalybeate), .	18.14	215.36	28.60	268.45
Americanus Mineral Well, Michigan (carbonated muriated calcic-sodic chalybeate), ...	3.06	246.51	183.84	503.90
Wilhoit's Soda Spring, Oregon (carbonated muriated magnesic-sodic chalybeate), ...	6.00	205.12	201.00	421.97
Pavilion Spring, Mt. d'Or, France (carbonated muriated calcic-sodic chalybeate), ...	1.12	71.28	16.24	99.77

	Iron Salts, Grains in One U. S. Gallon	Sulphates, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Saline Chalybeates (Sulphated):			
Austin's Springs, Tennessee (sodic-magnesic chalybeate), ...	14.60	24.80	46.00
Cresson Alum Spring, Pennsylvania (calcic-magnesic alumino-chalybeate),	44.64	90.28	145.46
Versailles Medical Springs, Illinois (calcic-magnesic alumino-chalybeate), .	22.42	167.82	192.93
Eldorado Springs, Park Spring, Missouri (carbonated calcic-sodic chalybeate), ...	3.39	3.12	10.47
St. Moritz, Switzerland (carbonated calcic-sodic chalybeate), ...	2.39	125.94	172.00
Saline Chalybeates (Muriated):		Chlorids	
Erckenbrecker's Salt Well, Ohio (sodic chalybeate), ...	54.46	5628.75	5738.10
Aurora Round Spring, Missouri (sodic chalybeate), ...	6.06	10.96	20.87
Acid Chalybeate:		Sulphates	
Oak Orchard Acid Spring, New York (sulphated calcic-alumino-chalybeate), ...	28.62	172.66	314.42

ARSENIC WATERS

Arsenic occurs in many mineral waters, but never in sufficiently large proportion to classify the waters according to our scheme. In many of them it is in such small quantity that it is doubtful if it exercises any therapeutic action when utilized medicinally. In some waters, however, it does exist in appreciable and effective quantity, even if it is not enough to entitle the water to be placed in a distinct class. Weber makes 'arsenical waters' one of the principal subdivisions of his scheme; this is not the case, however, in the other classifications. The arsenic usually occurs as sodium arsenate or as arsenic acid, associated usually with salts of iron.

The waters of LA BOURBOULE, in France (carbonated sodic muriated), belonging to the first division of the bicarbonated class of the French scheme, may be taken as typical arsenic waters. Some of the spring-waters of the YELLOWSTONE NATIONAL PARK are said to be comparable to those of La Bourboule.

Arsenic occurs in a number of American springs other than those of the Yellowstone Park, particularly in the southern Appalachians. The amount of arsenic contained in the waters of the latter region is frequently little more than a trace, and in those of the Yellowstone Park thus far analyzed it is only a fraction of one per cent. of the solid contents. CROCKETT ARSENIC LITHIA SPRING, MASSANETTA SPRINGS, and ROCKBRIDGE ALUM SPRINGS of Virginia, and the THOMPSON BROMINE-ARSENIC SPRING of North Carolina, may be mentioned as waters of this description in the eastern section of the country.

The principal waters containing arsenic among the Yellowstone Park springs are the following:

	PERCENTAGE OF SODIUM ARSENATE	TOTAL SOLID CONTENTS, GRAINS IN ONE U. S. GALLON
Hygeia Spring (Lower Geyser Basin),	0.41	68.79
Pearl Geyser (Norris Geyser Basin),	0.30	91.19 (?)
Chrome Spring (Hayden Valley),	0.25	166.32
Excelsior Geyser (Midway Geyser Basin),	0.23	85.70
Cleopatra Spring (Mammoth Hot Springs),	0.20	121.64
Old Faithful Geyser (Upper Geyser Basin),	0.19	81.03
Fountain Geyser (Lower Geyser Basin),	0.18	81.03
Great Fountain Geyser (Lower Geyser Basin),	0.17	76.37
Splendid Geyser (Upper Geyser Basin),	0.15	95.02
Bee Hive Geyser (Upper Geyser Basin),	0.12	70.54
Artemisia Geyser (Upper Geyser Basin),	0.12	86.28
Constant Geyser (Norris Geyser Basin),	0.11	94.44
Turban and Grand Geyser (Upper Geyser Basin),	0.10	81.03

Other spring-waters containing arsenic, usually as sodium arsenate, are as follow:

	ARSENIC SALTS, GRAINS IN ONE U. S. GALLON	TOTAL SOLID CONTENTS, GRAINS IN ONE U. S. GALLON
Arsenic Spring, HARBIN SPRINGS, California,	0.27	52.16
Hot Sulphur Spring, HARBIN SPRINGS, California,	0.07	28.63
Crockett Arsenic Lithia Spring, Virginia,	0.02	18.35
Swineford's Arsenic Lithia Spring, Virginia,	0.007	1.64

Traces of arsenic are found also in the Orkney spring-water, also ... Blue Ridge Springs and Washington Springs, in Virginia; at Ashley

Bromide and Arsenic Spring, Ashe County, North Carolina, and at Anderson's Springs and Santa Barbara Sulphur Springs, in California.

LITHIA WATERS

The fact that a water contains **lithium**, even if in the most minute quantity appreciable by chemical analysis, will probably be expressed in the name given to the spring whence it is obtained. Spectroscopic examination will reveal the presence of lithium in nearly all waters. In many, it exists only as a trace, and in others is less than half a grain to the gallon. Lithiated waters are found in every section of this country and in many European springs, as in those of BADEN-BADEN and ROYAT.

In the **United States** such waters are found in **Virginia, Massachusetts, New Hampshire,** and many other States, but are most notable at SARATOGA in **New York,** and in the YELLOWSTONE NATIONAL PARK. The lithium occurs usually as a chlorid or sulphate, and sometimes as the carbonate. In the latter case the water would be classified under the head of the **alkalines,** and in the former two either under the **salines** or **alkaline-salines.**

Among springs producing water of this character, according to published analyses, are the following:

	Lithium Salts, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
BALLARDVALE Lithia Spring, Massachusetts,	22.01	13.57
GENEVA Red Cross Lithia Spring, New York,	16.09	210.01
Pack Monadnock Lithia Spring, New Hampshire,	15 41	24.06
Clinton Lithia Spring, FRANKLIN SPRINGS, New York,	13.34	109.60
Shelbyville Lithia Spring, Indiana,	12.06	874.85
Rex Ferro Lithia Springs, Ohio,	12.05	1,052.19
GENEVA Lithia Water, New York,	10.03	243.33
HOWARD SPRINGS, Arkansas,	8.35	156.84
Artesian Lithia Spring, BALLSTON SPA, New York,	7.75	1,233.25
LONDONDERRY Lithia Spring, New Hampshire,	7.29	74.85
Franklin Artesian Well, BALLSTON SPA, New York,	6.78	1,183.37
NYE Lithia Springs, Virginia,	6.41	18.54
ARKANSAS Lithia Spring, Arkansas,	6.35	73.21
Franklin Lithia Springs, FRANKLIN SPRINGS, New York,	5.25	349.09
BOWDEN Lithia Springs, Georgia,	4.45	185.74
CUYAHOGA Lithia Well, Ohio,	4.26	791.58
FARMVILLE Lithia Springs, Virginia,	3.76	26.38
ÆTNA Lithia Springs, Virginia,	3.64	42.73
PAGOSA SPRINGS, Colorado,	3.28	351.09
Silver King Spring, EASTMAN SPRINGS, Michigan,	3.03	13.57
CUYAHOGA Bitter Water Spring, Ohio,	2.74	515.82
VERONA Mineral Springs, New York,	2.38	781.29
Harris Lithia Spring, South Carolina,	2.32	111.68
BUFFALO Lithia Springs, Virginia,	2.25	98.36
BATH Alum Spring (No. 2), Virginia,	1.71	65.38
KIRKLAND MINERAL SPRING, near Clinton, New York,	1.51	437.94
Round Spring, AURORA, Missouri,	1.43	20.87
IDAN-HA Spring, Idaho,	1.27	152.06
Lithium Spring, ATTICA, Indiana,	1.16	390.6f
WEBSTER Salt Sulphur Spring, West Virginia,	1.06	414.2
Iron Lithia Springs, Virginia,	0.18	23.5

Lithium occurs in all the SARATOGA Spring-waters. The following table gives the proportion in grains to the gallon. The lithium occurs mainly in the form of bicarbonate.

	Lithium Salts, Grains in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Hathorn Spring,	11.45	888.40
New Putnam Spring,	9.83	640.03
Pavilion Spring,	9.49	687.28
Geyser Spring,	9.00	991.54
Champion Spring,	6.25	1,195.58
Kissingen Spring,	5.13	644.63
United States Spring,	4.85	331.84
Congress Spring,	4.76	700.90
Crystal Spring,	4.33	537.15
Flat Rock Spring,	3.23	270.53
Union Spring,	2.61	697.17
Empire Spring,	2.08	680.44
Vichy Spring,	1.76	367.32
Saratoga A or Alum Spring,	1.72	658.63
Star Spring,	1.50	617.37
Red Spring,	0.94	255.68
Seltzer Spring,	0.90	302.02

Lithium is found in traces or in quantities less than one-tenth of a grain to the gallon in many other springs. Among them are the following, some of which have not been analyzed accurately:

Crockett Arsenic and Lithia Spring, Virginia.
Swineford's Arsenic Lithia Spring, Virginia.
Fonticello Lithia Spring, Virginia.
Bear Lithia Springs, Virginia.
Beaufont Lithia Springs, Virginia.
Virginia Waukesha Lithia Springs, Virginia.
Chase City Lithia Springs, Virginia.
Otterburn Lithia and Magnesia Springs, Virginia.
Bear Lithia Springs, Virginia.
Elk Lithia Springs, Virginia.
Seawright Magnesian Lithia Springs, Virginia.
Lake Como Lithia Spring, Virginia.
Houston Lithia Well, Virginia.
Powhatan Lithia and Alum Springs, Virginia.
Jeffress Lithia Springs, Virginia.
Golindo Lithia Springs, Virginia.
Roanoke Red Sulphur Springs, Virginia.
Orkney Springs, Virginia.
Dagger's Spring, Virginia.
Wolf Trap Lithia Spring, Virginia.
Mida Spring near Charlotte, North Carolina.
Vade Mecum Spring, Stokes County, North Carolina.
Thompson Bromine-Arsenic Springs, Ashe County, North Carolina.
Artesian Lithia Well, Austell, Georgia.
Louch Lithia Spring, Austell, Georgia.
Medlock Lithia Spring, Austell, Georgia.
Sulpho-Magnesia Lithia Spring, Austell, Georgia.
Columbia Natural Lithia Spring, District of Columbia.
Cloverdale Lithia Spring, Pennsylvania.
Tuscarora Lithia Spring, Pennsylvania.
Tuckahoe Lithia Spring, Pennsylvania.
East Mountain Lithia Well, Pennsylvania.
Binghampton Vichy Spring, New York.
Sizer Magnetic Mineral Spring, Pennsylvania.
Cresson Alum Spring, Pennsylvania.
Split Rock Natural Lithia Spring, New York.
Old Sweet Lithia Springs, Vermont.
Buckeye Lithia Spring, Belmont County, Ohio.
Ripley Bromo-lithia Springs, Ohio.
Odovene Natural Spring. Ohio.
Columbia Lithia Spring, Massachusetts.
Welcome Island Lithia Springs, Michigan.
White Rock Mineral Spring, Waukesha, Wisconsin.
Aurora Lithia Spring, Illinois.
Wright's Epsom Lithia Well, Tennessee.
Arundel Lithia Springs, Mississippi.
Deseret Lithia Springs, Utah.
Ojo Caliente, New Mexico.
Manitou Springs, Colorado.
Anderson Springs, California.
Bartlett Springs, California.

El Paso de Robles Springs, California.	Litton Seltzer Springs, California.
Eureka Springs, California.	Napa Soda Springs, California.
Harbin Springs, California.	Skaggs's Hot Springs, California.
Highland Springs, California.	Ukiah Vichy Springs, California.

Among the springs of YELLOWSTONE NATIONAL PARK, the following contain lithium in the greatest quantity:

Bee Hive Geyser (Upper Geyser Basin),	3.05 per cent.
Fountain Geyser (Lower Geyser Basin),	3.02 "
Artemisia Geyser (Upper Geyser Basin),	2.86 "
Old Faithful Geyser (Upper Geyser Basin),	2.44 "
Giantess Geyser (Upper Geyser Basin),	2.44 "
Fountain Geyser (Lower Geyser Basin),	1.52 "
Grotto Geyser (Upper Geyser Basin),	1.75 "
Hygeia Spring (Lower Geyser Basin),	1.64 "
Turban and Grand Geyser (Upper Geyser Basin),	1.57 "
Splendid Geyser (Upper Geyser Basin),	1.41 "
Constant Geyser (Norris Geyser Basin),	1.14 "

CARBONATED WATERS

Carbonic acid gas is present in nearly all waters in large or small proportions, but a water is not usually designated as **carbonated** unless it is present in excess. It is more frequently found in the alkaline waters, but may occur in those of all classes, whether thermal or nonthermal, and frequently exists in connection with free sulphureted hydrogen, when the water is termed **sulphocarbonated.** It is in the saline and alkaline-saline classes that the sulphocarbonated waters are of most frequent occurrence. When carbonic acid is in excess, the salts exist as bicarbonates. The French classification makes bicarbonated waters one of the principal divisions of the scheme, while the German makes them a subdivision of the alkaline waters, as does Walton. The carbonated waters of the **United States** are indicated under the heads of the Alkaline, Alkaline-saline, Saline, and Acid classes. To enumerate them here would require too much space, as most of them have already been referred to under the various classes. Comparatively few published analyses give the exact amounts of carbon dioxid that occur in the waters as found at the springs. Very often it is said to be present 'in large quantity' or 'in excess,' or the water is said to be 'saturated' with it. Hence it is difficult to make an accurate comparison of carbonated waters. The following list gives a few American waters containing large quantities of the gas, the four classes being represented. Others will be seen upon reference to preceding lists.

	CARBON DIOXID, CUBIC INCHES IN ONE U. S. GALLON
Saratoga Springs, New York (calcic-sodic muriated alkaline-saline),	212–963
Salutaris Spring, Michigan (sodic-calcic muriated alkaline-saline),	465.32
Ballston Spa, New York (calcic-magnesic-sodic muriated alkaline-saline),	244–460
Litton Seltzer Springs, California (calcic-sodic chalybeate muriated alkaline-saline),	375.60

	Carbon Dioxid, Cubic Inches in One U. S. Gallon
Adams Spring, California (sodic-magnesic-alkaline),	304.00
Bartlett Springs, California (calcic alkaline),	242.10
Ukiah Vichy Springs, California (sodic chalybeate muriated alkaline-saline),	224.75
Summit Soda Springs, California (sodic chalybeate muriated alkaline-saline),	187.25
Azule Springs, California (sodic-magnesic muriated alkaline-saline),	153.77
Iola Mineral Well, Kansas (calcic muriated alkaline-saline),	145.89
Pagoda Spring, Napa Soda Springs, California (magnesic chalybeate alkaline),	143.62
Glen Alpine Springs, California (calcic-sodic alkaline),	138.36
Skaggs's Hot Springs, California (thermal sodic borated alkaline),	124.00
Howard Springs, California (magnesic-sodic muriated alkaline-saline),	117–150
Lansing Magnetic Well, Michigan (sodic muriated alkaline-saline),	235.55
Sweet Chalybeate Springs, Red Spring, Virginia (calcic-magnesic chalybeate sulphated saline),	46.10
Fruitport Well, Michigan (sodic-calcic muriated saline),	7.00
Iron Lithia Springs, Virginia (magnesic alumino-chalybeate acid),	5.20

AZOTIZED WATERS

Nitrogen exists in small quantities in most waters, and is occasionally found in excess with other gases or alone. Nearly all the springs noted as containing free oxygen also contain nitrogen. Nitrogen is found free in many European waters, among which are those at Leuk, in Switzerland. In this country we find it in the following, among others:

	Cubic Inches in One Gallon
Pluto's Well, French Lick Springs, Indiana,	18.68
Indian Springs, Indiana,	7.48
Lafayette Artesian Well, Indiana,	54.88
Cameron Springs, Indiana,	4.46
Ravenden Springs, Arkansas,	1.33
Warm Springs, Arkansas,	21.10
El Paso De Robles Springs, California,	Traces
Cooper's Well, Mississippi,	36.00
Hot Springs, Virginia (Boiler Spring),	1.79
Sweet Chalybeate Springs, Virginia,	2.57
Wolf Trap Lithia Springs, Virginia,	3.60
Gray Sulphur Springs, West Virginia,	3.07
Blount Mineral Springs, Alabama,	7.08
Helicon Springs, Georgia,	10.98
West Baden Springs, Indiana,	20.27
Strontia Spring, Maryland,	1.22
Avon Sulphur Springs, New York,	5.42
Lebanon Thermal Spring, New York,	3.52
Three Springs, Huntingdon County, Pennsylvania,	3.85
Clarendon Springs, Vermont,	9.60
Bedford Alum Springs Virginia,	3.33
Rawley Springs, Virginia,	4.18
Rockbridge Alum Springs, Virginia,	3.19–4.19
Berkeley Springs, West Virginia,	64.30
Capon Springs, West Virginia,	3.71
Greenbrier White Sulphur Springs, West Virginia,	4.64
Old Sweet Spring, West Virginia,	4.31
Jordan Alum Springs, Virginia,	8.56
Orkney Springs, Virginia,	2.48
Blue Sulphur Springs, West Virginia,	7.49

OXYGENATED OR OZONATED WATERS

There is a considerable number of spring-waters in which free **oxygen** occurs in large quantity, usually with nitrogen or with carbonic acid gas. In small quantities it is found in nearly all mineral waters. According to Weber, some of the waters found under the head of 'simple' or 'indifferent waters' of his classification contain an unusual amount of oxygen. In the **United States** also they are not uncommon. One of the principal springs of this description, the water of which contains a large quantity of free oxygen gas, is found at BREESEPORT in **New York.** The White Rock spring-water of WAUKESHA, Wisconsin, as put on the market, is also oxygenated. Other waters containing oxygen are:

	CUBIC INCHES IN ONE U. S. GALLON
Berkeley Springs, West Virginia,	16.60
Blount Mineral Springs, No. 4, Alabama,	7.08
Bedford Iron and Alum Springs, Virginia,	1.32
Louisville Artesian Well, Kentucky,	1.36
Avon Sulphur Springs, New York,	0.57–0.97
Jordan Alum Springs, Virginia,	1.11–1.62
Ponce de Leon Springs, Pennsylvania,	7.23 [1]
Massanetta Springs, Virginia,	8.44
Red Spring, Sweet Chalybeate Springs, Virginia,	0.46
Lebanon Thermal Spring, New York,	2.00
Strontia Mineral Spring, Maryland,	0.82
Clifton Springs, New York,	10.21 [1]
Orkney Springs, Virginia,	1.64
Rockbridge Alum Springs, Virginia,	1.11–4.12
West Baden Springs, Indiana,	6.35

CARBURETED WATERS

Carbureted hydrogen characterizes a few mineral waters, especially in regions where natural gas occurs, as in **Western Pennsylvania** and portions of the **middle West.** Such waters are comparatively rare. Abroad we find them at PORETTA, in **Italy,** where the thermal muriated waters contain the gas in connection with sulphureted hydrogen. ACIREALE, in **Sicily,** also has a muriated water, containing carbureted hydrogen, with nitrogen, carbonic acid, and hydrogen sulphid. In the **United States** we have the following springs of this description:

	CUBIC INCHES IN ONE U. S. GALLON
Young's Mineral Springs, Lake County, California,	More than traces
Magnetic Mineral Springs, Vigo County, Indiana,	" " "
Tilford's Mineral Well, Tennessee,	" " "
Lauderdale Springs, Mississippi,	Traces
Byron Hot Springs, California,	More than traces
Massanetta Springs, Virginia,	2.25
Raleigh Mineral Springs, Tennessee,	Traces
Halleck's Spring, New York,	Traces

[1] With nitrogen.

SULPHUR WATERS

As frequently stated in this article, by **sulphur waters** is usually meant those in which the gaseous ingredient is **hydrogen sulphid,** or, as it is commonly called, **sulphureted hydrogen.** Other sulphids may and usually do coexist, but not in sufficient quantity to classify the waters. The gas, as we have noted, may characterize any class of waters, and in our scheme, therefore, the term 'sulphur waters' is not given a place coordinate with the terms 'alkaline,' 'saline,' and 'acid,' as it is in all the other classifications. Among other waters included under this head by Dr. Kisch, are the cold waters of EILSEN, in **Lippe Schaumberg,** LANGENBRUECKEN of **Baden,** MEINBERG of **Lippe Detmold,** and NENNDORF, in **Prussia.** Under thermal sulphur waters he places AACHEN, or Aix-La-Chapelle, of **Rhenish Prussia,** BADEN near Vienna in **Austria,** and BAGNÈRES-DE-LUCHON, in **France.** Dr. Weber also places these waters under the same head. They would be arranged in the same category in the French classification, and Walton also tabulates them similarly. Under our scheme, Eilsen is a **sulphureted calcic sulphated saline** water; Langenbruecken, a **sulphureted sulphated saline** water; Meinberg, a **sulphureted calcic-sodic sulphated alkaline-saline** water; and Nenndorf, a **sulphureted calcic-sodic sulphated saline** water. The waters of Aachen would be classed as **thermal sulphocarbonated and oxygenated sodic-muriated alkaline-saline;** Baden, near Vienna, as **thermal sulphureted calcic sulphated saline;** and Bagnères-de-Luchon, as **thermal sulphureted sodic muriated saline.**

In the **United States** sulphureted waters have a wide distribution, and there is scarcely a State that does not have within its borders a sulphureted spring; but they occur especially in the mountainous portions of the country and where volcanic rocks are found. Therefore many of them are thermal. The source of the hydrogen sulphid is to be found in the reduction of the sulphates of the alkaline earths by organic matter, either under pressure or by heat or both combined. In the brines or sodic muriated saline waters it may result simply from the action of organic matter upon calcium sulphate in the presence of carbon dioxid. Besides the free hydrogen sulphid, which exists, of course, in the gaseous form, there may be present other sulphids, sulphhydrates, and thiosulphates (sulphates in which one atom of the oxygen in the water of the sulphuric acid is replaced by sulphur), and these waters usually contain carbonates or alkaline carbonates. Professor Paul Schweitzer, of the Missouri Geological Survey, in writing of the sulphur waters of the State makes the positive statement that all sulphur waters must contain carbonates, and perhaps alkaline carbonates, to properly bind the hydrogen sulphid. Hence we are apt to find them under the head of the **alkaline-saline** waters and they are frequently **sulphocarbonated.** In all waters which are perceptibly sulphureted the thiosulphates are probably present. Those waters most strongly alkaline usually contain the sulphids, and those feebly so the sulphydrates. The soluble sulphids are rather unstable and easily decomposed. They are rarely fully determined in mineral water analyses because a part of the necessary work of analysis must be done at the spring. The majority of water analyses are therefore confessedly incomplete so far as the estimation of the gases is concerned. It is probable that more careful work would determine the presence of carbon dioxid in most, if not all, of the waters in the following lists, and possibly in the second list other sulphids would be found in the waters coexisting with hydrogen sulphid.

It has always been more or less questionable whether waters containing hydrogen sulphid alone, so far as sulphur compounds are concerned, produce any medicinal effects when used for drinking. Some authorities hold that only such waters as contain other sulphids, in addition to the sulphureted hydrogen, are physiologically effective; basing that opinion on the ground that the free gas taken internally in solution in the water is rapidly thrown off from the body without producing any apparent effect, whereas if it is eliminated from sulphids already in the circulation, they assert that its effect upon the organism is then both quick and powerful. Other writers are equally positive that the hydrogen sulphid, even when existing alone, has a therapeutic effect; but it must be remembered that small quantities of the other sulphids may be present in a water and have escaped detection. If the presence of the other sulphids is absolutely essential, then the only true sulphur waters would be those containing such compounds. These, as already noted, are unstable, and when present are usually found in small quantity in proportion to the total solid contents. However, in the table following the waters are arranged in accordance with the amount of the sulphids as stated in the published analyses, the first column of the table showing the amount present in each case. It is altogether probable that if some of the analyses were recombined, some of the sulphids would be expressed as sulphates. It will be noted that nearly half the waters in the table are sulphocarbonated—a proportion that would doubtless be increased were the analyses complete. A large proportion also is seen to fall under the head of alkaline-salines in accordance with what has been said as to the necessity of alkaline carbonates to hold the sulphids.

Some of the analyses given in the following table should possibly be remade, or at least recombined into the probable combinations. If this were done, it is possible that the proportion of the sulphids might be somewhat lowered.

	Sulphids other than Hydrogen Sulphid, Grains in One U. S. Gallon	Hydrogen Sulphid, Cubic Inches in One U. S. Gallon	Carbon Dioxid, Cubic Inches in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Alpena Magnetic Spring, Michigan (sodic-muriated saline),	210.61	7.38		534.39
Avon Sulphur Springs, Congress Hall Spring, New York (calcic-magnesic sodic-sulphated, and muriated alkaline-saline),	99.55	27.63	22.04	205.61
West Nashville Sulphur Springs, Tennessee (calcic sodic muriated alkaline-saline),	11.85	5.84		122.55
Cascade Springs, Tennessee (calcic-sodic muriated saline),	9.76	23.04		59 88
Ypsilanti Moorman Well, Michigan (sodic-muriated saline),	8.42	26.84		2256.26
Fernvale Springs, Tennessee (calcic-magnesic sulphated alkaline-saline),	8.22	16.64		73.84
Jones Sulphur Well, Tennessee (calcic-sodic sulphated alkaline-saline),	7.13	1.17	14.75	30.25
Hurricane Springs, Tennessee (calcic-sodic muriated alkaline-saline),	5.86	1.16	14.26	43.75
El Paso de Robles White Sulphur Spring, California (sodic-magnesic sulphated and muriated saline),	5.10	9.40	5.25	112.85
Sharon White Sulphur Spring, New York (calcic-magnesic sulphated alkaline-saline),	3.00	20.50		149.10
St. Helena White Sulphur Springs (No. 2), California (sodic-muriated saline),	2.65	6.15		36.69
Primm's Springs (No. 2), Tennessee (calcic-magnesic sulphated saline),	2.57			81.53
Florida Spring, New York (sodic-magnesic-muriated alkaline-saline),	2.19	3.76	32.17	48.39
Montesano Springs, Council Spring, Missouri (sodic-calcic muriated alkaline-saline),	1.97	1.43	34.30	393.77
St. Helena White Sulphur Springs (No. 6), California (sodic-muriated saline),	1.85	4.25		42.68
Montesano Springs, Thorn Spring, Missouri (sodic-calcic muriated alkaline-saline),	1.74	1.59	43.24	535.99
Richfield White Sulphur Spring, New York (calcic-magnesic sulphated alkaline-saline),	1.81	14.21		154.28
Chittenango Magnesic Spring, New York (calcic-chalybeate sulphated alkaline-saline),	1.68	5.62	19.44	153.35
Montesano Springs, Pearl Spring, Missouri (sodic-calcic muriated alkaline-saline),	1.64	1.76	44.14	530.94
Crisp Springs, Tennessee (calcic-magnesic sulphated alkaline-saline),	1.35	9.47		77.20
Cherry Valley, Bath House Spring, New York (calcic magnesic sulphated alkaline-saline),	0.60			140.71
Elliott's Well, Cass Co., Missouri (sodic-chalybeate alkaline-saline),	0.60	0.26		102.03

	Sulphids other than Hydrogen Sulphid, Grains in One U. S. Gallon	Hydrogen Sulphid, Cubic Inches in One U. S. Gallon	Carbon Dioxid, Cubic Inches in One U. S. Gallon	Total Solid Contents, Grains in One U. S. Gallon
Grayson Springs, Eye Spring, Kentucky, (calcic-magnesic sulphated alkaline-saline),	0.58	1.39		104.91
Orkney, Powder Spring, Virginia (sodic-calcic alkaline), ...	0.53	5.91	8.62	20.89
Tilford's Mineral Well, Tennessee (sodic-sulphated alkaline-saline), ...	0.45	Trace	14.00	36.16
Montesano Springs, Casco Spring, Missouri (sodic-calcic muriated alkaline-saline),	0.43	1.60	43.20	541.62
Montesano Springs, Montesano Spring, Missouri (sodic-calcic muriated alkaline-saline), ...	0.34	1.40	64.43	538.58
Montebello Spring, Vermont (calcic-alkaline), ...	0 32			37.60
McClelland's Well, Cass Co., Missouri (sodic-sulphated alkaline-saline), ...	0.12	Present		120.59
Powder Springs (Spring No. 3), Georgia (Magnesic-calcic sulphated alkaline-saline),	0.05	75.00		21.36
Lebanon Thermal Spring, New York (calcic-magnesic sulphated alkaline-saline),	0.02		0.48	24.38

In the table following are given a number of springs arranged in order according to the amount of hydrogen sulphid gas contained; only this and the carbon dioxid being here stated. Many more springs of this character might be included, but a sufficient number is given to show that sulphureted waters are distributed according to their solid contents in all the classes with the exception possibly of the alkaline class. The springs given in this table are those in which other sulphids than that of hydrogen are not mentioned as being present. It must be borne in mind, however, that solid sulphids may coexist with the hydrogen sulphid and may have escaped detection, or may have been present in very small quantity. Other sulphureted waters will be found not only in the table just preceding, but among those waters enumerated in previous pages under the heads of alkaline-saline, saline, and acid classes.

	Hydrogen Sulphid, Cubic Inches in One U. S. Gallon	Carbon Dioxid, Cubic Inches in One U. S. Gallon
Cold Sulphur Springs, Virginia (calcic-alumino-chalybeate), ...	253.00	5.65
Lane's Mineral Springs, California (magnesic chalybeate sulphated acid), ...	105.00	
Cullum's Sulphur Spring, Alabama (sodic-potassic muriated alkaline-saline), ...	97.10	
Talladega Spring, Alabama (sodic-calcic sulphated alkaline-saline), ...	82.00	

	Hydrogen Sulphid, Cubic Inches in One U. S. Gallon	Carbon Dioxid, Cubic Inches in One U. S. Gallon
Clark's Riverside Mineral Spring, Michigan (calcic-magnesic-sodic sulphated and muriated saline), . . .	40.76	
Crocker Springs, Tennessee (calcic sodic-magnesic sulphated alkaline saline), ...	40.25	37.99
Mt. Clemens Mineral Springs, Michigan (sodic muriated saline), ...	40.00	5.85
French Lick Springs, Indiana (calcic-magnesic sulphated alkaline saline), ...	17.00	10.12
Anderson Springs, Bellmer Spring, California (calcic-sodic-magnesic alkaline-saline), ...	9.47	149.60
Anderson Springs, Sulphur Spring, California (calcic-sodic magnesic alkaline-saline), ...	4.20	243.50

In comparatively few analyses are the gases estimated with accuracy, and in many it is simply stated that sulphureted hydrogen is present or that it is 'in excess,' or, as in the case of some of the California Geyser Springs, the water is said to be 'saturated' with it. The following list, arranged alphabetically by States, gives some of the many sulphureted waters of the United States in which the gas is not very exactly estimated:

Alabama:
White Sulphur Springs, Clarke County

Alaska:
Sitka Warm Sulphur Springs

Arkansas:
Black Sulphur Springs, Van Buren County
Dardanelle Sulphur Springs, Yell County
Sulphur Springs, Benton County

California:
Blank's Hot Sulphur Springs, Colusa County
Las Cruces Hot Springs, Santa Barbara County
Matilija Hot Springs, Ventura County
Montecito Hot Springs, Santa Barbara County
Ojai Hot Sulphur Springs, Ventura County
Piedmont White Sulphur Springs, Alameda County
San Marcos Sulphur Springs, Santa Barbara County
Santa Rosa Hot Sulphur Springs, Sonoma County
Simmons Hot Sulphur Springs, Colusa County
Tassajara Hot Springs, Monterey County
Vallejo Sulphur Springs, Solano County
Warm Sulphur Springs, Kern County

Colorado:
Hartsel Hot Mineral Springs, Park County

Steamboat Springs, Routt County
Tomichi Hot Springs, Gunnison County

Connecticut:
Sulphur Spring near Litchfield, Litchfield County

Florida:
Newport Sulphur Springs, Wakulla County
Suwanee Sulphur Springs, Suwanee County
White Sulphur Springs, Hamilton County

Georgia:
Catoosa White Sulphur Spring, Catoosa County
Oconee White Sulphur Springs, Hall County
White Sulphur Springs, Meriwether County

Idaho:
Warm Sulphur Springs, Idaho County

Illinois:
Perry Springs, Pike County
Ross Mineral Springs, Saline County

Indiana:
Eaton's White Sulphur Well, Crawford County
Hartford Sulphur Springs, Ohio County
Indian Springs, Martin County

Iowa:
White Sulphur Springs, Scott County

Kansas:
Fort Scott Artesian Well, Bourbon County
Sulphur Springs, Cloud County

Kentucky:
Chameleon Springs, Edmonson County
Olympian Springs, Sulphur Spring, Bath County
White Sulphur Mineral Springs, Warren County
White Sulphur Well, Metcalf County

Louisiana:
White Sulphur Springs, Catahoula Parish

Maine:
Boothbay Medicinal Spring, Lincoln County
West Newfield Spring, York County

Maryland:
Carroll White Sulphur Springs, Alleghany County
Windsor Sulphur Springs, Carroll County

Michigan:
St. Clair Mineral Springs, St. Clair County
Wyandotte White Sulphur Spring, Wayne County

Mississippi:

Castalian Springs, Holmes County
Quitman Red Sulphur Springs, Clarke County
White Sulphur Springs, Jasper County

Montana:

Boulder Hot Springs, Jefferson County
Livingston Warm Springs, Park County
White Sulphur Springs, Meagher County

Nebraska:

Saratoga Sulphur Springs, Holt County

Nevada:

Golconda Hot Springs, Humboldt County
Mineral Hill Hot White Sulphur Springs, Eureka County
Sodaville Sulphur Springs, Esmeralda County
Whelan's White Sulphur and Mineral Springs, Eureka County

New Mexico:

Ojo Azufre, Bernalillo County
Stinking Springs, Valencia County
Warm Sulphur Spring, Taos County

New York:

Columbia White Sulphur Springs, Columbia County
Messena Sulphur Springs, Onondago County
Yates Sulphur Springs, Madison County

North Carolina:

Blackwell's White Sulphur Springs, Buncombe County
Cleveland White Sulphur Springs, Cleveland County
Haywood White Sulphur Springs, Haywood County
Warm Springs, Madison County

North Dakota:

Devil's Lake Sulphur Springs, Ramsey County

Ohio:

White Sulphur Springs, Delaware County
Wyandot Magnetic Well, Wyandot County

Oklahoma:

Granite White Sulphur Springs, Greer County

Oregon:

Sulphur Springs, Douglas County
White Sulphur Springs, Clackamas County

Pennsylvania:

Bedford Sulphur Spring, Bedford County
Kane Sulphur Spring, McKean County
White Sulphur Springs, Bedford County
York Sulphur Springs, Adams County

South Dakota:

Wessington Springs, Jerauld County

Tennessee:

Black Sulphur Springs, Grainger County
Hales Red and White Sulphur Springs, Hawkins County
Pickwick Red and White Sulphur Springs, Hardin County
White Sulphur Springs, Hamblen County
Yellow Sulphur Springs, Carter County

Texas:

Duffaus Sulphur Wells, Erath County
Sulphur Springs, Hopkins County
White Sulphur Springs, Cass County

Utah:

Beck's Hot Sulphur Springs, Salt Lake County
Salt Lake City Warm Springs, Salt Lake County

Virginia:

Fauquier White Sulphur Springs, Fauquier County
Jordan's White Sulphur Springs, Frederick County
Montgomery White Sulphur Springs, Montgomery County
Roanoke Red Sulphur Springs, Roanoke County
Yellow Sulphur Springs, Montgomery County

Washington:

Sulphur Spring, Garfield County

West Virginia:

Addison Sulphur Springs
Blue Sulphur Springs, Greenbrier County
Columbia White Sulphur Springs, Greenbrier County
Greenbrier White Sulphur Springs, Greenbrier County
Green Sulphur Springs, Summers County
Grey Sulphur Springs, Monroe County
Red Sulphur Springs, Monroe County
Salt Sulphur Springs, Monroe County

Wyoming:

Cascade Creek Sulphur Springs, Yellowstone National Park
Rawlins's Sulphur Springs, Carbon County
Sulphur Springs near Camp Brown, Fremont County

PART I

MINERAL WATERS AND THEIR USES

PART I

MINERAL WATERS AND THEIR USES

Section I

MINERAL BATHS

CHAPTER I

CONSTITUTION AND GENERAL EFFECTS OF MINERAL BATHS

Definition. Lack of Absorption. The Promotion of Absorption. Endosmosis and Exosmosis. Other Factors in the Efficacy of Mineral Baths—Chemical Stimulation; Gaseous Interchange; Electric Irritation; Thermic Irritation; Mechanical Irritation; Influence upon the Blood and General Metabolism. Classification of Mineral Baths.

Definition

By the term mineral baths we understand baths that are prepared with waters naturally characterized by the presence of a large proportion of solid or gaseous constituents, or by their peculiarly high temperature; also baths artificially prepared, in which are employed as media the gases, vapors, or salts derived from mineral springs. The physiologic and the therapeutic actions of mineral baths differ from those of ordinary baths especially in the fact that the former excite notably different forms of cutaneous reaction.

Lack of Absorption

That circumstance upon which, formerly, a particular emphasis was placed in estimating the value of mineral baths—namely, that the constituents of the mineral water employed for the bath were capable of exerting a direct influence by absorption into the blood—has been forced into the background by recent investigation. The question as to whether the uninjured human skin is capable of absorbing the substances dissolved in the water of the bath has been decided in the negative by recent thorough research. The results of earlier studies, apparently showing that increase in weight occurs after the bath, and that this is due to absorption of water; that the increase in the quantity of urine secreted after the bath is a result of the absorption of water; and, further, that after simple muriated baths there is an increase in the urinary chlorids, indicating a diffusion of the salt of the bath, have not been confirmed. The positive results showing the presence of iodin in the urine after bathing in water containing iodin are likewise valueless, as the experimenters failed to make sufficient allowance for the volatility of iodin, so that the inhalation, during the bath, of the vapors of this substance through the respiratory tract does not appear to be excluded. When Röhrig undertook such observations in the iodin bath, he protected the prepuce, by means of rubber, against the penetration of water, and similarly guarded the umbilical fold and the anal orifice by means of a coating of fat. Respiration was carried on through a tube terminating in the corridor. Although he remained for about three-quarters of an hour in full baths to which potassium iodid had been added, and that were maintained at a temperature of 35° C. (95° F.), no iodin appeared in the urine. Kletzinsky, Lehmann, Thomson, Rabateau, Ritter, and others obtained similar negative results in experiments with baths to which soluble substances, such as potassium ferrocyanid, potassium nitrate, ferrous sulphate, and ferrous carbonate, were added; whereas Willemin alone obtained positive results in this connection, and Chrzonszewski observed toxic symptoms in fleeced or shaved dogs or rabbits immersed in 1 or 2 per cent. solutions of morphin, nicotin, strychnin, atropin, digitalis, or potassium cyanid.

It is true that substances capable of injuring the horny layer of the skin—as, for instance, mercuric chlorid, arsenic, salicylic acid, salol—will, when added to the bath, be absorbed through the human skin, and this appears not unimportant in connection with certain varieties of baths, such as peat baths and mud-baths. Ethereal solutions also, as those of atropin, cocain, lithium chlorid, veratrin, and aconitin, are, according to the experiments of R. Winternitz, absorbed by the skin. On the other hand, Winternitz found it impossible to demonstrate the direct entrance of these substances into the skin from watery solutions. It may therefore be considered as established that the uninjured human skin is not permeable to water and indifferent substances dissolved in it, even after long-continued exposure, and that absorption of fixed constituents through the skin does not take place in mineral baths. The skin of the bather is probably, however, permeable by the gases and the volatile constituents of the mineral water, as the author has demonstrated for carbon dioxid, and Röhrig for hydrogen sulphid, carbon dioxid, and illuminating gas. This applies also to the absorption from the water of the bath, of volatile, ethereal substances that penetrate the epidermis and exert a certain irritative effect upon the peripheral nerve filaments in the cutis. Finally, the absorption, through the skin, of watery solutions in a fine spray has been demonstrated by Serrey and Brémont, who found the skin permeable for watery vapor in the steam-bath when the temperature of the vapor was above 38° C. (100.4° F.). Röhrig and Juhl found that not only alcoholic, but also watery, solutions of potassium ferrocyanid, tannic acid, salicylic acid, and potassium iodid were capable of penetrating the body through the skin, a result, however, that has recently been questioned, in consequence of investigations by Fleischer, Ritter, Levin, and du Mesnil. The force with which the finely divided particles of water and saline matter are thrown against the skin appears to exert an influence upon the absorption under consideration.

The Promotion of Absorption

By means of certain methods it is possible to favor absorption during the bath, and especially by removing the principal obstacles to this process. The sebum of the hair follicles, the secretion of the sweat-glands, and the scales of epidermis form a fatty layer that must be removed in order to render imbibition, and thus absorption, possible during the bath. By previous washing with soap and water the skin is rendered more permeable during the bath.

Fullness of the cutaneous capillary vessels, in consequence of which opportunity is afforded for more extensive contact between the blood and the fluid imbibed by the epidermis, also may be brought about by increased temperature of the water of the bath and vigorous friction of the skin. Such fullness of the capillary vessels is capable of increasing the absorption.

Endosmosis and Exosmosis

Apart from absorption in the mineral bath, an effect that cannot wholly be excluded is that obtained from contact between the skin and the water, depending upon the concentration of the bath and upon the quantity of saline matter in solution. In accordance with the physical laws of endosmosis and exosmosis, diffusion must take place, or at least be facilitated, as the skin of the individual in the bath separates two saline solutions of different concentration—on the one hand, the water of the bath; on the other, the blood-serum. Should, however, the skin prevent such diffusion, there will still result an approximation of the separated fluids of the bath soltion and of the salt solution in the blood. The fluids of the body—blood and intercellular fluid—pass rapidly toward the periphery of the body, which then becomes the seat of increased movement of fluid. In this connection the quantitative relation of the solids dissolved in the water of the bath is of importance, even without reference to the process of absorption. The more concentrated the mineral bath considered as a saline solution, the more energetically will the effects mentioned be manifested.

Other Factors in the Efficacy of Mineral Baths

The **chemical nature** of the dissolved salts appears of itself to possess a certain activity. The **chemical stimulation of the skin** is the effect particularly distinctive of the action of mineral baths. This stimulation, due to the gaseous and saline constituents of the mineral water, represents a relatively feeble but accumulating sensory irritation affecting an extensive cutaneous area; as a result of which the ordinary influence of the warm water baths upon the circulation of the blood, and, through reflex influences, upon the centers regulating the action of the heart, as well as upon the nervous system in general, is materially increased. This tactile irritation I attribute to a peculiar quality so operating that the various mineral waters, through the irritation excited by their contained gases and salts, affect in a different manner the reflex influence upon circulation and innervation. The investigations of Grützner and Heidenhain, Röhrig, and Naumann, who have demonstrated that various kinds of cutaneous irritants exert widely different influences upon the arterial blood-pressure, support this view. Liebreich, in his experimental investigations on rabbits, reached the conclusion that the animal skin reacts differently in manner and degree in accordance with the slightest differences in the chemical constitution of fluids to which it is exposed.

Another circumstance related to the chemical irritation of mineral baths appears of significance—namely, that the carbon dioxid that is contained in these baths excites chemical stimulation of the **heat nerves**, as a result of which an increased appreciation of heat on the part of the bather is induced, and, accordingly, baths may be taken in waters containing carbon dioxid at a lower temperature than can baths in ordinary water. Owing to the presence of gas and saline matters, the mineral baths exert, further, a more energetic after-effect upon the dilatation of the capillary vessels of the skin, than do baths in ordinary water; the gases and salts dissolved in the water appearing to possess a vasodilator influence. After every mineral bath, moreover, there remains upon the skin for a considerable period of time, as Lehmann was the first to demonstrate, a finely divided coating of the constituents of the bath. In consequence of the adhesive properties of saline substances, a considerable degree of cutaneous irritation will persist for some time, although the mineral bath contains but a small quantity of saline matter.

The chemical irritation of the skin by the mineral bath is capable of exerting a considerable influence upon metabolism, through reflex augmentation of this process. In general, the increased oxidation is proportionate to the chemical irritation of the saline constituents of the mineral bath upon the skin.

The **respiratory gaseous interchange** in mineral baths rich in saline matters is greater than in baths of sweet water at the same temperature. Various investigations have demonstrated also the influence exerted upon the quantity of normal urinary constituents excreted, and particularly that of urea, by various mineral baths. As a result of the chemical cutaneous irritation of the mineral baths upon the sensory nerves, various paresthesias, ranging from the slightest sense of prickling to the most pronounced burning, occur in these baths. Further, contraction of the unstriped muscular tissue of the small arteries, of the muscles of the skin, and the hair follicles, as well as general redness of the skin of those portions of the body exposed to the influence of the water, occur. Among the **constituents of the baths** capable principally of causing cutaneous irritation are carbon dioxid, hydrogen sulphid, the volatile organic acids, such as formic acid, malic acid, then sodium chlorid, and calcium chlorid. This chemical irritation of the skin is in turn the cause for the so-called bath exanthemata — cutaneous eruptions, formerly considered serious—that are so frequently observed after courses of treatment with mineral baths, and to which, further, the high temperature and the protracted duration of the bath materially contribute. The erythemata, eczemas, and furuncles that occur as bath exanthemata, and were formerly believed to be an indication of the curative effect of the bath, may really be considered as a sign of opposite significance; for they indicate too active irritation of the skin and consequent atonic or paralytic dilatation of the vessels.

A peculiar **electric irritation** also has been considered an important factor in the efficacy of mineral baths. This view has been held since Scoutetten, setting out from the observation that mineral waters applied to the surface of the human body create a much stronger current in the latter than ordinary water, considered this electric current as the principal source for the irritation of the peripheral cutaneous nerves. Further investigations have demonstrated a greater electric conducting power for certain mineral waters.

Among the **gases** contained in mineral waters, carbon dioxid and hydrogen sulphid, according to Heymann and Krebs, cause in general greater deflection of the multiplier, whereas distilled water impregnated with oxygen and ozone causes much slighter deflection.

Since Karfunkel's accurate investigations of the waters of twenty-six medicinal springs, the view that certain **thermal baths** possess a greater electric conducting power peculiarly specific to them, and with a specific activity, has been abandoned. He found that the degree of electric conducting power of a mineral water represents only the expression of certain factors predominating in the water, and which are definite for all waters; thus increasing with the quantity of saline matters present and with the elevation of temperature, and depending, likewise, upon the quality of the saline matters in solution, as well as upon the amount of the contained gases.

The **thermic irritation** of mineral baths is similar to that of baths with ordinary water at the same temperature. The view expressed by Renz with reference to the thermal baths—that a water that has been exposed to the high atmospheric pressure of the incandescent heat of the interior of the earth presents an arrangement of its molecules different from that of artificially warmed water, and therefore engages in different thermic vibrations—is not in harmony with currently accepted physical laws; and the experiments reported by Scholz, according to which the heat-capacity of natural thermal water is far greater than that of artificially heated water, do not give the impression of exact scientific observations. Nevertheless, it must be emphasized that through certain kinds of mineral baths, particularly **moor baths**, as well as through certain balneotherapeutic methods, a ready means is afforded for conveying to the body considerable degrees of heat; and, by elevation of the temperature of the blood and the tissues, irritative phenomena can more readily be induced on the part of the nervous system, than through baths with ordinary water.

In the same way the **mechanical irritation** of certain mineral baths, such as **mud-baths**, **moor baths**, **wave-baths**, and baths containing **carbon dioxid**, and which is in part due to the method of their employment, will be far greater than those obtained from baths with ordinary water.

Within recent years a series of **experimental investigations** has been made for the purpose of determining the irritative effects of the mineral waters, through the skin, upon the heat-regulating activity of the cutaneous structures, upon the peripheral nerve-cells, as well as in a reflex way upon the respiratory, the cardiac, the vasomotor, the trophic, and the secretory centers, upon oxidation of the tissue elements, upon changes in hemogenesis, and upon metabolism.

The substances contained in the water of the mineral bath may influence the bather through a channel other than the skin—namely, through the **inhalation**, by the respiratory organs, of the evaporated and gaseous substances, and thus their introduction into the circulation, where they manifest their activity. The evaporation of the water increases in geometric ratio with its temperature. In association with this watery vapor all the gases and substances convertible, by reason of their chemical constitution, into gases contained in the water of the bath, diffuse into the surrounding atmosphere, whence they enter the respiratory organs.

The **influence upon the blood and the general metabolism** can be demonstrated in the secretions with relative rapidity. The following substances, developed from the mineral baths and inhaled, are of importance in this connection: Carbon dioxid, hydrogen sulphid, nitrogen, saline vapor, and aromatic substances.

Classification of Mineral Baths

Mineral baths are divided, in accordance with the constitution of the mineral water that is employed for the purpose of the bath, as follows: **Acratothermal baths,** also designated indifferent thermal baths, **acid baths, brine baths, sulphurous baths, steel baths, gas baths, moor baths** (peat baths, bog baths), and **mud-baths.**

CHAPTER II

ACRATOTHERMAL BATHS

Definition. Constituents. Temperature. Therapeutic Division. Baths of Indifferent Temperature—Effects; Indications; Localities. Temperature-elevating Baths—Effects; Indications; Localities.[1]

Definition

Acratothermal (ἀ, privative; κρατός, "mixed") baths, or simple, unmixed, or indifferent thermal baths, are baths prepared from natural mineral waters characterized by peculiarly high temperature, but whose saline and gaseous constituents are extremely small in amount and of but feeble therapeutic effect.

Constituents

The maximal amount of solid constituents in the acratothermal waters may in general be stated to be 0.6 to 1000 parts of water[2]; such substances as iodin, bromin, iron, arsenic, and others that are active when present in even small amount being excluded from consideration. The fixed constituents of these thermal waters are generally alkaline salts and sodium chlorid. The natural degree of temperature varies from 19° to 70° C. (66.2° to 158° F.). The water is quite transparent, and the baths prepared from it are generally of a faint bluish-green tint. The high temperature of these waters is due to the great depth from which they are derived, in consequence of which they acquire the temperature of the interior of the earth. They are generally obtained from mountain springs, which arise from varieties of rock not readily accessible to climatic changes and processes of decay. The earlier claims for the specific heat, for the greater heat-capacity, as well as for the specific electric action of the acratothermal waters, cannot be sustained, and in view of their chemical indifference, the active therapeutic factor of these baths must be sought for in the temperature at which they are employed. With relation to their activity, acratothermal baths and ordinary warm water baths cannot,

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[1] In connection with the localities mentioned in this and succeeding chapters, volumes III and IV, "Climatotherapy," should be consulted; also resorts additional to those here mentioned will be found noted in the indexes to those volumes under the headings *Baths* and *Waters* of the various classes.

[2] Approximately 35 grains in a U. S. gallon; but 50 grains in the gallon has been taken as a convenient limit in the assignment of American springs to this class.

however, be considered as wholly identical. Experience distinctly indicates the contrary, even though an adequate scientific explanation has not yet been attained. The small amounts of solids contained in these acratothermal waters, and the constancy of the temperature of the thermal water in the bath-reservoirs, are probably not without effect.

Temperature and Therapeutic Division

Most thermal baths are provided with reservoirs,—so-called piscines, or pool baths,—in which the supply and discharge of the mineral water are continuous, so that the constancy of the temperature is maintained. Acratothermal baths are divided into two therapeutically distinct groups, according to the temperature at which the waters appear—*indifferent* acratothermal waters, with a temperature below 37° C. (98.6° F.), and *temperature-elevating* acratothermal waters, with a temperature above 37° C. (98.6° F.).

The *altitude* of the individual bathing resort is of importance, as also are its general *climatic conditions*.

Effects and Uses

Acratothermal baths of indifferent temperature, owing to the slight thermal irritation they produce, are **indicated** when it is desired to maintain the temperature of the body at a uniform level, to preserve the equilibrium of heat-production and heat-dissipation, to stimulate the cutaneous nerves mildly, to exert a sedative influence upon, or to influence but slightly, the central nervous system through reflex action from the peripheral nerves, and to stimulate metabolism in a limited degree. Their employment is therefore indicated for purposes of *conservation in protracted convalescence* from *febrile and infectious diseases*, in *debilitated conditions* resulting from general constitutional disorders, *premature senile marasmus*, *irritability of the nervous system*, *hyperesthesia* and *hyperkinesia*, *nervous sleeplessness*, and *neuralgia*. The heat-dissipating quality of acratothermal baths of indifferent temperature becomes more conspicuous, and their action more closely resembles that of the **cold-water treatment,** the further below 34° C. (93.2° F.) the temperature falls.

Temperature-elevating acratothermal baths are **indicated** in cases in which it is desired to accelerate greatly the circulation of the blood in the skin and in the parts accessible to the external application of heat, to increase the secretion of sweat, to exert a powerful influence upon the central organ of the circulation and the nervous system, and, finally, to hasten absorption through stimulation of the nervous system, as well as through increased rapidity of movement and increased pressure of the blood. They are therefore employed: In the presence of rheumatic and gouty exudates and the resulting morbid alterations in the muscles and the joints, in the presence of exudates resulting from traumatic influences and their consequences, in the presence of residua of inflammations in the skin and subcutaneous connective tissue, of peritonitis, perityphlitis, perimetritis, chronic pelvic exudates, neuralgia, especially sciatica, and paralyses of various kinds, both peripheral, in consequence of exudates, and central.

The **action** of the temperature-elevating acratothermal baths in stimulating absorption is often aided by mechanical manipulations, by the employment of hot douches locally, by friction and massage, as well as by systematic diaphoresis in bed immediately after the bath, the routine varying somewhat at the different health resorts. With such baths at a high temperature the water should be permitted to reach only to the level of the breasts, while cold compresses are applied to the head and the precordium. Provision should always be made for maintaining the constancy of the temperature of the water.

Localities

The chief **indifferent acratothermal baths of Europe** are: In **Austro-Hungary**: JOHANNISBAD, in Bohemia (29.6° C.—85.3° F.); NEUHAUS, in Styria (24° to 37° C.—75.2° to 98.6° F.); TOBELBAD, in Styria (28.7° C.—83.7° F.). In the **German Empire**: BADENWEILER, in Baden (26.4° C.—79.5° F.); LANDECK, in Prussian Silesia (28.5° C.—83.3° F.); LIEBENZELL, in Würtemburg (26° C.—78.8° F.); SCHLANGENBAD, in Nassau (32.5° C.—90.5° F.). In **Italy**: COMANO (28.5° C.—83.3° F.). In **Switzerland**: RAGATZ (29° to 35° C.—84.2° to 95° F.).

In the **British Isles** the following baths may best be classed with this group: In **England**: BUXTON, in Derbyshire (82° F.—28.3° C.); Hot-well at CLIFTON, in Gloucestershire (73° F.—22.8° C.); MATLOCK BATH (68° F.—20° C.). In **Ireland**: MALLOW, in County Cork (70° to 72° F.—21° to 22.2° C.).

In the **United States** baths most nearly corresponding with the foregoing are: In **Arkansas**: certain of the springs at HOT SPRINGS (76° to 98° F.—24.4° to 37° C.). In **California**: IRON GEYSER CREEK in Geyser Cañon (96° F.—35.6° C.); Iron Spring at GEYSER SPRINGS (70° F.—21° C.). In **Georgia**: WARM SPRINGS, in Merriwether County (90° F.—32.2° C.). In **Virginia**: Gentlemen's Pleasure Bath at HOT SPRINGS (78° F.—25.6° C.); HEALING SPRINGS, in Bath County (88° F.—31.1° C.).

The chief temperature-elevating acratothermal baths of **Europe** are the following: In **Austro-Hungary**: GASTEIN, in Salzburg (24° to 48.7° C.—75.2° to 119.7° F.); KRAPINA-TÖPLITZ, in Croatia (37.5° to 43.7° C.—99.5° to 110.3° F.); ROEMERBAD, in Styria (38.4° C.—108.7° F.); TEPLITZ-SCHOENAU, in Bohemia (28.7° to 46.2° C.—83.7° to 115.2° F.); TOPUSKO, in Croatia (50° to 57.6° C.—122° to 135.7° F.); TÜFFER, in Styria (39° C.—102.2° F.). In **France**: BAINS (30° to 50° C.—86° to 122° F.); DAX (53° to 60° C.—127.4° to 140° F.); LUXEUIL (28° to 52.5° C.—82.4° to 126.5° F.); NÉRIS (49.5° to 53.9° C.—121.1° to 129° F.); PLOMBIÈRES (60.6° C.—141° F.). In the **German Empire**: WARMBRUNN, in Prussian Silesia (25° to 43° C.—77° to 109.4° F.); WILDBAD, in Würtemburg (33° to 40.3° C.—91.4° to 109.4° F.). In **Italy**: BORMIO (41° C.—108.5° F.); MASINO (39° C.—102.2° F.).

In the **British Isles**, the waters of BATH in Somersetshire, in **England** (104° to 120° F.—40° to 69° C.), are the only really hot natural springs (Weber).

In the **United States**, waters containing less than 50 grains of solid constituents to the gallon, and of high temperature, are available in the following localities: In **Arkansas**: Certain of the springs at HOT SPRINGS (98° to 150° F.—37° to 65.5° C.); in **California**: CALISTOGA SPRINGS (95° to 121° F.—35° to 49.5° C.); GEYSER SPRINGS (Indian Spring, 101° F.—38.3° C.); SANTA BARBARA (Hot Sulphur Springs, 112° to 122° F.—44.5° to 50° C.); in **Colorado**: CHALK CREEK HOT SPRINGS (130° F.—54.6° C.); STEAMBOAT SPRINGS (Bath Spring, 103° F.—39.5° C.); in **Montana**: HUNTER'S HOT SPRINGS (148° to 168° F.—64.5° to 75.5° C.); in **Nevada**: WALLEY'S HOT SPRINGS (136° to 160° F.—57.8° to 71° C.); in **New Mexico**: LAS VEGAS HOT SPRINGS (No. 1, 130° F.—54.6° C.); in **North Carolina**: HOT SPRINGS (96° to 104° F.—35.5° to 39° C.); in **Virginia**: HOT SPRINGS (Boiler Bath, 110° F. —43.3° C.; Sulphur Bath, 102° F.—39° C.).

With these acratothermal baths may be included the natural hot-vapor baths at MONSUMMANO, BATTAGLIA, and BAGNI-DI-LUCCA in **Italy**, and at GLENWOOD in **Colorado**, which are employed for similar therapeutic purposes. At these resorts are found grottoes containing hot springs whose vapors, applied to the body of the patient, exert an active diaphoretic effect.

CHAPTER III

ACID BATHS AND BRINE BATHS

Acid, Carbonated, or Effervescing Baths—Effects and Uses. Auxiliaries to the Efficacy of Acid Baths. Artificial Gas Baths. Common Salt or Brine Baths (Soolbäder)—Definition; Effects and Uses. Thermal Brine Baths—Indications; Localities. Inhalation of Brine Vapors. Cold Brine Baths—Indications; Localities. Artificial Brine Baths.

ACID, CARBONATED, OR EFFERVESCING BATHS

Baths prepared with mineral waters containing a large quantity of carbon dioxid are designated **acid, effervescing,** or **carbon dioxid baths.** For these baths are employed both the simple acidulous or carbonated waters, which are highly charged with carbon dioxid gas and contain negligible quantities of solid matters, and the carbon dioxid waters, containing measurable but small quantities of mineral constituents, such as the weak alkaline acidulous waters, or the carbonated waters containing sodium sulphate or sodium chlorid in small quantities.

Effects and Uses

The action of these baths depends upon the temperature of the water and the contained carbon dioxid. The small amounts of sodium carbonate, or sulphate, or chlorid, applied externally, are capable of exerting but a slightly stimulating and saponifying effect upon the skin, and causing slight swelling of the epidermis. The carbon dioxid in the water of the bath exerts especially a profoundly stimulating effect upon the skin, which, in such a bath, is covered with innumerable bubbles of gas and subsequently becomes intensely reddened. The irritating effect upon the sensory centripetal nerves, as well as upon the heat-nerves, is manifested in a sense of marked prickling, as well as a sense of intense heat, particularly in the genital region. With the redness of the skin is associated contraction of the unstriated muscular fibers, which is especially marked in the scrotum and on the nipples. The tactile sensibility of the skin is materially increased. The stimulating effect of the carbon dioxid upon the sensory cutaneous nerves extends to the nerve-centers, and, through radiation and reflex action, throughout the entire nervous system; and thus induces a feeling of general well-being as well as an increase in all the nutritive processes.

The action of carbonated baths upon the **heart and circulation** is of especial importance. According to my observation, there occurs, after immersion in the bath for from ten to fifteen minutes, an average decrease in the frequency of the pulse of from four to six beats a minute. This diminution persists for from fifteen to twenty minutes, an observation that has been confirmed by other investigators, such as Jacob, Röhrig, and Stifler. Likewise, most observers agree that the carbonated bath increases the blood-pressure. These baths also induce, through reflex influences, a more powerful action of the heart, a more vigorous pulse, with longer intervals; further, greater fullness of the arterial system, and probably also of the coronary arteries (Schott), is induced. Even without causing marked thermal irritation the total effect of the carbonated bath tends to increase greatly the action of the heart and the circulation of the blood. There is an immediate and persistent arterial hyperemia of the skin, causing dilatation of the peripheral vessels and contraction of the internal vessels, increasing the blood-pressure, slowing the pulse, which shows increased fullness and strength, increasing the volume of each individual cardiac systole, improving the tone of the heart-muscle, and lessening the work of the heart.

The **diuretic action** of the carbonated baths is probably also dependent upon these conditions. According to Flechsig, there takes place finally, as a result of these baths, an absolute increase in the production of carbon dioxid in the body, and the elimination of urea further appears to be diminished in proportion to the amount of ingested organic substances.

The acid baths are therefore **indicated**: In conditions of debility following acute diseases, after hemorrhage or other wasting discharge, in cases of neurasthenia and various disorders of the nervous system, in the presence of disease of the female genitalia, particularly derangements of menstruation.

These baths have, however, been recommended especially in recent years in the treatment of the most varied kinds of cardiac insufficiency and diseases of the heart. The mineral baths, previously so greatly feared in the treatment of diseases of the heart, have acquired a favorable and increasing reputation in this connection. To Beneke is due the credit for having first called attention, in 1872, to the fact that the warm carbonated brine baths have a sedative influence upon the action of the heart in cases of disease of that organ, favoring compensation of circulatory disturbances, as well as effecting distinct improvement in the general condition. The brothers Schott, Jacob, Scholz, Groedel, myself, and numerous other clinicians who have practised at health resorts provided with carbonated baths, have established the favorable effects of these baths upon chronic cardiac affections, including disease of the myocardium and valvular lesions, as well as nervous or functional disorders, and have recommended these mineral baths as a tonic of the first rank in the treatment of the enfeebled heart. Theodore Schott, especially, in a large number of cases has determined by percussion, and recently also by X-ray examination, that following the use of the carbonated baths, an appreciable and progressive reduction in the area of cardiac dullness is demonstrable in the course of a few days; an observation that has been confirmed by other clinicians. This improvement in the tone of the heart-muscle in consequence of such courses of treatment with baths is a fact of great importance, for it is well known that the greatest danger in cases of chronic cardiac disease is due to lowering of the tone of the myocardium and dilatation of the wall of the ventricle. The effect of these baths can be varied by variations in the charge of carbon dioxid, in the temperature of the water, in the concentration of the saline constituents, and in the bath procedure. The clinician is thus enabled cautiously to make a gradual transition from the warm bath, containing a moderate amount of carbon dioxid,—and thus relieving the heart through a sedative influence upon the cardiac nerves,—to baths of a lower temperature and, by reason of their higher charge of carbon dioxid, of more active movement, which, by more marked stimulation, increase the functional energy of the heart and of the nerves of the vessels, and thereby invigorate the myocardium and augment its muscular activity.

Auxiliaries to the Efficacy of Acid Baths

In connection with the acid baths it is of importance that the heating of the water of the bath should be effected in such a manner that the quantity of carbon dioxid present in the mineral water should be preserved as fully as possible. A certain quantity of carbon dioxid is indispensable for the definite action of the carbonated bath; the lowest limit is probably about 20 volumes per cent. The preservation of the mineral water, its conveyance into the reservoirs and the bath tubs, must be effected in such a manner that the loss of gas is confined within the narrowest limits. The warming of the water is best effected by the method of Schwarz, in which hot steam is passed between the double floor of the metallic tubs, or through the direct introduction into the water of the bath, of hot steam under high pressure (Pfriem's method). A third method of warming the water consists in passing the hot steam through pipes situated in the angle between the floor and the sides of the tub.

Acid baths are to be **obtained** at most bathing resorts possessing mineral waters containing considerable quantities of carbon dioxid.

Numerous attempts have been made to substitute **artificially prepared carbonated baths** for the natural acid baths. To this end either bicarbonates (sodium) are dissolved with acids (hydrochloric or tartaric acid) in the water of the ordinary bath, or the water is saturated with carbon dioxid under high pressure. Although these artificially carbonated baths are useful and must be employed when it is necessary to treat a patient at home, they have the disadvantage, as compared with the natural baths, that a rapid and more or less violent development of gas takes place in the water of the bath, which interferes with the persistent and deliberate action of the carbon dioxid upon the peripheral sensory nerves. The preparation of these artificial carbonated baths is described in the Appendix. (See page 536.)

COMMON SALT OR BRINE BATHS (SOOLBÄDER)

Definition

The term **brine baths** (Soolbäder) is applied to those baths that are prepared from mineral waters containing **sodium chlorid** in such quantity that the specific gravity exceeds 1050, and that are available either directly or after previous graduation. The brine waters occur as natural or bored wells, or are prepared by washing out deposits of sodium chlorid. They are derived in part from cold and in part from hot springs. They contain, of solid substances, principally sodium chlorid, and, in addition to this, other chlorids, such as calcium chlorid and magnesium chlorid, and also sulphates, such as sodium sulphate, and only exceptionally are they charged with large amounts of gases, and then, principally, carbon dioxid. The concentrated brine waters are employed to obtain sodium chlorid, and this is accomplished by boiling or graduation. The latter is effected by means of 'Gradirhäuser,' large, wide, long, and high fences of interlaced faggots of thorns, from which the salt water drips to undergo evaporation.

A bath prepared with muriated water containing at least 1.5 per cent. of saline matter constitutes a brine or salt bath. It is known as a weak brine bath when it contains not more than 2 per cent. of saline matter, whereas a brine bath of moderate strength contains from 3 to 6 per cent. of saline matter. Concentrated salt waters, which contain a higher percentage of saline matter, must be diluted when employed for baths. From the salt waters are obtained 'Mutterlauge,' or mother-lye, concentrated salt water, and brine salts, and these may be employed to strengthen weak salt baths. **Mother-lye** is the fluid that remains after concentration of the salt water by boiling, and contains, in addition to sodium chlorid, other chlorin combinations, principally calcium and magnesium chlorids, as well as potassium, magnesium, and calcium sulphates, and iodin and bromin. It possesses a high specific gravity, and in general varies between 30 and 40 per cent. of solids. Concentrated salt waters are likewise obtained by graduation. These contain from 16 to 20 per cent. of salts. Brine salts are obtained by further concentration of the mother-lye, and contain the solid constituents of the latter, with but a small amount of water.

The action of the brine bath depends, apart from the effect of the temperature, in the first place, upon the chemical irritation that the concentrated solution of sodium chlorid exerts upon the skin and its nerves. This is indicated by increased tactile sensibility of the skin, by increase in the blood-pressure, by increased production of carbon dioxid. The salt bath exercises no characteristic effect upon the pulse frequency or the respiratory frequency. According to Röhrig and Zuntz, the absorption of oxygen and the elimination of carbon dioxid are not inconsiderably increased in rabbits placed in a 3 per cent. brine bath at a temperature of 36° C. (96.8° F.).

Effects and Uses of Brine Baths

With regard to the influence of the brine bath upon the metabolism in human beings, Keller found that the 3 per cent. salt baths, at a temperature of 35° C. (95° F.), for a period of thirty minutes, caused a distinct diuretic effect, an inconsiderable increase in the chlorids, a slight diminution in the elimination of nitrogen. Robin, however, as a result of his investigations, has reached the conclusion that a 6 per cent. brine bath diminishes the amount of urine, as well as the organic substances, the uric acid and the nitrogenous extractive substances, but increases the inorganic substances, the total nitrogenous elimination, the urea, the chlorids, the phosphoric acid, and the ratio between the phosphoric acid and the nitrogenous elimination. According to Beneke, the simple salt bath, at a temperature of 35° C. (95° F.) and of half an hour's duration, causes exceedingly slight acceleration of metabolism. The effect is somewhat greater in the salt bath to which the mother-lye has been added, the elimination of urea being slightly increased; the increase, however, occurs only during the hours immediately following the bath, and the total metabolism undergoes no considerable quantitative alteration. Recently Koestlin has concluded from his experiments that salt baths, whether of 4 per cent. or of 20 per cent. strength, exert no effect whatever upon the tissue changes, and cause no increase in albuminous metabolism. Nevertheless the fact, based upon extensive experience, remains, that the brine baths exert an especially favorable influence upon chronic exudates, swellings of the lymphatic glands, and the residua of inflammatory processes. They cause also, as experience has shown, an increased demand for food; as a result of which, increased assimilation and improvement of the general constitutional state occur. Brine baths are, therefore, **indicated** in cases of scrofulosis and rachitis, with their tendency to chronic inflammation, in cases of rheumatism, gout, exudates of various kinds, particularly pelvic exudates, disorders of the female genitalia, various diseases of the skin, rheumatic paralysis, and neuralgia.

In pasty and scrofulous individuals and in the presence of massive exudates the more concentrated brine baths are employed, and with the addition of mother-lye; whereas for delicate individuals the weaker baths and those of moderate strength are to be recommended. In general, 3 per cent. brine baths are employed. If these are strengthened by the addition of mother-lye, this must be done gradually. At first 3 liters (3 quarts) are added to a tub-bath containing from 250 to 350 kilos (60 to 90 gallons) of water, and the amount is increased cautiously, until 15, 20, or more liters are added. Brine baths of from 50 to 75 per cent. have recently been recommended.

Thermal brine baths—that is, those saline waters that have a high temperature—possess in this thermal quality and in the presence of carbon dioxid a material advantage over the cold saline waters, which must be heated artificially for bathing purposes. The thermal brine baths are therefore especially indicated when it is desired to improve the nervous forces, as well as the general nutrition of the body; and they are, accordingly, recommended especially in cases of paralysis, neuroses, tabes dorsalis, and spinal irritations, but also in diseases of the heart. The amount of carbon dioxid present in these thermal muriated waters permits their use at a lower temperature than other brine baths. Although the latter are employed generally at a temperature of 35° C. (95° F.), a temperature so low as 25° C. (77° F.) will be borne if carbonated waters are employed.

Inhalations of the saline vapor are sometimes associated with the brine baths, for which purpose special inhalatoriums are provided at the bathing resorts, or the patients breathe the air of the 'graduation-house.'

In the first method the cold water is heated, and the vapor generated, together with the contained particles of saline matter, is inhaled; or at the thermal muriated springs the warm water is permitted to rise for some distance, and then like a fountain is precipitated into a reservoir, where it is broken into a spray, the entire room becoming filled with a dense mist saturated with saline particles. In the 'graduation-house' the salt water is precipitated, drop by drop, in large amounts, by day and night, and impregnates the air with a greater amount of moisture and of saline matter. In cases of chronic catarrh of the air-passages, such inhalations at times exert quite a favorable influence. (See volume x, "Pneumatotherapy and Inhalation Methods.")

Location of Cold Brine Baths

In **Austro-Hungary**: AUSSEE, in Salzkammergut; GMUNDEN, in Salzkammergut; HALL, in Tirol; ISCHL, in Salzkammergut. In **France**: SALIES-DE-BÉARN and SALINS. In the **German Empire**: ARNSTADT, in Thuringia; COLBERG, in Pomerania; DÜRRHEIM, in Baden; ELMEN, in Prussia; GOCZALKOWITZ, in Prussian Silesia; HALL, in Wurtemberg; HEILBRONN, in Bavaria; JAXTFELD, in Wurtemberg; JULIUSHALL, in the Harz Mountains; KOESEN, in Thuringia; KOENIGSDORF-JASTRZEMB, in Prussian Silesia; KOESTRITZ, in Reuss; KRANKENHEIL-TOELZ, in Bavaria; KREUZNACH, in Prussia; PYRMONT, in Waldeck; REICHENHALL, in Bavaria; ROSENHEIM, in Bavaria; SALZUNGEN, in Thuringia; SUDERODE, in the Harz Mountains; SULZA, in Thuringia; WITTEKIND, in Prussia. In **Italy**: CASTROCARO; RIVANAZZANO; VITTORIO. In **Switzerland**: BEX; RHEINFELDEN.

In the **British Islands**: In **England**: ASHBY-DE-LA-ZOUCH in Leicestershire; DROITWICH in Worcestershire; HARROGATE in Yorkshire; MALVERN in Worcestershire; NANTWICH in Cheshire; WOODHALL SPA in Lincolnshire. In **Scotland**: STRATHPEFFER in Ross-shire. In **Wales**: LLANDRINDOD WELLS.

In the **United States**: In **Kansas**: The GEUDA SPRINGS (17° C.—63° F.). In **Michigan**: The Excelsior Spring, at BENTON HARBOR; the Moorman Mineral Well, at Ypsilanti, in Washtenaw County; MT. CLEMENS MINERAL SPRINGS, in Macomb County; the ST. CLAIR SPRINGS, in St. Clair County. In **Pennsylvania**: The PARKER MINERAL SPRINGS, in McKean County (10° C.—50° F.).

Location of Thermal Brine Baths

On the **Continent of Europe**: In **France**: BRIDES-SALINS, in Savoy (35° C.—95° F.). In the **German Empire**: KISSINGEN, in Bavaria (20° C.—68° F.); MONDORF, in Luxemburg (24.6° C.—76.2° F.); MUENSTER-ON-THE-STEIN, in Rhenish Prussia (31° C.—87.8° F.); NAUHEIM, in Hesse (21° to 35.3° C.—69.8° to 95.5° F.); REHME-OEYNHAUSEN, in Westphalia (33.5° C.—92.2° F.); SODEN, in the Taunus (30° C.—86° F.). In **Italy**: MONTECATINI (25° C.—77° F.).

In **Great Britain**: The waters of cold brine springs are artificially heated.

In the **United States**: In **California**: The Black Sulphur Spring (32.4° C.—90.3° F.) and the Hot Salt Spring at BYRON SPRINGS (50.2° C.—122.3° F.), in Contra Costa County. In **Colorado**: PAGOSA SPRINGS, in Archuleta County (68.3° C.—155° F.). In **New Mexico**: JEMEZ HOT SPRINGS, in Bernalillo County (21.7° to 75.6° C.—70° to 168° F.). In **Utah**: BECK'S HOT SULPHUR SPRINGS, in Salt Lake County (53.3° C.—128° F.); SALT LAKE HOT SPRINGS, in Salt Lake County (43.3° C.—110° F.); UTAH HOT

Springs, in Box Elder County (55° to 62.2° C.—131° to 144° F.); Warm Springs, in Salt Lake County (44.4° C.—112° F.).

Attempts have been made to substitute **artificially prepared brine baths** for the natural salt waters. For this purpose a residuum of salts obtained from Stassfurt is employed; this, however, contains but 13.6 per cent. of sodium chlorid and 55 per cent. of potassium salts. Or from 7 to 10 kilos (15 to 22 pounds) of sodium chlorid are taken to prepare such a bath, which will then correspond with a brine bath containing 3 per cent. of saline matter.

To the brine baths are related **sea-baths** in so far as the sea-water is similar in its chemical constitution to the mineral waters containing sodium chlorid. These baths are considered in the chapter following.

CHAPTER IV

SEA-BATHS

General Considerations. Effects and Uses. Indications. Seasons. Localities.

General Considerations

In the action of sea-baths, in addition to the saline matters present in the water, the low temperature and the movement of the water must be taken into consideration as factors. The quantity of saline matter present in sea-water varies widely in different places, and particularly at different parts of the coast, in accordance with the greater or lesser degree of evaporation of the water, and with the greater or lesser admixture of sweet water. In general, sea-water contains from 3 to 4 per cent. of solid matters, of which sodium chlorid forms the chief part. In addition, potassium chlorid, potassium sulphate, and magnesium sulphate are present, and, likewise, as a rule, salts of iodin and bromin. The amount of saline matter in the Red Sea and in the Mediterranean Sea is, according to Lersch, from 3.2 to 4.1 per cent.; in the Atlantic Ocean, from 3 to 3.7 per cent.; in the North Sea, from 3.1 to 3.4 per cent.; in the Baltic Sea, from 0.7 to 1.9 per cent.; in the Black Sea, 1.7 per cent.; in the Sea of Asov, 1.1 per cent.

In consequence of the presence of saline matter in sea-water the action of a warm sea-bath corresponds approximately with that of a brine bath of the same concentration and temperature. Some importance is to be attached to the crystallization of the salt upon the epidermis, which exerts an irritating effect upon the terminal filaments of the nerves. An important feature of the sea-baths consists in the **active movement of the water,** the impact of the waves, which is dependent upon the ebb and the flow, the prevailing winds, the character of the coast, and various local conditions. The North Sea and the Atlantic Ocean are characterized by the vigorous impact of their waves, in contrast with the less active surf of the Baltic Sea and the Mediterranean Sea. Only where the coast is exposed to the ocean-winds and where the beach is not too level is it possible for the waves to exert considerable force. In consequence of the impact of the waves there is associated in sea-baths in the open air, with the thermic stimulation of the cold and the chemical irritation of the salt water, an additional powerful mechanical influence, exerted upon the entire surface of the body, thus giving rise to intense nervous stimulation rapidly transmitted to the central organs, with energetic primary vascular contraction and marked reactive increase in the circulation of the blood. This mechanical effect of the sea-bath must be recognized as an important factor in influencing the movement of the fluids of the body, the changes in the tissues, in alterations in the diffusion processes, and in direct and reflex modifications of action.

With regard to the **effects** of the external use of **cold water,** reference has already been made under the head of "Hydrotherapy," and what was said in that connection is applicable also to the sea-baths. In this place, however, emphasis will be placed upon the great sensory stimulation that the wave movement of the sea exerts upon the mental state of the bather, and it can be understood that, as a result of such influences, lost self-confidence, courage, and energy can be restored to many persons. The moving water finally causes greater irritation from cold than when baths are taken in still water, and the dissipation of heat in a bath whose water has a velocity of 0.5 meters exceeds, according to Hiller, that of the quiet bath by about one-third.

The primary effect appreciated by the body on entering a sea-bath is a feeling of coldness which is more or less intense in accordance with the temperature of the water. Shivering and chilliness appear, respiration becomes difficult, the action of the heart is more vigorous, and a sense of anxiety arises. The irritative effect of the cold upon the cutaneous nerves causes general contraction of the cutaneous vessels, both directly and through reflex action, in consequence of which the temperature of the peripheral portions of the body falls rapidly. After a short time these manifestations subside, and the blood, which had been driven to the central organs, again flows into the peripheral vessels; the pulse becomes slower, respiration again becomes easier, the peripheral body-temperature increases, and throughout the entire system there is a feeling of comfort and well-being.

The direct loss of heat that the body suffers in the cold sea-bath is considerable, inasmuch as the bath is continued for only a few minutes. According to Zimmermann, the temperature of an individual in a sea-bath in Heligoland declined from 37° C. (98.6 °F.) immediately before the bath, to 36.85° C. (98.3° F.) twelve minutes after the bath. Lindemann observed, after cold full baths in sea-water, more rapid elevation of the cutaneous temperature than after fresh-water baths at the same temperature; and, further, a slowing and deepening of the respiration, and also, frequently, slowing of the pulse.

Lindemann has attempted, by means of sphygmographic pulse-tracings made after the arrival and before the departure of visitors in Heligoland, to demonstrate the influence of a sojourn at the seaside, both with and without sea-baths, in increasing the vigor of the heart and the circulation. From these tracings it appears that, as evidence of a dilated vascular system and of a greatly stimulated and a stronger heart, the pulse-wave after arrival soon becomes higher and rises and falls more nearly vertically.

With regard to the influence of cold sea-baths upon the **metabolism**, investigations have been made, particularly by Beneke, from which it may be inferred that increased elimination of urea, sulphuric acid, and chlorin, and diminished elimination of uric acid and phosphates take place, and the body-weight increases rapidly. The augmentation of the oxidation processes increases within certain limits with the intensity of the irritation induced by the cold of the sea-bath, by the impact of the waves, and by the proportion of saline matters contained in the sea-water. A common phenomenon is an increase in appetite.

The influence of the sea-air, with the characteristic properties of the high atmospheric pressure, the large amount of moisture in the air, and the intensity of the air-current are also to be taken into consideration.[1]

Effects and Uses

The action of the cold sea-bath combines that of the brine bath at a low temperature, with the effect of stimulating hydrotherapeutic procedures. Sea-baths are, therefore, an admirable means of effecting a rapid reaction and hardening.

Indications.—They are **indicated** in conditions of weakness of most varied kind, when active stimulation of metabolism is desired, in cases of the torpid and pasty variety of scrofulosis, in the presence of the general scrofulous habitus, in a number of functional disturbances of the nervous system, in cases of neurotic dyspepsia, and in neuralgia dependent upon anemia. On the other hand, cold sea-baths are **counterindicated**, on account of their influence in causing contraction of the peripheral vessels and intropulsion of the blood to internal organs, in the presence of diseases that predispose to internal hemorrhage, to hemoptysis, hematemesis, uterine hemorrhage, and, in the aged, cerebral hemorrhage; further, in cases of valvular disease of the heart, arteriosclerosis, cholelithiasis, recent rheumatism, and gastric catarrh, and the like. As, further, the irritation of the cold induces, through reflex action, increase in fatty metabolism, and as the dissipation of heat makes increased demands upon the production of carbon dioxid and the absorption of oxygen, it is evident that the cold sea-bath is not adapted for greatly emaciated or profoundly anemic individuals, or for those recently convalescent from severe diseases.

[1] Thus some authors describe as a special remedial method, the combined influences of sea-bathing, sea-air, etc., under the term, 'sea therapeutics,' or 'thalassotherapy'; and ocean voyages are likewise included under this head.

The **seaside bathing resorts in southern climates,** in which the sea-water is of higher temperature, and the force of the waves is less, are suitable for anemic individuals, for neurasthenics and hysteric patients, and for scrofulous persons with glandular enlargement. Likewise, **warmed sea-baths** may be employed in any climate; the sea-water, admitted or conveyed into a suitable pool or bath, being used at a determined temperature. These baths are suitable for enfeebled individuals with impaired nutrition who desire to enjoy the sea-air.

The **nature of the beach** and the character of the **soil** are of importance in connection with sea-baths. A gently sloping beach of fine pebbles or sand is more advantageous for sea-bathing than a steep, rugged coast. This characteristic gives to the sea-bathing resorts of New Jersey, in the United States, their great popularity.

The **duration** of the sea-bath depends especially upon the temperature of the water. Cold sea-baths should be continued only for from three to five minutes; frequently a brief immersion suffices: an exposure to two or three waves may induce the desired reaction. At times friction with cold sea-water may be recommended. In the southern seaside resorts the bath may be protracted for as long as half an hour during the warm season of the year. Although strong, resistant individuals may often bathe in the sea twice a day, it may be necessary to restrict debilitated persons to a bath only every second day. At the northern seaside resorts a course of treatment includes from ten to twenty-eight baths, and in the southern resorts, at times from thirty to forty baths. An important precaution is to be noted; namely, that a person whose skin becomes unusually red while bathing should immediately abandon the treatment and forego further bathing. The observation of sudden death following a sea-bath on the part of such persons justifies the assumption that the intense redness of the skin indicates paralysis of the vasomotor nerves, and that shortly after cessation of the bath there occurs suddenly a marked increase in the supply of blood to the brain, with consequent cerebral pressure and general paralysis.

Seasons

With regard to the **season** for courses of sea-baths, this will depend upon the local climatic conditions and the temperature of the water. In any event, the temperature of the atmosphere should be that of moderate summer heat, and this must be present for a sufficiently long time for the water to have a minimum constant temperature of 15° C. (59° F.).

To illustrate the **temperature** of the sea-bath, the following examples may be given: In HELIGOLAND the average temperature of the sea-water is, in the month of May, 8.9° C. (48° F.); in June, 12.6° C. (54.7° F.); in July, 16° C. (60.8° F.); in August, 17.3° C. (63.1°

F.); in September, 16.5° C. (61.7° F.); in WARNEMÜNDE it is, in May, 10.3° C. (50.5° F.); in June, 14.7° C. (58.5° F.); in July, 17.7° C. (63.9° F.); in August, 17.5° C. (63.5° F.); in September, 16.1° C. (61° F.); in ABBAZIA it is, in May, 17.8° C. (64° F.); in June, 23.1° C. (73.6° F.); in July, 26.5° C. (79.7° F.); in August, 25.2° C. (77.3° F.); in September, 20.1° C. (68.2° F.); in October, 16.1° C. (61° F.); in PALERMO it is, in May, 16.1° C. (61° F.); in June, 19.4° C. (66.9° F.); in July, 24.7° C. (76.5° F.); in August, 26.6° C. (79.9° F.); in September, 23.7° C. (74.7° F.); in October, 20.5° C. (68.9° F.); in November, 15.1° C. (59.2° F.).

At ATLANTIC CITY, New Jersey, the mean temperature of the water of the Atlantic Ocean is in January, 35.8° F. (2.1° C.); in March, 39.7° F. (4.3° C.); in May, 56.2° F. (13.4° C.); in July, 72.1° F. (22.3° C.); in September, 71.1° F. (21.7° C.); in November, 52.3° F. (11.3° C.). At GRAND HAVEN, Michigan, the temperatures of the lake water for June, July, and August are 70.4° F. (21.3° C.), 75.6° F. (23.6° C.), and 74° F. (24.2° C.) respectively. At CORONADO, California, the water of the Pacific Ocean has the following mean temperatures: in January, 56° F. (13.5° C.); in February, 58° F. (14.5° C.); in March, 60° F. (15.5° C.); in April, 67° F. (19.5° C.); in May, 68° F. (20° C.); in June, 70° F. (21° C.); in July, 74° F. (23.3° C.); in August, 74° F. (23.3° C.); in September, 73° F. (22.5° C.); in October, 67° F. (19.5° C.); in November, 61° F. (16° C.); in December, 54° F. (12.5° C.). Maximum, 78° F. (25.5° C.) in August; minimum, 46° F. (7.8° C.) in January.

The NORTH SEA is the best European representative of the vigorous sea-bath, for it offers the advantage of a great amount of salt in the water and a vigorous wave-impact, as well as a uniform temperature during the summer months, and a fresh, stimulating sea-air. In the BALTIC SEA there is less salt and the wave-impact is less; the contrast between the low temperature of the water and the higher temperature of the air, also, is greater. The sea-baths situated in southern climates may be resorted to during the autumn months, on account of the high temperature of the water.

Localities

Among the better-known **European** sea-baths [1] are the following:

On the **North Sea**: BORKUM, CUXHAVEN, NORDERNEY, WANGEROOG, SPIEKEROOK, HELIGOLAND, WYK ON FOEHR, WESTERLAND-SYLT, DANGAST, FANO, in **Germany**; SCHEVENINGEN, ZANDVOORT, in **Holland**; BLANKENBERGHE, OSTEND, MIDDELKERKE, NIEUPORT, in **Belgium**; STROEMSTAD, GUSTAFSBERG, MARSTRAND, in **Sweden**; SANDE-

[1] See also vol. III, Index, *Sea-bathing;* and *Coast Resorts.*

FJORD, in **Norway**; RAMSGATE, SANDGATE, MARGATE, HARWICH, ALDBOROUGH, LOWESTOFT, YARMOUTH, CROMER, BRIDLINGTON, SCARBOROUGH, CHATHAM, HARTLEPOOL, in **England**; PORTOBELLO, ELIE, ST. ANDREWS, in **Scotland.**

On the **Baltic Sea**: APENRADE, GLUECKSBURG, DUESTERNBROOK, HAFTKRUG, TRAVEMUENDE, BOLTERHAGEN, HEILIGENDAM, DOBERAN, WARNEMUENDE, CAMMIN, DIEVENOW, COLBERG, STOLPMUENDE, ZOPPOT, CRANZ, SASSNITZ, BINZ, AALBIG, ZINNOWITZ, HERINGSDORF, SWINEMUENDE, MISDROY, in **Germany**; MARIENLYST, KLAMPENBORG, SKODSBORG, MIDDELFART, AALSGARD, in **Denmark**; LIBAU, DUBBELN, KAUPERN, PERNAU, HAPSAL, REVAL, HELSINGFORS, ARENSBURG, in **Russia**; WISBY, FURUSUND, RONNEBY, KARLSKRONA, BORGHOLM, in **Sweden.**

On the **English Channel**: HAVRE, DIEPPE, TROUVILLE, ETRETAT, FÉCAMP, BOULOGNE, DUNKIRK, CALAIS, in **France**; DEVONPORT, PLYMOUTH, TORQUAY, TEIGNMOUTH, TOPSHAM, LYME-REGIS, LYMINGTON, SOUTHAMPTON, BOURNEMOUTH, NORTHING, BRIGHTON, EASTBOURNE, HASTINGS, HYTHE, FOLKESTONE, in **England**; on the **Isle of Wight**: COWES, RYDE, SANDOWN, SHANKLIN, VENTNOR.

On the **Atlantic Ocean**: BLACKPOOL, SOUTHPORT, BARMOUTH, TOWYN, TENBY, MINEHEAD, BARNSTAPLE, ILFRACOMBE, in **England**; CAMPBELTON, ROTHESAY, HELENSBURGH, GREENOCK, in **Scotland**; PORTRUSH, BELFAST, NEWCASTLE, DUNMORE-WATERFORD, MOORE'S BAY, in **Ireland**; BIARRITZ, ARCACHON, LA TESTE DE BUCH, ROYAN, LA ROCHELLE, in **France**; SAN SEBASTIAN, SANTANDER, PORTUGALETE, OLAVIJAJA, CADIZ, JUNQUERA, FINISTERRE, BAYONA, in **Spain**; LISBON, ERICEIRA, CEZIMBA, SETUBAL, ESPOZENDE, PAVOA DE VARZIM, in **Portugal.**

On the **Mediterranean Sea**: ALICANTE, BARCELONA, VILLAJOYOSA, VALENCIA, TARRAGONA, in **Spain**; CETTE, MARSEILLES, HYÈRES, ANTIBES, CANNES, NICE, MENTONE, AJACCIO, in **France.** MONACO, in **Monaco**; STURLA, S. MARGHARITA, RAPALLO, NERVI, SPEZIA, SESTRI, LEVANTE, CORNIGLIANE, SESFUI, PONENTE, PEGLI, ALASSIO, SAVONA, SAN REMO, MASSA, VIAREGGIO, LEGHORN, CIVITAVECHIA, NETTUNA, NAPLES, CASTELLAMMARE, ISCHIA, PALERMO, MESSINA, ACIREALE, CATANIA, SYRACUSE, in **Italy.**

On the **Adriatic Sea**: ANCONA, RIMINI, VENICE, in **Italy**; ABBAZIA, LOVRANA, PORTOROSE, GRADO, ROVIGNO, TRIESTE, FIUME, CIRKVENICA, PONTO RÉ, BUCCARI, in **Austro-Hungary.**

On the **Ægean Sea**: PHALERON, in **Greece.**

On the **Black Sea**: FONTAN, IALTA, SEBASTOPOL, in **Russia.**

In the **United States** [1] sea-baths may be had at many resorts, of which the following may be selected as types:

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[1] See also vol. IV, Index *Sea-bathing;* and *Coast Resorts.*

On the **Atlantic Coast**: At MIAMI and PALM BEACH, in **Florida**; BRUNSWICK, in **Georgia**; KENNEBUNKPORT, OLD ORCHARD BEACH, YORK BEACH, and WELLS BEACH, in **Maine**; BUZZARD'S BAY, COHASSET, HYANNIS, NANTASKET, NANTUCKET, SWAMPSCOTT, and WOODS HOLL, in **Massachusetts**; HAMPTON and RYE BEACH, in **New Hampshire**; ATLANTIC CITY, BEACH HAVEN, CAPE MAY, LONG BRANCH, and SPRING LAKE, in **New Jersey**; NARRAGANSETT and NEWPORT, in **Rhode Island**; OLD POINT COMFORT and VIRGINIA BEACH, in **Virginia.** CONEY ISLAND, MANHATTAN BEACH, and certain resorts on Long Island Sound and along the coast of Delaware and Maryland also furnish sea-baths. The waters of the **Gulf of Mexico** and certain of its inlets are likewise suitable for sea-bathing.

On the **Pacific Coast**: At AVALON, CORONADO BEACH, LONG BEACH, SANTA BARBARA, SANTA MONICA, and other resorts in **California**, and at certain primitive resorts in **Oregon**.

CHAPTER V

SULPHUR BATHS; IRON BATHS

Sulphur Baths—Composition; Effects; Indications; Methods; Localities. Steel Baths—Composition; Effects; Indications; Methods; Localities. Vitriol Baths—Effects; Indications; Localities.

SULPHUR BATHS

Composition

Those waters are employed for sulphur baths that are characterized by the presence of binary sulphur compounds, and, in particular, the **thermal sulphurous waters.**

Effects

These baths, especially when the water is rich in hydrogen sulphid, exert an intensely irritating effect upon the skin, causing turgescence, augmented transpiration, and desquamation of epithelium. The high temperature of the thermal sulphurous waters and the methods usually employed in such resorts, with the use of local and general hot douches and frictions, increase the effects of the bath in augmenting the cutaneous function and stimulating absorption. Investigations made by Beissel and Mayer with regard to the influence of the thermal sulphurous douches of Aachen upon the bodily metabolism show that on the days on which the douche is employed, there occurs a diminution in the excretion of urine, with a simultaneous increase in the quantity of uric acid and urea; although on the days succeeding the douche baths the quantities of urea and uric acid eliminated are materially diminished. Marchisio found after the hydrogen sulphid gaseous baths at Vinadio—which are given at a temperature of 61° C. (141.8° F.), and are not borne for more than from five to ten minutes—that in spite of the brief duration of the exposure, there were produced an increase in the body-temperature of from 2° to 3° C. (3.6° to 5.4° F.) and marked diaphoresis, with correspondingly enormous reduction in diuresis. Often as much as 3.5 grams of urea were found in 1000 grams of sweat. It is also noteworthy that the alkalinity of the sulphurous bath contributes materially to the removal of fatty matter and pigment adhering to the skin, as well as of the inspissated sweat and sebaceous matter. Perhaps also some importance is to be attached to the antimycotic property of the sulphur springs, and this may justify the recommendation of these baths for the treatment of cutaneous diseases. At present no specific activity is attributed to the sulphurous baths in the treatment of syphilis, or any power to render latent syphilis apparent; and, accordingly, no diagnostic importance can be attached to them in doubtful cases, as was formerly believed. The activity of the sulphurous thermal waters is analogous to that of other thermal baths. The well-recognized action of sulphur baths in cases of syphilis and chronic metallic poisoning is attributable to the fact that these baths effect a thorough cleansing of the skin, so that saturation, whether from within or without (absorption or elimination), requires a greater quantity of material. Hence in the event of courses of treatment by inunction, large doses of mercury can be absorbed through the integument. The same factor of the greater capacity, and hence increased activity, of the skin also constitutes the principal part of the efficacy of the sulphur baths in combating gouty affections. In addition, Mayer and E. Beissel emphasize the marked increase in the elimination of uric acid that they observed during a course of treatment with thermal baths (and a drinking-cure) in combination with massage, at the sulphur springs of Aachen.

Indications

The sulphur baths appear to be especially indicated in the presence of gouty and chronic rheumatic affections, chronic exanthemata, especially psoriasis, prurigo, acne, and urticaria, syphilis, and chronic metallic poisoning, the sequels of traumatic lesions, motor and sensory neuroses, and tabes dorsalis.

Methods

Sulphur baths are generally employed at a **high temperature** (36° C.—96.8° F.; at times even as high as 42° C.—107.6° F.). The **duration** of these baths is, on an average, half an hour, although at many sulphur springs prolonged baths, lasting three or four hours, are employed. At some sulphur springs two baths daily are permitted.

Auxiliaries.—Together with the general baths, general and local warm douches, descending and ascending, as well as alternating hot and cold douches (so-called Scottish douches) are usually employed. After the bath, a rest of one or two hours is taken, generally in bed, in order to permit the continuance of the stimulating effect upon the skin for a considerable time.

In some of the sulphur baths of Hungary, Switzerland, and the Pyrenees, the practice, objectionable in several respects, of the associated bathing of several persons, at times even of men and women, in large piscines—**pool baths**—still exists. At other sulphur springs, where a considerable quantity of water can be obtained, large swim-

ming-pools have been constructed for gymnastic purposes. When cold sulphurous waters must be warmed for bathing, or, conversely, when hot sulphurous waters must be cooled for this purpose, certain balneotechnic arrangements are necessary to prevent, as thoroughly as possible, exposure of the gases and the sulphur combinations to the influence of the air.

With the sulphur baths, **steam sulphur baths** and **vapor baths** are generally combined. At the thermal sulphur springs the natural vapors and gases that escape are received into cabinets in which the patient sits, and that completely envelop him, the head alone being free. From the cold sulphur waters the steam is obtained through the application of artificial heat.

The vapors and gases of the sulphur waters are also employed by **inhalation,** and for this purpose the water is thrown into a fine spray, by means of special apparatus, or the vapor is collected in so-called vaporiums. (See volume x, on "Inhalation Methods.")

Localities

Thermal sulphurous baths are found, on the **Continent of Europe**—In **Austro-Hungary**: At BADEN, near Vienna (33.7° C.—92.7° F.); BUDA-PEST (Artesian Bath, Kaiserbad, Margaretta Island, St. Lucas Bath) (43° to 74° C.—109.4° to 165.2° F.); HARKANY, in Hungary (62.2° C.—140.4° F.); HERCULESBAD, in Hungary (48.2° C.—118.8° F.); ILIDZE, in Bosnia (57.5° C.—135.5° F.); MONFALCONE, in Austria (38° C.—100.4° F.); PYSTJAN, in Hungary (64° C. —147.2° F.); TRENZSIN-TOEPLITZ, in Hungary (40.2° C.—104.4° F.); WARASDIN-TOEPLITZ, in Croatia (57° C.—134.6° F.). In **France**: AIX-LES-BAINS, in Savoy (46° C.—114.8° F.); AMÉLIE-LES-BAINS, in Pyrénées-Orientales (60° C.—140° F.); AX-LES-THERMES, in Ariège (77° C.—170.6° F.); BAGNÈRES-DE-LUCHON, in Haute-Garonne (68° C. —154.4° F.); BARÈGES, in Hautes-Pyrénées (44.5° C.—112.1° F.); CAUTERETS, in Hautes-Pyrénées (50° C.—122° F.); EAUX CHAUDES, in Basses-Pyrénées (36° C.—96.8° F.); LA PRESTE, in Pyrénées-Orientales (44.5° C.—112.1° F.); VERNET-LES-BAINS, in Pyrénées-Orientales (34.8° to 57.8° C.—94.6° to 136° F.). In the **German Empire**: AACHEN, in Rhenish Prussia (55° C.—131° F.); BURTSCHEID, a suburb of Aachen (74.6° C.—166.3° F.). In **Italy**: VINADIO, in Piedmont (63° C.—145.4° F.). In **Russia**: PIATIGORSK, on Mashuka Hill (45.2° C.—113.4° F.). In **Switzerland**: BADEN, in Canton Aargau (47° C.—116.6° F.); LAVEY, in Canton Vaud (45° C.—113° F.); SCHINZNACH, in Canton Aargau (35° C.—95° F.).

In the **British Islands** there are arrangements for thermal sulphurous baths at HARROGATE, in Yorkshire, **England**, at LISDOONVARNA, in County Clare, **Ireland**, and at LLANDRINDOD WELLS, in Radnorshire, **Wales**.

In the **United States** thermal sulphurous baths are found—In **California**: at GILROY HOT SPRINGS, in Santa Clara County (42.2° to 46° C.—108° to 115° F.); MONTICITO SPRINGS, five miles from Santa Barbara (37° to 50° C.—99° to 122° F.); SANTA YSABEL, in San Luis Obispo County (36° C.—96.3° F.); ST. HELENA WHITE SULPHUR SPRINGS, in Napa County (18° to 36° C.—64.4° to 97.25° F.). In **Colorado**: GLENWOOD SPRINGS, in Garfield County (51.1° C.—124° F.); HOT SULPHUR SPRINGS: Big Sulphur (46° C.—115° F.); Little Sulphur (44° C.—111° F.); Red Sulphur (43° C.—109.5° F.), in MIDDLE PARK, Grand County. In **New York**: AVON SULPHUR SPRINGS, in Livingston County (10° C.—50° F.); CLIFTON SPRINGS, in Ontario County (12.2° C.—54° F.); RICHFIELD SPRINGS, in Otsego County (8.3° C.—47° F.); SHARON SPRINGS, in Schoharie County (8.9° C.—48° F.)—all these waters are heated artificially and used for bathing. In **Tennessee**: RED BOILING SPRINGS, in Macon County (11.1° C.—52° F.). In **Virginia**: FAUQUIER WHITE SULPHUR SPRINGS (12.7° C.—55° F.); WARM SPRINGS, in Bath County (35.6° C.—96° F.). In **West Virginia**: RED SULPHUR and SALT SULPHUR SPRINGS, in Monroe County (10.5° C.—51° F.).

In **Alaska** there are numerous undeveloped hot sulphurous springs, chiefly those near Sitka; for instance—SITKA HOT SPRINGS, on Baranoff Island (48.9° C.—120° F.).

In **Canada** there are sulphurous thermal baths at HOT SULPHUR SPRINGS, in Banff.

IRON BATHS

STEEL BATHS

Composition of Steel Baths

Baths prepared from carbonated iron waters are designated steel baths. These are, therefore, baths that contain only a small quantity of solid matter—rarely more than from 0.05 to 0.3 per cent., and chiefly ferrous carbonate held in solution by carbonic acid; but which, on the other hand, are notably rich in carbon dioxid.

Effects

As the theory of absorption of the iron into the blood stream through the external integument can scarcely be accepted at present, any notable difference in effect between the steel baths and the acid baths is not to be expected. Steel baths, like other carbonated baths, are effective through irritation of the skin by the carbon dioxid. This irritation renders possible, through the sense of warmth created, the employment of these baths at a lower temperature, favoring metabolism, and permitting their use with debilitated, unresisting, and anemic individuals. This constitutes an important factor in the usefulness of the steel baths. The steel bath induces, through the influence of the carbon dioxid upon the skin, a maintained stimulating effect transmitted from the periphery to the center, and exercising, through reflex action and radiation, a good influence upon various processes in the organism. Particularly does its good effect become manifest in conditions of pathologic nervous activity. Lehmann attributes, further, a contact effect to the steel baths, inducing, through frequently repeated, brief contractions of the surface, an especial stimulation of the nutritive activity of the integument, effecting compression of the cells of the upper layers, and forcing them more closely together; further, exerting from the surface a similar effect upon the subjacent tissues, and thus opposing the flaccidity and the general lack of tonicity present in cases of anemia. As the result of a study of the action of the steel baths, Flechsig states that after their use, in addition to improvement in the appetite, there is increased absorption of the ingested organic substances into the body fluids; further, that an absolute increase occurs in the production of carbon dioxid in the body, a phenomenon not observed after baths in sweet water; and, finally, that in proportion to the amount of organic substances introduced, the elimination of urea is diminished. It must, therefore, be concluded that as the result of the influence of the baths there is nutritive retention of organic matters in the form of albumin.

Indications for Steel Baths

Steel baths are, therefore, especially **recommended** in cases of anemia and chlorosis and their sequels; in conditions of debility, or of chronic disease of the nervous system, sensory or motor, if associated with anemia; and in the presence of diseases of the female sexual organs, especially disorders of menstruation.

Methods

The mode of employing steel baths is the same as that for the acid baths. They are generally given at a **lower temperature,** of from 32° to 25° C. (89.6° to 77° F.), and the **duration** is from ten to twenty minutes. In using these baths the water must be warmed, with precautions directed especially to the retention, as fully as possible, of the carbon dioxid. In order to prevent the inhalation of the carbon dioxid by the patient in the bath, the bathing cabinet must be adequately **ventilated.** The bath-tubs should not be too full. In some places the bath-tubs are provided with a lid; in others, cloths are stretched over the tubs. The bather should not engage in active movement in the water, in order not to deprive it of its gas.

Localities

In all resorts on the **Continent of Europe** supplied with carbonated iron waters (see section on "Crounotherapy") establishments for giving steel baths have been erected; as, for example, in **Austro-Hungary**: At BARTFELD and SZLIACS, in Hungary; at FRANZENSBAD and MARIENBAD, in Bohemia. In **Belgium**: At SPA, in the Province of Liège. In the **German Empire**: At ELSTER, in Saxony; at CUDOWA, in Prussia; at PYRMONT, in the Principality of Waldeck-Pyrmont; at REINERZ, in Prussian Silesia; at SCHWALBACH, in Hesse-Nassau; at STEBEN, in Bavaria.

In the **United States**, where the term chalybeate is used to designate carbonated and other iron waters, the principal springs of this class, used for bathing purposes, are the following: In **Alabama**: MATCHLESS MINERAL WELLS, in Butler County. In **California**: GEYSER SPA, in Sonoma County; NAPA SODA SPRINGS, in Napa County; NEWSOM'S ARROYO GRANDE SPRINGS, in San Luis Obispo County. In **Michigan**: OWASSO SPRING, in Shiawassee County. In **New Mexico**: OJO CALIENTE, in Taos County. In **Texas**: WOOTAN WELLS, in Robertson County. In **Virginia**: SWEET CHALYBEATE SPRINGS, in Alleghany County. In **Wisconsin**: SPARTA MINERAL WELLS, in Monroe County.

VITRIOL (IRON SULPHATE) BATHS

The designation vitriol baths is employed to describe baths prepared from iron sulphate waters.

Effects

The utility of these baths depends upon the astringent and bactericidal properties of ferrous sulphate, particularly in their application to the accessible mucous membrane of the female genital canal. These properties appear to be of significance also in the action of the vitriol bath upon the entire tegumentary organ of the body.

Indications

Vitriol baths have been lauded for their good effects in general cutaneous debility with a marked tendency to sweating; in chronic exanthemata; and in vaginal catarrh of long standing. Such baths are provided in most health resorts with iron sulphate waters.

Localities

On the **Continent of Europe**—In **Austro-Hungary**: LEVICO, MITTERBAD, and RATZES, in the Tirol; PARAD, in Hungary. In the **German Empire**: ALEXISBAD, in the Duchy of Anhalt; MUSKAU, in Prussian Silesia. In **Sweden**: RONNEBY.

In the **United States**—In **Virginia**: BATH ALUM SPRINGS, in Bath County; CHURCH HILL ALUM SPRINGS, in Henrico County; ROCKBRIDGE ALUM SPRINGS, in Rockbridge County; STRIBLING SPRINGS, in Augusta County.

CHAPTER VI

GAS BATHS; PEAT BATHS AND MUD-BATHS; MINERAL STEAM BATHS; MEDICATED BATHS

Dry Gas Baths—Composition. Carbonic Acid Gas Baths—Effects; Indications; Methods; Localities. Sulphurous Gas Baths—Indications and Methods. Peat Baths and Mud-baths—Peat Baths: Composition; Effects; Indications; Localities—Iron Peat Baths; Sulphurous Peat Baths. Mud-baths—Effects and Uses; Localities. Salt Mud-baths—Localities. Mineral Steam Baths—Methods; Effects; Indications; Localities. Irish-Roman Baths—Indications. Mineral Water Spray Baths. Medicated Baths—Preparation; Effects and Uses. Thermal Calcium Baths—Indications.

DRY GAS BATHS

Composition

The **dry gases** arising from mineral springs, especially **carbon dioxid** and **hydrogen sulphid**, are employed therapeutically for baths.

CARBONIC ACID GAS BATHS

Effects

The action of **carbon dioxid** upon the external integument, and also upon the entire organism, has been considered in the discussion of acid baths and steel baths. According to my observations, full baths of dry carbon dioxid gas give rise to an increased sense of warmth in all portions of the body exposed to the action of the gas, particularly the genitalia and the perineum; increased tactile sensibility of the skin, as well as general cutaneous sensibility; increased secretion and increased turgescence of the skin; diminution in the frequency of the pulse in the first period—up to half an hour—of the gaseous bath, with subsequent increase in frequency. With the increase in the frequency of the pulse there is likewise an increase in the rate of respiration. The temperature of the body is not influenced during and after the gas baths, although the evening temperature is higher on the days on which the bath is taken than on the intervening days. Following the gas bath, micturition becomes more frequent and there is an increase in the amount of urine passed during the twenty-four hours of the day of the bath, without an increase in the amount of urea excreted. The increased sense of warmth depends neither upon elevation of temperature nor upon dilatation of the vessels, but upon chemical irritation of the heat-nerves by the carbon dioxid.

[illegible] congestion [illegible] of the skin, [illegible] nerves. [illegible] upon the [illegible] absorp- [illegible] gas [illegible] discharge [illegible] circumstances.

Indications

[illegible] neuralgia and [illegible] derange- ments [illegible] male; con- [illegible] cutaneous [illegible]

Methods

Local carbonic gas-douches are used for anesthetic purposes. [illegible] in a primitive manner, [illegible] the escaping [illegible] After a time the carbon [illegible] these springs, [illegible] The cabinets in use for [illegible] of wood and are provided [illegible] chest or neck. The patient [illegible] lower portion of the body—[illegible] or that the head alone [illegible] gas chambers have been constructed that permit several persons to bathe at the same time, each occupying a chair or a bench with a perforated seat-board, the gas rising to a certain level of the body. These gas baths are given dry. The patient removes his shoes, but beyond this does not undress, as the gas readily penetrates the clothing and reaches the skin.

The **duration** of the bath is generally from ten to twenty minutes. Care is necessary to prevent inhalation of the gas. The **temperature** of the gas bath varies with the temperature of the springs from which the gas is derived. As a rule, the carbonic gas baths are cold. In order to reduce their temperature hot gases may be conveyed through cooling apparatus, and, conversely, heating apparatus may be employed for warming cold gases.

Localities

Among resorts on the **Continent of Europe** where carbonic gas baths are administered are—**In Austro-Hungary**: FRANZENSBAD and MARIENBAD, in Bohemia; SZLIACS, in Hungary. In the **German**

Empire: DRIBURG, in Prussia; HOMBURG, in Hesse-Nassau; MEINBERG, in Lippe-Detmold; NAUHEIM, in the Grand Duchy of Hesse; PYRMONT, in Waldeck-Pyrmont.

In the **United States** carbonic gas baths may be had at the BYRON SPRINGS, in Contra Costa County, **California**; and at GLEN SPRINGS, in Schuyler County, and SARATOGA SPRINGS, in Saratoga County, **New York.**

SULPHUROUS GAS BATHS

Hydrogen sulphid from the sulphur springs is also employed, in the same way as carbon dioxid, for gas baths. It is, however, generally admixed with carbon dioxid, nitrogen, and carbon disulphid, so that a positive opinion as to the action of the hydrogen sulphid gas in such a bath cannot be given.

Effects

In general a **sedative action** upon the cutaneous nerves is attributed to these gas baths, and this, in turn, reduces the increased general nervous irritability. The pulse frequency and the respiratory movement also are reduced in the bath. **Absorption** of the hydrogen sulphid through the external integument has likewise, as in the case of carbon dioxid, been demonstrated; but during the bath the hydrogen sulphid enters the circulation also through **inhalation.** If the quantity of gas inhaled is large, it may induce toxic effects, including languor, syncopal attacks, muscular weakness, respiratory disturbance, and cardiac derangement.

Indications and Methods

Hydrogen sulphid gas baths are **indicated** in general hyperesthesia; hysteria; neuralgia; and chronic exanthemata.

As the emanations of hydrogen sulphid at the sulphur springs are generally admixed with steam, such gas baths are often employed also as **gaseous steam baths** at a high temperature. The gaseous steam baths greatly increase diaphoresis and absorption.

The hydrogen sulphid gas baths are given, like the carbonated gas baths, in **cabinets** inclosing the entire body with the exception of the head, or, by means of **tubes**, selected portions of the body are exposed to the action of the gas.

Localities

Hydrogen sulphid gas baths are situated, on the **Continent of Europe**—In the **German Empire**: At AACHEN, in Rhenish Prussia; at WEILBACH, in Hesse-Nassau, and at other sulphur springs.

In the **United States** hydrogen sulphid gas baths are employed at RICHFIELD SPRINGS, in Otsego County, New York.

PEAT BATHS AND MUD-BATHS

Composition.—Baths prepared from mineral peat and mineral mud are partially solid baths, of varying density. In their mode of application and in their action they are related to the mineral water baths, but they possess various characteristic properties.

PEAT BATHS

Mineral peat is a form of turfy soil consisting of decomposed vegetable matter that has come into constant intimate contact with mineral waters for long periods of time, often estimated at thousands of years, and in consequence has undergone peculiar chemical changes. This peat contains vegetable substances, humus and humic acid, resin, silica, aluminum, iron phosphate, iron sulphid, sodium chlorid, sulphates, as well as free sulphuric acid, carbon dioxid, and hydrogen sulphid. By exposure to the weather the peat becomes disintegrated, and is then mixed with hot water to form a more or less consistent mushy mass; and this is employed for the peat baths. The quantities of solids and fluids contained in these baths depend upon the character of the decomposed vegetable matter that constitutes the principal portion of the peat; upon the amount of saline matters present in the mineral water that has been used for admixture with the peat; and upon the degree of decomposition of the dried peat. As a result of the decomposition that takes place in consequence of the process of oxidation of the principal constituents of the peat, the insoluble mineral and organic compounds are converted into soluble substances, iron disulphid being transformed into iron sulphate, and organic acids, such as formic acid and acetic acid, being developed. Peat earth that is especially rich in alkaline sulphates and earthy salts is designated **saline peat,** whereas **iron or ferruginous peat** is characterized by the presence of large amounts of iron sulphate, and **sulphurous peat** by the presence of sulphur and hydrogen sulphid.

Effects

Peat baths differ from all other varieties of baths in several respects. Their capacity for heat is much less than that of water-baths, and they can therefore be employed at a much higher average temperature. As the different layers of peat, cooling rapidly, possess varying degrees of heat, the peat baths should be classed among stimulating baths with varying layers. The consistence of the bath may vary, in accordance with the amount of peat employed, from semiliquid to an almost solid mass. This consistent mass of peat exerts a considerable mechanical effect through compression and friction, its action thus bearing a close resemblance to that of massage. The large amounts of carbon dioxid, hydrogen sulphid, and fluid organic acids contained in the peat bath give rise to marked irritation of the motor and sensory cutaneous nerves; and, at the same time, a chemical effect, resulting from absorption of those substances which cause detachment of the epithelial cells, cannot be excluded.

As a result of my experiments with the **iron peat baths** at Marienbad, the principal results of the **action** of these baths were found to consist in an acceleration of the frequency of the pulse of from eight to twelve beats in a minute; an increase in the blood pressure in proportion to the density of the peat mass; acceleration of respiratory frequency; elevation of the bodily temperature; augmentation of cutaneous transpiration; diminution in the secretion of urine; increase in the elimination of urea, as well as of most of the solid constituents of the urine; diminution in the excretion of phosphates; and, in women, increase in the menstrual discharge. The iron peat baths possess, further, certain bactericidal properties that are the more marked the greater the amount of acid present in the peat.

Indications

The peat baths, among which the iron peat baths occupy the foremost place, are especially to be preferred to other varieties of baths when a powerful cutaneous irritation with simultaneous increase of the body-heat is desired. They are therefore indicated particularly in the presence of various forms of neuralgia, notably of arthritic or rheumatic origin; in cases of paralysis, especially when the cause of the interruption in nerve conduction is in the distribution of the peripheral nerves; in the presence of exudates; in rheumatic and gouty affections; in diseases of the sexual organs in women, such as chronic metritis, parametritis, and menstrual derangement.

The peat baths are **counterindicated** in the presence of organic disease of the heart, arteriosclerosis, or pulmonary tuberculosis; when a tendency to hemoptysis exists; and during pregnancy. At resorts where peat baths are furnished, in addition to full peat baths—which, for instance at Marienbad, contain so much as five or six kilograms (about 10 or 12 pounds) of iron sulphate, 220 grams of formic acid, 225 grams (about 7½ ounces) of other volatile organic substances—local peat baths, sitz peat baths, foot and hand peat baths, as well as peat cataplasms are employed.

Localities

Iron peat baths prepared from bog containing iron salts and organic acids in abundance are to be obtained, on the **Continent of Europe**, notably—In **Austro-Hungary**: At FRANZENSBAD and MARI-

ENBAD, in Bohemia. In **Belgium**: At SPA, in the Province of Liège. In the **German Empire**: At ELSTER, in Saxony; at PYRMONT, in Waldeck-Pyrmont; at REINERZ, in Prussian Silesia; at STEBEN, in Bavaria. In **Sweden**: At RONNEBY, in the Län of Blekinge.

Sulphurous peat baths, prepared from the turfy peat obtained from the vicinity of sulphur springs, are principally **indicated** in the presence of chronic rheumatic and gouty exudates and their sequels; as well as for the consequences of traumatisms. Such sulphurous peat baths are **situated** at DRIBURG, EILSEN, and MEINBERG, in Germany.

MUD-BATHS

Related to the peat baths in **composition and action** are the mud-baths, prepared from the mud-like precipitates of various mineral waters or of sea-water.

Effects and Uses

Mud-baths exert a similar thermic and mechanical, though by no means so considerable a chemical, effect as the peat baths. Among them the **sulphurous mud-baths** especially, which contain the valuable organic and mineral constituents of the sulphurous thermal waters, have a favorable reputation on account of their marked influence upon diseases of the joints; paralysis; and neuralgia.

Localities

The best-known **sulphurous mud-baths** on the **Continent of Europe** are—In **Austro-Hungary**: MEHADIA, PYSTJAN, and WARASDIN-TOEPLITZ, in Hungary. In **France**: AIX-LES-BAINS, in Savoy. In **Italy**: ACQUI, in the Province of Alessandria. In **Sweden**: LOKA, in the Län of Wermland.

In the **United States** baths corresponding to the foregoing can be obtained—In **California**: At the ARROWHEAD HOT SPRINGS, in San Bernardino County; BYRON SPRINGS, in Contra Costa County; EL PASO DE ROBLES SULPHUR SPRINGS, in San Luis Obispo County; HOT MUD SPRINGS, in Siskiyou County. In **New Mexico**: LAS VEGAS HOT SPRINGS, in San Miguel County.

At a number of **seaside resorts** the sea-mud—that is, the slimy material obtained from sea-water—is used for bathing purposes. This material contains mineral matters, vegetable and animal substances, and micro-organisms.

The principal resorts on the **Continent of Europe** at which **sea-mud baths** are furnished are—In **Norway**: At SANDEFJORD, on the North Sea. In **Russia**: On the Baltic Sea, at ARENSBURG on the island of Oesel; HAPSAL, in Esthonia; and at PERNAU in Livonia, on the northeastern shore of the Gulf of Riga. On the Black Sea, at ODESSA, in Kherson; at SAKI, MOINAK, SEBASTOPOL, TCHOKRAK, and KERTCH in the Crimea. At most of the Russian Baltic resorts the mud comes from the sea, but at Pernau it is obtained from boggy ground. At the Black Sea resorts, the mud of the 'limans' or brine lakes is employed.[1]

MINERAL STEAM BATHS

Some mineral waters are employed for the preparation of **steam baths**, in which to the effects of extremely high degrees of temperature upon the body, is added the irritation induced by the gases contained in the steam, particularly carbon dioxid and hydrogen sulphid. The term steam bath is applied in general to the action of air saturated or oversaturated with aqueous vapor of a temperature not less than 37.5° C. (90.5° F.), and as high as from 50° C. (122° F.) to 56° C. (132.8° F.), whether the effect be exerted upon the entire body or confined to any given portion thereof.

Methods

While in the original **Russian steam bath** the steam is generated by sprinkling water upon intensely hot stones, nowadays this is generally effected, especially in mineral steam baths, by means of a boiler. The steam is introduced into a general bath-room, large enough for several persons, the temperature and distribution of the aqueous vapor being regulated at will; or it is introduced into cabinets in which the body is only partially surrounded by steam, while the head remains outside of the cabinet, so that the patient does not breathe steam, but ordinary air. The general bath-room is provided with a number of benches, arranged as in an amphitheater, upon which the bathers lie down and expose themselves to the action of the steam. At times the stimulating effect of the steam upon the skin is enhanced by adding the volatile oils of the terebinthinate group contained in a fresh decoction of pine needles. Near the steam baths, rooms are fitted up with douches and full baths at different temperatures.

The true Russian bath-room consists of three apartments, a dressing-room, the actual bath-room, and a room for douching and rubbing. In the latter is a tile stove with a niche that can be closed by doors and windows, and contains hot bricks. If it be desired to fill the room with steam, water is poured upon the bricks. Against the wall nearest the stove three wooden benches placed one above the other like terraces are generally found, upon which the douching and switching of the body with birch twigs is practised.

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[1] See vol. III, p. 114 and p. 145.

Effects

The experiments of Frey and Heiligenthal have yielded the following results with regard to the mineral steam baths given at the sodium chlorid thermal springs of BADEN BADEN, with an atmospheric temperature of 50° C. (122° F.) and of a half-hour s duration : Increase in delicacy of the sensibility of the skin for touch and temperature, during and particularly after the bath; improvement in the general condition and the feeling of a sensation of increased strength. On entering the bath there is brief, transitory contraction of the capillaries of the skin and, as a result, increased pressure in the arterial system and moderate acceleration of the pulse. This is soon followed by enormous dilatation of the cutaneous capillaries, reduction in blood pressure and cardiac vigor, and further acceleration of the pulse. During the bath the flow of blood to the skin is increased, while that to the internal organs is diminished. In the bath perspiration occurs. On the days of the bath there is reduction in the amount and increase in the specific gravity of the urine. There is diminution in the elimination of urea and uric acid on the first day and increase in this elimination on the next succeeding days.

It is customary in the steam baths to practise cold affusions, fric tion of the skin, beating with twigs, kneading, massage, and similar mechanical manipulations, in order to increase the redness of the skin and stimulate the secretion of sweat, and, on the other hand, to exert a stimulating effect upon the sensory peripheral nerves and, through them, upon the cardiac nerves. The duration of the bath should not be too protracted.

In mineral steam baths, in which the steam-saturated air contains particles of salt and of carbon dioxid and hydrogen sulphid, depending on the composition of the spring, the influence of the steam upon cutaneous hyperemia and secretion is reinforced by the chemical and mechanical effects of the gaseous and solid constituents.

Indications

Mineral steam baths are indicated in obstinate chronic rheumatism, in exudations into muscles and joints, in arthritis and sciatica, general derangement of metabolism, obesity, syphilis, and mercurialism; they have recently been recommended also in cases of anemia and chlorosis. **Counterindications** to the employment of such steam baths are furnished by heart disease, a tendency to internal hemorrhage, and arteriosclerosis.

Localities

Mineral steam baths have been provided at many sodium chlorid thermal springs, sulphurous thermal springs, earthy thermal springs, and alkaline-saline springs. In some localities in Italy, Iceland, and

America there are grottos in the vicinity of volcanoes and thermal springs, which represent natural mineral steam baths. One of the best known of these is the grotto of Monsumano in Italy, Province of Lucca, which is filled with steam and represents a steam bath at a temperature of 33.5° to 35° C. (92.3° to 95° F.). The air contains in 1000 c.c. 4 c.c. of water in the form of vapor, and 3.25 per cent. carbon dioxid, as well as a quantity of calcium carbonate in a finely divided state.

In this connection reference may be made to the **Irish-Roman** baths, which are likewise provided at many health resorts, and in which dry hot air at exceedingly high temperatures is employed. The dryness of the air, making it a poor conductor of heat, and the cooling of the skin by evaporation of the sweat, combine to render high temperatures more endurable under such circumstances than they would be in the steam bath. The temperature of the blood is less markedly raised and the increase in pulse-frequency is slighter than in the steam bath. The Irish-Roman bath is therefore to be preferred to the steam bath, when it is desired to employ high degrees of temperature and at the same time to produce a less pronounced effect than with the employment of steam, and when it is desired to induce marked desquamation of the epidermis.

The Irish-Roman bath consists of an ante-room at the ordinary room-temperature, 19° or 20° C. (66.2° or 68° F.), and communicating rooms at a temperature of from 35° to 40° C.—95° to 104° F.—(tepidarium), and of from 45° to 50° C.—113° to 122° F.—(sudatorium). The two latter are well ventilated, and uniformly heated by means of hot-water pipes, which pass beneath the floor and along the lower portion of the walls. In some Irish-Roman baths there is a fourth room, with a temperature of from 65° to 90° C.—149° to 194° F.—(caldarium). The bather is covered only with a bath robe and wears sandals to protect the feet against the heat of the floor. Sweating generally takes place after a stay of from fifteen to twenty minutes in the tepidarium.

Indications

These hot-air baths are practised preferably for the purpose of stimulating the elimination of morbid products or foreign bodies through the skin, and of exerting a sorbefacient effect upon exudates and morbid secretions. They are therefore indicated in cases of arthritis, rheumatism, syphilis, metallic poisoning, and paralysis of various sorts.

In this connection the **mineral water spray** baths (bains à l'hydrofère) recommended by French clinicians may also be considered.

By means of an especial spraying apparatus the skin of the patient is continuously brought in contact with a fresh layer of water in a finely divided state. If mineral waters are employed, the effect of the gaseous and solid constituents is superadded to that of the spray, and the absorption of the former through the skin is increased in consequence of their fine division. These spray baths have the advantage over ordinary baths that the mechanical impact of the sprayed mass upon the skin exerts a more marked sedative effect upon the nerves of the part, that the uninterrupted renewal of the stream upon the skin facilitates the removal of secretion from the latter, and, finally, that absorption through the skin takes place more readily.

MEDICATED BATHS

For the sake of completeness, **artificially medicated baths** may be mentioned at this point. In these baths vegetable and animal matters are added to the water for the purpose of inducing irritation of the skin; softening indurated areas of the epidermis through imbibition; exerting a sedative effect upon abnormally irritated skin; or, finally, improving the general bodily nutrition.

Preparation and Effects

The best known of these baths are the **pine needle baths.** To the bath-water is added a decoction of the needles and young shoots of firs or pines, or, what is more serviceable, preparations made from these, namely, the ethereal oil (fir-wool oil) and the alcoholic extract and infusion of pine needles. One-half to one teaspoonful of the ethereal oil, or from 1/4 to 1/2 kilogram (about 1/2 to 1 pound) of the extract, should be added to the bath. The volatile ethereal constituents penetrate the epidermis, excite the cutaneous nerves, stimulate the capillary circulation of the skin, and are eliminated through the skin, lungs, and kidneys.

Similar effects may be obtained by the addition to the bath water of **aromatic plants,** as chamomile, wild thyme, elderflower, calamus (sweet flag), spearmint, lavender, sweet marjoram, balm, peppermint, sage, and milfoil. Of these herbs from 1/4 to 1 kilogram (1 1/2 to 2 pounds) is used for a full bath, from 25 to 150 grams (1 to 6 ounces) for a local bath or a child's bath. The herbs are tied up in a sac and scalded with 4 liters (quarts) of boiling water; the juices are then expressed and the decoction added to the bath. An equally efficient and simpler method of preparing an aromatic stimulating bath consists in adding the alcoholic extracts of the above-mentioned herbs, or the aromatic spirits of the

Pharmacopeia; from 50 to 125 grams (2 to 4 ounces) of the latter suffice for a full bath.[1]

Still more efficacious is the addition of **ethereal oils** to the bath-water; only 1 gram (15 minims) of the ethereal oil is required to bring about the desired effect upon the skin.

In order to induce a sharp, half-corrosive effect upon the skin of the patient, **lye-baths** are employed. In the preparation of these 2 or 3 grams (30 or 45 grains) of crystalline soda or a decoction of wood-ashes is boiled with 8 liters (quarts) of water and the strained fluid is added to the bath. Local lye-baths, especially foot-baths, constitute a universally familiar derivative measure in the presence of congestive states of the head and the thoracic viscera. **Mustard baths**—made by the addition of from 100 to 250 grams (4 to 8 ounces) of mustard-seed to the bath, or of 100 grams (4 ounces) to the local bath—act in the same manner.

Baths intended to allay irritation are prepared by adding **bran, starch,** or **malt** to the water. From 1/4 to 1 1/4 kilograms (1/2 to 2 1/2 pounds) of wheat bran, or from 1/8 to 1/2 kilogram (1/4 to 1 pound) of starch or malt, is boiled for about half an hour in from 4 to 6 liters (quarts) of water, and the decoction added to the bath.

The addition of oil to the bath, practised since antiquity, has recently been recommended for the treatment of burns and local inflammations of the skin, as well as for exudates situated in the deeper tissues. In the latter event it is thought that absorption is favorably influenced by the interference with evaporation due to the coating of oil on the skin.

For **astringent baths** substances containing tannic acid are

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[1] The following preparations are officinal in the United States and Great Britain:

Aqua amygdalæ amaræ.
" anisi (Br.).
" aurantii florum.
" carui (Br.).
" cinnamomi.
" fœniculi.
" menthæ piperitæ.
" menthæ viridis.
" sambuci (Br.).
Decoctum aloes comp. (Br.).
" papaveris (Br.).
" quercus (Br.).
" sarsaparillæ comp.
Infusum anthemidis (Br.).
" aurantii (Br.)
" calumbæ (Br.).
" caryophylli (Br.).
" lupuli (Br).
Oleum coriandri.
" fœniculi.
" gaultheriæ.
" juniperi.
Oleum lavandulæ florum.
" menthæ piperitæ.
" menthæ viridis.
" myrciæ.
" pini sylvestris.
" rosmarini.
" sabinæ.
" sassafras.
" sinapis volatilis.
" terebinthinæ.
" thymi.
Spiritus amygdalæ amaræ.
" anisi.
" aurantii.
" gaultheriæ.
" juniperi.
" lavandulæ.
" menthæ piperitæ.
" menthæ viridis.
" myrciæ.
" rosmarini (Br.).

employed, such as **oak bark, elm-willow bark,** or **walnut leaves.** A decoction of ½ to 1 kilogram (1 to 2 pounds) of the vegetable substances in 3 liters (quarts) of water is the quantity for one bath.

Animal baths are applications of the parts of recently slaughtered animals, especially the intestines, to the (paralyzed) extremities of human beings. In this category may be included also the sedative baths prepared by adding **glue,** 1 kilogram (2 pounds) dissolved in boiling water, or **gelatin** obtained by boiling calves' feet; the use of these baths was probably at first suggested by a primitive conception of the absorptive power of the skin in the bath.

Milk, whey, buttermilk, and **beef-broth,** which were formerly employed to increase the invigorating action of baths (**bouillon baths**), are now administered internally to better advantage.

THERMAL CALCIUM OR LIME BATHS

The efficacy of baths prepared with **thermal earthy waters,** thermal calcium or lime baths, depends chiefly on their high temperature, and to some extent, according to certain authorities, on the presence of calcium salts. There is little to support such a view, however, since all that is known of the physiologic action of calcium salts when applied externally is that they have a "desiccating effect on the skin and diminish secretion." I do not believe that it is possible to distinguish the effect of these baths from that of those acratothermal baths which increase the temperature. They are therefore mentioned here only for completeness. In some of the earthy mineral baths—as, for instance, at LEUK—the continuous application for several hours (from five to eight) is the main therapeutic factor. The bath then acts as a prolonged thermal bath and exerts a powerful influence on the cutaneous structures through imbibition and maceration (swelling); acts as a sedative to the irritated nerves; hastens the healing process in open wounds and ulcers; and, finally, stimulates the excretory organs of the body.

Indications

Thermal calcium or lime baths are accordingly indicated in the following conditions: Chronic diseases of the skin and ulcers; hyperesthesia and hyperkinesia; syphilis and mercurialism; old exudates in muscles, joints, and bones; rheumatism; arthritis; periostitis; and caries.

Localities

Calcium thermal baths are found at BATH, in England, 49° C. (120° F.); BORMI lin, 41° C. (105.8° F.); BUDA-PEST, in

Hungary, from 43° to 50° C. (108.4° to 122° F.); LEUK, in Switzerland, 51° C. (123.8° F.); LIPPSPRINGE, in Westphalia, 21.2° C. (70.2° F.); SZKLENO, in Hungary, from 41° to 53° C. (105.8° to 127.4° F.); USSAT, in France, 39° C. (102.2° F.); WEISSENBURG, in Switzerland, 26° C. (78.8° F.).

In the United States, HOT SPRINGS, in **Arkansas**, is the most noted locality at which baths of this nature can be obtained.

The **nitrogen** escaping from the thermal springs is also employed at some of these baths by **inhalation**, the efficiency of which is thought to be considerable, particularly in cases of pulmonary disease. However, this gas can have only a negative effect. It is in nowise utilized by the organism, and its effect consists only in attenuation of the inspired air, in a diminution of the amount of oxygen contained, and thereby in an increase of the respiratory demand. If, however, the nitrogen replaces the necessary amount of oxygen in excessive degree, it may even induce the injurious effects resulting from an insufficiency of oxygen in the air.

Section II

CROUNOTHERAPY: THE USE OF MINERAL WATERS FOR DRINKING-CURES

CHAPTER I

PRINCIPLES OF CROUNOTHERAPY[1]

General Considerations. Constituents of Mineral Springs. Classification.

General Considerations

In the employment of mineral waters for drinking-cures it should especially be borne in mind that much more elaborate and complex pharmacologic preparations are concerned than those obtained from the apothecary; and, moreover, their use at health resorts takes place under such peculiar conditions that a curative agent is raised to the dignity of a therapeutic method. Nevertheless, the inference must be rejected that mineral waters are capable of any specific action not explicable by the chemical and physical laws applicable to other remedies of the pharmacopeia. Although an adequate explanation either of the peculiar composition of mineral waters or of the activity of all their constituents is yet to be given, pharmacologic investigations have materially contributed to an estimation of the effect induced by the sodium salts (chlorid, carbonate, and sulphate), the magnesium sulphate, the calcium carbonate, and the iron carbonate conveyed to the body even in minimal amounts through the mineral waters. It is now properly emphasized as a point of especial importance that the active constituents of the mineral waters, even though in small quantities, are present in a finely divided state[2] and are capable of easy absorption; as also that the combination of several substances chemically different, but having similar action, is of especial curative value. I would also lay stress upon the distribution of the dosage in several portions repeated throughout the day, as a means of favoring absorp-

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[1] From κρουνός, *spring;* and θεραπεία. For this word, which is needed, as 'balneotherapy' should be restricted to the medicinal use of baths, the editor is indebted to the Greek scholarship of his friend, Dr. David Riesman, of Philadelphia.

[2] The recent chemical doctrines concerning the ions, and physiologic investigations based upon those doctrines, lend much importance to these conditions.—[ED.]

tion and stimulating the activity of the tissues as well as the secretory and excretory processes. In the application of drinking-cures with mineral waters two principles especially are to be kept in mind: First, that in the practice of crounotherapy we are provided with agents capable of exerting powerful stimulating effects upon the individual diseased organ and its vital functions, and, at the same time, of influencing in no less degree the functional metabolism of the whole cellular aggregation constituting the organism; and, second, that it is the duty of the physician at a health resort to regulate these stimulating effects in each case in accordance with the individual susceptibility, and with the modification of irritability induced by morbid processes. The importance and the efficacy of drinking-cures with mineral waters at health resorts can be greatly increased if they are closely associated with dietetic treatment and general hygienic measures; and thus, when in conjunction with the effects of the drinking-cure, an alteration in the proportions of the integral elements of the blood and the body-fluids is brought about through the influence of climate, diet, exercise, and the like, the spa becomes a **curative place** for cases of chronic disease.

The **mineral springs,** whose waters differ from ordinary drinking-water in the greater quantity of solid or gaseous constituents they contain or in their higher temperature, owe their origin to the continuous circulation of the water that is responsible for all springs. The water of the air, which reaches the soil by precipitation, penetrates to a greater or lesser depth accordingly as the earth or the rocks are more or less permeable to water, and reappears at various situations upon the surface of the earth in the form of springs. If the springs abstract from the rocks through which they flow considerable amounts of gaseous or mineral constituents, or if they arise from a great depth and, accordingly, are endowed with a high temperature, they constitute mineral springs.

Constituents

Among the **gaseous constituents** that the mineral waters derive from the strata of the earth from which they originate, carbon dioxid and hydrogen sulphid occupy the first place, and their escape is generally dependent upon communication with the deeper strata of the earth. The **solid substances** that occur most frequently in mineral waters include alkaline or earthy salts, of which principally sodium, potassium, calcium, magnesium, aluminum, and, less commonly, barium and lithium act as bases. The acids combined with these salts are carbon dioxid, sulphuric acid, hydrochloric acid, silicic acid, boric acid, and phosphoric acid. **Metallic salts,** of which iron occurs quite frequently and salt-forming elements, particularly iodin, bromin, chlorin, fluorin, and sulphur, may also be present. Of organic nitrogenous matters, partly vegetable, partly animal, coniferæ, algæ, and infusoria are at times found.

Classification

The customary classification of the mineral waters, in accordance with their chemical constitution, is as follows:

Alkaline mineral waters, characterized by the preponderance of carbon dioxid and alkaline carbonates; with the following subgroups: simple acidulous waters; alkaline acidulous waters; alkaline muriated acidulous waters; and alkaline saline acidulous waters.

Sodium chlorid waters, which contain sodium chlorid as the preponderant ingredient; with the following subgroups: simple sodium chlorid waters; sodium chlorid springs containing iodin and bromin; brine or saline waters (Soolen), which contain also other salts, chiefly chlorids.

Bitter waters, characterized by the presence of large amounts of sodium sulphate and magnesium sulphate.

Sulphurous waters, which contain hydrogen sulphid or some other binary sulphur compound as a constant normal ingredient.

Iron waters (chalybeate waters), which contain iron in large amounts, the sum-total of their solid constituents not being large. The subgroups are: carbonated iron waters; sulphated iron waters; and iron and arsenic waters.

Earthy mineral waters, characterized by the presence of calcium sulphate and carbonate, which are present in large amounts, both absolutely, and relatively to the remaining constituents.

Acratothermal waters (simple or indifferent thermal waters), which contain no especial solid or gaseous ingredient in large amount, and are characterized by their high temperature.[1]

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[1] The subject of classification is considered at greater length, and with some differences from the scheme outlined in the foregoing paragraphs, in a special chapter contributed to this work by Dr. A. C. Peale, of the United States National Museum and United States Geological Survey. In the same article will also be found extended lists of American waters of various classes, which should be consulted in connection with the notes on the location of mineral springs in the United States contained in the following chapters. See pages 299 to 365.

CHAPTER II

ALKALINE MINERAL WATERS

Simple Acidulous (Carbonated) Waters—Effects and Uses. Alkaline Acidulous Waters—Constituents; Effects; Indications; Localities. Alkaline Muriated Acidulous Waters—Effects and Uses; Indications; Localities. Alkaline Saline Mineral Waters—Constituents; Effects and Uses; Indications; Dosage; Localities.

SIMPLE ACIDULOUS (CARBONATED) WATERS

Among the springs in the alkaline group the **simple acidulous (carbonated) waters** are quite deficient in solid ingredients, and are characterized especially by the large amount of carbon dioxid they contain, which is not less than 500 c.c. in 1000 c.c. of water.

Effects and Uses

The carbon dioxid contained in these carbonated waters excites an increased peristaltic action of the stomach and the intestines, as well as an increased secretion of the intestinal juices, exerting also a stimulating effect upon the central organs of the circulation and upon the nervous system generally. Upon this is based the dietetic, rather than the therapeutic, significance of the simple gaseous waters, which, distributed and used as table-waters, constitute mild stimulants for the digestive organs. These simple carbonated waters may also be employed for systematic drinking-cures in the presence of slight dyspeptic and cardialgic disturbances, as well as of mild catarrhal states of the respiratory organs. Among the best-known and most widely used of the carbonated waters of **Europe** is the Apollinaris water of AHRWEILER, in Rhenish **Prussia,** in the German Empire. Other waters often classed with these as 'table-waters,' although many of them contain appreciable quantities of calcium, iron, and other salts, as well as of sodium chlorid and bicarbonate, are—In **Belgium**: the Adonis water. In **Bohemia**: the Dorotheenquelle at CARLSBAD; GIESSHUEBL; and KRONDORF. In **France**: BUSSANG; BONDONEAU; CONDILLAC; CHATELDON; TEISSIERES LES BOULIES. In **Germany**: BELLTHAL; BIRRESBORN; the Taunusquelle, near FRANKFURT; GEROLSTEIN; GOEPPINGEN; the Wilhelmsquelle, at KRONTHAL; ROSBACH; SELTERS; and the Johannis Spring, at ZOLLHAUS.

In **Great Britain**: MALVERN water artificially aerated is sometimes used on account of its great purity and its freedom from excess of calcium carbonate (Weber).

In the **United States** the waters of GEYSER SPA in California and of MANITOU SODA SPRING in Colorado are highly carbonated and contain but small quantities of solid ingredients; they may therefore be placed in this class.

ALKALINE ACIDULOUS WATERS

Constituents

The **alkaline acidulous (gaseous or carbonated) waters** contain, in addition to large amounts of carbon dioxid, considerable quantities of sodium carbonates.

Effects

When used in moderate doses, they stimulate the secretory activity of the mucous membrane of the digestive tract, of the respiratory and of the urinary organs, and favor liquefaction of these secretions. These gaseous alkaline waters, both those from the cold and those from thermal sources, dissolve the mucus that has collected in the pharynx and the stomach, and, when the stomach juices are too highly acid, are capable of neutralizing a portion of the free acid and thus of aiding digestion by the production of a proper degree of acidity, and by counteracting abnormal fermentative processes. These waters may, through the sodium carbonate, which enters into combination with the bile and the pancreatic juice, also exert a modifying influence upon the secretion of the intestine, neutralize the excessive acidity of the chyme that passes through the pylorus, and further stimulate intestinal peristaltic activity. After the use of the alkaline gaseous waters there is increased excretion of fluid mucus from the respiratory tract, or a liquefaction of abnormal viscid collections of mucus in the air-passages. These mineral waters increase further, at least in a transient manner, the alkalinity of the blood and of the body-fluids, induce increased elimination of carbon dioxid and absorption of oxygen, and, as a result, increased metabolism of nitrogenous and nonnitrogenous matters within the body.

The urine acquires a neutral or an alkaline reaction in most marked degree; earliest if the alkaline gaseous water be taken when the stomach is empty, and most persistent when large quantities of these waters are used. Such waters are thus capable of liquefying the accumulations of mucus consequent upon catarrhal conditions of the urinary bladder, and of allaying the irritation of the diseased mucous membrane by the acid urine. The solvent effect upon uric acid of the alkaline gaseous waters rich in sodium has recently been emphasized by Pfeiffer. This action is the greater, the larger the quantity of sodium bicarbonate contained in the water, and it persists for some time after the cessation of treatment. The alkaline springs of FACHINGEN, VALS, and VICHY are reputed to be especially effective in this connection. In the **United States** the SARATOGA Vichy, of New York, the IDAN-HA SPRING, of Idaho, the NAPA SODA SPRINGS (Pagoda Spring) and the MENDOCINO COUNTY SELTZER SPRINGS, of California, have similar qualities, while they do not in strictness belong to this class. These mineral waters are, furthermore, believed to exert a cholagogue effect—they have at least the property of causing long-continued and marked dilution of the bile. I have observed, moreover, that after the alkaline waters have been taken for several weeks, a diminution takes place in the quantity of oxalic acid excreted with the urine.

The **warm alkaline waters** exert a mildly stimulating effect upon the digestive organs, and are more rapidly absorbed than the cold sodic gaseous waters containing considerable amounts of carbon dioxid, which latter, on the other hand, exert a more marked diuretic effect.

Indications

The indications for drinking-cures with alkaline acidulous waters are dyspepsia, with the formation of excessive gastric juice; mild gastric catarrh; catarrhal conditions of the respiratory organs; catarrh of the urinary bladder; the formation of uric acid concretions and the presence of oxalates in the urine; catarrhal affections of the biliary passages; biliary calculi; and, finally, gout and diabetes.

Localities

Cold alkaline acidulous (carbonated) waters can be obtained, on the **Continent of Europe**—In **Austro-Hungary**: At BILIN, in Bohemia; GIESSHUEBL, in Bohemia; KRONDORF, in Bohemia; PREBLAU, in Carinthia; SALVATOR SPRINGS, in Hungary. In **France**: At VALS, in the Department of Ardèche. In the **German Empire**: At FACHINGEN, in Hesse-Nassau; SALZBRUNN, in Prussia.

In the **United States**: In addition to those previously mentioned, and more strictly an alkaline carbonated water, is that of BLADON SPRINGS in Choctaw County, **Alabama.**

Warm alkaline acidulous (carbonated) waters are found, on the **Continent of Europe**—In **Austro-Hungary**: BILIN, in Bohemia; SALVATOR SPRINGS, in Hungary. In **France**: MONT DORE, in the Department of Puy-de-Dôme; VALS, in the Department of Ardèche; VICHY, in the Department Allier. In the **German Empire**: FACHINGEN, in Hesse-Nassau; NEUENAHR, in Rhenish Prussia; SALZBRUNN, in Prussian Silesia. Neuenahr and Vichy are well-known health resorts suitable in catarrhal states of the digestive tract and the urinary organs; and in diabetes.

One liter of water contains at—

Bilin, of sodium bicarbonate,	3.31	grams
Fachingen, of sodium bicarbonate,	3.57	"
Neuenahr, of sodium bicarbonate,	1.09	"
Salzbrunn, of sodium bicarbonate,	2.15	"
Salvator Springs, of sodium bicarbonate,	0.3	gram
Vals, of sodium bicarbonate,	7.28	grams
Vichy, of sodium bicarbonate,	4.88	"
Bladon (Vichy), of sodium carbonate,	0.8	gram
California Seltzer, of sodium bicarbonate,	0.9	"
Idan-ha, of sodium and magnesium bicarbonates,	1.2	grams
Napa Soda (Pagoda), of sodium and magnesium carbonates and bicarbonates,	0.7	gram
Saratoga (Vichy), of sodium bicarbonate,	1.42	grams
" " of calcium and magnesium bicarbonates,	2.35	"

ALKALINE MURIATED ACIDULOUS WATERS

The **alkaline muriated acidulous** (or **gaseous**) **waters** differ from the foregoing groups of acidulous waters in the predominance of sodium chlorid present, in addition to sodium carbonate.

Effects and Uses

The sodium chlorid not only supports and increases the effect of the sodium carbonate upon the solution of albumin, in increasing the alkalinity of the blood, and in favoring retrogressive metamorphosis, but, in addition, facilitates the digestion of albuminoid food by increasing the activity of diffusion processes in the endosmotic absorption of chyle. The sodium chlorid is readily absorbed, and then exerts a diuretic effect. Only large amounts exert a purgative effect. The quantity of sodium chlorid present in the alkaline muriated acidulous waters varies between 0.17 and 4.61 grams to the liter of water (approximately from 10 to 300 grains in the gallon). Through the presence of sodium chlorid the action of these mineral waters after absorption differs from that of simple alkaline gaseous waters in the greater solvent power upon uric açid, and in an especial fluidifying action upon the secretions of the mucous membrane of the respiratory tract. Certain disadvantages of the alkaline gaseous waters, such as the marked neutralization of the gastric juice after their protracted use, disturbance of digestion, and impairment of the bodily vigor, are, further, overcome by the admixture of sodium chlorid in the alkaline muriated gaseous waters, which are considered as the mineral waters exerting the least stimulating effect upon the organism. The weaker waters of this class, in fact, approximate the constitution of a physiologic saline solution (0.6 per cent. of sodium chlorid). In general, the stronger waters of this group influence osmosis from and toward the blood, and in this way lead to a dehydration from the swollen tissues that is comparable to drainage, and that finds expression in a notable increase in diuresis. The weaker waters and the thermal waters are especially adapted to cases in which the mucous membranes are in a condition of subacute inflammation and are exceedingly sensitive. On the other hand, the stronger cold waters of this group are more effective in the presence of atony of the mucous membrane, in which condition, moreover, the active stimulating effect of the carbon dioxid is desirable.

Indications

Drinking-cures with alkaline muriated gaseous waters are indicated for the relief of catarrhal affections of the mucous membranes, especially chronic bronchial catarrh in scrofulous individuals; and of pulmonary tuberculosis in its first stage, as these waters under these conditions, on the one hand, mitigate the distressing bronchial and laryngeal catarrh, and, on the other hand, improve the digestion, as well as the nutrition of the entire organism. They are indicated for the same reason in the presence of residua of previous pleurisy. A favorable influence is exerted also upon several varieties of chronic gastric catarrh, as well as upon chronic catarrhs of the biliary passages and of the urinary organs.

In addition to drinking-cures, the alkaline muriated gaseous waters are especially employed for gargling and inhalation and for cleansing the air-passages. For this purpose various forms of vaporizing apparatus, gargling chambers, and inhalatoriums are provided at the health resorts where they are found. These waters are employed further for **baths,** and exert varying effects as bath media in accordance with their temperatures and the greater or less amounts of carbon dioxid and of sodium chlorid present.

Localities

Well-known alkaline muriated gaseous springs are located, on the **Continent of Europe**—In **Austro-Hungary**: At GLEICHENBERG, in Styria; LUHATSCHOWITZ, in Moravia; RADEIN, in Styria; SZCZAWNICA, in Galicia. In **France**: ROYAT, in the Department of Puy-de-Dôme. In the **German Empire**: ASSMANNSHAUSEN, in Hesse-Nassau; EMS, in Prussia; ROISDORF, in Rhenish Prussia; SELTERS, in Hesse-Nassau; WEILBACH, in Hesse-Nassau. The waters of Gleichenberg and Weilbach, as well as the thermal springs of Ems, have an especial reputation in the treatment of chronic laryngeal and bronchial catarrh; Assmannshausen and Royat particularly in the treatment of gout and uric-acid deposits in the urine; Luhatschowitz and Szczawnica in the treatment of disorders in torpid scrofulous persons. The waters of Radein, Roisdorf, and Selters are generally employed for export.

In the **United States**[1] waters analogous to those just mentioned are—In **California**: ÆTNA SPRINGS, in Napa County; AZULE SPRING, in Santa Clara County; GLEN ALPINE MINERAL SPRINGS, in El Dorado County. In **Michigan**: PLYMOUTH ROCK MINERAL WELL, in Wayne County; Salutaris Spring at ST. CLAIR SPRINGS, in St. Clair County. In **New York**: SARATOGA (Vichy), in Saratoga County. In **Virginia**: COLEMANVILLE MINERAL SPRINGS, in Cumberland County.

In one liter of water there are contained:

AT:	SODIUM CARBONATE	SODIUM BICARBONATE	SODIUM CHLORID
Ætna,	1.25 grams		0.41 gram
Assmannshausen,	. .	0.13 gram	0.57 "
Azule,	1.0 gram	. .	1.56 grams
Ems,	. .	2.03 grams	1.0 gram
Gleichenberg,	. .	2.54 "	1.85 grams
Glen Alpine,	. .	0.56 gram	0.36 gram
Luhatschowitz,	. .	6.76 grams	4.45 grams
Radein,	. .	3.01 "	0.6 gram
Roisdorf,	. .	1.24 "	1.84 grams
Royat,	. .	1.35 "	1.73 "
Salutaris,	. .	0.08 gram	1.40 "
Saratoga Vichy,	. .	1.48 grams	2.20 "
Selters,	. .	1.23 "	2.33 "
Szczawnica,	. .	8.44 "	4.61 "
Weilbach,	. .	1.35 "	1.25 "

ALKALINE SALINE MINERAL WATERS

Constituents

The **alkaline saline mineral waters** (sodium sulphate waters) are most important by reason of their constitution, which comprises sodium sulphate in addition to sodium bicarbonate and sodium chlorid. They occur in both cold and thermal springs. In the former the large amount of carbon dioxid and generally also of iron, and in the latter the high temperature, are effective factors in conjunction with the ingredients already named. The amount of sodium sulphate varies between 0.5 and 5 grams in the liter of water (approximately, 30 and 300 grains in the gallon); of sodium bicarbonate, between 0.6 and 4.8 grams (approximately, 36 and 287 grains in the gallon); and of sodium chlorid, between 0.2 and 3.6 grams (approximately, 12 and 215 grains in the gallon).

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[1] For more extended lists of these and other waters consult the introductory chapter, by Dr. Peale, pp. 299 to 365.

Effects and Uses

The **cold sodium sulphate waters** exert a marked diuretic effect, particularly if the amount of carbon dioxid contained is large; and, further, if given in large quantities, a purgative action, inducing semiliquid intestinal evacuations. The principal effect of the sodium sulphate consists in a stimulation of intestinal peristaltic activity and liquefaction of the intestinal contents, the latter principally because the salts are absorbed from the stomach and the upper portion of the intestinal tract in small amount only, so that considerable quantities enter the terminal portion of the bowel.

The **warm waters** contain sodium sulphate in small amounts, and diminish the secretion of urine not inconsiderably; exerting a less stimulating effect upon intestinal activity, though favorably influencing the digestive processes. The body-metabolism is influenced by the alkaline saline mineral waters in such a manner that retrogressive metamorphosis of nitrogenous matters is retarded, and the decomposition of fat is increased. Similarly to other alkaline mineral waters, those of this group also exert a solvent effect upon uric acid, as well as a stimulating effect upon the secretion of bile.

Indications

The **warm alkaline saline waters** are indicated particularly in severe cases of gastric and intestinal catarrh, and in cases of ulcer of the stomach; in connection with which their good effects are exerted notably through reduction of the hyperacidity and the secretion of the gastric juice. They are useful, likewise, in cases of catarrhal jaundice, hyperemia of the liver, and cholelithiasis; in cases of gout and lithemia; and in the presence of urinary concretions. They have an especial vogue also in cases of diabetes, more particularly of the gouty type.

The **cold sodium sulphate waters** are suitable for the same conditions in plethoric, well-nourished individuals, and when, in consequence of organic changes in the heart or in the large vessels, water of a high temperature would be too stimulating. They have, further, a more powerful effect upon the reduction of fat in the organism, and their purgative action is also more pronounced, so that they are adapted for the relief of the large group of symptoms due to abdominal plethora.

Dosage.—The sodium sulphate waters are generally taken when the stomach is empty, in amounts varying from 200 to 1200 grams (6 to 40 ounces). They should not be taken immediately after eating or in the course of a meal, because at this time they may readily neutralize too much of the acid gastric juice. For delicate persons a combination of the cold waters with warm milk or whey may be employed.

Localities

Cold alkaline saline springs are situated, on the **Continent of Europe**—In **Austro-Hungary**: At FRANZENSBAD, in Bohemia; MARIENBAD, in Bohemia; ROHITSCH, in Styria. In the **German Empire**: ELSTER, in Saxony. In **Switzerland**: TARASP-SCHULS, in Canton Grisons.

In **Canada**: CALEDONIA SPRINGS, Province of Ontario; SANDWICH SPRINGS, Ontario; ST. CATHERINE'S WELLS, Ontario; CAXTON SPRINGS, Province of Quebec.

In the **United States** corresponding waters are—In **California**: AGUA DE VIDA SPRINGS (Lower Spring), at Arroyo Mucho; CASTALIAN MINERAL SPRINGS, in Inyo County; GORDON SPRINGS, in Lake County. In **Colorado**: SPRINGDALE SELTZER SPRINGS, in Boulder County. In **Kansas**: The TOPEKA MINERAL WELLS, in Shawnee County. In **Kentucky**: HARRODSBURG SPRINGS, in Mercer County. In **Texas**: GIBSON MINERAL WELL, in Palo Pinto County.

Thermal alkaline saline springs are found, on the **Continent of Europe**—In **Austro-Hungary**: At CARLSBAD, in Bohemia. In the **German Empire**: At BERTRICH, in Rhenish Prussia.

In the **United States** waters of this group are found—In **Arizona**: CASTLE CREEK HOT SPRINGS, in Yavapai County. In **California**: GEYSER SPA, in Sonoma County; HARBIN HOT SPRINGS, in Lake County. In **Colorado**: IDAHO HOT SPRINGS, in Clear Creek County; MANITOU SPRINGS, in El Paso County; PAGOSA HOT SPRINGS, in Archuleta County; ROYAL GORGE HOT SPRINGS, in Fremont County.

One liter of water contains:

AT:	SODIUM SULPHATE	SODIUM CARBONATE	SODIUM BICARBONATE	SODIUM CHLORID
Agua de Vida (Lower Spring), .	0.24 gram	0.05 gram		0.05 gram
Bertrich, ...	0.88 "		0.72 gram	0.21 "
Carlsbad, ...	2.40 grams		1.29 grams	1.04 grams
Elster, ...	5.16 "		1.68 "	0.82 gram
Franzensbad, ...	2.80 "		0.67 gram	1.14 grams
Geyser Spa, ...	0.04 gram	0.08 "	0.34 "	0.14 gram
Manitou (Manitou Spring), . .	0.20 "	0.02 "		0.40 "
Marienbad, ...	5.04 grams		1.82 grams	2.04 grams
Rohitsch, ...	3.02 "		1.07 "	0 07 gram
Royal Gorge (Iron Duke Spring),	0.19 gram	1.24 grams		1.34 grams
Springdale Seltzer, ...	1.74 grams		0.09 gram	0.08 gram
Tarasp, ...	2.10 "		4.87 grams	3.67 grams

The most important of these health resorts with alkaline saline springs are MARIENBAD and CARLSBAD. The **special indications** for the former are, as I have elsewhere published, conditions of stasis in the portal area, caused by overeating, habitual constipation, and a sedentary mode of life; excessive deposition of fat; and the disturbances of the climacteric period in women; whereas Carlsbad is specifically effective in the treatment of the various disorders of the stomach and the liver; gall-stones; urinary concretions; and diabetes. FRANZENSBAD and ELSTER are particularly adapted when the indications for cold sodium sulphate water occur in anemic individuals with impaired nutrition; ROHITSCH and BERTRICH, when the pathologic changes have occurred in but a slight degree; and TARASP, when the effect of high altitude is desirable.

The therapeutic employment of the **salts** obtained from the sodium sulphate waters, and particularly of those of the springs at Carlsbad and Marienbad, is also worthy of mention. In the preparation of the salts, the water is evaporated, the precipitated amounts of earthy carbonates, iron oxid, and silicic acid are filtered, and the moist salt, which contains sodium sulphate, sodium bicarbonate, and sodium chlorid, is treated with carbon dioxid. There results a mixture that contains sodium sulphate, sodium bicarbonate, and sodium chlorid in exactly the natural proportions in which these salts are present in the springs. The salt is employed by dissolving from 3 to 5 grams (45 to 80 grains) in a glass of simple or carbonated water.

There are contained in:

	Carlsbad Sprudel-Salt	Marienbad Spring-Salt
Sodium sulphate,	43.25 per cent.	54.38 per cent.
Sodium bicarbonate,	36.29 " "	23.81 " "
Sodium chlorid,	16.81 " "	20.40 " "

CHAPTER III

SODIUM CHLORID WATERS

Constituents. Effects and Uses. Indications. Dosage. Localities. Lithia Waters. Iodin Waters—Constituents; Effects and Uses; Localities.

Constituents

The sodium chlorid springs include those mineral waters, both cold and warm, that contain sodium chlorid as the principal ingredient, and, in addition, other chlorin combinations in small amounts—as, for instance, magnesium chlorid, potassium chlorid, and calcium chlorid, as well as minimal amounts of lithium chlorid, aluminum chlorid, and, at times, also combinations of iron, iodin, and bromin, and of gaseous elements, especially carbon dioxid.

The mineral waters of this group occur in almost all strata of the earth thus far exposed, as sodium chlorid is distributed in all rocky formations. In all sedimentary formations, likewise, particularly where adjacent strata contain extensive deposits of mineral salts, large amounts of sodium chlorid are found.

For drinking-cures, the simple sodium chlorid waters and the springs containing lithium, as well as those containing iodin and bromin, are mainly employed.

Simple sodium chlorid waters are derived from springs of this group that contain carbon dioxid in considerable quantity, and in which the total amount of solids does not exceed 2 per cent., more than one-half consisting of sodium chlorid and other chlorids.

Effects and Uses

Sodium chlorid, which, as we know, is indispensable in the nutrition of man, stimulates more active secretion on the part of all the mucous membranes, and exerts an important influence particularly upon the stomach, whose digestive power appears to be increased. The sodium chlorid contributes not only to an increase in the secretion of the gastric juice, but also to the better solution of the albuminous and amylaceous elements of the food, and thus favors the more complete utilization for the body of the nutritive values of the food. The albuminous metabolism, according to Daepper, is not increased by sodium chlorid waters, and the use of these waters likewise does not interfere with the absorption of fat. The excretion of uric acid remains unaltered, or is slightly increased. The sodium chlorid waters, both cold and thermal, exert, further, a diuretic effect; but if the amount of sodium chlorid administered is too great to be absorbed completely, the stools become thin and diuresis suffers diminution.

Indications

The most common indications for the use of the simple sodium chlorid waters are chronic catarrhal states of the pharynx and the nasopharyngeal space, with involvement of the larynx and the bronchi; chronic catarrh of the stomach, the duodenum, and the biliary passages; abdominal stasis and its sequels; scrofulosis and rachitis; arthritis and lithiasis. With regard to the two diseases last named, particular importance has recently been attached to the presence of **lithium** in the sodium chlorid waters.

Lithia Waters.—An especial solvent effect upon uric acid has been attributed to lithium salts, and springs containing any appreciable amount of these substances have been designated **lithia waters.** It has not yet been demonstrated experimentally that the introduction of the lithium salts into the human body is sufficient to convert the precipitated uric acid into readily soluble combinations; and, further, the quantity of lithium salts in the waters under consideration is usually infinitesimal. Nevertheless, it is certain that lithium possesses considerable diuretic activity, even when present in this great dilution,—perhaps for that reason,—and therefore the systematic employment of such waters is to be recommended in cases of gout and renal calculi: on the one hand, to prevent attacks of gout, and, on the other hand, to aid in the expulsion of the urinary concretions.

Dosage

The quantity in which the simple sodium chlorid waters can be taken varies between 120 and 1200 grams (4 and 40 ounces) daily. The ingestion of a single draft in the morning, when the stomach is empty, is to be preferred to repeated drafts several times in the course of the day. When the constitution of the patient is torpid and insensitive and a powerful impression is desired, large amounts of the simple cold sodium chlorid waters are indicated; whereas in the presence of more marked irritability of the gastric mucous membrane, the thermal sodium chlorid waters are to be preferred, or warm milk or whey is to be added to the cold waters.

Localities

Cold simple sodium chlorid waters are found, on the **Continent of Europe—In Austro-Hungary**: At ALSO-SEBES, in Hungary. In the **German Empire**: ARNSTADT, in Thuringia; HOMBURG, in Prussia; KISSINGEN, in Bavaria; KRONTHAL, in Prussia; MERGENTHEIM, in Wurtemberg; NEU RAKOCZY, in Prussia; NIEDERBRONN, in Alsace; PYRMONT, in Waldeck-Pyrmont; REHME (OEYNHAUSEN), in Westphalia; SCHMALKALDEN, in Hesse-Nassau. In the **British Isles—In England**: At DROITWICH, in Worcestershire; HARROGATE, in Yorkshire; NANTWICH, in Cheshire. In **Scotland**: BRIDGE-OF-ALLAN, in Stirlingshire.

Waters corresponding to the foregoing are found in the **United States—In California**: BYRON SPRINGS, in Contra Costa County. In **Colorado**: CAÑON CITY MINERAL SPRINGS, in Fremont County; PARNASSUS SPRINGS, in Pueblo County. In **Kentucky**: LOWER BLUE LICK SPRINGS, in Nicholas County; UPPER BLUE LICK SPRINGS, in Nicholas County. In **Maine**: LUBEC SALINE SPRING, in Washington County. In **Missouri**: AKESION SPRING, in Saline County. In **New York**: BALLSTON SPA, in Saratoga County; COLUMBIA SPRINGS, in Columbia County; Congress, Excelsior, Hathorn, High Rock, Seltzer Springs, at SARATOGA SPRINGS, in Saratoga County; HALLECK'S SPRING, in Oneida County. In **Pennsylvania**: Salt Spring near ALBA, in Bradford County. In **Wisconsin**: SHEBOYGAN MINERAL WELL, in Sheboygan County.

Thermal sodium chlorid waters are situated, on the **Continent of Europe—In France**: At BALARUC (50° C.—122° F.), in the Department of Hérault; BOURBONNE-LES-BAINS (58° C.—136.4° F.), in the Department of Haute-Marne. In the **German Empire**: BADEN-BADEN (68° C.—154.4° F.), in the Grand Duchy of Baden; CANNSTADT (20° C.—68° F.), in Wurtemberg; MONDORF (24° C.—75.2° F.), in Luxemburg; NAUHEIM (21° C.—69.8° F), in the Grand Duchy of Hesse; SODEN IN THE TAUNUS (23° C.—73.4° F.), in Hesse-Nassau; WIESBADEN (68° C.—154.4° F.), in Hesse-Nassau. In **Italy**: BATTAGLIA (58° C.—136.4° F.), in the Province of Venice.

In the **British Isles** springs corresponding to the foregoing are to be found—In **England**: At BATH (40° to 48.8° C.—104° to 120° F.), in Somersetshire.

In the **United States** waters of this group are—in **Colorado**: The LIBERTY HOT SPRINGS, at Wagon Wheel Gap, in Rio Grande County (65.5° C.—150° F.); GLENWOOD SPRINGS, Garfield County (124.6° to 126.4° F.—51.4° to 52.4° C.); SILOAM SPRINGS, Garfield County (103° F.—39.5° C). In **Utah**: SALT LAKE THERMAL SPRINGS (43.3° C.—110° F.), in Salt Lake County; UTAH HOT SPRINGS, near Ogden (131° to 144° F.—55° to 62.2° C.).

Of the springs named, those of KISSINGEN particularly are **indi-**

cated for the diseases previously mentioned, when the bodily metabolism is impaired, or anemia or scrofulosis is present, and only a moderate influence upon the digestive organs is desired. The Elizabethbrunnen at HOMBURG exerts a powerful solvent effect. Of the thermal springs, those of WIESBADEN are the most active.

One liter of water contains of sodium chlorid:

AT:		
Baden-Baden,	2.01	grams
Bath,	0.20	gram
Bourbonne,	5.8	grams
Byron Springs (Liver and Kidney),	10.08	"
Byron Springs (Byron Surprise),	304.27	"
Cannstadt,	2.45	"
Congress, at Saratoga Springs,	6.49	"
Droitwich,	310.0	"
Glenwood Springs (Yampa),	17.66	"
Harrogate,	12.70	"
Homburg,	9.86	"
Kissingen,	5.82	"
Kronthal,	3.54	"
Liberty Hot Springs,	0.33	gram
Mondorf,	8.71	grams
Pyrmont,	7.05	"
Seltzer, at Saratoga Springs,	4.97	"
Soden in the Taunus,	3.42	"
Upper Blue Lick,	8.37	"
Utah Hot Springs,	17.05	"
Wiesbaden,	6.82	"

Lithia Waters.—Among lithia waters may be mentioned the following, with the lithium compounds in a liter of water:

On the **Continent of Europe**—in **Austro-Hungary**: The JOSEFSBRUNNEN, at BILIN, in Bohemia—0.01 gram; at RADEIN (Sauerbrunn), in Styria—0.041 gram; the Salvator Spring, at EPERIES (SZINYE-LIPOCZ), in Hungary—0.022 gram. In the **German Empire**: ASSMANNSHAUSEN, in Hesse-Nassau—0.027 gram; Bonifacius Spring, at SALZSCHLIRF, in Hesse-Nassau—0.218 gram; Elizabethbrunnen, at HOMBURG, in Hesse-Nassau—0.021 gram; Kaiser Friedrich Spring, at OFFENBACH ON THE MAIN, four miles from Frankfurt—0.019 gram; Koenigsquelle, at ELSTER, in Saxony—0.108 gram; Kronenquelle, at SALZBRUNN, in Prussian Silesia—0.011 gram; New Spring, at DUERKHEIM, in Rhenish Bavaria—0.039 gram; Oberbrunnen, at SALZBRUNN, in Prussian Silesia—0.013 gram; Rakoczy Spring, at KISSINGEN, in Bavaria—0.02 gram; Ungemachquelle, at BADEN-BADEN, in the Grand Duchy of Baden—0.053 gram; WEILBACH (sodium and lithium spring), in Hesse-Nassau—0.009 gram; Wilhemsquelle, at EMS, in Prussia—0.01 gram.

Of the lithia waters in the **United States** the most important are—in **Arkansas**: ARKANSAS LITHIA SPRINGS, in Hempstead County—6.35 grains in a gallon—0.102 gram in a liter. In **California:**

HOWARD SPRINGS, Lake County (Excelsior Spring No. 1). 8.35 grains in a gallon—0.133 gram. In **Georgia**: BOWDEN LITHIA SPRINGS, in Fulton County—1.67 to 4.45 grains in a gallon—0.027 to 0.072 gram in a liter. In **Massachusetts**: BALLARDVILLE LITHIA SPRING, in Middlesex County, the strongest lithia spring in the world, containing 22 grains of lithium carbonate in a gallon of water—0.356 gram in a liter. In **New Hampshire**: LONDONDERRY LITHIA SPRING, in Rockingham County—7.29 grains—0.118 gram. In **New York**: GENEVA LITHIA SPRING, in Ontario County—10.03 grains—0.162 gram; SARATOGA SPRINGS (Champion Spouting Spring, 6.25 grains—0.101 gram; Congress Spring, 4.76 grains—0.075 gram; Crystal Springs, 4.33 grains—0.070 gram; Empire Spring, 2.08 grains—0.033 gram; Geyser Spouting Spring, 9 grains—0.145 gram; Hathorn Spring, 11.45 grains—0.184 gram; Kissingen or Triton Spring, 5.13 grains—0.083 gram; New Putnam Spring, 9.83 grains—0.143 gram; Pavilion Spring, 9.49 grains—0.153 gram; Red Spring, 0.94 grain—0.015 gram; Saratoga A or Alum Spring, 1.72 grains—0.026 gram; Seltzer Spring, 0.9 grain—0.015 gram; Star Spring, 1.5 grains—0.023 gram; Union Spring, 2.61 grains—0.042 gram; United States Spring, 4.85 grains—0.078 gram; Vichy Spring, 1.76 grains—0.028 gram), in Saratoga County. In **Pennsylvania**: CLOVERDALE LITHIA SPRING, in Cumberland County, 0.17 grains—0.002 gram; TUSCARORA LITHIA SPRING, in Juniata County. In **Virginia**: BUFFALO LITHIA SPRINGS, in Mecklenburg County—2.25 grains—0.036 grams; CROCKETT ARSENIC LITHIA SPRINGS, in Montgomery County—0.07 grain—0.001 gram; DAGGERS SPRINGS, in Botetourt County; FARMVILLE LITHIA SPRINGS, in Prince Edward County—3.76 grains—0.060 gram; Nye Lithia Spring, No. 1, in Wythe County—6.41 grains—0.103 gram; Virginia Magnesian Lithia Springs, at STAUNTON, in Augusta County; Virginia Waukesha Lithia Springs, at STAUNTON, in Augusta County; OTTERBURN MAGNESIA AND LITHIA SPRINGS, in Amelia County.

IODIN WATERS

Those sodium chlorid waters that contain a compound of iodin or bromin in relatively large amount are designated **iodin waters** or **bromin waters.**

Constituents

The **iodin compounds** present in the mineral waters are magnesium iodid containing 91 per cent. of iodin, calcium iodid containing 86 per cent. of iodin, and sodium iodid containing 84 per cent. of iodin. The bromin also occurs principally in the form of sodium bromid and magnesium bromid. The quantities of iodin introduced in the course of a drinking-cure with iodin waters are naturally quite small, and they have therefore been considered by several observers to be of no significance. Nevertheless, investigations quite recently made have shown that even such minimal amounts of material in spring-waters are capable of a pharmacodynamic effect. Moreover, the discovery of Baumann—that the effective agent of the thyroid gland-substance is an organic iodin combination, thyro-iodin, which when used for a considerable period of time, in daily doses containing but 0.003 gram ($\frac{1}{22}$ of a grain) of iodin, exerts a marked influence upon metabolism—is an indication of the possible activity of the iodin waters.

Effects and Uses

The salts of iodin and bromin stimulate greatly the activity of the lymphatic vessels and increase absorption, particularly in the glandular organs, but also in all other tissues. Their employment in drinking-cures is, therefore, **indicated** in cases of scrofulosis, characterized by disease of the glands and the lymphatic vessels, or, in the further course of the case, by affections of the bones and joints; in cases of syphilis, and particularly syphilitic disease of the bones, enlargement of the lymphatic glands, and cutaneous syphilids; in various diseases of the glands, particularly goiter; in obstinate exudates in and around the female genitalia, and in diseases of the skin.

The **amount** of the strong iodin waters to be taken must be regulated with care; from 1 to 5 deciliters (3 to 16 ounces) being given in divided doses throughout the day. Usually, **saline baths** containing iodin are conjoined with the drinking-cure.

The internal employment of iodin waters is **counterindicated** in the presence of chronic inflammatory states of the digestive organs, as well as in anemic and cachectic states.

Localities

Among **iodin waters** available for drinking purposes the following may especially be mentioned:

On the **Continent of Europe**—in **Austro-Hungary**: HALL, in Upper Austria; IVONITCH, in Galicia; LIPIK, in Hungary; ZAIZON, in Siebenbuergen, Transylvania. In the **German Empire**: HEILBRUNN, in Upper Bavaria; KRANKENHEIL, in Bavaria; KREUZNACH, in Prussia; SULZBRUNN, in Bavaria; SALZSCHLIRF, in Hesse. In **Switzerland**: WILDEGG, in Canton Aargau.

In the **British Isles** waters corresponding to the foregoing are found—in **England**: At WOODHALL SPA, in Lincolnshire.

In the **United States** iodin waters are found—In **California**: TOLENAS SPRINGS, in Solano County; TUSCAN or LICK SPRINGS (Red

Spring), Tehama County. In **Colorado**: SPRINGDALE SELTZER SPRINGS, in Boulder County. In **Georgia**: LOWER BOWDEN LITHIA SPRING, in Fulton County. In **Kentucky**: LOUISVILLE, or Dupont's Artesian Well, in Jefferson County. In **New York**: BALLSTON SPA SPRINGS (Artesian Lithia Spring and Franklin Artesian Well), in Saratoga County; DEER LICK SPRINGS, or SENECA SPA SPRINGS, in Erie County; SARATOGA SPRINGS (Champion Spouting Spring; Congress Spring; Excelsior Spring; Hathorn Spring; Kissingen or Triton Spring; Union Spring), in Saratoga County. In **North Carolina**: LINCOLN LITHIA SPRING, in Lincoln County; THOMPSON'S BROMINE-ARSENIC SPRING, in Ashe County; ASHLEY'S BROMIDE AND ARSENIC SPRING, in Ashe County. In **West Virginia**: SALT SULPHUR (Iodin) SPRINGS, in Monroe County.

Of these iodin waters employed for drinking purposes, that of HALL has an especial reputation in the treatment of various forms of scrofulosis and of struma, as has also the Adelsheidsquelle, at HEILBRUNN, whereas KRANKENHEIL is preferred for its high altitude.

There are contained in one liter of water:

AT:	SODIUM CHLORID	MAGNESIUM IODID	SODIUM IODID	SODIUM BROMID
	(Grams)	(Grams)	(Grams)	(Grams)
Champion Spouting Spring, .	12.02	. .	0.0039	0.061
Excelsior Spring, . . .	6.34	. .	0.0708	. .
Franklin Artesian Well, .	11.28	. .	0.004	. .
Hall, ...	12.17	0.042	. .	. .
Heilbrunn, ...	4.07	0.03	. .	. .
Ivonitch, ...	8.37	0.016	. .	. .
Krankenheil, ...	0.20	0.0015	. .	. .
Kreuznach, ...	10.52	0.0004	. .	. .
Lippik, ...	0.01	0.0209	. .	. .
Lower Bowden Lithia Spring,	2.13	. .	0.012	. .
Red Spring (Tuscan Springs),	0.35	. .	0.073 (Iodin)	. .
Salzschlirf, ...	10.24	0.005	.	. .
Salzbrunn, . .	1.0	0.015	. .	. .
Saratoga (Kissingen Spring), .	5.06	. .	0.0006	0.0308
Wildegg, ...	10.02	0.03	. .	. .
Woodhall Spa, ...	10.50	0.0075 (Pot. iod.)		0.02 (Pot. brom.)
Zaizon, ...	0.02	0.001	. .	. .

CHAPTER IV

BITTER WATERS; SULPHUROUS WATERS

Bitter Waters—Constituents; Action and Effects; Indications and Counter-indications; Dosage; Localities. Sulphurous Waters—Constituents and Classification; Effects; Indications and Counterindications; Dosage; Localities.

BITTER WATERS

Constituents

The mineral waters designated bitter waters are distinguished from all other springs employed for drinking purposes by the large amount of solid substances they contain, of which the principal are sodium sulphate and magnesium sulphate. In addition to these two salts, magnesium carbonate, calcium carbonate, sodium chlorid, magnesium chlorid, and magnesium nitrate also are present in considerable amounts; the gaseous constituents, particularly carbon dioxid, are uncommon. This is explained by the origin of the bitter waters from rather superficial strata of the earth, through the washing-out of the mineral ingredients by the water of percolation. For this reason the bitter waters are not invariably of the same composition, as are other mineral waters, but the amount of saline matters present depends upon atmospheric influences and the duration of the contact of the water with the source of the spring. Likewise the bitter waters are, by reason of their superficial origin in the strata of the earth, always cold springs.

Action and Effects

The **action** of the bitter waters depends partly upon the purgative property of the magnesium sulphate, with its stimulating effect upon the secretions of the intestinal canal, its influence in liquefying the fecal matter, and its pronounced stimulating effect upon the mucous membrane; partly upon the action of the sodium sulphate. These **effects** are manifested if the strong bitter waters are taken in but small doses of from 100 to 200 grams (3 to 7 ounces). Upon this purgative action probably depends also the influence of the bitter waters upon metabolism, inasmuch as the metamorphosis of fat is increased by stimulation of peristaltic activity; and after long-continued use of large amounts, a reduction in the albuminous constituents of the body, and impairment of hemogenesis, result. The stimulating effect of the strong bitter waters is often not merely transient, but persists even after expulsion of the salt with the intestinal evacuations, so that opportunity is readily afforded for the development of gastric and intestinal catarrh. The bitter waters should, therefore, be given only in small quantities, which vary naturally in accordance with the amount of saline matters contained in the particular water; and their use should not be continued for too long a time. They are not used at the springs in systematic 'cures,' but they are exported for use at the patient's home.

Indications

The use of the bitter waters **in small doses** continued for some time is **indicated** in the presence of conditions in which long-continued stimulation of intestinal activity is desired, but in which the administration of carbonated waters is counterindicated to avoid stimulation of the vascular system—as, for instance, during pregnancy, and in the presence of arteriosclerosis or of marked organic disease of the heart.

Considerable quantities of bitter waters, given on a single occasion, or repeated several times, are **indicated** in the presence of habitual constipation, when rapid and copious evacuation of the bowels is desired; or if foreign bodies, such as migrated worms and concretions, are to be expelled from the intestinal tract; or when a derivative effect is desired for the relief of stasis in various organs, or of inflammatory processes, such as cerebral hyperemia, meningitis, or pleuritis.

The use of the bitter waters is **counterindicated** in the presence of catarrhal affections of the stomach and the intestines, and in the presence of a tendency to diarrhea.

Dosage

Generally from 80 to 160 grams (2½ to 5 ounces) of a bitter water may be taken in the morning on an empty stomach, and in urgent cases from 200 to 300 grams (6 to 10 ounces) may be given in a single dose. At times the bitter waters are given in small amounts, as an addition to other mineral waters.

Localities

Well-known bitter waters are found, on the **Continent of Europe**—In **Austro-Hungary**: At ALAP, in Hungary; BUDA-PEST, in Hungary; PUELLNA, in Bohemia; SAIDSCHITZ, in Bohemia. In the **German Empire**: FRIEDRICHSHALL, in Saxe-Meiningen; KISSINGEN, in Bavaria; MERGENTHEIM, in Wurtemberg. In **Switzerland**: BIRMENSTORF, in Canton Aargau.

In the **British Isles** bitter waters are found—In **England**: At CHELTENHAM, in Gloucestershire; LEAMINGTON, in Warwickshire; MELKSHAM, in Wiltshire; SCARBOROUGH (North Well and South Well), in Yorkshire.

In the **United States** waters of this class are—In **California**: CASTALIAN MINERAL SPRINGS, in Inyo County. In **Colorado**: IDAHO HOT SPRINGS, in Clear Creek County; PAGOSA HOT SPRINGS, in Archuleta County; ROYAL GORGE HOT SPRINGS, in Fremont County; SPRINGDALE SELTZER SPRINGS, in Boulder County. In **Kentucky**: CRAB ORCHARD SPRINGS (Epsom or Foley's Spring), in Lincoln County; HARRODSBURG SPRINGS (Saloon Spring), in Mercer County. In **Pennsylvania**: BEDFORD SPRINGS, in Bedford County. In **Wyoming**: LEROY SPRINGS, in Uinta County.

One liter of water contains:

AT:	SODIUM SULPHATE	MAGNESIUM SULPHATE
Alap,	19.14 grams	2.90 grams
Bedford Springs,		0.55 gram
Birmenstorf,	7.0 "	22.0 grams
Buda-Pest bitter waters:		
Apenta,	15.4 "	24.4 "
Hunyadi Jànos,	22.55 "	22.35 "
Franz Josef,	23.18 "	24.78 "
Victoria,	33.5 "	24.19 "
Castalian Mineral Springs,	11.14 "	
Crab Orchard Springs (Epsom or Foley's Spring),	1.01 "	3.51 "
Friedrichshall,	6.05 "	5.15 "
Kissingen Bitterquelle,	5.8 "	5.0 "
Le Roy Springs,	2.00 "	
Mergentheim,	6.67 "	5.43 "
Pagosa Hot Springs,	2.57 "	
Puellna,	9.59 "	10.85 "
Saidschitz,	6.09 "	10.96 "

SULPHUROUS WATERS

Constituents and Classification

The sulphurous waters include those mineral waters that contain as a constant normal ingredient some binary sulphur compound, either free hydrogen sulphid and carbon oxysulphid, a carbon dioxid in which one atom of oxygen is replaced by sulphur, or an alkaline sulphid—sodium sulphid, calcium sulphid, magnesium sulphid, or potassium sulphid. Frequently both solid and gaseous compounds of sulphur exist in the same water. In addition to these ingredients that characterize the springs of this group other salts may be present, in accordance with which the sulphur waters are subdivided into **sulphurous sodium chlorid waters,** containing considerable amounts of sodium chlorid; **alkaline sulphurous waters,** containing considerable amounts of sodium carbonate; **sulphurous calcium waters,** which contain especially calcium sulphid and carbonate; **sulphurous sodium waters,** in which the sulphur is especially combined with sodium.

The sulphurous waters are in part cold and in part **thermal waters,** and they occur generally in the calcium portions of more recent formations, which are characterized by large deposits of calcium sulphate and organic remains of a destroyed flora or fauna.

Effects and Uses

Although the pharmacodynamic actions of hydrogen sulphid and carbon oxysulphid have been but little investigated, and although the alkaline sulphids are present in these waters only in small amounts, empiric observation has demonstrated the efficacy of the latter in various directions. Further, H. Schulz has shown recently by experiment that the sulphur, even in such small doses as are present in sulphurous waters, is capable of a fairly active stimulating effect upon healthy organs. Still smaller amounts of this substance therefore are capable of exciting in diseased organs reactions through which it may induce therapeutic results. Hydrogen sulphid affords a combination that permits the introduction into the body of sulphur in the finest conceivable division. The sulphur, it is thought, is capable, under certain conditions, among which the presence of substances of alkaline reaction plays a material part, of acting as a carrier of oxygen; thereby augmenting not inconsiderably the energy of certain processes of oxidation, and perhaps rendering possible the intramolecular combustion of albumin.

Indications

The favorable effects that experience has shown to follow the use of sulphurous waters in the treatment of syphilis and chronic metallic poisoning is attributed to the fact that through such drinking-cures, particularly when supplemented by the appropriate baths, elimination through the kidneys, intestines, and skin is materially increased. With regard to the action of the sulphurous waters in cases of syphilis, the rapid saturation of the tissues by the hydrogen sulphid taken up by the stomach and intestines renders not improbable a solution of metallic albuminates and elimination of the metallic molecules through the liver and the urine. The view formerly so much emphasized, of the specific action of the sulphurous waters upon syphilis, or the capability of these waters to render latent syphilis apparent, and thus their diagnostic value in doubtful cases, can by no means be sustained.

The internal use of the sulphurous waters in cases of syphilis has no advantage over the use of drinking-cures with sodium sulphate waters or sodium chlorid waters, which also stimulate excretion and improve the body-metabolism. Likewise, the recommendation of these waters for drinking-cures in the presence of abdominal plethora, hemorrhoidal disorders, and hyperemia of the liver, is based upon stimulation of intestinal activity, with increase in the secretion of bile. Chronic catarrhal conditions of the pharynx, the larynx, and the bronchi are improved by the use of the sulphurous waters containing sodium chlorid or sodium. With the thermal waters the solvent influence of heat upon the secretion of mucous membranes must be taken into consideration.

Drinking-cures with sulphurous waters are **counterindicated** in individuals with greatly enfeebled digestion or profound anemia. Further, great care is required in their use by persons suffering from functional disturbances of cardiac activity, as symptoms of cardiac irritability sometimes occur in the course of drinking-cures with sulphurous waters.

Dosage

The daily amount of sulphurous waters employed in drinking-cures varies from 150 to 1350 grams (5 to 45 ounces), generally taken in the morning when the stomach is empty. At times milk, whey, gruel, or syrup of acacia is added to these waters, or they may be taken together with bitter waters or laxative salts. Generally the drinking-cure is combined with a course of **baths.** At some sulphur springs **inhalations** of vapor are conjoined with the drinking-cure, as a result of which, increase in the secretion of the mucous membranes of the respiratory tract, relaxation of the tissues, and desquamation of epithelium take place—an effect that is favorable in the presence of chronic catarrhal states of the respiratory organs. In the **fumaroli** of PUZZUOLI, near Naples, the **solfatara** or crater of a partially extinct volcano, from which sulphurous vapors escape, is utilized for inhalation.

Localities

Of the sulphurous waters employed for drinking purposes the following may be mentioned:

Cold sulphurous waters are situated, on the **Continent of Europe**—In the **German Empire**: At EILSEN, in the Principality of Lippe-Schaumburg, containing 0.019 gram of calcium sulphid and 0.19 gram of sodium chlorid in a liter of water; at LANGENBRUECKEN, in the Grand Duchy of Baden, containing 0.056 gram of calcium sulphid; at MEINBERG, in Lippe-Detmold, containing 0.008 gram of sodium sulphid and 0.29 gram of calcium carbonate; at NENNDORF, in Hesse-Nassau, containing 0.07 gram of calcium sulphid; at WEILBACH, in Hesse-Nassau, containing 0.038 gram of calcium sulphid and 0.27 gram of sodium chlorid. In **Switzerland**: at GURNIGEL, in Canton

Bern, containing 0.004 gram of calcium sulphid and 0.005 gram of sodium chlorid in a liter of water.

In the **British Isles** cold sulphurous waters are found—In **England**: At ASKERN SPA, in Yorkshire; at HARROGATE, in Yorkshire, the 'Old Sulphur Spring,' containing 0.07 per mille of sodium sulphid and 37 volumes per mille of hydrogen sulphid. In **Ireland**: At BALLYNAHINCH, in County Down, containing 3.5 volumes per mille of sulphureted hydrogen gas; LISDOONVARNA, in County Clare—the Gowlaun spring contains 5.5 volumes per mille of sulphureted hydrogen gas; SWANLINBAR, in County Cavan, possesses cold sulphur springs fashionable in former years. In **Scotland**: At STRATHPEFFER, in Ross-shire, containing 0.02 per mille of potassium sulphid, 0.007 per mille of sodium sulphid, and 40 volumes per mille of hydrogen sulphid. In **Wales**: BUILTH WELLS, in Brecknockshire; LLANDRINDOD WELLS, in Radnorshire—the Park Spa contains 0.04 per mille calcium sulphid, and about 22 volumes per mille sulphureted hydrogen gas; LLANWRTYD WELLS, in Brecknockshire, possesses a sulphur spring containing 36 volumes per mille of sulphureted hydrogen.

In the **United States** cold sulphur springs are the following—In **Alabama**: CULLUM'S SULPHUR SPRING, near Bladen Springs, Choctaw County, with 97.10 cu. in. hydrogen sulphid in one U. S. gallon; TALLADEGA SPRING, near Fayetteville, Talladega County,—82 cu. in. hydrogen sulphid in one U. S. gallon. In **California**: ANDERSON'S SULPHUR SPRINGS (Cold Sulphur Spring), in Lake County,—4.20 cu. in. hydrogen sulphid and 243.50 cu. in. carbon dioxid in one U. S. gallon; EL PASO DE ROBLES (White Sulphur Spring), in San Luis Obispo County,—9.40 cu. in. hydrogen sulphid, 5.10 grains (0.08 gram in a liter) other sulphids, and 5.25 cu. in. carbon dioxid in one U. S. gallon; LANE MINERAL SPRING, in Calaveras County,—105.00 cu. in. hydrogen sulphid in one U. S. gallon. In **Georgia**: POWDER SPRINGS (Spring No. 3), in Cobb County,—75.00 cu. in. hydrogen sulphid and 0.05 grain (0.0008 gram in a liter) other sulphids in one U. S. gallon. In **Indiana**: FRENCH LICK SPRINGS, in Orange County,—17.00 cu. in. hydrogen sulphid and 10 12 cu. in. carbon dioxid in one U. S. gallon. In **Kentucky**: GRAYSON SPRINGS (Eye Spring), in Grayson County,—1.39 cu. in. hydrogen sulphid and 0.58 grain (0.0099 gram in a liter) other sulphids in one U. S. gallon. In **Michigan**: ALPENA MAGNETIC SULPHUR SPRING, in Alpena County,—7.38 cu. in. hydrogen sulphid and 210.61 grains (3.78 grams in a liter) other sulphids in one U. S. gallon; CLARK'S RIVERSIDE MINERAL SPRINGS, in Wayne County,—40.76 cu. in. hydrogen sulphid in one U. S. gallon; Moorman Mineral Well, at YPSILANTI, Washtenaw County,—26.84 cu. in. hydrogen sulphid and 8.42 grains (0.144 gram in a liter) other sulphids in one U. S. gallon. In **Missouri**: MONTESANO SPRINGS (Casco Spring), in Jefferson

County,—43.20 cu. in. carbon dioxid, 1.60 cu. in. hydrogen sulphid, and 0.43 grain (0.007 gram in a liter) other sulphids in one U. S. gallon. In **New York**: AVON SULPHUR SPRINGS (Congress Hall Spring), in Livingston County,—22.04 cu. in. carbon dioxid, 27.63 cu. in. hydrogen sulphid, and 99.55 grains (1.74 gram in a liter) other sulphids in one U. S. gallon; CHITTENANGO SULPHUR SPRINGS (Magnesia Sulphur Spring), in Madison County,—19.44 cu. in. carbon dioxid, 5.62 cu. in. hydrogen sulphid, and 1.68 grains (0.029 gram in a liter) other sulphids in one U. S. gallon; RICHFIELD SPRINGS (White Sulphur Spring), in Otsego County,—14.21 cu. in. hydrogen sulphid and 1.81 grains (0.030 gram in a liter) other sulphids in one U. S. gallon. In **Tennessee**: CASCADE SPRINGS, in Franklin County,—23.04 cu. in. hydrogen sulphid and 9.76 grains (0.167 gram in a liter) other sulphids in one U. S. gallon; CROCKER SPRINGS, in Davidson County,—37.99 cu. in. carbon dioxid and 40.25 cu. in. hydrogen sulphid in one U. S. gallon. In **Virginia**: COLD SULPHUR SPRINGS, in Rockbridge County,—5.65 cu. in. carbon dioxid and 253.0 cu. in. hydrogen sulphid in one U. S. gallon; ORKNEY SPRINGS (Orkney Powder Spring), in Shenandoah County,—8.62 cu. in. carbon dioxid, 5.91 cu. in. hydrogen sulphid, and 0.53 grain (0.009 gram in a liter) other sulphids in one U. S. gallon.

Thermal sulphurous waters used for drinking-cures are to be found, on the **Continent of Europe**—In **Austro-Hungary**: At BADEN (34° C.—93.2° F.), near Vienna, containing 0.195 gram of calcium sulphid and 0.25 gram of sodium chlorid in a liter of water; at MEHADIA, in Hungary (48.2° C.—118.8° F.), containing 0.03 gram of calcium sulphid and 3.2 grams of sodium chlorid. In **France**: BAGNÈRES-DE-LUCHON (55.2° C.—131.4° F.), in Haute-Garonne, with 0.02 gram of sodium sulphid and 0.06 gram of sodium chlorid in a liter of water; CAUTERETS (39.4° C.—102.9° F.), in Hautes-Pyrénées, containing 0.02 gram of sodium sulphid. In the **German Empire**: AACHEN (55° C.—131° F.), in Rhenish Prussia, containing 0.014 gram of sodium sulphid and 2.61 grams of sodium chlorid in a liter of water. In **Switzerland**: SCHINZNACH (36° C.—97.° F.), in Canton Aargau, containing 0.008 gram of calcium sulphid and 0.58 gram of sodium chlorid in a liter of water.

Of the sulphurous waters mentioned, the thermal springs of Aachen and of Mehadia have the greatest reputation in the treatment of syphilis and mercurial poisoning, whereas Cauterets and Bagnères-de-Luchon are especially well known for the treatment of chronic catarrhal disorders of the respiratory organs.

In the **United States** hot sulphur waters are found—In **California**: CALISTOGA SPRINGS (23.8° to 85.5° C.—75° to 189° F.), in Napa County, containing 4.75 cu. in. hydrogen sulphid in one U. S.

gallon; El Paso de Robles Hot Springs (Main Hot Sulphur Spring, 40.5° to 43.3° C.—105° to 110° F.), in San Luis Obispo County, containing 3.75 cu. in. hydrogen sulphid and 8.90 cu. in. carbon dioxid in one U. S. gallon; Gilroy Hot Springs (42.2° to 46.1° C.—108° to 115° F.), in Santa Clara County, containing 9.25 cu. in. hydrogen sulphid and 12.17 cu. in. carbon dioxid in one U. S. gallon; Harbin Hot Sulphur Springs (50° C.—122° F.), in Lake County, containing 11.74 cu. in. hydrogen sulphid and 4.26 cu. in. carbon dioxid in one U. S. gallon; Santa Barbara Hot Springs (37° to 50° C.—99° to 122° F.), in Santa Barbara County, containing 9.16 cu. in. hydrogen sulphid and 19.14 cu. in. carbon dioxid in one U. S. gallon. In **Colorado**: Glenwood Springs (Yampa Spring, 51.5° C. —124.6° F.), in Garfield County; Hot Sulphur Springs (32.7° to 47.2° C.—91° to 117° F.), Middle Park, Grand County. In **Utah**: Beck's Hot Sulphur Springs (53.3° C.—128° F.), in Salt Lake County; Salt Lake Hot Springs (43.3° C.—110° F.), in Salt Lake County.

CHAPTER V

IRON OR CHALYBEATE WATERS

Constituents. Carbonated Iron or Steel Waters—Effects and Uses; Dosage; Indications and Counterindications; Localities. Vitriol or Iron Sulphate Waters—Indications; Localities. Arsenical Iron Waters—Indications; Localities.

Constituents

Iron is an exceedingly common ingredient of mineral waters; but only when it is present in considerable quantity, while the total amount of other solid constituents is not large, is the water designated an iron water. When the iron occurs in the form of the carbonate, or, as is usually stated, the bicarbonate,—*i. e.*, ferrous carbonate held in solution by carbonic acid,—these waters are designated carbonated iron waters, or steel springs; when it occurs as a sulphate (ferrous sulphate), they are termed sulphated iron waters, or vitriol waters. The **carbonated iron waters** usually contain also large amounts of carbon dioxid. In these steel springs the amount of iron equals not less than $\frac{1}{200}$ of the total weight of all the contained solids, and it may be even as much as $\frac{1}{10}$ of this weight, so that such a pure iron water will rarely possess any other solid ingredients. Iron waters are generally cold; but a few of the iron springs have an elevated temperature. They occur in rocks of igneous as well as of aqueous formation.

Effects and Uses of Steel Waters

In the drinking-cures with steel waters, the **effects** both of the iron and of the carbon dioxid are important. With regard to the former, it has been established that after the use of the iron waters for several weeks an increase in the number of red blood-corpuscles and in the amount of hemoglobin takes place; and, in connection therewith, augmentation of the body-weight and of the elimination of urea; an elevation of from half a degree to a degree C. (1° to 2° F.) in the body-temperature; acceleration in pulse frequency. The appetite generally is improved in the course of such drinking-cures, and intestinal activity is retarded, so that constipation is the rule. It appears that when the waters contain small amounts of iron in dilute form, the mineral is absorbed more readily than from waters containing large amounts. This view is supported by the experiments of Schroff, Hamburger, and Bunge. The manner in which it exerts its favorable influence upon the blood, whether through direct utilization for the formation of hemoglobin or through protection against decomposition of the iron supplied with the food, or whether the iron serves only as a stimulating agent to the blood-forming organs (von Noorden), has not yet been decided. It is also disputed whether or not the principal utility of the iron waters consists, as Glax asserts, in their dehydrating effect upon the organism, thus rendering it more capable of absorbing iron from any source.

A number of **subordinate constituents** of the iron waters modify their action. Thus, to the presence of large amounts of free carbon dioxid is to be attributed a stimulating influence upon the motility of the stomach and intestinal peristalsis; and to the small amounts of sodium chlorid, sodium carbonate, and sodium sulphid, a favorable influence upon digestion.

Dosage

The **quantity** of steel water to be employed in a drinking-cure should be divided into several portions, to be taken throughout the day, and should amount to between 400 and 800 grams (about from 12 to 25 ounces). According to Quincke, it is important for the absorption of the oxygen-salts of iron that the metal should come in contact with the wall of the stomach in a greatly diluted form; for this reason it is advisable that the iron waters be taken with the principal meal of the day.

Indications and Counterindications

The **principal indication** for drinking-cures of steel waters is any oligemic condition, whether primary or dependent upon diseases of various kinds: Chlorosis, anemia following acute diseases or overexertion, or the result of malaria or exhausting conditions; diseases of the nervous system associated with anemia or caused thereby; sexual diseases associated with conditions of debility, in the male and in the female.

Drinking-cures with pure iron waters are **counterindicated** in the presence of all febrile states, organic disease of the heart, arteriosclerosis, and pulmonary tuberculosis.

Location of Steel Springs

Pure carbonated iron waters are located, principally, on the **Continent of Europe**—In **Austro-Hungary**: At BARTFELD, in Hungary; FRANZENSBAD, in Bohemia; KOENIGSWART, in Bohemia; KRYNICA, in Galicia; MARIENBAD, in Bohemia. In **Belgium**: SPA, in the Province of Liège. In the **German Empire**: BOCKLET, in

Bavaria; CUDOWA, in Prussia; DRIBURG, in Prussia; ELSTER, in Saxony; IMNAU, in the Principality of Hohenzollern; LIEBENSTEIN, in Saxe-Meiningen; LOBENSTEIN, in Reuss-Schleiz; PETERSTHAL, in the Grand Duchy of Baden; PYRMONT, in Waldeck-Pyrmont; REINERZ, in Prussian Silesia; RIPPOLDSAU, in Baden; SCHWALBACH, in Hesse-Nassau; STEBEN, in Bavaria. In **Switzerland**: ST. MORITZ, in Canton Grisons.

Of the steel springs mentioned, the following are especially characterized by the great amount of carbon dioxid and of iron they contain, with an almost total absence of other solid ingredients: The steel springs of SCHWALBACH, the Ambrosiusbrunnen at MARIENBAD, the steel springs at FRANZENSBAD, the Victorquelle at KOENIGSWART, the Hauptquelle at PYRMONT, and the Tempelquelle at STEBEN.

In the **British Isles** waters corresponding to those just named are—In **England**: At HARROGATE (the Kissingen Well), in Yorkshire, containing 0.13 gram of iron bicarbonate in a liter of water; TUNBRIDGE WELLS, in Kent, containing 0.06 gram of iron bicarbonate.

In the **United States** springs of this class are—In **California**: GEYSER SPA, in Sonoma County (4 grains in the gallon); NAPA SODA SPRINGS, in Napa County (8 grains); PACIFIC CONGRESS SPRINGS, in Santa Clara County (14 grains). In **Colorado**: MANITOU SPRINGS (Iron Ute Spring), in El Paso County (3 grains). In **Indiana**: TAR SPRING, in Crawford County (4 grains). In **Michigan**: OWOSSO SPRING, in Shiawassee County (16 grains). In **New Mexico**: OJO CALIENTE, in Taos County (6 grains). In **New York**: ADIRONDACK MINERAL SPRING, in Washington County (4 grains); RICHFIELD (Iron Spring), in Otsego County (5 grains). In **Pennsylvania**: CRESSON SPRINGS, in Cambria County (5 grains). In **Tennessee**: MONTVALE SPRINGS, in Blount County (2.4 grains). In **Virginia**: ROCK ENON SPRINGS, in Frederick County (14.25 grains of iron protoxid); WASHINGTON SPRINGS, in Washington County (0.52 grain). In **Wisconsin**: SPARTA MINERAL WELLS (Artesian Well), in Monroe County (6 grains).

Iron thermal springs are situated, on the **Continent of Europe**—In **Austro-Hungary**: At SZLIACS (23° C.—73.4° F.), in Hungary; VIHNYE (36° C.—96.8° F.), in Hungary. In **France**: At BARBOTAN (15° to 37.7° C.—59° to 100° F.), in the Department Gers; LAMALOU (15° to 47.2° C.—59° to 117° F.), in the Department of Hérault; RENNES-LES-BAINS (45° C.—115° F.), in the Department Ande. In **Russia**: JELEZNOVODSK (20° to 44.4° C.—68° to 112° F.), in the Caucasus. In **Switzerland**: ACQUAROSSA (25° C.—77° F.), in Canton Ticino; ANDEER-PIGNIEU (18.8° to 20° C.—66° to 68° F.), in Canton Grisons.

In the **United States** thermal iron waters are found—In **Colorado**: CHALK CREEK HOT SPRINGS (65.5° C.—150° F.), in Chaffee County; ELBERT IRON SPRINGS (32.2° C.—90° F.), in La Plata County. In **Florida**: WESSON'S IRON SPRING (22.7° C.—73° F.), in Hamilton County. In **New Mexico**: OJO CALIENTE HOT SPRINGS (32.2° to 50° C.—90° to 122° F.), in Taos County. In **New York**: LEBANON THERMAL SPRINGS (23.8° C.—75° F.), in Columbia County. In **Virginia**: SWEET CHALYBEATE SPRINGS (23.8° to 26.1° C.—75° to 79° F.), in Alleghany County.

One liter of water contains:

AT:	IRON BICARBONATE	IRON CARBONATE	FREE CARBON DIOXID
Bartfeld,	0.087 gram	. .	1683 c.c.
Bocklet,	0.087 "	. .	1505 "
Cresson Springs,	0.085 "	. .	. .
Cudowa,	0.063 "	. .	1200 "
Elster,	0.084 "	. .	1266 "
Franzensbad,	0.079 "	. .	1528 "
Imnau,	0.052 "	. .	987 "
Iron Ute Spring,	. .	0.057 gram	. .
Koenigswart,	0.085 "	. .	1163 "
Krynica,	0.029 "	. .	1513 "
Liebenstein,	0.1 "	. .	906 "
Marienbad,	0.166 "	. .	1173 "
Ojo Caliente,	. .	0.102 "	. .
Owosso Spring,	0.273 "	. .	. .
Pacific Congress Springs,	0.239 "	. .	. .
Pyrmont,	0.077 "	. .	1486 "
Richfield Iron Spring,	0.085 "	. .	. .
Rock Enon Springs,	. .	0.243 (protoxid)	. .
Schwalbach,	0.08 "	. .	1571 "
Spa,	0.07 "	. .	304 "
Sparta Artesian Well,	0.01 "	. .	. .
Steben,	0.06 "	. .	1382 "
Szliacs,	0.119 "	. .	894 "
St. Moritz,	0.035 "	. .	1282 "
Vihnye,	0.016 "	. .	337 "

Sulphated Iron Waters

The **sulphated iron waters** contain the ingredient that distinguishes them—namely, ferrous sulphate, in amounts varying from 0.1 to 4.2 grams in a liter of water (about from 6 to 250 grains in the gallon), and, besides this, small amounts of sodium sulphate, magnesium sulphate, and calcium sulphate, and, at times, also alum, free sulphuric acid, and arsenic. These waters are **cold,** deficient in gases, and occur where combinations of iron sulphid are present in the rocks through which the water flows, and these are in process of disintegration. In the **employment** of these iron waters for drinking-cures, in addition to the action of iron in improving hemogenesis, the influence of iron sulphate in exerting an astringent and a disinfectant effect upon the gastro-intestinal tract is to be taken into consideration. They are, in general, more difficult of digestion than the carbonated iron waters. The **quantities to be taken** are, therefore, smaller, being in general 500 grams (one pint), and for children, 300 grams (10 ounces), in divided doses, throughout the day.

Drinking-cures with iron sulphate waters are especially **indicated** in cases of chronic diarrhea in anemic and cachectic children, cases of chronic gastric catarrh and ulcer of the stomach, and cases of chronic malarial cachexia.

One liter of water contains:

At:	Iron Sulphate
Alexisbad,	0.046 gram
Church Hill Alum Springs,	2.718 grams
Kittaning Mineral Spring,	0.410 gram
Mitterbad,	0.29 "
Muskau,	0.19 "
Oak Orchard Springs,	0.565 "
Parad,	1.1 grams
Ratzes,	0.3 gram
Ronneby,	2.49 grams
Schuyler County Spring,	1.197 "

Localities

Iron sulphate waters are situated, on the **Continent of Europe**—In **Austro-Hungary**: MITTERBAD, in the Tirol; PARAD, in Hungary; RATZES, in the Tirol. In the **German Empire**: ALEXISBAD, in the Duchy of Anhalt; MUSKAU, in Prussia. In **Sweden**: RONNEBY, in the Laen of Blekinge.

In the **British Isles** sulphated iron waters are found—In **England**: BRIGHTON (St. Anne's Well), in Sussex; DORTON, in Buckinghamshire; Flitwick Well, near Ampthill, in Bedfordshire; GILSLAND SPA, in Cumberland; HORLEY GREEN, near Halifax, in Yorkshire; Lady Ida Well, at Knockin, in Shropshire; SANDROCK, near Blackgang Chine, on the Isle of Wight. In **Scotland**: HARTFELL SPA, near Moffat; VICAR'S BRIDGE, near Dollar. In **Wales**: TREFRIW, in North Wales.

In the **United States** waters containing ferrous sulphate are —In **Illinois**: SCHUYLER COUNTY SPRING, in Schuyler County (69.96 grains). In **New York**: OAK ORCHARD SPRING, in Genesee County (33 grains); SHARON CHALYBEATE SPRING, in Schoharie County (1.4 grains). In **Pennsylvania**: KITTANING MINERAL SPRING, in Armstrong County (24 grains). In **Virginia**: BATH ALUM SPRING, in Bath County (26.78 grains); BEDFORD ALUM SPRINGS, in Campbell County (19 grains); CHURCH HILL ALUM SPRINGS, in Henrico County (158.79 grains); FAUQUIER WHITE SULPHUR SPRINGS, in Fauquier

County (2 grains); ROCKBRIDGE ALUM SPRINGS, Spring No. 2, in Rockbridge County (1.95 grains); STRIBLING or AUGUSTA SPRINGS, Alum Spring, in Augusta County (13 grains); VARIETY SPRINGS, in Augusta County (5 grains).

Arsenical Iron Waters

Those iron sulphate waters that contain considerable amounts of arsenic, and are, therefore, designated arsenical iron waters, are of much therapeutic importance. The small quantities of arsenous acid contained in these waters are quickly absorbed from the stomach and enter the blood stream. They exert their effect especially upon the skin, which appears to be better nourished; upon the respiration, which is rendered considerably easier; and upon the blood, the hemoglobin of which becomes increased. According to the investigations of Schulz and Binz, the process of transformation of arsenous acid into arsenic within the body may possibly cause a to-and-fro movement of the oxygen atoms in the protoplasm, which, in connection with the direct effect of small doses of arsenic, stimulates the processes of tissue formation. As a result of the use of these arsenical iron waters there occur marked improvement in the general condition and in the nutrition, and, finally, subsidence of certain morbid manifestations in anemic, chlorotic, and neurasthenic individuals, and this, even in cases in which other preparations of iron have been ineffective.

The **indications** for drinking-cures with arsenical iron waters include oligemic states and chlorosis, especially if attended with emaciation; tumors of lymphatic glands in anemic persons; chronic malarial fever; neuralgia and other nervous disorders of anemic origin; and the torpid varieties of scrofulosis. The arsenical waters may be used at their source, but they are also bottled and exported.

Dosage

At first, one or two tablespoonfuls are given daily, after the principal meals of the day, not when the stomach is empty; the amount is increased gradually to from four to six tablespoonfuls in the course of the day. Children receive but half this quantity. Should symptoms of intoxication appear, such as pain in the pharynx, conjunctivitis, derangement of appetite, or pressure in the epigastrium, the use of the arsenical water must at once be suspended, or, at least, the dose be diminished.

Localities

Strong arsenical waters can be obtained, on the **Continent of Europe—In Austro-Hungary:** Guberquelle, at SREBERNIK, in Bosnia; LEVICO, in the Tirol; RONCEGNO, in the Tirol. In the

German Empire: LAUSIGK, in Saxony. In **Italy**: RECOARO, in the Province of Vicenza.

In the **United States** the principal waters containing arsenic are—In **California**: HARBIN HOT SULPHUR SPRINGS, in Lake County. In **North Carolina**: THOMPSON'S BROMINE-ARSENIC SPRING, at Crumpler, in Ashe County; ASHLEY'S BROMIDE AND ARSENIC SPRING, in Ashe County. In **Virginia**: CROCKETT ARSENIC LITHIA SPRINGS, in Montgomery County; SWINEFORD ARSENIC LITHIA SPRINGS, in Osceola County.

One liter of water contains:

AT:	IRON SULPHATE	ARSENIC ACID	ARSENOUS SALTS
Crockett Arsenic Lithia Springs,	0.0006 gram	. .	0.0003 gram
Guberquelle (Srebernik),	0.37 "	0.0061 gram	. .
Harbin Hot Sulphur Springs,	0.03 "	. .	0.005 "
Lausigk,	4.18 grams	0.0001 "	. .
Levico,	2.56 "	0.0086 "	. .
Recoaro,	3.2 "	0.0039 "	. .
Roncegno,	3.0 "	0.15 "	. .

CHAPTER VI

EARTHY MINERAL WATERS; ACRATOTHERMAL WATERS

Earthy Mineral Waters—Constituents; Effects and Indications; Localities. Acratothermal Waters.

EARTHY MINERAL WATERS

Constituents

Among the earthy mineral waters are included those waters, both cold and warm, that are characterized by the presence, almost exclusively, of large amounts of the salts of calcium and magnesium. Frequently the amount of carbon dioxid, and at times also that of sodium chlorid and iron, is notable, and some springs contain moderate amounts of nitrogen.

Effects and Indications

The carbonates of calcium and magnesium inhibit the production of acid in the stomach, and diminish the secretions of the mucous membranes of the respiratory, digestive, and urinary tracts. They are believed also to induce changes in the composition of the urine favorable to the solution of uric acid. That the introduction of calcium into the body is of importance in the formation of bone has long been known.

The **cold earthy mineral waters**, containing carbon dioxid in considerable amounts and also calcium carbonate, exert a markedly diuretic effect, and are more easily digested than the thermal earthy waters or the earthy waters containing large quantities of calcium sulphate.

Drinking-cures with the earthy waters are **indicated** in the presence of chronic catarrhal conditions of the urinary organs, with a tendency to the formation of concretions in the kidneys and the bladder; in the presence of the uric acid diathesis and gout, of chronic gonorrhea, of chronic bronchial catarrh with profuse secretion; in cases of cheesy pneumonic processes, of scrofulosis, rachitis, and osteomalacia.

The **quantity** to be taken may, in general, be from three to five glasses, each of 200 grams (say 7 ounces), and it should be increased only when a more marked diuretic effect is desired. In addition to drinking-cures, **inhalation** of the gases, particularly the nitrogen, that escape from the earthy mineral waters at the springs is also practised.

Localities

Cold earthy mineral waters exist on the **Continent of Europe**—In **Austro-Hungary**: At BORSZEK, in Hungary; MARIENBAD, in Bohemia. In **France**: CONTREXÉVILLE, in Department of Vosges; CRANSAC, in Department of Aveyron; SIRADAN, in Hautes-Pyrénées. In the **German Empire**: DRIBURG, in Prussia; WILDUNGEN, in Waldeck. In **Switzerland**: FAULENSEE-BAD, in Canton Bern; PEIDEN, in Canton Grisons.

The cold earthy mineral springs in the **United States** are—In **California**: NAPA SODA SPRINGS, in Napa County (10 grains of calcium carbonate in a gallon). In **Colorado**: MANITOU SPRINGS, in El Paso County (from 23 to 65 grains of calcium bicarbonate); SELTZER SPRINGS, at Springdale, in Boulder County (43.31 grains of calcium carbonate). In **Georgia**: CATOOSA SPRINGS, in Catoosa County (from 40 to 45 grains of calcium sulphate). In **Idaho**: IDAN-HA SPRINGS, in Bannock County (58 grains of calcium bicarbonate and 62.4 grains of magnesium bicarbonate). In **Kentucky**: ESTILL SPRINGS (Chalybeate Spring), in Estill County (26.36 grains of calcium sulphate and 3 grains of calcium carbonate). In **Michigan**: BUTTERWORTH'S MINERAL SPRING, in Kent County (75 grains of calcium sulphate); EASTMAN SPRINGS, in Berrien County (from 5 to 8 grains of calcium bicarbonate); EATON RAPID WELLS, in Eaton County (from 45 to 55 grains of calcium sulphate); MOORMAN MINERAL WELL, in Washtenaw County (1573 grains of sodium chlorid and 175 grains of calcium sulphate); MT. CLEMENS MINERAL SPRINGS, in Macomb County (from 44 to 100 grains of calcium sulphate and 11,900 grains of sodium chlorid); OWOSSO SPRING, in Shiawassee County (25.67 grains of calcium bicarbonate); ST. CLAIR MINERAL SPRING, in St. Clair County (144 grains of calcium sulphate and 8120 grains of sodium chlorid). In **New York**: CHERRY VALLEY SPRINGS (North Spring), in Otsego County (150 grains of calcium sulphate); CHITTENANGO SULPHUR SPRINGS (Chittenango Magnesia Sulphur Spring), in Madison County (115 grains of calcium sulphate); CLIFTON SPRINGS, in Ontario County (9.68 grains of calcium carbonate and 69.2 grains of calcium sulphate); RICHFIELD SPRINGS (White Sulphur Spring), in Otsego County (112 grains of calcium sulphate). In **Pennsylvania**: BEDFORD SPRINGS (Magnesia Spring), in Bedford County (107.8 grains of calcium sulphate); BEDFORD CHALYBEATE SPRING, in Bedford County (11.62 grains of calcium salts); EAST CLARION SPRING, in Elk

County (9.8 grains of calcium bicarbonate); GETTYSBURG KATALYSINE SPRING, in Adams County (16 grains of calcium bicarbonate); McCARTHY'S SPRINGS, in Huntingdon County (95 grains of calcium bicarbonate and calcium sulphate); PARKER MINERAL SPRINGS, in McKean County (282 grains of sodium chlorid and 12 grains of calcium carbonate). In **Tennessee**: TATE EPSOM SPRING, in Grainger County (161 grains of calcium sulphate). In **Vermont**: GUILFORD MINERAL SPRINGS, in Windham County (15.18 grains of calcium carbonate). In **Virginia**: ALLEGHANY SPRINGS, in Montgomery County (115 grains of calcium sulphate); BLUE RIDGE SPRINGS, in Botetourt County (100 grains of calcium sulphate); HOLSTON SPRINGS, in Scott County (20 grains of calcium sulphate); YELLOW SULPHUR SPRINGS, in Montgomery County (63 grains of calcium sulphate). In **West Virginia**: CAPON SPRINGS (Beauty Spring), in Hampshire County (8.32 grains of calcium carbonate and 0.59 grain of calcium sulphate); GREENBRIER WHITE SULPHUR SPRINGS, in Greenbrier County (78 grains of calcium sulphate); IRONDALE SPRINGS, in Preston County (60 grains of calcium sulphate); SALT SULPHUR SPRINGS, in Monroe County (from 10 to 33 grains of calcium carbonate and from 68 to 84 grains of calcium sulphate). In **Wisconsin**: ALLOUEZ MINERAL SPRINGS, in Brown County (24.69 grains of calcium bicarbonate and 27.53 grains of magnesium bicarbonate); WAUKESHA MINERAL SPRINGS, in Waukesha County (from 13 to 17 grains of calcium bicarbonate and from 9 to 13 grains of magnesium bicarbonate). ARCTIC SPRINGS, in Trempeleau County (13 grains of calcium bicarbonate and 10 grains of magnesium bicarbonate).

Thermal earthy mineral waters are situated, on the **Continent of Europe** In **Austro-Hungary**: At GRAN (28.0° C.—83.6° F.), in Hungary; SKLENO (53° C.—127.4° F.), in Hungary. In **France**: [illegible] (21.1° C.—70° F.), in Department of Ariège; CAPVERN (21.1° to 24.4° C.—70° to 76° F.), in Hautes-Pyrénées. In the **German Empire**: INSELBAD (18.2° C.—64.8° F.), in Prussia; LIPPSPRINGE (21.2° C.—70.2° F.), in Prussia. In **Italy**: BAGNI DI LUCCA (54° C.—[illegible] F.), in the Province of Lucca; CHIANCIANO (37.7° C.—100° F.), in Tuscany. In **Switzerland**: LEUKERBAD (LOÈCHE-LES-BAINS) (51° C.—123.8° F.), in Canton Valais; VALS (25° to 2[illegible]° C.—[illegible] to [illegible]° F.), in Canton Grisons; WEISSENBURG (20° C.—[illegible] F.), in Canton Bern.

In the **British Isles** waters of this group are found at BATH ([illegible] to 49° C.—104° to 120° F.), in **England**.

In the **United States** thermal earthy springs are [illegible]— In **Arkansas**: ARKANSAS HOT SPRINGS ([illegible] C.—[illegible] F.), in Garland County, containing, in a gallon, [illegible] of calcium carbonate. In **California**: [illegible] C.—85° [illegible] Santa Clara County ([illegible]

In **Colorado**: IDAHO HOT SPRINGS (29.4° to 48.9° C.—85° to 120° F.), in Clear Creek County (9.52 grains of calcium carbonate and 3.44 grains of calcium sulphate). In **Virginia**: WARM SULPHUR SPRINGS (35.5° C.—96° F.), in Bath County (15 grains of calcium sulphate). In **West Virginia**: BERKELEY SPRINGS (23.8° C.—75° F.), in Morgan County (5 grains of calcium carbonate); OLD SWEET SPRINGS (26.1° C.—79° F.), in Monroe County (13 grains of calcium sulphate and 30 grains of calcium carbonate). In **Wisconsin**: PALMYRA MINERAL SPRINGS (22.2° C.—72° F.), in Jefferson County (from 9 to 15 grains of calcium bicarbonate). Some of these have been mentioned in a previous chapter among waters suitable for acratothermal baths, their mineral constituents falling below 0.75 gram in a liter (or 50 grains in a gallon). They are likewise the waters to be employed for so-called thermal lime baths.

Of the springs named, those at WILDUNGEN, then the Rudolfsquelle, at MARIENBAD, both of which contain carbon dioxid in large quantity, have the greatest reputation in the treatment of chronic nephritis, catarrh of the bladder, and uric-acid concretions; whereas LIPPSPRINGE and INSELBAD are especially noted for their good effects in chronic catarrhal conditions of the larynx and the bronchi.

One liter of water contains:

AT:	CALCIUM SULPHATE	CALCIUM BICARBONATE	CALCIUM CARBONATE
Alleghany Springs,	1.8 grams	. . .	0.06 gram
Allouez Mineral Springs,	. . .	0.42 gram	0.47 magn. bicarb.
Arkansas Hot Springs,	. . .	. . .	0.12 gram
Bath,	1.5 grams	. . .	. . .
Bedford Springs (Magnesia Spring),	1.84 "	. . .	. . .
Clifton Springs,	1.18 "	. . .	0.16 gram
Contrexéville,	1.1 "	0.45 gram	. . .
Driburg,	1.04 "	1.44 grams	. . .
Eaton Rapid Wells,	0.77 to 0.94 gram	. . .	0.34 to 0.78 gram
Greenbrier White Sulphur Springs,	1.33 grams	. . .	0.12 gram
Inselbad,		0.30 gram	. . .
Leukerbad,	1.42 grams	0.09 "	. . .
Lippspringe,	0.82 gram	0.41 "	. . .
Manitou Springs,	. . .	.	0.4 to 1.11 grams
Marienbad (Rudolfsquelle),	. . .	1.6) grams	.
Old Sweet Springs,	0.22 gram	. . .	0.51 gram
Szkleno,	. . .	0.10 gram	. . .
Warm Sulphur Springs,	0.24 gram	. . .	0.08 gram
Weissenburg,	. . .	1.27 grams	. . .
Wildungen,	2.0 grams	. . .	. . .

ACRATOTHERMAL WATERS

The acratothermal waters ('simple' or 'indifferent' thermal waters of English writers), those mineral waters that are characterized by their high temperature, but that contain no conspicuous solid or gaseous ingredient in amount sufficient to explain their activity, are seldom employed for drinking purposes; but, as has already been mentioned, they are generally employed for thermal baths. Their usefulness for drinking-cures is merely that of the ingestion of large quantities of warm water.

PART II

BALNEOTHERAPEUTIC AND CROUNOTHERAPEUTIC INDICATIONS FOR THE INDIVIDUAL FORMS OF CHRONIC DISEASE

PART II

BALNEOTHERAPEUTIC AND CROUNOTHERAPEUTIC INDICATIONS FOR THE INDIVIDUAL FORMS OF CHRONIC DISEASE

CHAPTER I

CONSTITUTIONAL DISEASES AND DISORDERS OF METABOLISM

Anemic States. Scrofulosis. Excessive Deposition of Fat and Obesity. Diabetes Mellitus. Gout. Rachitis. Constitutional Syphilis.

ANEMIC STATES

In the various forms of **anemia**, whether the result of altered blood composition or due to profuse loss of blood or chronic disease, as well as in conditions of debility following acute diseases (**protracted convalescence**), balneotherapy is indicated especially to stimulate hemogenesis, as well as to counteract the weakness. For this purpose the mineral waters containing iron are particularly to be recommended, both for drinking purposes and for bathing. Both the pure carbonated iron waters, which, in the presence of a small amount of solid constituents, contain a considerable quantity of iron, and certain alkaline carbonated waters containing quite a large quantity of iron, are available.

In the selection of the health resort, the presence of well-arranged steel baths and ferruginous peat baths, as well as the question of an appropriate climate, are to be taken into consideration.

The pure iron springs of BOCKLET, DRIBURG, ELSTER, FRANZENSBAD, IMNAU, KOENIGSWART, MARIENBAD, PYRMONT, SCHWALBACH, SPA, STEBEN, ST. MORITZ, and SZLIACS are characterized especially by their richness in iron and free carbon dioxid, and in these places excel-

[1] Regarding the recommendations under the various headings of this part, see also the volumes on "Climatotherapy" and, in this volume, Dr. Peale's lists of American springs.

lent steel baths and, as a rule, also strong iron-peat baths are to be had. **For flabby, torpid constitutions, for simple anemia and chlorosis,** a certain elevation is of material significance. The iron baths of Germany, Austria, and Switzerland of highest altitude are located at St. Moritz (1770 meters—5841 feet—above sea-level), Steben (730 meters—2409 feet—above sea-level), and Marienbad (630 meters—2079 feet—above sea-level).

When the condition of the digestive organs in anemic patients is such that the pure iron waters are not well borne; further, when a slight stimulating influence upon the digestive tract by means of salines appears desirable, then alkaline-saline chalybeate or alkaline-muriated chalybeate waters are to be preferred to the pure iron-waters. Under such circumstances the Salzquelle and the Luisenquelle, at Franzensbad, the Moritzquelle and the Marienquelle, at Elster, the Ferdinandsbrunnen at Marienbad, the Wenzelquelle at Rippoldsau, the Hauptquelle at Bartfeld, the springs at Petersthal and Freiersbach, the Eugenquelle of Cudowa, and many others, may be prescribed.

In the **United States** suitable springs are the Rawley Springs, Church Hill Alum Springs, Bath Alum Springs, Rock Enon Springs, Bedford Alum Springs, and Massanetta Springs, in Virginia; Richfield Springs (Iron Spring) and Sharon Springs (Chalybeate Spring), in New York. Schooley's Mountain Spring (Heath House Spring), in New Jersey, is a weakly saline chalybeate water. The Pacific Congress Springs, in California, contain an excellent chalybeate water, mildly saline.

If **chronic intestinal catarrh, persistent diarrhea, and malarial disease** are associated with the anemic conditions and states of debility, the sulphated iron waters may be drunk instead of the carbonated iron waters—that is, those mineral waters in which the iron is present in considerable quantity as a sulphate, together with alum and arsenic acid. In any case, only small, gradually increased amounts —from 100 to 500 grams (3 to 16 ounces) daily for an adult—may be given. Such greatly emaciated and anemic individuals may drink the waters of Alexisbad, Levico, Mitterbad, Muskau, Parad, Ratzes, Roncegno, Ronneby, and Serebrenica.

In the **British Isles,** among waters locally termed chalybeate and principally sulphated, are: Cheltenham, in Gloucestershire; Gilsland Spa, in Cumberland; Sandrock, near Blackgang Chine, Isle of Wight; Tunbridge Wells, in Kent; the last is a pure chalybeate.

Of **American waters** the Adirondack Mineral Spring, in New York; the Bedford (Iron Spring), and Rockbridge Alum Springs, in Virginia, and the CLOVERDALE LITHIA SPRING, in Pennsylvania, are suitable. The last-named spring is only slightly chalybeate. OJO CALIENTE SPRING, in New Mexico; and THOMPSON'S BROMINE AND ARSENIC SPRING, in North Carolina, are waters adapted to the treatment of anemic conditions.

In European health resorts, baths containing sulphated iron waters, so-called vitriol baths (see p. 400), may also be taken; these appear indicated especially in the presence of **diseases of the genitalia** in anemic women. Under such conditions the advisability of brine baths may also be considered, especially those situated at mountainous elevations, as at ISCHL, AUSSEE, REICHENHALL, GMUNDEN, and KREUTH. At DROITWICH, in Worcestershire, **England**, artificially heated brine baths are provided. In the **United States** hot brine springs at mountainous elevations are the UTAH HOT SPRINGS (4246 feet) and the SALT LAKE HOT SPRINGS (4345 feet), in Utah; the Yampa Spring at GLENWOOD (5200 feet) and ROYAL GORGE HOT SPRINGS (5200 feet), in Colorado.

Sea-baths, which frequently are useful in mild anemic states, especially when nervous symptoms are marked, as an after-cure following the drinking-cures with pure carbonated iron waters, are not, however, advisable in the presence of advanced anemia.

SCROFULOSIS

In the presence of this constitutional disorder, characterized by an especial tendency to irritative processes and pathologic deposits in the lymph-glands, mucous membranes, and joints, as well as bones, and both in the erethistic and in the torpid variety, the object of the drinking-cure with mineral waters is improvement of the metabolism, whereas by means of the mineral baths an influence is exerted especially upon the local disorders.

For **internal use** the mild sodium chlorid waters and alkaline muriated carbonated waters are especially to be considered for the reason that the sodium chlorid contained in these mineral waters is believed to cause increased proteid metabolism; further, in the **severe cases** of scrofulosis, with a preponderance of glandular infiltrations and important localizations upon the skin, in the bones, and in the joints, the drinking of sodium chlorid waters containing iodin and bromin, which powerfully stimulate the activity of the lymphatic glands, increases absorption in the glandular organs and other tissues.

The use of drinking-waters containing decided quantities of sodium chlorid, such as those of Elizabethbrunnen at HOMBURG, the Rakoczy at KISSINGEN, and the sodium chlorid thermal waters at BADEN-BADEN, WIESBADEN, SODEN, and NAUHEIM, is generally suitable for cases of **torpid scrofulosis** with slight glandular infiltration, limited scrofulous lesions of the mucous membranes, conjunctivitis, otitis, scrofulous ozena, blennorrhea of scrofulous origin, and the general scrofulous habitus.

In the **British Isles**, suitable sodium chlorid waters are found —In **England**: at ASHBY-DE-LA-ZOUCH, in Leicestershire; DROITWICH, in Worcestershire; MALVERN, in Worcestershire; NANTWICH, in Cheshire; WOODHALL SPA, in Lincolnshire. In **Scotland**: at BRIDGE-OF-ALAN, near Airthrie, in Stirlingshire. In **Wales**: at LLANGAMMARCH WELLS, in Brecknockshire.

In the **United States** waters suitable in these cases are those of BALLSTON SPA and SARATOGA SPRINGS, in New York; BEDFORD SPRINGS, in Pennsylvania; GREENBRIER WHITE SULPHUR SPRINGS, in West Virginia; SHEBOYGAN MINERAL SPRING, in Wisconsin; YPSILANTI MINERAL WELL and SALUTARIS SPRING, in Michigan; and TOLENAS SPRING, in California.

In cases of **erethistic scrofulosis** the milder alkaline muriated carbonated waters, less rich in sodium chlorid and containing also iron, are to be preferred; for instance, the Constantinsquelle at GLEICHENBERG, the Vincenzbrunnen at LUHATSCHOWITZ, or the thermal springs of the same character at SODEN, the Fuerstenbrunnen at EMS, and the waters of ROYAT. In the **United States** the CAMBRIDGE SPRINGS, in Pennsylvania; ROCKBRIDGE ALUM SPRING and SWEET CHALYBEATE SPRING, in Virginia; and the mildly saline sulphureted RED SULPHUR SPRING, in West Virginia, are useful in the conditions under consideration.

The waters of Royat are suitable also for cases of scrofulosis in which **digestion** is seriously impaired, or in which the differentiation between scrofulosis and **tuberculosis** is difficult. Two or three glasses each of 200 grams (6 or 7 ounces) may be drunk daily (half this quantity for children), and often in combination with milk, whey, and meat-broth.

The iodin waters, which enjoy a good reputation in the treatment of the **severe forms of scrofulosis** particularly, are the Elisenquelle at KREUZNACH; the Trinkquelle at HALL, in Upper Austria; the Adelheidsquelle at HEILBRUNN; the Roemerquelle at WILDBAD-SULZBRUNN; the drinking springs at IWONICZ, KRANKENHEIL, LIPIK, SAXON, and ZAIZON. (For iodin waters in the United States see p. 431.) The amounts in which these strong sodium chlorid waters containing iodin and bromin may be taken should be determined with care in the individual case, the dose varying from one to ten liters (quarts) daily, given in divided portions throughout the day. The drinking of the iodin-containing waters appears **counterindicated,** however, on the part of scrofulous individuals, in whom acute inflammatory conditions, especially in the digestive organs, are present, or in whom anemic-cachectic conditions have developed.

Torpid scrofulous individuals, who exhibit marked symptoms of **anemia,** also scrofulous girls at the period of **puberty,** who do not exhibit erethistic states of the vascular system, may with advantage drink iron waters that contain considerable quantities of calcium carbonate and iron carbonate—as, for instance, the springs at PYRMONT, DRIBURG, IMNAU, BOCKLET, and BUZIAS, as well as the iron springs rich in sodium chlorid and lime-salts at BARTFELD, KRYNICA, LIEBWERDA, and REINERZ.

Among suitable waters in the **United States** are the ROCK ENON SPRINGS (1200 feet) and RAWLEY SPRINGS (2000 feet), in Virginia; LONDONDERRY LITHIA SPRING, in New Hampshire; CRESSON SPRINGS (Iron Spring) (2300 feet), in Pennsylvania; BAILEY SPRINGS (Rock Spring), in Alabama; NEWSOM'S ARROYO GRANDE SPRINGS (400 feet) and PACIFIC CONGRESS SPRINGS (835 feet), in California.

In the treatment of scrofulous individuals great stress must be placed upon the use of **baths** that stimulate the activity of the skin, thus increasing metabolism and absorption. Among these the brine baths have a high reputation, particularly for torpid persons. Such brine baths, in conjunction with the drinking-cure, bring about admirable results if the resort be so selected that favorable climatic influences may operate also. Such favorably situated brine baths may be found at AUSSEE, ARNSTADT, BEX, COLBERG, GMUNDEN, GOCZALKOWITZ, ISCHL, KOESEN, REICHENHALL, DUERKHEIM, ELMEN, KREUZNACH, and HALL in Upper Austria. At the last four places are brine baths containing iodin and bromin, and therefore having a good effect upon scrofulous affections of the bones, as well as upon glandular infiltration.

In the **British Isles,** celebrated brine baths are found at DROITWICH, MALVERN, NANTWICH, and WOODHALL SPA, in England.

In **America** brine baths are found—in **Canada,** at CALEDONIA SPRINGS and ST. CATHERINE'S WELLS, in Ontario; CAXTON SPRINGS, in Quebec. In the **United States** similar baths are the ST. CLAIR SPRINGS, in Michigan, and the SALT LAKE HOT SPRINGS, in Utah. OWENS LAKE, in California, called the 'American Dead Sea,' contains 2451 grains of sodium chlorid and 2428 grains of sodium sulphate in a gallon of water. The strongest brine baths in the United States are the MT. CLEMENS MINERAL SPRINGS, containing a total of 13,654 grains of solids, 11,900 of which are sodium chlorid, and CLARK'S RED CROSS MINERAL WELL, containing 17,825 grains of solids, of which 13,048 grains are sodium chlorid, both in Michigan.

All brine baths, especially, however, those containing iodin, must be regulated carefully with regard to temperature and degree of concentration, in accordance with variations in individual irritability. Increase in heat and in strength (from 1 to 6 per cent. of sodium chlorid) must be made gradually and methodically. **In the treatment of scrofulous children** at home, iodin-brine baths may be prepared artificially. The iodin salts of HALL, KRANKENHEIL, KREUZNACH, and DARKAU may be procured for this purpose—from one-fourth to one kilogram of these salts being mixed with an equal quantity of sodium chlorid, in accordance with the age of the child. Locally, especially in the presence of lymphomata, the iodin brine is applied in the form of cataplasms; these are covered with gutta-percha, and are kept moist and warm.

Upon children with a **scrofulous tendency,** but in whom there has been no development of definite localizations, as well as in the mild varieties of scrofulous enlargement of the glands and affections of the mucous membranes, sea-baths exert an excellent effect. The choice of the sea-bath depends upon the constitution of the child. For the torpid, a vigorous surf and waters containing a large proportion of salt, such as those of the German Ocean (North Sea) resorts, are to be recommended; for instance, BLANKENBERGE, HELIGOLAND, NORDERNEY, OSTEND, SCHEVENINGEN, and WYK. For the erethistic, bathing in the Baltic Sea, which contains a smaller amount of salt and whose surf is less violent, as at CRANTY, COLBERG, DOBERAN, HERINGSDORF, MISDROY, WARNEMUENDE, and ZOPPOT, is to be preferred. Delicate and sensitive patients may be advised to take sea-baths in the warmer, southern seaside resorts. If scrofulous individuals exhibit great **hyperesthesia,** it is advisable to begin the course of sea-water bathing with lukewarm baths at a temperature of from 32° to 34° C. (about 89.5° to 93° F.), and only gradually progressing to cold baths. In general, children under the age of five years should not take cold sea-baths. It is worthy of note, further, that **scrofulous affections of the eyes** are frequently aggravated at the seaside, whereas **bone affections** and indurated, scrofulous **gland tumors** remain unaffected.

In recent years charitable establishments for the treatment of scrofulous children of the poor have been erected at a number of seaside resorts. Such seaside sanatoriums have been established, on the **Continent of Europe,** in Austro-Hungary, at ABBAZIA and GRADO; in Germany, at NORDERNEY, WYK-ON-THE-FOEHR, SYLT, COLBERG, and ZOPPOT; in France, at CANNES, BERCK-SUR-MER, and elsewhere.

In **Great Britain,** may be mentioned the Royal Sea Bathing Infirmary at MARGATE.

In the **United States** seaside sanatoriums for children have been established at ATLANTIC CITY and CAPE MAY, in New Jersey; in New

York there is a FLOATING HOSPITAL FOR CHILDREN under the management of St. John's Guild.

The protracted sojourn at the seaside and the persistent enjoyment of the sea air exert a most favorable influence upon scrofulous children, even if they do not take the sea-baths.

EXCESSIVE DEPOSITION OF FAT AND OBESITY

In the presence of an excessive deposition of fat in the organism and its consequences, denutrition-cures with mineral waters play an important part; next to the dietetic methods, preferably, however, combined with these, they are of the greatest efficacy. In this connection it should be carefully noted, however, whether the obesity be plethoric or anemic in character. From the mild degrees of obesity to the most marked stages—threatening life by fatty degeneration of the myocardium—the best results have unquestionably been obtained from alkaline saline springs characterized by the presence of large quantities of sodium sulphate—Glauber's Salt waters. In the front rank stand the cold Glauber's Salt waters, the Kreuzbrunnen and Ferdinandsbrunnen, at MARIENBAD; then the similar springs at TARASP-SCHULS; both to be preferred on account of the large quantity of carbon dioxid and iron they contain, together with the sodium sulphate. In cases of **plethoric obesity** they will be found more useful than the thermal springs of Carlsbad, because the cold water exerts a more marked diuretic effect and is less irritating to the vascular system, whereas the thermal Glauber's Salt waters of Carlsbad are to be preferred when obesity is associated with diabetes and the uric acid diathesis. The springs at Marienbad, already referred to, are especially efficacious for drinking-cures if the obesity is due to *luxus nutrition*, or if the tendency to obesity is hereditary; they are useful, further, to reduce the accumulation of fat in women at the **climacteric period**, and in cases in which obesity is associated with **abdominal stasis, hemorrhoidal conditions**, and **gout.** By suitable employment of the cold Glauber's Salt waters in drinking-cures of from four to six weeks' duration it is possible to effect not only a material reduction in the amount of superfluous fat, but also to exert a favorable influence upon the sequels in the circulatory organs by stimulating an abundant secretion of urine, and causing intestinal discharges of a liquid or semiliquid character.

In determining the dosage of these mineral waters care should be taken to maintain a correct relation between the ingestion and the elimination of fluid, so that the obese patient shall drink only so much water as he is capable of eliminating within a short time.

For **anemic**, pasty persons with marked **obesity** it is necessary to combine, with a drinking-cure of cold Glauber's Salt waters, the drinking of pure carbonated iron waters; or the weaker Glauber's Salt waters containing iron—for instance, those of ELSTER, FRANZENSBAD, or ROHITSCH may be selected. Less energetic in action, and therefore less available in the presence of marked obesity, are the cold sodium chlorid waters of HOMBURG and KISSINGEN, or the warm springs of similar character at WIESBADEN. Drinking-cures, combined with the employment of carbonated acidulous baths, peat baths, brine baths, iodin baths, and steel baths, to be chosen accordingly as certain symptoms, such as **cardiac disorders, anemic manifestations, cutaneous diseases, or local accumulations of fat**, predominate, are exceedingly useful. Further reference will be made to this subject, particularly in connection with **fatty heart**. If, in cases of obesity, the heart is still in good condition and arteriosclerosis is not present, steam baths and Irish-Roman baths may be employed with success for the purpose of denutrition, as they cause powerful cutaneous irritation and greatly stimulate the secretion of sweat. For domestic use by the obese, baths exerting a stimulating effect upon the skin,—baths of lukewarm water to each of which from one to three kilograms (two to six pounds) of ordinary washing soda (sodium carbonate) are added,—with subsequent cold frictions and douches, are suitable. An effect similar to that of steam baths is exerted by the electric-light baths (radiant heat baths), which have recently been recommended for the obese, and which likewise cause profuse secretion of sweat. The light bath, which induces considerable loss of weight, is more agreeable than a bath in the ordinary steam chamber, but otherwise it possesses no special advantage over the latter for this purpose. Sea-baths are suitable for the obese only when the patient is still of robust constitution, and, further, so long as no symptom of arteriosclerosis or fatty degeneration of the myocardium is present.

DIABETES MELLITUS

In those varied morbid states in which **glycosuria** is a constant and characteristically prominent symptom, experience has shown that mineral waters often exert an extremely favorable influence, suppressing or diminishing the elimination of sugar with the urine, as well as aiding in the improvement of the general state of nutrition. The well-earned reputation of certain springs in the treatment of diabetes is not to be affected by the skeptical objections that have recently been raised. As experience in general is in favor of the employment of alkalis in the treatment of diabetes, drinking-cures with thermal alkaline waters rich in sodium carbonate have been most highly recommended. The thermal alkaline waters of VICHY, NEUENAHR, MONT-DORE; the thermal alkaline saline (sulphated) waters of CARLSBAD; and the thermal alkaline muriated waters of EMS, ROYAT, and ASSMANNSHAUSEN; and, in **Great Britain,** the muriated sulphurous waters of HARROGATE and LLANDRINDOD, are indicated in such conditions. The best results are obtained at Carlsbad and Vichy. The favorable effects of these drinking-cures are to be expected only when the organism still possesses sufficient powers of resistance, when the digestive organs still perform their functions normally, and when a generous meat diet is well borne. Under such conditions diabetics who, previously to the use of these mineral waters, excreted sugar on a mixed diet may acquire a greater tolerance for sugar and starches; moreover, patients who excreted considerable amounts of sugar on a purely animal diet may, after the use of the thermal alkaline waters mentioned, excrete no sugar at all or much less than formerly. The body-weight increases considerably during the course of treatment; the thirst and the dryness of the mouth diminish; the secretion of the urine becomes less abundant; sleep improves; and the patients gain in strength. The diminution in the elimination of sugar is, in the majority of cases, maintained. In the later advanced stages of diabetes the use of the thermal alkaline waters is of only limited usefulness. The course at the springs at Carlsbad should last from four to five weeks, but in no event longer than two months, in order not to debilitate the diabetic patient too greatly. Occasionally it is advisable to repeat the course of treatment after an interval of from three to four months. The treatment is begun with the less warm springs, and the hot waters are reached gradually. The cold alkaline saline waters of MARIENBAD are indicated in the presence of glycosuria occurring in obese individuals, in cases of **'lipogenic diabetes'** (Kisch), in which the quantity of sugar eliminated is small and disappears entirely or largely with reduction in the obesity.

Following a drinking-cure with the alkaline mineral waters, and especially in cases of **diabetes presenting marked anemia,** the use of the pure carbonated iron waters of SCHWALBACH, SPA, PYRMONT, FRANZENSBAD, STEBEN, and similar resorts is indicated as an after-cure, and may then be combined with the employment of steel baths and ferruginous peat baths, on account of their favorable influence on hemogenesis. In the winter, and for a considerable time, diabetics can be advised to use **at the table** the alkaline acidulous waters —as, for instance, of GIESSHUEBL, BILIN, FACHINGEN, SELTERS, KRONDORF, and MALVERN, because these acidulous waters, through the presence of carbon dioxid, allay thirst and stimulate the gastric nerves; they also seem desirable on account of their alkalinity. For protracted domestic use for drinking purposes by children with diabetes and by greatly reduced diabetic patients, the arsenical waters of LEVICO, RONCEGNO, and the Guberquelle of SREBERNIK may be advised.

With the drinking-cure, the employment of warm baths should always be conjoined, because these influence favorably the condition of the skin, which is so important in cases of diabetes. For this reason after-cures at high altitude resorts with acratothermal waters are at times to be recommended; thus, especially, GASTEIN, JOHANNISBAD, RAGATZ, and WILDBAD. Sea-baths are suitable only for those among diabetic patients whose bodily vigor is still sufficient to insure adequate reaction, in order to bring about a hardening against the influence of cold.

In the **United States** there are no waters of particular efficacy in the treatment of diabetes. The SARATOGA waters, especially the Hathorn and Congress Springs, in New York, which contain lithia, may be found useful in **diabetes associated with gout.** The POLAND SPRINGS in Maine, the WAUKESHA waters in Wisconsin, BALLARDVILLE LITHIA SPRING in Massachusetts, CROCKETT ARSENIC-LITHIA SPRING in Virginia, and WOOTAN WELLS in Texas may be mentioned as among the most popular of American waters in the treatment of diabetes.

GOUT

In the balneotherapeutic management of **gout** (arthritis urica) the objects of treatment are to counteract the underlying derangement of metabolism, to neutralize the excess of uric acid, and to stimulate its elimination, as well as to influence symptomatically the affections of the joints, muscles, tendons, and fasciæ, caused by deposition of uric acid.

For **drinking-cures** in cases of gout the alkaline and alkaline saline mineral waters are preferably employed. Of the former, the thermal springs of ASSMANNSHAUSEN, EMS, NEUENAHR, ROYAT, and VICHY are suitable in those cases of gout that exhibit periodic attacks and a rather acute character. Of the alkaline saline waters, the springs of CARLSBAD and MARIENBAD are best suited for those gouty patients who are plethoric and robust, who have a hereditary predisposition to the disorder, and who present associated symptoms of disease of the stomach, intestines, liver, and kidneys. The sodium chlorid waters of KISSINGEN, HOMBURG, BADEN-BADEN, BOURBONNE-LES-BAINS, HARROGATE, and WIESBADEN, deserve especial recommendation in cases of **chronic gout** in which the patients are greatly debilitated.

For long-continued **domestic use** in the milder cases of gout the alkaline acidulous waters of BILIN, FACHINGEN, GIESSHUEBL, SALVATORQUELLE, and VALS may be used as dietetic beverages on account of the presence of alkaline carbonates. About one bottle, containing between 400 and 500 grams (12 to 16 ounces), is the daily dose. In obstinate cases of gout, waters containing lithium are prepared for this purpose—those of the Bonifaciusquelle at SALZSCHLIRF; the Oberbrunnen and the Kronenquelle at SALZBRUNN; the Natronlithionquelle at WEILBACH; the Koenigsquelle at ELSTER, and others.

The annoying **local effusions** that so often remain after repeated attacks of gout, indicate the employment of the most varied thermal **baths** of high temperature. In the presence of local gouty affections of long standing, as well as for the consecutive **palsies** and **neuralgias,** baths may be taken at the acratothermal springs of TEPLITZ-SCHOENAU, WARMBRUNN, and PLOMBIÈRES. For debilitated and reduced individuals GASTEIN, PFAEFERS-RAGATZ, WILDBAD, and LOÈCHE-LES-BAINS are suitable. If large gouty **nodules, contractures, ankyloses,** and **disorders of the locomotor apparatus** resulting from effusions are present, peat baths and mud-baths may be used in the form of full baths and as local affusions. Among those most suitable are the baths at MARIENBAD, FRANZENSBAD, PISTYAN, TEPLITZ-TRENCZIN, LOKA, and WARASDIN-TEPLITZ. In cases in which gout is complicated by **chronic diseases of the skin,** or when suspicion of **syphilis** exists, the sulphurous thermal baths of AACHEN, BADEN in Austria, BADEN in Switzerland, BAGNÈRES-DE-LUCHON, BARÈGES, AMÉLIE-LES-BAINS, and CAUTERETS are to be preferred. For individuals of impaired vigor and cardiac enfeeblement suffering with **arthritis,** the thermal brine waters of NAUHEIM, REHME, KISSINGEN, and SODEN are selected.

For **domestic use** by gouty patients steam baths are suitable. Of these, a considerable number—from thirty to fifty—may be taken, and their influence will be augmented by friction. Hot sand-baths are likewise useful. For **local application** cataplasms of peat earth, sulphurous mud, and fango may be employed. The peat cataplasms are applied in the form of sacks containing heated peat. The fango is heated, and spread in a thick layer upon a linen sheet laid upon the bed, and upon this the affected portion of the body is placed. The upper aspect of the body also is then covered with heated fango, and the patient is enveloped in the sheet, over which are placed a rubber cloth and woolen blankets, so that by means of this pack profuse perspiration is induced. Finally, in severe cases of gout, apparatus may be employed for the purpose of securing the local action of hot air. The affected part of the body being stripped of clothing and protected from burning by means of asbestos, is exposed in a suitable appliance (see page 271) to the influence of a hot-air bath at a temperature of from 75° to 95° C. (167° to 203° F.).

Of **American** waters for **external use** those of HOT SPRINGS, in Virginia; HOT SPRINGS, in North Carolina; MT. CLEMENS, in Michigan; HOT SPRINGS, in Arkansas; and LAS VEGAS HOT SPRINGS, in New

Mexico are most efficient in the treatment of gout and rheumatism. For internal use various lithia waters, SARATOGA VICHY, MOUNT HARTFORD, and POLAND WATER—a plain diuretic water—are to be recommended. The waters of the GETTYSBURG KATALYSINE SPRINGS, MINNEQUA SPRINGS, GLEN SUMMIT SPRINGS, and SWEET SPRINGS, in Pennsylvania; CAPON SPRINGS, in West Virginia; GLENWOOD SPRINGS, in Colorado; CORONADO SPRINGS, in California—are all useful.

RACHITIS

The crounotherapeutic measures employed in cases of rachitis are the same as those that have been mentioned for scrofulosis. A special action is attributed, however, to the earthy mineral waters containing lime. It is assumed that calcium carbonate, which is introduced into the body with these waters, will correct the intestinal catarrh, attended with increased acidity of the secretions and with diarrhea, so often observed in rachitic children; and thereby will restore the conditions for the assimilation of the lime-salts and normal nutrition. Such abundant administration of lime is brought about by the drinking of the iron waters rich in lime-salts, such as those of DRIBURG, IMNAU, BOCKLET, MARIENBAD, ST. MORITZ, BARTFELD, KRYNICA, FRANZENSBAD, and REINERZ, which the children may take in doses of from a tablespoonful to 150 grams (5 ounces), several times daily, according to age; at times in combination with milk, whey, or meat-broth.

In the British Isles suitable waters are found at HARROGATE and at TUNBRIDGE WELLS.

In the United States there are numerous springs of this kind, among which the following may be mentioned: ADIRONDACK MINERAL SPRING and RICHFIELD SPRINGS, in New York; CRESSON SPRINGS, in Pennsylvania; ROCK ENON SPRINGS, in Virginia; NAPA SODA SPRINGS and PACIFIC CONGRESS SPRINGS, in California; MANITOU SPRINGS, in Colorado.

For rachitic children brine baths, peat baths, steel baths, and sea-baths are indicated, in accordance with the physical condition in the individual case. Baths with rock-salt are much preferred for domestic use. For an infant, one-eighth of a kilogram (about 4 ounces) of rock-salt is added to the bath; for older children, from one-fourth to one-half of a kilogram (about from 8 ounces to 1 pound). Kreuznacher salt or Halleiner mother-lye salt (Mutterlaugensalz) may likewise be employed. These salt-baths are taken twice or thrice weekly.

CONSTITUTIONAL SYPHILIS

Although any specific influence upon syphilis of mineral waters of whatever character, such as was formerly assumed, must be denied at the present day, drinking-cures and bathing-cures are, nevertheless, of utility in this connection. They are capable of invigorating the organism in general, and of improving the impaired nutrition resulting from the constitutional disease or from injudicious courses of treatment. They have, however, a special purpose also, inasmuch as they hasten the appearance of the delayed local lesions of the skin, causing latent syphilis to become manifest, and in this way verifying the diagnosis in doubtful cases. The thermal sulphurous waters especially, employed for drinking and bathing, are the best adjuvants to the specific treatment of syphilis by means of mercurial inunctions. By the employment of these thermal baths not only is the power of the skin to absorb mercury increased, but also the action of this remedy is augmented by elevation of the body-temperature and heightening of proteid metabolism. These thermal sulphurous baths constitute, moreover, an admirable remedy against the varieties of **rheumatism, arthritis,** and **mercurialism** associated with syphilis. A special reputation is enjoyed by the thermal sulphurous waters of AACHEN, BADEN in Austria, BADEN in Switzerland, BAGNÈRES-DE-LUCHON, MEHADIA, and PISTYAN.

In obstinate cases of syphilis in which it becomes necessary to intermit the employment of specific measures, drinking-cures and bathing-cures with the sodium chlorid waters containing iodin and bromin may be prescribed in the interval. These waters are useful also for after-cures following vigorous mercurial treatment, and, finally, in the so-called tertiary stage of syphilis, in the presence of **periostitis** and **exostoses.** Under such circumstances KREUZNACH, HALL in Upper Austria, IVONITCH, LIPIK, KRANKENHEIL, and HEILBRUNN are especially suitable.

For collateral reasons the prescription of courses of treatment with those sulphurous waters that are known among the laity as 'antisyphilitic' must at times be avoided. Under such circumstances drinking-cures and bathing-cures with the strong Glauber's Salt waters of MARIENBAD and CARLSBAD are suitable on account of their influence in stimulating diuresis and intestinal secretion ; for experience has shown that not only the increased activity of the skin, but also that of the intestine and the kidneys, contributes to the successful treatment of syphilis and aids materially the effects of specific treatment. As an after-cure following vigorous drinking- and bathing-cures by syphilitics, the internal use of iron waters is at times advisable, as well as steel baths and ferruginous peat baths.

In the **United States** thermal sulphurous waters are found at CALISTOGA SPRINGS, EL PASO DE ROBLES HOT SPRINGS, SANTA BARBARA HOT SPRINGS, in California; at GLENWOOD SPRINGS and HOT SULPHUR SPRINGS, in Colorado; and at SALT LAKE HOT SPRINGS, in Utah. The waters of HOT SPRINGS, in Arkansas, are much used externally in the treatment of syphilis. The baths, in conjunction with appropriate medicinal treatment, tend to dispel cachexia and improve vitality, and thus favor the constitutional action of the drugs employed.

CHAPTER II

DISEASES OF THE RESPIRATORY ORGANS

Chronic Rhinopharyngitis, Laryngitis, and Bronchitis. Chronic Emphysema of the Lungs and Bronchial Asthma. Chronic Pulmonary Tuberculosis.

CHRONIC RHINOPHARYNGITIS, LARYNGITIS, AND BRONCHITIS

In the presence of **chronic catarrh of the nasopharyngeal, laryngeal,** and **bronchial mucous membrane** systematic drinking-cures with the alkaline muriated mineral waters of EMS (Salzbrunnen), GLEICHENBERG, and LUHATSCHOWITZ are especially to be advised, if these catarrhal conditions are dependent upon persistently injurious influences—as, for instance, in teachers and singers; or if they occur in delicate individuals of scrofulous or lymphatic tendency, and are characterized by great irritability and scanty secretion from the mucous membrane. A mild and moist climate at the health resort selected exerts a favorable influence upon the cure of such catarrhal conditions. In the same way, in the presence of chronic bronchial catarrh with abundant secretion and **bronchiectasis,** the feebler sodium chlorid waters of SODEN, BADEN-BADEN, CANSTATT, KRONTHAL, and MONDORF are indicated; and in this connection, the favorable climatic conditions contribute materially to the curative results.

In the **United States** suitable waters are the mild saline chalybeate ROCK CASTLE SPRINGS (2000 feet), in Kentucky, and the SUWANEE SULPHUR SPRINGS and WHITE SPRINGS of Florida. The ORANGE SPRING, in Florida, said to be the largest spring in the world, is also useful in the condition under consideration.

In most of the European health resorts, **inhalations** of the respective mineral waters are also practised, and these are especially suitable for those cases in which the secretion of the mucous membrane is viscid and its production is to be increased. The same purpose is fulfilled by inhalations of brine in spray, as is practised at ISCHL, REICHENHALL, and REHME, or by inhalations of the brine vapor that develops in the seething of the brine—as, for instance, at ACHSELMANNSTEIN, KISSINGEN, KOESEN, and MUENSTER.

In cases of **chronic bronchial catarrh** in torpid, scrofulous individuals, as well as in gouty subjects, and in the presence of **laryn-**

geal disorders complicated by syphilis, sulphurous waters, and especially those containing sodium chlorid, such as the springs at WEILBACH, NENNDORF, LANGENBRUECKEN, WIPFELD, and, in the **United States,** SARATOGA and MT. CLEMENS, as well as the thermal sulphurous waters of AACHEN, BADEN in Austria, BADEN in Switzerland, EAUX-BONNES, BUDA-PEST, and MEHADIA may be taken internally. By reason of especially favorable climatic conditions the sulphurous thermal springs of AMÉLIE-LES-BAINS, BARÈGES, BAGNÈRES-DE-LUCHON, CAUTERETS, and SAINT-SAUVEUR, in the Pyrenees, are well suited. In the **United States** ROANOKE RED SULPHUR SPRINGS, in Virginia, an alkaline chalybeate carbonated water, is used in the treatment of chronic bronchial, pulmonary, and throat affections and for hay-fever. RED SULPHUR SPRINGS, in West Virginia, a light saline sulphureted water, is also useful.

At many of the European resorts mentioned there are excellent arrangements for the **inhalation** of hydrogen sulphid gas, a useful expedient in the presence of marked irritability of the mucous membrane of the larynx, the trachea, and the bronchi. Inhalation of the nitrogen escaping from the earthy springs is provided for at the earthy mineral waters of INSELBAD, LIPPSPRINGE, and WEISSENBURG, and is recommended in the presence of a markedly erethistic bronchial mucous membrane, with a tendency to hemoptysis. (See volume on "Inhalation Methods.")

For the **chronic catarrhal conditions of the larynx and bronchi in drunkards, hearty eaters, and gluttons,** in whom circulatory disturbances and stasis in the pulmonary circulation constitute the etiologic factor, the laxative sodium sulphate waters of MARIENBAD, TARASP, and CARLSBAD, exerting a derivative effect upon the intestinal tract, as well as the stronger sodium chlorid waters of KISSINGEN and HOMBURG, are indicated.

For domestic purposes in the treatment of **simple, chronic catarrhal conditions of the pharyngeal mucous membrane** of moderate severity, and of **chronic laryngeal** and **bronchial catarrh,** the alkaline acidulous waters of BILIN, GIESSHUEBL, FACHINGEN, GEILNAU, KRONDORF, MALVERN, and PREBLAU may be recommended as table waters mitigating the tendency to cough, stimulating the secretion of mucus, and facilitating its expulsion. In the United States SARATOGA VICHY SPRING, in New York, LONDONDERRY LITHIA SPRING, in New Hampshire, BETHESDA SPRING and CLYSMIC SPRING, in Wisconsin, CAPON SPRING, in West Virginia, and Sweet Spring, at BEDFORD in Pennsylvania, correspond fairly well with the foregoing waters, but are not used for similar purposes.

At times, in the presence of marked irritative states, the addition of milk or whey to the mineral water is most appropriate.

Lukewarm mineral baths, especially brine baths, supplement the effect of the drinking-cure; the invigoration and stimulation of the skin tending to prevent relapses of the catarrhal condition. After the catarrhal conditions are entirely healed, cold frictions of the skin with brine water, and also with sea-water, may be practised for the purpose of hardening the skin. Sea-bathing, however, is not to be recommended.

CHRONIC EMPHYSEMA OF THE LUNGS AND BRONCHIAL ASTHMA

What has been said with regard to chronic bronchial catarrh is applicable also to the crounotherapy of **chronic pulmonary emphysema,** which is almost invariably accompanied by such catarrh. Under these conditions, the alkaline muriated acidulous waters as well as the alkaline saline mineral waters are to be recommended, preferably at health resorts possessing a favorably high mountainous elevation with stimulating fresh air and extensive pine woods—as, for example, SALZBRUNN, LUHATSCHOWITZ, SZCZAWNICA, MARIENBAD, and TARASP. If, however, a state of marked irritation of the mucous membrane of the respiratory tract is additionally present, drinking-cures at EMS, GLEICHENBERG, BADEN-BADEN, CANSTATT, KRONTHAL, and SODEN, with weaker waters and a milder climate, will be indicated. Also the French **baths** in the Pyrenees, at AMÉLIE-LES-BAINS, EAUX-BONNES, CAUTERETS, and BAGNÈRES-DE-LUCHON, have a special reputation for the relief of the bronchial asthma dependent upon pulmonary emphysema.

In the **United States** the waters of CASTLE CREEK HOT SPRINGS (2300 feet) in Arizona, with a temperature of 45.6° C. (114° F.), and those of MANITOU in Colorado, are suitable in these conditions.

CHRONIC PULMONARY TUBERCULOSIS

The favorable influence that, according to diverse and unequivocal experience, mineral waters exert upon pulmonary tuberculosis, depends upon the fact that these waters, including, in the first place, the alkaline muriated acidulous waters and the mild sodium chlorid waters, are calculated to correct the accompanying catarrh of the respiratory mucous membrane, and, at the same time, to improve digestive activity and nutrition in general. Inasmuch as they thus increase hemogenesis and assimilation, augment the resisting powers of the organism, and, on the other hand, locally diminish the hyperemia of the lungs and improve the catarrhal state, these mineral waters aid in depriving the tubercle bacillus of its appropriate culture-medium and in bringing the tuberculous process to an end. In the choice of a health resort for the carrying out of such drinking-cures, the favorable climatic situation of the place is of great importance.

In this connection the health resorts of BADEN-BADEN, GLEICHENBERG, LUHATSCHOWITZ, KRONTHAL, REICHENHALL, SALZBRUNN, SODEN, CANSTATT, and WEILBECK appear to be advisable for young individuals presenting the suspicious so-called **phthisical habitus**, who suffer frequently from recurring catarrhal conditions of the respiratory organs; further, for developed and even **advanced cases** of pulmonary tuberculosis, with marked infiltration at the apices, and even formation of cavities of moderate size—providing only that fever and hemoptysis are not present. Caution is necessary with regard to the presence of carbon dioxid, and to the temperature of the mineral water. This should be only lukewarm and the carbon dioxid should be in part dispelled by heating or by the addition of warm milk and whey. In suspicious, recurring obstinate cases of bronchial catarrh, in which, however, tubercle bacilli cannot be demonstrated, the waters of EMS also exert a favorable anticatarrhal influence. The same may be said of the thermal sulphurous springs with a favorable climatic situation in the French Pyrenees, among which EAUX-BONNES and MONT-DORE are the principal representatives of the French health resorts for tuberculosis; whereas ST. HONORÉ, ALLEVARD, AMÉLIE-LES BAINS, LE VERNET, and ENGHIEN are recommended for cases of suspicious **catarrh at the apices.** In the presence of pulmonary tuberculosis in delicate, anemic individuals, when the morbid process has become completely stationary, and, in general, in cases of suspicious catarrh at the apices in debilitated young persons, when the improvement of the **general nutrition** is the object of primary importance, drinking-cures with alkaline chalybeate acidulous waters in favorably situated places—as, for instance, in CUDOWA, CHARLOTTENBRUNN, REINERZ, RIPPOLDSAU, PETERSTHAL, and FLINSBERG—render good service.

In the United States no attempt has been made to systematize the use of mineral waters in the treatment of tuberculosis. Many of the springs in the mountains of Pennsylvania, North Carolina, Virginia, Colorado, New Mexico, Utah, or Southern California would, no doubt, be available, but the benefit derived from their use would most likely be attributed to the good influences of the air, the sunlight, and the mode of life, rather than to any special virtue of the waters.

The pure carbonated iron waters are **counterindicated** in cases of pulmonary tuberculosis, because they readily give rise to hyperemia of the lungs and to hemoptysis. Lukewarm baths at a temperature of 35° C. (95° F.) may be recommended to patients suffering from pulmonary tuberculosis, in order to increase the complementary respiration through the skin, which is especially important to them, and to augment the general cutaneous activity. Care is necessary to avoid the bad effects of exposure to cold. On getting out of the bath, the patient should be carefully covered and rapidly dried.

CHAPTER III

DISEASES OF THE HEART AND THE BLOOD-VESSELS

Functional Disorders of the Heart. Valvular Lesions—Arteriosclerosis. Neurotic Disorders of the Heart. Fatty Heart.

FUNCTIONAL AND NEUROTIC DISORDERS OF THE HEART

Functional Disorders of the Heart

Although diseases of the heart were, until within a few decades, considered as a counterindication for all balneotherapeutic measures, at the present day both drinking-cures and bathing-cures are largely recommended for a number of functional cardiac disorders, as well as in the treatment of organic disease of the heart; and the reputation they enjoy is well deserved.

Among the drinking-cures, those with the cold sodium sulphate waters of MARIENBAD, TARASP, ELSTER, and ROHITSCH, as well as the cold sodium chlorid waters of HOMBURG, KISSINGEN, GLEICHENBERG, WOODHALL SPA, HARROGATE, LUHATSCHOWITZ, and SALZBRUNN, exert an especially favorable influence upon the cardiac symptoms of those who eat largely of rich food and suffer from **hypertrophy of the heart.** They are useful, as well, in the **dilated** hypertrophy of the heart dependent upon **chronic pulmonary emphysema,** by relieving blood stasis and facilitating the movement of the circulating fluid, and in this way lessening the labor of the heart; and, on the other hand, by actively stimulating intestinal secretion, and thereby utilizing a portion of the blood collected in abundance. In order to avoid overstimulation of the heart by the carbon dioxid, the cold carbonated mineral waters should be freed from gas as thoroughly as possible by being stirred and permitted to stand before they are drunk. The thermal springs are **counterindicated** because the high temperature increases the action of the heart and causes greater fulness of the arteries.

Valvular Lesions

In the same way as in these functional cardiac disorders, the mineral waters indicated are employed also in the presence of valvular lesions of the heart, providing that serious derangement of compensation or dropsy is not present. They bring about considerable alleviation and improvement in the symptoms of stasis and in the gastro-intestinal catarrh, the hemorrhoidal symptoms, the enlargement of the liver, and abnormalities of menstruation dependent upon the stasis. When the action of the heart is excessively violent, and the blood pressure is extremely high, all carbonated mineral waters should be avoided as beverages, and, under such circumstances, in order to afford symptomatic relief and to overcome rapidly the manifestations of venous stasis in the abdominal viscera, bitter waters, such as those of the Bitterquellen of OFEN, and those of FRIEDRICHSHALL, PULLNA, VICTORIA SPA, and SAIDSCHITZ, may be employed in small but effective doses for a short time. These bitter waters are suitable also for cases in which arteriosclerosis is marked, whereas in the presence of lesser grades, the milder alkaline saline and alkaline muriated waters render good service, inasmuch as they lower the arterial pressure and lessen the work of the heart, by stimulating both intestinal activity and diuresis. Nevertheless, these waters must, so far as possible, be freed from the carbon dioxid.

Neurotic Disorders of the Heart

In cases of cardiac neuroses various forms of drinking-cure are indicated in accordance with the underlying cause: thus, for cardiac symptoms dependent upon the anemia and chlorosis of puberty, the ferruginous waters of FRANZENSBAD, ELSTER, SCHWALBACH, SPA, PYRMONT, CUDOWA, REINERZ, STEBEN, RIPPOLDSAU, HARROGATE, and TUNBRIDGE WELLS; in the cases of tachycardia of the climacteric period, as well as in the cases of cardiac neuroses caused by coprostasis, the laxative sodium sulphate waters of MARIENBAD and TARASP, as well as bitter waters, are indicated. The cardiac palpitation in cases of exophthalmic goiter is often materially relieved by the use of the pure iron waters at health resorts situated at an altitude, such as ST. MORITZ, STEBEN, MARIENBAD, and KOENIGSWART, and, in the United States, the IRON UTE MANITOU SPRING, in Colorado, and the OJO CALIENTE SPRING, in New Mexico.

Baths.—In the presence of various cardiac symptoms and functional disorders of the heart, carbonated baths have recently been recommended, and are employed with great success in the treatment of the enfeebled heart, on account of their stimulating effect and their influence in causing hypertrophy of the myocardium. These favorable effects have been credited especially to the thermal carbonated muriated springs of NAUHEIM, but also to the carbonated steel baths of CUDOWA and the acidulous baths of MARIENBAD. All such carbonated baths, applied in the proper manner and adapted to individual conditions, are capable of bringing about a reduction in the action of the heart and an improvement in the tone of the myocardium, and thereby dissipating the threatening symptoms due to distention of the wall of the ventricle.

Artificially prepared carbonated baths may be employed at home in certain cases of heart disease. (See 'Appendix,' p. 536.)

Baths that exert an excessively irritating effect upon the skin, or of too high or too low a temperature, as well as of very long duration, but especially steam baths, Irish-Roman baths, and electric hot-air baths, are **counterindicated** in the presence of cardiac disorders.

In the United States so-called Nauheim baths may be had at GLEN SPRINGS and SARATOGA, in New York, and at LAKEWOOD, in New Jersey, as well as in most large cities.

Climbing Exercise.—In most health resorts for patients suffering from disease of the heart, there are associated, with the drinking and the bathing, systematic courses of exercise, including walking upon the level and upon moderate grades, on specially prepared paths, in traversing which an invigorating influence is exerted upon the heart. Generally four classes of paths are distinguished, in accordance with their gradients: Horizontal, easily traversed paths over an undulating surface; paths leading to heights of slight elevation; paths of greater inclination, leading to summits of higher altitude; hills, and steep, mountainous paths, difficult of ascent. The dynamic demands of the ascent must be regulated carefully in accordance with the individuality of the patient and the condition of his heart and his respiratory organs. By means of markings with lines, the distances along the paths are divided into parts, each of which can be traversed in a period of a quarter of an hour, as the normal. This form of treatment is employed in the United States at GLEN SPRINGS, in New York; and in a modified form the topography of the patient's place of residence may be utilized. (See volume IV, "Climatotherapy," p. 339.)

FATTY HEART

The **cardiac symptoms of the obese**—the 'heart of hypernutrition' (Kisch)—constitute a frequent and amenable object for courses of treatment with drinking and bathing. If, in an obese person, the cardiac impulse is feeble, the pulse is small, enlargement of the area of cardiac dulness is demonstrable, and thus the suspicion of the presence of the heart of hypernutrition is justified, a systematic drinking-cure with the cold sodium sulphate waters, especially of MARIENBAD, is indicated. These not only prove efficacious in the milder forms, but also are indicated when, in consequence of the deposition of fat upon the heart, serious symptoms have already been produced; even if cardiac asthma and marked symptoms of stasis in the venous system are manifest. In the same class of cases TARASP is likewise suitable, and, in slighter degrees, the use of the cold sodium chlorid waters of KISSINGEN and HOMBURG. In the United States suitable waters are those of SARATOGA SPRINGS, HALLECK SPRING, VERONA SPRINGS, and BALLSTON SPA, in New York; BLUE LICK SPRINGS, in Kentucky; LUBEC SPRING, in Maine; AKESION SPRING, in Missouri. Careful and discriminating medical supervision of the use of these mineral waters is necessary, and for a considerable period. Drastic courses of treatment with active purgatives are to be avoided.

In cases of advanced, fatty degeneration of the myocardium with anasarca due to stasis, hydremic conditions, and loss of strength, these drinking-cures are counterindicated.

For anemic individuals with a fatty heart, the use of the iron waters of FRANZENSBAD, PYRMONT, SCHWALBACH, HARROGATE, TUNBRIDGE WELLS, and others, is to be recommended, especially as after-treatment following the drinking of sodium sulphate waters. In the United States, iron waters serviceable for anemic patients are: SHARON CHALYBEATE SPRING, ADIRONDACK SPRINGS, and OAK ORCHARD SPRINGS, in New York; SPARTA ARTESIAN WELL, in Wisconsin; SCHUYLER COUNTY SPRINGS, in Illinois; TAR SPRING, in Indiana; THORP'S SPRING, in Texas; NAPA SODA SPRINGS, in California; BEDFORD CHALYBEATE SPRING, in Pennsylvania; BEDFORD IRON, ALUM, AND LITHIA SPRING, and MASSANETTA SPRINGS, in Virginia; BERKELEY SPRINGS, in West Virginia.

With the drinking-cure may be associated, for persons with fatty heart, courses of bath-treatment with carbonated or acidulous baths, steel baths, or brine baths, all having in common the effect of causing powerful stimulation of the skin, of increasing the activity of the kidneys, and of augmenting the entire metabolism. Steam baths and electric-light baths, as well as Irish-Roman baths, which materially aid in reducing the amount of fat, are to be taken into consideration only when, in the presence of fatty heart, the myocardium itself is still intact and the vessels have not become sclerotic.

CHAPTER IV

DISEASES OF THE DIGESTIVE ORGANS

Diseases of the Stomach. Diseases of the Liver and the Biliary Passages. Diseases of the Spleen.

DISEASES OF THE STOMACH

Chronic Gastro-intestinal Catarrh

Of mineral waters that are employed in the form of drinking-cures, in the presence of chronic gastro-intestinal catarrh, as well as of the various dyspepsias, the alkaline springs—and both the alkaline acidulous waters and the alkaline saline waters—are of the greatest importance. By reason of the large amount of sodium carbonate they contain, they are capable of neutralizing the excessive amount of acid in the stomach and of inducing renewed and continued secretion of gastric juice. In addition, because of the presence of carbon dioxid and sodium sulphate, they exert a profound influence upon the intestine, its peristalsis, and its secretion. In the mild cases of **dyspepsia and gastric catarrh,** when abnormal production of acid, acid eructation, flatulence, and cardialgia are present, the thermal alkaline waters of VICHY and NEUENAHR, and, in the United States, IDAHO HOT SPRINGS, in Colorado, OJO CALIENTE SPRINGS and HUDSON'S HOT SPRINGS, in New Mexico, and ARROWHEAD HOT SPRINGS, in California; and thermal alkaline muriated waters, as those of EMS, in the German Empire, render especially good service. In the severe cases, when the mucous membrane of the stomach is very sensitive and the nutrition is greatly impaired, with the presence of **disorders of the liver and the kidneys** in association, the thermal saline waters of CARLSBAD are to be preferred to all others.

The cold alkaline saline waters of MARIENBAD, TARASP, ROHITSCH, ELSTER, and FRANZENSBAD are indicated in cases of **chronic gastric catarrh** of long standing, with abnormal production of mucus; atony and torpor of the muscular coat of the stomach; diminished reflex irritability of the mucous membrane; and stasis of the gastric contents; in the presence of chronic gastric catarrh in gourmands and drunkards; and in dyspeptic states resulting from a sedentary mode of life. In the United States the waters of WAUKESHA SPRINGS, in Wisconsin; CAMBRIDGE SPRINGS, in Pennsylvania; HOLLY SPRING, in Rhode Island; ASPINOCK SPRING, in Connecticut; SARATOGA SPRINGS, in New York; TOPEKA MINERAL WELLS and WACONDA, or GREAT SPIRIT, MINERAL SPRINGS, in Kansas; MANITOU SPRING, in Colorado; AZULE MINERAL WELL, in California—meet similar indications.

If **torpor of the intestine and constipation** are associated with these conditions, the waters of MARIENBAD (Kreuzbrunnen) and FRANZENSBAD, and, in the United States, of BEDFORD SPRINGS, in Pennsylvania, exert a good effect. The Salzquelle of Franzensbad is especially suitable for dyspeptic disturbances attended with anemia and chlorosis. The milder thermal sodium chlorid waters of SODEN, CANSTATT, BADEN-BADEN, and WIESBADEN, as well as the cold waters of similar character at HOMBURG, KISSINGEN, and WOODHALL SPA, have indications similar to those of the alkaline saline waters, and are suited for debilitated, emaciated, scrofulous individuals with gastric catarrh. In the United States suitable waters include CLARENDON SPRINGS and ALBURGH SPRINGS, in Vermont, and GLENWOOD SPRINGS, in Colorado.

In cases of **chronic ulcer of the stomach** the waters of CARLSBAD, given in small amounts, particularly the less warm springs,—namely, Schlossbrunnen, Theresienbrunnen, Marktbrunnen,—enjoy the highest reputation. The Kreuzbrunnen and the Waldquelle of MARIENBAD may be taken warmed.

In selecting a **health resort** for patients suffering from disease of the stomach, it is advisable to recommend the tentative use, for a few days at home, of the mineral water that is under consideration, in order to determine whether or not it is well borne. In cases of chronic gastric catarrh only small amounts of the mineral water are to be taken, and always distributed over several periods in the course of the day. At the beginning of the course of treatment the cold mineral waters should be warmed before being drunk. For domestic use, in cases presenting mild dyspeptic symptoms, the alkaline acidulous table waters of BILIN, GIESSHUEBL, FACHINGEN, and PREBLAU are suited. American alkaline acidulous waters include those of BLADON SPRINGS in Alabama, GEYSER SPA in California, and MANITOU SODA SPRING in Colorado.

The crounotherapeutic indications for **chronic intestinal catarrh** coincide with those for chronic gastric catarrh. If this is associated with **atony of the bowel, with habitual constipation,** and with **hemorrhoidal disturbances** in consequence of unsuitable food, a sedentary mode of life, or stasis in the portal area, the strong cold sodium sulphate and sodium chlorid springs are indicated—

namely, the Ferdinandsbrunnen of MARIENBAD, the Luciusquelle of TARASP, the Salzquelle of ELSTER and that of FRANZENSBAD, the Rakoczyquelle of KISSINGEN, and the Elisabethbrunnen of HOMBURG. In the **United States** similar waters are CRAB ORCHARD SPRINGS, in Kentucky; GLEN SPRINGS, in South Carolina; SPRING LAKEWELL, in Michigan; MANITOU SODA SPRINGS, SPRINGDALE SELTZER SPRING, and Vichy, Pagosa, and Iron Duke Springs, at CAÑON CITY, in Colorado.

Obese, well-nourished individuals suffering from **habitual constipation** and the symptoms of **chronic gastro-intestinal catarrh,** with hemorrhoids or well-marked enlargement of the hemorrhoidal veins, constitute the principal contingent for the drinking-cures at MARIENBAD.

For emaciated, enfeebled individuals, especially if the intestinal catarrh is associated with **chronic diarrhea,** the thermal sodium sulphate and sodium chlorid waters at CARLSBAD, EMS, VICHY, NEUENAHR, WIESBADEN, and BADEN-BADEN are indicated. Of the springs at Carlsbad, the Sprudel, drunk in small quantities, acts favorably upon the diarrhea resulting from chronic intestinal catarrh or following dietetic error, as well as upon the diarrhea caused by excessively increased or qualitatively altered secretion of bile. In the **United States** similar waters are found at GEYSER SPA and HARBIN HOT SPRINGS in California; MANITOU SPRINGS, ROYAL GORGE HOT SPRINGS, LIBERTY HOT SPRINGS, and GLENWOOD SPRINGS in Colorado; UTAH HOT SPRINGS in Utah.

For the **diarrhea of anemic and feeble children,** the sulphated iron waters of ALEXISBAD, MUSKAU, PARAD, RONCEGNO, LEVICO, or Guberquelle, at SREBERNIK, are often effective. In the **British Isles** sulphated iron springs are BRIGHTON, GILSLAND SPA, HARTFELL SPA, in Scotland; TREFRIW, in Wales. In the **United States**: OAK ORCHARD SPRINGS and SHARON SPRINGS, in New York; KITTANING MINERAL SPRING, in Pennsylvania; BEDFORD ALUM SPRING, CHURCH HILL ALUM SPRINGS, and FAUQUIER WHITE SULPHUR SPRINGS, in Virginia.

For the **chronic diarrhea of scrofulous** as well as of **rachitic individuals,** the earthy waters containing lime-salts, as well as earthy iron waters, are recommended; as, for example, the waters of WILDUNGEN, LIPPSPRINGE, LIEBWERDE, REINERZ, DRIBURG, BOCKLET, and the Rudolfsquelle of MARIENBAD; but these mineral waters can be drunk only in small quantities and for but a short time, on account of the disturbance of digestion they cause. In the **United States** waters corresponding to those just mentioned are: RICHFIELD MAGNESIA

SPRINGS, CHERRY VALLEY SPRINGS, CHITTENANGO SPRINGS, and CLIFTON SPRINGS, in New York; CAPON SPRINGS and WHITE SULPHUR SPRINGS, in West Virginia; WAUKESHA SPRINGS, in Wisconsin; CATOOSA SPRINGS, in Georgia; TATE EPSOM SPRING and MONTVALE SPRINGS, in Tennessee; ST. LOUIS, OWASSO, and BUTTERWORTH'S SPRINGS, in Michigan; CHALYBEATE SPRINGS, in Kentucky; NEWBURY SPRINGS, in Orange County, Vermont; MANITOU SPRINGS, in Colorado; MINERAL PARK BITTER SPRING, in Arizona.

Baths often supplement the drinking-cure in cases of chronic disease of the gastro-intestinal tract. As a rule, moderately warm acidulous, brine, steel, and peat baths are indicated. For highly irritable persons with **cardialgia** and **enteralgia,** the acratothermal waters of BATH, SCHLANGENBAD, GASTEIN, JOHANNISBAD, and TUEFFER render good service as after-cures following the drinking-cures. In the **United States,** HOT SPRINGS and WARM SPRINGS, in Virginia; HOT SPRINGS, in South Dakota; and the baths at LAKEWOOD, in New Jersey, are indicated. In the presence of great **sensitiveness of the gastric nerves,** severe **cardialgic attacks,** and also **chronic gastric ulcer,** if hemorrhage has not occurred, the application of hot peat poultices in the gastric region is to be recommended.

DISEASES OF THE LIVER AND THE BILIARY PASSAGES

Chronic hyperemia of the liver as a symptom of stasis in the portal circulation resulting from overfeeding, from a sedentary mode of life, or from habitual constipation, as well as the form induced by disease of the heart, the lungs, the spleen, or the uterus, is frequently subjected to mineral-spring treatment. If the condition occurs in vigorous persons with good powers of resistance, and if the liver is found to be large, hypostatic, and tender on pressure, drinking-cures at CARLSBAD, MARIENBAD, KISSINGEN, and HOMBURG are indicated; for flabby, anemic, scrofulous individuals, drinking-cures at FRANZENSBAD, ELSTER, SODEN, EMS, and GLEICHENBERG are suitable. Among American waters suitable for the first group of cases are: BEDFORD SPRINGS, in Pennsylvania; BALLSTON SPA and SARATOGA SPRINGS, in New York; GREENBRIER WHITE SULPHUR SPRINGS, in West Virginia; CRAB ORCHARD SPRINGS (Epsom Spring), in Kentucky; AMERICAN CARLSBAD SPRINGS, in Illinois; BYRON SPRINGS, GORDON SPRINGS, and CORONADO SPRINGS, in California; CAÑON CITY MINERAL SPRINGS and SPRINGDALE SELTZER SPRINGS, in Colorado. For anemic and scrofulous individuals the waters of SHARON SPRINGS (Chalybeate Spring), in New York; CRESSON SPRINGS (Iron

Spring), in Pennsylvania; SWEET CHALYBEATE SPRINGS and HEALING SPRINGS, in Virginia; GEYSER SPA and HARBIN HOT SPRINGS, in California; MANITOU SPRINGS and ROYAL GORGE HOT SPRINGS, in Colorado; and CASTLE CREEK HOT SPRINGS, in Arizona, may be employed. The springs of the first-named group—sodium sulphate and sodium chlorid waters—are indicated also in cases **of fatty liver** as a symptom of general obesity. In the presence of marked general **obesity,** and in combination with **arthritis,** MARIENBAD or, in the United States, the HOT SPRINGS of Virginia, LAS VEGAS HOT SPRINGS in New Mexico, or the HOT SPRINGS of South Dakota are appropriate. When there is a tendency to **diarrhea,** the alkaline thermal waters of CARLSBAD and EMS may be used with advantage. For **scrofulous individuals,** HOMBURG, KISSINGEN, and WIESBADEN are of benefit. In the presence of marked **anemia,** FRANZENSBAD and ELSTER are to be preferred.

Catarrhal jaundice, if it has not caused profound alterations and has existed for but a short time, often yields to the domestic employment of the alkaline acidulous waters of BILIN, FACHINGEN, SELTERS, and GLEICHENBERG. If, however, the jaundice has persisted for some time and the liver is considerably enlarged, drinking-cures at CARLSBAD, EMS, and VICHY, with the thermal waters of these places, are indicated, especially if the jaundice is attended with irritation of the lower portions of the intestinal tract, and diarrhea is accordingly present.

Appropriate waters in the United States are those of BEDFORD (Magnesia) SPRINGS, in Pennsylvania; SARATOGA (Vichy) SPRINGS, in New York; GREENBRIER WHITE SULPHUR SPRINGS and IRONDALE SPRINGS, in West Virginia; BEDFORD ALUM, IRON, AND LITHIA SPRINGS, ROCKBRIDGE ALUM SPRINGS, and BATH ALUM SPRINGS, in Virginia; BLADON SPRINGS, in Alabama.

For full-blooded, strong, easily excitable individuals with jaundice; or when **coprostasis** is present, the cold waters of MARIENBAD, KISSINGEN, HOMBURG, and, in the United States, SARATOGA, are to be preferred.

The same differential indication is applicable in cases of **gall-stones,** in which, as Frerichs had previously pointed out, complete courses of treatment at CARLSBAD, MARIENBAD, VICHY, and EMS have proved the most effective remedy. This opinion remains completely sound at the present day, in spite of current operative tendencies. These mineral waters may be used at the patient's home, or may be more effectively drunk at their source, for from four to six weeks. A considerable number of gall-stones often are expelled as an immediate result. In order to prevent the formation of further concretions, the course of treatment is repeated, annually or at shorter intervals, for two or three years or longer. Even after operative intervention for gall-stones such a course of treatment should certainly be undertaken. At CARLSBAD the patient first drinks the cooler waters, gradually, in the course of two weeks, reaching the Sprudel. At MARIENBAD the course is begun with heated Kreuzbrunnen, and subsequently the waters of the Ferdinandsbrunnen are drunk. At VICHY the waters of the Grande Grille and Source de L'Hôpital are drunk; at EMS the waters of Kesselbrunnen and Kraehnchen. During the winter, patients with gall-stones should drink regularly the waters of BILIN, FACHINGEN, PREBLAU, and SALVATOR; these acidulous waters contain sodium carbonate and carbon dioxid. Regular action on the part of the bowels should be secured by the administration of a bitter water.

In the presence of **cirrhosis of the liver,** good results following the internal administration of the sodium chlorid waters containing iodin and bromin at HALL, KREUZNACH, and KRANKENHEIL are doubtful. In **amyloid degeneration of the liver** quite as little is to be expected from the alkaline thermal waters of EMS and NEUENAHR; these waters and their American analogues (see pp. 419, 421, and 422) may, nevertheless, be tried.

Warm baths of any kind act as adjuvants to the drinking-cure in **all forms** of disease of the liver. In the presence of considerable **enlargement of the liver,** as well as of **cholelithiasis** and obstinate **catarrhal jaundice,** warm peat cataplasms are useful. (See p. 404.)

CHRONIC ENLARGEMENT OF THE SPLEEN

The chronic enlargement of the spleen that remains after **malarial fever,** as well as the hypostatic enlargement of the spleen dependent upon **circulatory disturbance** or **digestive disorders,** and the like, responds favorably to drinking-cures with the sodium sulphate waters of CARLSBAD, MARIENBAD, TARASP, and ROHITSCH, in connection with which an after-cure with pure ferruginous waters is necessary, in order to improve the disturbed hemogenesis. As the most efficient adjuvant to bring about reduction in the size of existing enlargement of the spleen, and to improve the anemic and the leukemic state of the blood, the use of the peat baths containing the greatest quantity of iron sulphate at MARIENBAD, FRANZENSBAD, ELSTER, MEINBERG, and MUSKAU is highly to be recommended. If the enlargement of the spleen is one of the manifestations of a constitutional disorder, such as **syphilis** or **mercurial cachexia,** the sulphurous waters, especially of AACHEN and BADEN in Austria, and the iodin waters, as, for instance, those at HALL, KREUZNACH, KRANKENHEIL, and LIPPIK, are indicated; brine baths and sulphurous baths being employed in addition. The enlargement of the spleen that occurs in **scrofulous** and **rachitic** individuals is favorably influenced by drinking-cures at KISSINGEN, HOMBURG, NAUHEIM, KREUZNACH, BADEN-BADEN, and WIESBADEN; and by the employment of the baths provided at these resorts. Among suitable resorts and waters in the United States are those of SARATOGA, SHARON, RICHFIELD, and GLEN SPRINGS in New York; ROANOKE RED SULPHUR SPRINGS in Virginia; PARKERSBURG MINERAL WELL in West Virginia; YPSILANTI and MT. CLEMENS in Michigan; CALISTOGA HOT SPRINGS and CORONADO SPRINGS in California; Tampa Spring at GLENWOOD, Colorado; and LOWER BLUE LICK SPRINGS in Kentucky.

CHAPTER V

DISEASES OF THE NERVOUS SYSTEM

Diseases of the Brain. Paralysis. Diseases of the Spinal Cord; Peripheral Neuroses.

DISEASES OF THE BRAIN

Chronic hyperemia of the brain frequently constitutes the indication for depletion of the cerebral vessels by derivation, through the intestine and the skin, in order thereby to avert the dangers of cerebral hemorrhage. In the absence of urgent symptoms this indication will be met by drinking-cures with the laxative cold sodium sulphate and sodium chlorid waters. Of the former, those of MARIENBAD and ROHITSCH are suitable, while TARASP, on account of its high altitude, is to be avoided in such cases. Of the sodium chlorid waters, those of HOMBURG and KISSINGEN may be chosen. Employed systematically for a considerable period of time they constitute an admirable prophylactic against cerebral hemorrhage in plethoric, obese individuals. In the United States the waters of SARATOGA, OAK ORCHARD ACID SPRINGS, and BALLSTON, in New York; TOPEKA MINERAL WELLS, in Kansas; CRAB ORCHARD and BLUE LICK SPRINGS, in Kentucky; Magnesia Spring, at BEDFORD in Pennsylvania—may be used with advantage.

The thermal waters, on the contrary, are **counterindicated** in those cases of cerebral hyperemia that exhibit a tendency to **apoplexy.** Warm, full **baths,** especially mineral baths rich in carbon dioxid, peat baths, and, as a matter of course, in still greater degree, steam baths, Irish-Roman baths, and electric light baths are to be avoided in the presence of cerebral hyperemia. When a rapidly derivative effect is desired, as when threatening symptoms of cerebral hyperemia arise, the most active bitter waters, such as HUNYADI JÁNOS, are indicated, because they act promptly upon the intestines, even when given in small doses.

Recent **cerebral hemorrhage,** and the resulting **palsy,** do not constitute an indication for drinking- and bathing-cures with mineral waters. Only after the lapse of from three to six months, and in cases in which the irritative apoplectic symptoms have been or are in process of involution, are balneotherapeutic measures applicable.

In cases of stationary apoplectic paralysis baths of acratothermal waters, such as those of TOEPLITZ-SCHOENAU, GASTEIN, RAGATZ, and WILDBAD, are suitable, and possess a long-established reputation; so, too, the waters of WARMBRUNN, PLOMBIÈRES, and TOEPLITZ-KRAPINA may be employed advantageously. In highly irritable individuals the less hot acratothermal baths of BADENWEILER, JOHANNISBAD, LANDECK, LIEBENZELL, SCHLANGENBAD, and NEUHAUS are to be recommended.

The thermal sodium chlorid waters of BADEN-BADEN, WIESBADEN, BALARUC, BOURBONNE, and LAMOTTE also may be found useful. When the apoplexy is not of recent date and the paralytic symptoms prove resistant to the influence of the acratothermal waters and thermal sodium chlorid baths, the thermal brine baths rich in carbon dioxid at NAUHEIM, REHME, and KISSINGEN, or the ferruginous peat baths of FRANZENSBAD, MARIENBAD, and ELSTER, as well as the sulphurous mud-baths at PISTYAN and WARASDIN-TOEPLITZ, may be employed; the latter tend especially to correct the flaccidity and contracture of the muscles and tendons. The sulphurous thermal waters at AACHEN, BADEN in Austria, TOEPLITZ-TRENCSIN, and MEHADIA, and, in the United States, at RICHFIELD SPRINGS and SHARON SPRINGS, in New York, the Potash Sulphur Spring and Gillen's White Sulphur Spring, near ARKANSAS HOT SPRINGS, are to be preferred in the treatment of a paralysis of which **syphilis** must be assumed to be the cause.

In all these morbid conditions, in which the existing cerebral hyperemia should be taken into consideration, the bathing should be begun carefully, with water at moderate degrees of temperature, as well as with half-baths; cold affusions being applied to the head during the bath. Hot douches to the head are to be avoided. The baths should not be taken daily. When, in the course of the bath treatment in apoplectic patients, headache, vertigo, muscular twitching, or contractures occur, indicating increased irritation of the morbid process in the brain, the bathing should be intermitted at once. Carbonated steel baths, steam baths, and sea-baths are **counterindicated** in cases presenting apoplectic paralysis.

Paralysis

In **paralysis after exhausting diseases**, such as **typhoid fever**, the **acute exanthemata, puerperal processes**, and **diphtheria**, drinking-cures and bathing-cures with iron waters render good service in improving the general nutrition, and thereby relieving the paralysis. Especially such chalybeate spas should be selected as are situated at **high** altitudes among mountains, such as ST. MORITZ, STEBEN, MARIENBAD, RIPPOLDSAU, REINERZ, TATRA-FUERED, GRIESBACH, ANTOGAST, and FLINSBERG. In these, as in other well-known health resorts with iron waters, steel baths should be taken, or brine baths containing a considerable quantity of carbon dioxid, such as are to be had at Rehme, Nauheim, or Kissingen; or the ferruginous peat baths at Franzensbad, Elster, Marienbad, Parad, Muskau, or Cudowa, repeatedly mentioned, are prescribed. In the United States suitable brine baths are found at Byron Springs, in California, and Salt Lake Hot Springs, in Utah; steel baths may be had at Sweet Chalybeate Springs, in Virginia; Geyser Spa, in California; Sparta Mineral Wells, in Wisconsin. Arrowhead Hot Springs, California, enjoys some repute on account of its mud-bath. On the other hand, sea-bathing is **counterindicated** in the presence of such forms of paralysis because the organism in general possesses too little reactive power after severe disease processes.

In the presence of **hysteric paralysis** steel baths, ferruginous peat baths, and strong brine baths are useful. Carbonated gas-baths likewise exert a powerful stimulating influence upon the peripheral nerves and an active alterative effect upon the entire nervous system, especially upon the genitalia. They may be employed in the form of full gas-baths, and, in addition, local gas douches may be applied to the paralyzed members. These dry carbonated gas-baths can be taken at Franzensbad, Marienbad, Pyrmont, Nauheim, Homburg, and Cudowa, and, in the United States, at Glen Springs, in New York, Lakewood, in New Jersey, and St. Augustine, in Florida. When the subjects of hysteric paralysis exhibit considerable **reflex irritability and hyperesthesia,** the favorably situated acratothermal waters of Gastein, Schlangenbad, Johannisbad, Tobelbad, and Neuhaus; Bath, in England; and, in the United States, Arkansas Hot Springs; Healing Springs, Virginia; Santa Barbara Hot Springs, California; and Las Vegas Hot Springs, New Mexico, should be employed.

In cases of **traumatic paralysis** the acratothermal waters of high temperature, such as those of Toeplitz-Schoenau, Gastein, Ragatz, Warmbrunn, and the peat baths and mud-baths, as well as the thermal brine baths, render admirable service. In such cases the baths should be taken at as high a temperature as can be borne,—from 36° to 40° C. (96.8° to 104° F.),—and be combined with strong hot douches for a considerable length of time—from thirty to forty-five minutes. They should be followed by rest in bed for at least one hour. **Reflex paralysis** and **rheumatic, arthritic,** and **syphilitic paralyses** require the drinking- and bathing-cures suitable for the underlying diseases.

DISEASES OF THE SPINAL CORD; PERIPHERAL NEUROSES

Diseases of the Spinal Cord

By means of **baths**, which play the most important part in the treatment of diseases of the spinal cord with mineral waters, it is possible to exert a reflex influence upon the cord, and thereby, to a certain degree, to improve its circulatory and nutritive conditions. In cases of **functional disturbances of the spinal cord**, as **spinal irritation**, or **spinal weakness**, or **slight spinal commotion**, the **baths** at the acratothermal springs, at the gaseous thermal brine springs, and at the carbonated steel springs, are to be employed, in accordance with the individuality of the patient, in the manner that has been described when speaking of the various forms of paralysis: Thus, for irritable, debilitated individuals the acratothermal waters at a favorable altitude—GASTEIN, JOHANNISBAD, BADENWEILER, LANDECK, SCHLANGENBAD, LIEBENZELL, and WILDBAD; for torpid individuals the warmer springs of TOEPLITZ, RAGATZ, and WARMBRUNN, and the thermal brine springs of NAUHEIM, REHME, and KISSINGEN, as well as of WIESBADEN and BADEN-BADEN; for anemic individuals the steel baths of SCHWALBACH, PYRMONT, DRIBURG, and SPA. (For American waters corresponding to the foregoing see page 443.) In **chronic inflammation of the spinal meninges**, especially with fluid effusions, in addition to the baths named, the ferruginous peat baths—MARIENBAD, FRANZENSBAD, CUDOWA, ELSTER, and MUSKAU—are to be recommended to stimulate absorption. The same measures are applicable in the treatment of the **chronic structural lesions** of the spinal cord itself, although success can be hoped for from peat baths, acratothermal baths, thermal brine baths, and steel baths only in the early stages and in mild cases. If **syphilis** is believed to be the cause of a given case of **tabes**, the sulphurous thermal waters are those most recommended; for the **myelitis** dependent upon spondylarthroses or deforming or gouty arthritis of the vertebral articulations the thermal brine waters are appropriate.

The **technic** of the baths must be carefully regulated and supervised, in the treatment of diseases of the spinal cord. The tempera-ture of the baths should not be too high—preferably [1]
32° C. (84° to 90° F.). The bath should not be
tion, and should not be taken daily, but at inte
measures should be avoided, in order to preven
hyperemia of the spinal cord.

For **drinking-cures** the milder sodium
sodium chlorid waters that have been
hyperemia should be employed, in order,

hyperemia, to secure a derivative effect through the intestinal tract. Further, alkaline hydrochloric acidulous waters, to correct the dyspeptic disorders so often present, and saline ferruginous acidulous waters, to improve the general nutrition, may be utilized.

Peripheral Neuroses

Balneotherapy is employed for the relief of **peripheral neuroses**; **neuralgias**; and **hyperesthesia** in accordance with the same indications as those mentioned in the treatment of cerebral and spinal diseases. The mountainous acratothermal waters at not too high an altitude, as at SCHLANGENBAD, LANDECK, TUFFER, LIEBENZELL, TOBELBAD, WILDBAD, and, in the United States, LEBANON SPRINGS, in New York, and WARM SPRINGS, in Georgia, as well as the thermal calcium baths of LIPPSSPRINGE and INSELBAD, exert a sedative and antispasmodic effect. For the **neuroses** induced by trauma or by rheumatism, arthritis, malaria, scrofulosis, and syphilis; for the **neuralgia** accompanying chloranemia, gastric disorders, and uterine disorders, the underlying disease must furnish the indication for the employment of the various baths and drinking-cures. In the United States the waters of HOT SPRINGS, in Virginia, LAS VEGAS HOT SPRINGS, in New Mexico, TATE SPRINGS (cold), in Tennessee, HOT SPRINGS, in Arkansas, and HOT SPRINGS, in South Dakota, are employed in the conditions under consideration. It should be pointed out that recently the favorable influence of drinking-cures with alkaline saline mineral waters upon **trigeminal neuralgia, hemicrania,** and **sciatica** of long standing, dependent upon habitual constipation, has been extolled. For the relief of obstinate **sciatica,** peat baths, hot acratothermal baths, sulphurous thermal baths, and sulphurous mud-baths are most to be recommended; Russian steam baths and hot sand baths are also useful. **Hypochondriasis, hysteria, chorea,** and **epilepsy** may be subjected to balneotherapy with various forms of mineral waters in accordance with the underlying disease, or with the most prominent symptomatic manifestations.

CHAPTER VI

DISEASES OF THE URINARY ORGANS

Diseases of the Urinary Bladder. Diseases of the Kidneys. Urinary Concretions.

DISEASES OF THE URINARY BLADDER

In **chronic catarrhal states of the urinary bladder,** as well as of the **pelvis of the kidney,** drinking-cures with the alkaline mineral waters are serviceable in several ways: By abundant and long-continued drinking of these waters, in consequence of the entrance of sodium carbonate into the blood, the reaction of the urine is rendered neutral or alkaline, the irritation of the acid urine is lessened, the mucus is liquefied, and the diseased mucous membrane is favorably influenced. In the presence of chronic catarrhal states of the bladder and the pelvis of the kidney following **blennorrhea of the urethra,** and in catarrh of the bladder in elderly persons, as well as in catarrhal irritation resulting from the presence of **urinary calculi,** drinking-cures with the alkaline thermal waters of VICHY and NEUENAHR, with the alkaline saline thermal waters of CARLSBAD; and, in the United States, HOT SPRINGS, Virginia; GEYSER SPA, California; and MANITOU SPRINGS, Colorado, are useful. The alkaline muriated springs of EMS, SALZBRUNN, GLEICHENBERG; and, in the United States, SARATOGA (Vichy Spring), New York; GLEN ALPINE MINERAL SPRINGS, California; PLYMOUTH ROCK MINERAL WELL, Michigan, also render good service. The vesical catarrh occurring in hearty eaters and drinkers from the ingestion of an excess of irritating food and drink, or dependent upon stasis and circulatory disorders,—so-called **vesical hemorrhoids,**—is an indication for the use of the sodium sulphate waters of CARLSBAD and MARIENBAD, and, in the United States, of CRAB ORCHARD SPRINGS, HARRODSBURG SPRINGS, and LOUISVILLE ARTESIAN WELL, in Kentucky; PAGOSA HOT SPRINGS, in Colorado; ALBURGH SPRINGS, in Vermont; GLEN SPRINGS, in South Carolina; CASTLE CREEK HOT SPRINGS, in Arizona. The **sodium** chlorid springs of ELSTER and FRANZENSBAD, or the **sodium** chlorid waters of HOMBURG, KISSINGEN, LUHATSCHOWITZ, WIESBADEN, and BADEN-BADEN, also may be employed with advanta Of similar utility are, in the United States, the waters of SARAT

SPRINGS, WASHINGTON LITHIA WELL (the old BALLSTON CONDE DENTONEAN SPRING), and HALLECK SPRINGS, in New York; BLUE LICK SPRING, in Kentucky; BYRON SPRINGS, in California; and the saline springs of Michigan and Wisconsin.

In chronic catarrhal states of the bladder and the pelvis of the kidney, when the secretion of mucus is profuse; in **chronic gonorrhea**; in severe **neuralgia** of the neck of the bladder and the urethra, and in **hemorrhages** and **weakness** of the bladder, the earthy waters containing carbon dioxid in considerable amount are especially indicated, particularly the Helenenquelle at WILDUNGEN, the Rudolfsquelle at MARIENBAD, the Hesterquelle at DRIBURG, the Source Pavillon at CONTREXÉVILLE; and, in the United States, the RICHFIELD Magnesia Spring and CHITTENANGO Cave Spring, in New York; EASTMAN SPRINGS, EATON RAPIDS WELLS, and LESLIE MAGNETIC WELLS, in Michigan; CAPON SPRINGS, OLD SWEET SPRINGS, and BERKELEY SPRINGS, in West Virginia; OTTERBURN LITHIA AND MAGNESIA SPRING, OSCEOLA SPRING, and ROCKBRIDGE ALUM SPRINGS, in Virginia; TATE SPRINGS, in Tennessee; WARM SPRINGS and CATOOSA SPRINGS, in Georgia; NAPA SODA SPRINGS (Iron Spring), in California. All the American springs mentioned are earthy waters containing carbon dioxid, except those of Virginia, Tennessee, and Georgia. The last are, however, suitable for the affections indicated.

For anemic women with vesical catarrh as a result of **disease of the uterovaginal mucous membrane**, the calcic ferruginous acidulous waters of KRYNICA, FRANZENSBAD, ELSTER, BORSZEK, ELOEPATAK, and RECOARO, are to be recommended. In the United States suitable waters are the ROCKBRIDGE ALUM SPRINGS, WALLAWHATOOLA ALUM SPRINGS, SWEET CHALYBEATE SPRINGS, and BATH ALUM SPRING, in Virginia; HARRODSBURG SPRINGS, ESTILL SPRINGS, and CRAB ORCHARD SPRINGS, in Kentucky; TEXAS SOUR SPRINGS, in Texas. For long-continued domestic use in **chronic catarrhal conditions of the uropoietic tract** the pure alkaline acidulous waters of VALS, BILIN, PREBLAU, FACHINGEN, the Salvatorquelle near EPERIES, GEILNAU, GIESSHUEBEL, and KRONDORF are useful, preferably taken when the stomach is empty.

DISEASES OF THE KIDNEYS

When symptoms of **chronic passive stasis** in the kidneys manifest themselves, such as occur as the result of heart disease, pulmonary emphysema, general obesity, and in drunkards, carefully conducted and supervised drinking-cures at CARLSBAD, MARIENBAD, ROHITSCH, EMS, GLEICHENBERG, SODEN, and WIESBADEN, render good service;

these alkaline mineral waters acting upon the disordered lesser circulation and, for the time at least, influencing favorably the renal symptoms.

In the treatment of marked **chronic nephritis**, the waters just named often likewise act favorably upon the symptoms; particularly as they improve the deranged digestion and the abnormal assimilative conditions of the blood. For these reasons CARLSBAD and MARIENBAD especially are recommended when **albuminuria** is present. Drinking-cures with pure carbonated iron waters and with sulphurous iron waters at home, as well as at the respective resorts, are advisable also as an after-cure, in order to check hemolysis. If, however, the quantity of albumin in the urine is large; if the patient is considerably debilitated; if nephritic asthma is frequent; and if the development of anasarca is rapid, the systematic employment of mineral waters would be injurious and would hasten the process of dissolution.

In disease of the uropoietic system **warm baths** of every kind exert an important sedative and anodyne influence, especially when of prolonged duration. In the presence of great **irritability** of the **vesical mucous membrane** with **dysuria** and **ischuria**, bathing-cures at the acratothermal springs are useful. In cases of **chronic nephritis** warm baths at temperatures of from 38° to 43° C. (100.4° to 109.4° F.) may be given at the patient's home. After the bath, the patient should be wrapped in woolen blankets.

URINARY CONCRETIONS

In the treatment of **uric acid sediment** and **concretions in the kidneys and the bladder**, drinking-cures with alkaline mineral waters are of great utility. The benefit derived from their use is not to be attributed to any solvent effect upon the calculi, as was formerly assumed, though by no means demonstrable, but is due chiefly to the diuretic effect exerted by the constituents of these mineral waters,—the carbon dioxid, the sodium carbonate, the sodium sulphate, and the sodium chlorid,—resulting in a mechanical washing out from the tissues, and especially from the **uriniferous tubules**, of the urinary sediment, and facilitating the expulsion of the more, the alkalis influence favorably the underlying itself. Finally, they relieve the annoying sympt region of the kidneys and of the bladder, the and the vesical tenesmus. Among excellent cures in the treatment of uric acid calculi thermal alkaline springs of VICHY an

ENAHR, especially when severe pains are present. In the United States similar waters are: HARBIN HOT SPRINGS, in California, and MANITOU SPRINGS, in Colorado; CASTLE CREEK HOT SPRINGS, in Arizona. When abdominal stasis is associated with **arthritis**, the cold sodium sulphate waters of MARIENBAD are to be preferred. In cases of uric acid sediment in which the deposit is less abundant the waters of EMS, SALZBRUNN, and GLEICHENBERG; in the United States ÆTNA SPRING, California; PLYMOUTH ROCK MINERAL WELL, Michigan; SARATOGA SPRINGS (Vichy), New York, are useful. When, in addition to uric acid concretions, an excessive secretion of mucus takes place in the urinary passages, the earthy waters of WILDUNGEN are highly to be recommended. A few of the more important American earthy waters are BEDFORD SPRINGS (Magnesia Spring), and BEDFORD CHALYBEATE SPRING, in Pennsylvania; CHERRY VALLEY SPRINGS and CHITTENANGO SULPHUR SPRINGS, in New York; BUTTERWORTH'S MINERAL SPRING, in Michigan (see p. 449). The waters just mentioned and the others belonging to the group of alkaline springs are suitable also in cases of **uric acid lithiasis.** Even in the presence of vesical calculi of large size that render operative intervention necessary, they are useful, both as a preliminary measure before the institution of surgical treatment, and as an after-cure, to wash away the remaining sediment and to neutralize the uric acid diathesis in general. The dose is regulated in accordance with the conditions present in the individual case. When the calculus is made up of uric acid, sufficient of the alkaline mineral waters is taken—preferably in small amounts several times in the course of the day: the first dose when the stomach is empty—to render alkaline the reaction of the urine, without impairing digestion or inducing diarrhea. At the end of the treatment, the mild alkaline table-waters, preferably such as contain considerable amounts of lithium, may be drunk at home for months. In this connection especially the Bonifaciusquelle of SALZSCHLIRF, the water of ASSMANNSHAUSEN, the Sauerbrunnen of RADEIN, the Salvatorquelle of EPERJES, the Kaiser Friedrichsquelle of OFFENBACH-ON-THE-MAIN, the Oberbrunnen and the Kronenquelle of SALZBRUNN, the Sauerbrunnen of BILIN, and the sodium lithium springs of WEILBACH are to be recommended for domestic use.

In the United States suitable waters are the LONDONDERRY LITHIA SPRINGS, of New Hampshire; BALLARDVALE LITHIA SPRING, of Massachusetts; BEDFORD IRON, ALUM, AND LITHIA SPRINGS, and BUFFALO LITHIA SPRINGS, of Virginia; BOWDEN LITHIA SPRINGS, of Georgia.

When **urinary calculi** consisting of **calcium phosphate** and **calcium carbonate** exist, the abundant use of mineral waters containing a large amount of carbon dioxid, but little sodium chlorid, is indicated, whereas the earthy springs are strictly **counterindicated.** Alkaline-saline and sodium chlorid waters also exert rather a deleterious than a beneficial effect. The pure carbonated acidulous waters, on the other hand, may, owing to the presence of carbon dioxid, increase the acidity of the urine, and thus limit the growth of **calcium calculi** by the deposition of lime-salts, and possibly constitute a solvent also for small **phosphatic calculi.** Under such circumstances, therefore, the simple acidulous waters of SELTERS, KOENIGSWART, APOLLINARIS SPRINGS, HEPPINGERBRUNNEN, LANDSKRONER, SINNBERGER, and WERNATZERBRUNNEN; in the United States the waters of GEYSER SPA, in California, and MANITOU Soda Spring, in Colorado, may be recommended for drinking purposes. For **oxalate calculi** both the simple and the alkaline acidulous carbonated waters may be employed in large quantities for drinking purposes, and be continued for a considerable period of time. Warm baths exert an anodyne and sedative influence in the presence of urinary concretions of any kind.

CHAPTER VII

DISEASES OF THE GENITALIA

Diseases of the Female Genitalia—Chronic Inflammatory States; Menstrual Abnormities; Neoplasms. Diseases of the Male Genitalia.

DISEASES OF THE FEMALE GENITALIA—CHRONIC INFLAMMATORY STATES

Menstrual Abnormities

In the presence of **chronic inflammatory conditions of the** female sexual organs, of **chronic metritis** and **endometritis**, of **perimetritic** and **parametritic exudates, chronic oöphoritis,** and **pelvic peritonitis,** drinking-cures with cold sodium sulphate waters and sodium chlorid waters are most important. These purgative waters, through a derivative influence upon the intestinal canal, induce a lowering of the hypostatic pressure in the abdominal blood-vessels; overcome the hyperemia of the uterus and its adnexa, stimulate absorption of exudates. By improving the digestion, moreover, they promote the nutrition of the entire body. For women otherwise of robust constitution, whose digestion is torpid and who exhibit a tendency to constipation, the following waters may be recommended: The Kreuzbrunnen and the Ferdinandsbrunnen at MARIENBAD, the Salzquelle at FRANZENSBAD, the Salzquelle at ELSTER, the Tempelbrunnen at ROHITSCH, the Rakoczybrunnen at KISSINGEN, the Elisabethbrunnen at HOMBURG, and the Luciusquelle at TARASP. Waters of similar efficacy in the United States are the SARATOGA SPRINGS, in New York; BEDFORD MAGNESIA SPRINGS, in Pennsylvania; CRAB ORCHARD SPRINGS and HARRODSBURG SPRINGS, in Kentucky; SPRINGDALE SELTZER SPRINGS, in Colorado, and CALIFORNIA SELTZER SPRING, in California. (See p. 435.)

For delicate debilitated women with **chronic metritis,** in whom the catarrhal symptoms referable to the various mucous membranes are conspicuous, the alkaline muriated springs are suitable. among which those of EMS have long enjoyed a good reputation. Those of GLEICHENBERG, LUHATSCHOWITZ, NEUENAHR, and VICHY also are useful. In the United States the waters of WAUKESHA SPRINGS, in Wisconsin, may be employed.

If the patient has become chlorotic, or, in consequence of hemorrhage, anemic as well, the use of the pure iron waters of Schwalbach, Pyrmont, Driburg, Steben, Franzensbad, Cudowa, Bocklet, Reinerz, Spa, St. Moritz, and others, is appropriate as an after-cure following the drinking-cures mentioned. Suitable waters in the United States are the Berkeley Springs, in West Virginia, and Schooley's Mountain Spring, in New Jersey.

The drinking-cures are followed by, or combined with, bathing cures with carbonated steel baths and peat baths, the latter especially at Franzensbad, Marienbad, Elster, Cudowa, Muskau, and Meinberg; as well as the thermal brine baths at Rehme, Nauheim, and Kissingen, or the springs most favorably situated climatically at Ischl, Aussee, Reichenhall, and Kreuth. In the United States chalybeate springs used for bathing purposes are: Sweet Chalybeate Springs, in Virginia; Geyser Spa and Napa Soda Springs, in California; Owasso Spring, in Michigan, and a number of others. Thermal brine baths are to be had at Byron Springs, in California; Pagosa Hot Springs, in Colorado; Salt Lake Hot Springs, in Utah.

In the presence of **moderate exudates** that are not readily absorbed, the iodin brine baths of Kreuznach, Hall in Upper Austria, Duerkheim, Aschaffenburg, and Saxon-les-Bains; or in cases of marked sensibility, the mountainous acratothermal springs of Schlangenbad, Landeck, Badenweiler, and Wildbad may be employed. Corresponding baths in the United States are: Gentlemen's Pleasure Bath at Hot Springs; and Healing Springs, in Virginia; Warm Springs, in Georgia; and some of the springs at Hot Springs, Arkansas.

In cases of **chronic metritis, ophöoritis,** and **perimetritis,** warm baths are taken as full baths and as sitzbaths; in addition to which use is made of local irrigation of the vagina and the cervix with the respective mineral waters at a temperature of 35° C. (95° F.), as well as of uterine douches of varying temperatures and pressure; the latter, when there are marked induration of the tissues and scanty menstrual discharge. Peat poultices to the hypogastrium, local affusions of brine, and fomentations with concentrated iodin brine are employed as bathing procedures to favor absorption.

When **abnormities o**[illegible] a tendency to **abortion,**
and **sterility** are present, [illegible] stitutional alterations,
anemia, chlorosis, [illegible] the one hand, and
the existing geni[illegible] should be taken
into consideration [illegible] te balneothera-
peutic measures. [illegible] **scanty men-**

struation, the iron waters, the saline ferruginous acidulous waters, and the sodium chlorid waters containing iron are accordingly prescribed as drinking-cures for chlorotic and anemic individuals. In **obesity**, the ferruginous sodium sulphate waters may be used. In **scrofulosis**, the alkaline hydrochloric acidulous waters are indicated. For the relief of the symptoms that attend the **menopause** at the climacteric period, the cold sodium sulphate and sodium chlorid waters, and, finally, the bitter waters are useful. These waters are taken for the relief of **menorrhagia** due to circulatory disturbances in the pelvic organs.

Of **baths**, the employment of carbon dioxid in the form of dry gas douches, or of steel baths, gas sprudel baths, carbonated gas vapor baths, as well as hot peat baths, peat poultices, and packing of the vagina with peat, exert a good effect locally in the presence of conditions of **amenorrhea.**

For **menorrhagia** due to atony of the uterus or hypostatic hyperemia of the uterine mucous membrane, cold steel baths and peat baths yield good results. At the **climacteric period** carbonated acidulous baths, steel baths, and brine baths are in general **counterindicated.** Women suffering from disease of the sexual organs should not bathe during the menstrual period, and only exceptionally can this be permitted if, in the presence of scanty menstruation, it is desired, by means of baths, to bring about increased congestion in the genitalia during the menstrual period. During **pregnancy**, only moderately warm acratothermal, sodium chlorid, and alkaline baths may be permitted, and only with the observance of the following precautions: the temperature of the bath should be from 28° to 34° C. (82.4° to 93.2° F.); the duration should not exceed fifteen minutes; the bath should not be repeated daily, and should be suspended at once if reflex irritation in the abdominal and pelvic organs becomes manifest. Steel baths, peat baths, acidulous (CO_2) baths, steam baths, and sea-baths should, however, be forbidden to pregnant women.

Neoplasms

For **myomata of the uterus**, bathing-cures may be taken with advantage, not for the purpose of effecting a cure of such new growths, but in order to relieve the secondary manifestations; symptoms of irritation of the uterus and its surroundings, and hemorrhages induced by such tumors; also to improve the tone of the muscular coat of the uterus, and thereby to effect a reduction in the size of submucous and interstitial myomata. Upon this depends the favorable influence of brine baths, particularly those containing iodin and bromin, as at KREUZNACH, HALL in Austria, DUERKHEIM, ELMEN, SALZHAUSEN, and

SULZA, and, in the United States, GLEN SPRINGS (Deer Lick), in New York; PARKER MINERAL SPRINGS, in Pennsylvania; MT. CLEMENS MINERAL SPRINGS and ST. CLAIR SPRINGS, in Michigan. The carbonated brine baths of KISSINGEN, NAUHEIM, REHME, ISCHL, and REICHENHALL; and the ferruginous peat baths of MARIENBAD, FRANZENSBAD, ELSTER, and MUSKAU, may also be recommended. Care in bathing is required, particularly when myomata are attended with profuse hemorrhage. The baths should not be taken too warm, and their duration should not be too prolonged. The **drinking** of ferruginous waters may advantageously be associated with the bathing-cure; but, on the other hand, the internal use of iodin waters is not to be advised, on account of its debilitating influence.

For **incipient ovarian tumors**, the employment of brine baths and iron peat baths containing iodin is indicated, in order to mitigate the complicating inflammatory symptoms. The internal use of iron waters and saline ferruginous acidulous waters subserves the purpose, under such conditions, of improving the general nutrition and invigorating the individual for the necessary operation. In some cases of ovarian tumor, as well as in cases of uterine tumor, when the operation is impossible or is not permitted, drinking-cures with ferruginous sodium sulphate waters or sodium chlorid waters are indicated for obese women, in order, by reducing the amount of fat, to afford more room in the abdomen and to lessen the pressure symptoms to which the tumor gives rise.

DISEASES OF THE MALE GENITALIA

Of the diseases of the male sexual system, **impotence** is the condition most frequently subjected to balneotherapeutic measures, in so far as springs and baths are applicable for the relief of the etiologic factors of this condition. Accordingly, it is the nerve-invigorating baths,—steel baths, peat baths, and sea-baths,—in combination with drinking-cures at the steel springs of PYRMONT, SCHWALBACH, and FRANZENSBAD—in the United States, RICHFIELD Iron Spring, in New York; CRESSON SPRINGS, in Pennsylvania; ROCK ENON SPRINGS, in Virginia; PACIFIC CONGRESS SPRINGS, in California—that are capable of improving the condition in cases of sterility in anemic and neurasthenic men; when the intestinal functions are sluggish, and, as a result, a hypochondriacal tendency is present, with lowered sexual vigor, a systematic course of treatment at the springs of CARLSBAD, MARIENBAD, and KISSINGEN is capable of yielding favorable results. ... the presence of pollutions and spermatorrhe... ...mia and enfeeblement of the nervous system, the ferruginous waters, as well as the saline ferruginous acidulous waters, may be employed for drinking-cures, and be supplemented by cool steel baths and ferruginous peat baths. When a hyperemic state of the pelvic organs is responsible for the pollutions, in consequence of abdominal stasis, hemorrhoidal conditions, or habitual constipation, the cold sodium sulphate waters and sodium chlorid waters are indicated for drinking purposes; in cases of marked congestive states, the bitter waters are useful. All mineral waters should be freed from gas, as thoroughly as possible, and be drunk in small quantities, in order to lessen the irritative effect of the carbon dioxid upon the genitalia, and not to fill the bladder unduly.

In **chronic inflammatory affections of the testicle and the epididymis,** following gonorrhea, or caused by scrofulosis and syphilis, the **internal** use of the iodin waters for drinking, and the employment of the iodin peat baths—KREUZNACH, WOODHALL SPA, HALL, LIPIK, KRANKENHEIL, KOENIGSDORF-JASTRZEMB, SULZBRUNN, and BEX; in the United States, SARATOGA SPRINGS (Excelsior), in New York; SALT SULPHUR (Iodin) SPRINGS, in West Virginia; TUSCAN SPRINGS (Red Spring), in California—for **bathing,** as well as the thermal brine waters, prove efficient; and also ferruginous peat baths, sulphurous mud-baths, as well as peat poultices and mud cataplasms locally, are useful. Less success is to be expected from similar balneotherapeutic measures in cases of **hypertrophy of the prostate,** certainly not in the presence of **senile enlargement** and **induration of the prostate,** but rather when such swelling is attributable to syphilis or scrofulosis.

CHAPTER VIII

DISEASES AND INJURIES OF THE JOINTS

Chronic Muscular and Articular Rheumatism. Traumatic Injuries of the Organs of Locomotion.

CHRONIC MUSCULAR AND ARTICULAR RHEUMATISM

In the presence of **chronic rheumatic inflammation of the muscles and joints,** the various thermal baths are indicated: Acratothermal baths, sodium chlorid thermal baths, thermal brine baths, sulphurous thermal baths, brine baths, peat baths, and mud-baths. These baths have in common the property of exerting a favorable influence upon involution of the anatomic alterations, and absorption of the effusions, by stimulating metabolism, by increasing the secretory activity of the skin, and by locally inducing favorable changes in the affected parts through dilatation of the vessels, by influencing the circulatory conditions, and by irrigating the tissues; in connection with which, besides, the high temperature of the bath neutralizes the increased sensitiveness and irritability of the diseased parts. Nevertheless the stimulation induced by the baths at various places is different, and permits of a selection in accordance with the needs of the individual case. The action of the hot peat baths and mud-baths is the most intense in the large number of cases of **chronic rheumatic affections,** whether involving the muscles, the fasciæ, the periosteum, the synovial capsule, and the ligamentous structures, or other fibrous structures. These baths contain, in greatest abundance, salts, gases, and other cutaneous irritants, and are capable of exerting pressure and friction mechanically; besides, they can be employed at higher temperatures than mineral water baths. Peat baths and mud-baths, which combine the effects of a bath and of massage, favor, often to a surprising degree, the absorption of fluid effusions, and the retrogressive metamorphosis of inflammat[illegible] products of some standing. They exert a useful influe[illegible] [illegible]eumatic palsy, as they restore nerve conduction, whi[illegible] [illegible]nged by the presence of exudates, and, in unfavo[illegible] [illegible]st counteract the rapid atrophy of the paralyzed n[illegible]

In the operative and orthopedic treatment of **rheumatic ankylosis** a course of peat baths and mud-baths is useful as a preparatory measure and during the after-treatment. Among antirheumatic baths of this character the highest reputation is enjoyed by the peat baths of MARIENBAD, FRANZENSBAD, NEUDORF, ELSTER, and MUSKAU, and by the sulphurous mud-baths of PISTYAN, TRENCSIN, WARASDIN, NENNDORF, and EILSEN. The acratothermal waters of TOEPLITZ-SCHOENAU, WARMBRUNN, RAGATZ, PLOMBIERES, DARUVAR, TOEPLITZ-KRAPINA, TOPUSKO, and others; and, in the United States, HOT SPRINGS, in Arkansas, and LAKEWOOD, in New Jersey, are useful, especially for the chronic rheumatic affections due to cold, and their consequences, as well as in the presence of marked hypersensitiveness and a tendency to rheumatic relapses. Such thermal baths as are situated at not too high an altitude, but enjoy a sheltered climate, shielded from sharp winds, and with not too wide variations of temperature, are deserving of consideration. Chief among [illegible] that meet these requirements may be mentioned WIESBADEN, BADEN-BADEN, ISCHL, REICHENHALL, EMS, and LEUK. In the United States, HOT SPRINGS, in Arkansas, HOT SPRINGS, in Virginia, [illegible] in Michigan, and HOT SPRINGS [illegible] in South Dakota, are suitable waters.

W[illegible] articular rheumatism, **valvular disease** of the heart [illegible] the thermal brine baths of [illegible] deserve the preference. [illegible] disorders of long standing, particularly of [illegible] sulphurous thermal baths [illegible] PISTYAN, TOEPLITZ-TRENCSIN [illegible]

[illegible]

For domestic purposes in the treatment of cases of rheumatism pine-needle baths, prepared by the addition of fresh broken branches of pine, or of pine-needles, to the bath water at a temperature of between 36° and 40° C. (97° to 104° F.), may be employed, followed by rest in bed for several hours. Recently poultices of hot fango, the volcanic mud exported from Italy, have been introduced into domestic use.

At some of the health resorts previously mentioned—at the acratothermal springs, the sulphurous thermal springs, and the sodium chlorid thermal springs—the waters are employed also for drinking purposes in addition to the bathing-cure, in order to maintain the diaphoresis induced by the bath or to subject the organism to a thorough flushing.

INJURIES OF THE ORGANS OF LOCOMOTION

The balneotherapy of the sequels of **traumatism** involving the organs of locomotion employs the same baths that have just been referred to in connection with the treatment of chronic rheumatism; preferably, peat baths, mud-baths, acratothermal baths, and thermal brine baths. These varieties of baths are succesfully employed in cases of **fracture,** although only after complete bony union has taken place; in the presence of **gunshot wounds** of the soft parts; **false ankylosis** in consequence of fractures caused by gunshot wounds; **contractures of the muscles and ligaments** the result of **traumatic exudates**; after **sprains, luxations,** and **fractures.** The various forms of obstinate **neuralgia** persisting after traumatism, often yield to courses of treatment with such thermal baths.

excessive cerebral irritability; passive hyperemia and chronic inflammation of the choroid—**choroidal congestion** and **choroiditis**; and **incipient glaucoma**, the active derivative cold sodium sulphate waters and sodium chlorid waters may be employed with excellent results. The scrofulous inflammations of the eye, **chronic palpebral conjunctivitis**, and **chronic blepharadenitis**, furnish the indications for courses of treatment with iodin waters and brine baths, directed to the constitutional improvement of the condition. **Chronic catarrhal inflammations of the conjunctiva** dependent upon the rheumatic or the gouty diathesis are improved by the sodium chlorid thermal waters and by the drinking of purgative waters having a derivative effect. For a number of **ocular disorders resulting from sexual excesses** or **anemic states of the blood**, and dependent upon depression of the nervous system, ferruginous waters are recommended.

Diseases of the Ear

Of affections of the ear, **otorrhea in scrofulous individuals**, and **catarrhal conditions of the tympanic cavity** arising by extension from the pharyngeal mucous membrane, are at times treated by means of drinking-cures with iodin waters and inhalations of brine vapor and brine steam. The same statement is applicable to **chronic nasal catarrh** in scrofulous individuals.

APPENDIX

APPENDIX[1]

ADDITIONAL METHODS FOR THE THERAPEUTIC USE OF WATER, HEAT, COLD, LIGHT, AND MINERAL BATHS

In their descriptions of the hydriatric technic and in their recommendations as to the management of special disorders the collaborators of Professor Winternitz have, in specified terms, restricted themselves to the practice of their great master; pointing out, however, the necessity of modification in accordance with the requirements of individual cases, and fully setting forth the principles involved. I have, therefore, refrained from making material additions or changes. These articles are in no sense incomplete; yet it is my desire to make the passages devoted to methods among the most important of those pertaining to physiologic therapeutics, in the highest degree useful to physicians whose previous acquaintance with the subject may not have been sufficient to enable them, without further guidance, to undertake the modifications advised. Moreover, in the United States within recent years, and largely under the impetus given by the devoted labors of Dr. Simon Baruch, of New York, certain special developments in hydrotherapeutic technic have come into more or less general use, and therefore demand description. Thus, as illustrations of the manner in which the Winternitz technic may be modified upon occasion, and of the additional methods available in the treatment of certain classes of patients and in various acute and chronic disorders, I deem it advisable to append a number of Dr. Baruch's recommendations. At the same time opportunity is taken to utilize some suggestions of Dr. Kellogg's; to describe and illustrate a few expedients that I have personally found useful and readily available both in hospital and private practice; and to emphasize the merits of certain methods belonging to the general stock of knowledge and practicable in every home.

Hydrotherapy and allied methods are devoid of mystery; their employment should not be relegated either to specialists or to institutes. As in every other branch of medical practice, however, certain cases may present themselves in which the counsel of physicians of special experience, or the apparatus and facilities of special hospitals or institutions, may be necessary. Moreover, every practitioner cannot devote himself to the training of skilled attendants, or equip his office with elaborate instruments. For this reason there should be maintained in every city an establishment to which any physician might refer his patients with a definite hydriatric prescription, just as he can now send them to the apothecary with a definite pharmaceutic prescription. If such institutions can, in addition, be equipped to fulfil prescriptions for the application of all the methods of physiologic treatment, a further and important step toward the goal of scientific therapeutics will have been taken.

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[1] Much of the material for this appendix has been taken from the editor's lectures, particularly the course on "Special Therapeutics," delivered in the summer term at Jefferson Medical College, 1887 to 1891, and from various of his journal articles, among which may be cited "The Cold Water Treatment of Typhoid Fever, According to the Method of Brand," "Medical and Surgical Reporter," Philadelphia, June 25, 1887; "Extra-Routine Therapeutics," "The Polyclinic," Philadelphia, September, 1887; "Lavage in the Treatment of Gastric Affections," "Journal of the American Medical Association," December 10, 1887; and a number of editorial contributions to the "Medical News," "The Philadelphia Polyclinic," and "American Medicine." Miss Marion E. Smith, Chief Nurse of the Philadelphia Hospital, has kindly supplied the description of some of the methods of that institution.

APPARATUS

Baruch's Douche Table.—It seems wise to give a more detailed description than occurs in the text of Dr. Strasser, page 89, of Baruch's douche table, the first practical device for scientific and exact control of temperature, pressure, and other elements of the hydriatric prescription. It consists of a series of one-inch pipes compactly arranged within a marble box and supplied with mixing chambers which admit of rapid temperature changes. The supply comes from a two-inch pipe, which must be independent of the pipes supplying the house, to prevent fluctuation in temperature and pressure. By an ingenious arrangement on the top of the table a number of quickly opening levers connected with faucets turn on the rain, jet, circular (needle), perineal, and fog douche. Two sensitive thermometers indicate all temperatures and a pressure gage shows every pound of pressure. The latter is regulated by faucets at the back of the table behind which stands the attendant, who is thus protected against dripping water and may wear ordinary nurse's garb. The circular douche differs from the ordinary needle-bath in that it consists of a series of roses with removable plates for cleansing. Another important advantage is the mobility of the upper row of roses, which enables them to be adapted to the height of the patient. The rain douche in this apparatus is not vertical, so that the shoulder receives the larger part of the stream. The perineal or ascending douche rises from beneath the slatted floor of the douche room and strikes the patient while sitting on an open seat (Fig. 16, p. 84).

Baruch correctly insists that the douche is the most valuable procedure for clinical purposes in large institutions because of the ease with which large numbers may be treated, and because it is adapted chiefly for cases which have resisted other hydriatric measures. In his last report as medical director of the Hydriatric Department of the Riverside Association, which was the first hydrotherapeutic dispensary outside of Germany and Austria, Baruch states that treatment has been administered to patients sent by the principal dispensaries and hospital outdoor departments in New York. He concludes that the sixfold increase of patients shown in three years indicates the great value of the douche treatment in cases having resisted all other methods. The chief diseases treated are neurasthenia, chlorosis, the neuralgias, neuritis, rheumatism, gout, obesity, chronic bronchitis, phthisis, and hysteria.

TYPHOID FEVER

The use of **cold bathing** in typhoid fever, as described by Strasser in this volume, differs in certain respects from the general practice among American clinicians, which derives through S. Baruch, of New York, from Ernst Brand, of Stettin, by whom the methodic application of the cold[1] bath in typhoid fever, not as a mere expedient to reduce temperature, but specifically as an antityphic measure, was first suggested, in 1861.[2] After a

[1] Baruch terms it 'full bath,' but in this volume the German designation 'half-bath' has been retained. The expression most common in the United States is simply 'tubbing.'

[2] Currie and others had preceded Brand in the use of cold water in fevers, but reference is here made to a special technic applied to a special affection and persisted in, despite ridicule and opposition, with a propagandist fervor worthy of the highest honor.

period of considerable controversy, the method of Brand has been accepted not only in Germany, but practically over the whole civilized world, as at least the basis for the successful treatment of this affection. The following specific directions include the points upon which greatest stress is laid.

Technic.—The bath-tub is to be brought to the side of the patient's bed, and filled with water at the temperature decided upon. Brand and those who follow him strictly begin with water at 68° F. (20° C.), and may in subsequent tubbings reduce the temperature, but not lower than 59° F. (15 C.). The patient, wearing swimming trunks or covered merely with a sheet, is gently lifted[1] by two attendants (see Fig. 3, page 65) and so laid in the tub that he is thoroughly immersed in the water, his entire body being covered up to the chin, and the head being best supported out of the water upon a rubber air pillow suspended from the top of the bath-tub. Cold water—60° F. (15° C.) or less—is poured upon the head and face during the immersion, and the limbs and body, with the exception of the abdomen, are briskly rubbed during the entire period of the bath. In hospitals it is convenient to apply a cold douche to the head and shoulders by means of a current from an elevated reservoir—the irrigating apparatus of the surgeons, in fact (Fig. 4, page 67). The cold affusion and the brisk friction are important features of the treatment, and to their neglect may be attributed failures and unpleasant results. The duration of the bath is from ten to twenty minutes, according to the reactive power of the patient. Unless cyanosis or decided shivering, chattering of the teeth, general failure to react, or untoward effect upon the heart is noticed as a result of the bath, Brand insists that it be repeated every third hour so long as the rectal temperature shall exceed 39° C. (102.2° F.), and that this is to be done day and night, regardless of sleeping or other consideration. As a rule, I deem it better not to disturb a sleeping patient even to take his temperature; rarely, however, urgent indications, such as continuous high temperature above 105° F. (40.5° C.) or great depression calling for a brief stimulating plunge, may modify the rule. Each case is best managed in this respect, as in all others, according to its individuality.

Before the patient is put into the bath, and after he is taken out, Brand advises that he be given a glass of red wine. This is a common practice in Germany; in America alcohol is usually given in the form of whisky. I prefer to give aromatic spirit of ammonia, 30 to 60 minims, suitably diluted, or, in some instances, a small cup of hot coffee; reserving alcohol for cases presenting special indications. In the course of the bath the patient may drink a glass of cold water.

While the strict Brand method is favored by many physicians in America, among them J. C. Wilson,—to whom we are indebted for a statistical demonstration of the value of the treatment as carried out systematically at the German Hospital of Philadelphia and in his service at the Pennsylvania Hospital,—others prefer to begin the tubbing at a temperature varying according to the condition of the patient, and to reduce this gradually by the addition of ice or of very cold water during the progress of the bath;

[1] Wilson allows his patients, if the symptoms are mild and the bath treatment is instituted early, to rise and step into the tub assisted by the attendants, and has never observed any harm to result from permitting them to do so. This practice is, however, generally deprecated, and as a routine measure is hardly safe.

the degree of reduction, as well as the initial and final temperatures of succeeding baths and the duration of each bath, to be governed by the general effect upon the individual patient, together with the height of his temperature, the vigor of the heart, and the severity of his nervous symptoms at the time of immersion. This is my own practice. It is a flexible method, based on strict individualization. As has been sufficiently pointed out, the method is not antipyretic, but antityphic. The patient's temperature is a useful index as to the effect and the necessity for repetition of the bath, but nothing more. No greater mistake can be made than to try to reduce the pyrexia as far and as fast as possible. The charts resembling hectic fever seen in so many hospital wards are distinctly bad charts. In the normal progress of typhoid fever toward recovery no sudden change occurs in temperature or other symptoms, and no sudden change should be produced by treatment. Even during the fastigium in cases with quite high temperature a single bath should not be allowed to bring it down more than 1° C. or, at most, 2° F.[1] A reduction of 1° F. (0.5° C.) is often better. After this moderate fall the former height is rarely regained: and each bath produces a further slight reduction in the range of pyrexial activity, not by mere abstraction of heat, but by antagonizing the morbid process as a whole—especially by the stimulation of metabolism and the improved function of the emunctories. In this way successively lower levels are reached, the course of the disease becomes more mild, and the therapeutic lysis anticipates and reinforces the normal lysis. The patient's reactive powers are gauged by means of an initial bath of five minutes' duration at 90° reduced to 80° F. (32° to 27° C.) or a cold rub or a simple ablution: and the initial temperature, the reduction, and the duration of the following bath are determined accordingly. After this, each bath serves in a measure as a guide to that which succeeds it: the predetermined plan being held subject to modification during the procedure if necessary.

Whenever it is possible—in hospital practice always—a medical attendant should be present during the bath, not so much to guard against the occurrence of shock, as to insure that the benefits of the procedure are not needlessly curtailed by too anxious interference and too early termination of the bath. Chattering of the teeth may be disregarded in most patients, alarming as it may appear, nor is cyanosis of the extremities alone to be regarded as a signal to terminate the bath; but if a decided blueness is noted about the face, especially about the nose, the patient should be taken from the water at once. This will be found a more reliable sign than the condition of the radial pulse, which is necessarily influenced by the local chilling of the arms. Few patients tolerate a bath of more than fifteen minutes' duration in water at 68° F. (20° C.). Continuous cold affusions are usually helpful, but absolutely indicated only when stupor is profound, and respiration superficial and labored. In most cases it suffices to cover the patient's head with an ice-cap or a wet turban and have it bathed at short intervals either by himself or by the attendants; care being exercised that the water does not run into the ears. The patient's comfort while in the tub will be

[1] It is a fact of some diagnostic import that a cold bath at any temperature will rarely reduce the body-temperature more than two degrees in the first week of typhoid fever, while in croupous pneumonia even a moderately cool bath, say, at 85° to 80° F. (29° to 27° C.), may reduce the temperature from 2 to 4 degrees (Baruch).

materially increased by providing him with a rubber air cushion to support the buttocks, as well as with an air-pillow for his head. In lifting the patient out of the tub, the attendants should, if possible, allow the water to drain off for a fraction of a minute, to prevent flooding of the blankets (Fig. 5, page 68).

The **preparation of the bed** for the reception of the patient after the tubbing is very important, but is often neglected. To this neglect may be attributed many of the unpleasant results that some physicians imagine to have been caused by the bath, and that have, therefore, rendered them timid in the application of the method. Everything should be in readiness before the patient enters the water, so that there may be no delay should it be necessary to remove him from the tub sooner than was anticipated, and

FIG. 70.—ABDOMINAL COIL.

to relieve his anxiety at the thought of possibly having to remain longer in the tub than necessary while the bed is being prepared. There are needed, first, two warm blankets at a temperature of not less than 100° F. (38° C.). Three hot-water cans or bags should likewise be ready, properly wrapped, to be placed one at his feet and one to each thigh; and an ice-cap or rubber coil should be at hand for his head. Over the lower blanket should be placed a dry sheet, equally warm, and upon this the patient is laid when he is lifted out of the tub. The sheet is then wrapped about him from the two sides, and tucked between the arms and the trunk, and between the le legs, so that no two surfaces of wet skin shall be in contact (Fig. 6, 69). Friction is made over the sheet until the patient is thoroughly when the sheet is slipped out and he is allowed to lie between the bla with the hot-water cans at his feet and against his legs, and the ice-cap upon his head. The patient continues thus for from fifteen to twenty minutes, when he is again robed in his nightdress and permitted to lie between the sheets of his bed. After the hot-water cans have been removed, a cold compress, an ice-bag, or a cold coil (Fig. 70) is applied over the abdomen, unless too low a temperature for this has resulted from the bath. The ice-cradle (Fig. 77), which is described elsewhere, furnishes a convenient means of applying continuous cold to the abdomen, especially when the patient is restless under the weight of the coil or compress. In this matter of the application of continuous cold to the abdomen the patient's sensations cannot be depended upon as a guide; there is no doubt that the procedure has a distinct effect in keeping the temperature down and reducing the number of baths required. In some cases it seems to obviate the necessity

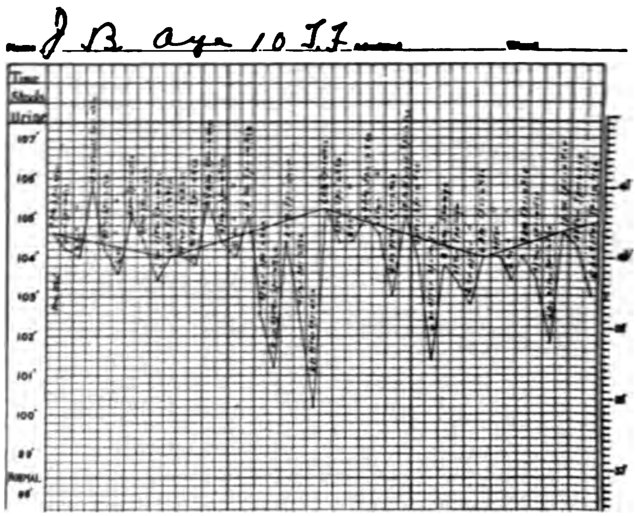

FIG. 71.—TEMPERATURE CHART SHOWING ANTIPYRETIC EFFECT OF SPRINKLING IN A CASE OF TYPHOID FEVER; EDITOR'S SERVICE, POLYCLINIC HOSPITAL.—(*Courtesy of "American Medicine."*)

of routine bathing. It certainly diminishes the tendency to tympanites and probably reduces to a minimum the danger of hemorrhage. Neither coil nor ice-bag should be placed directly upon the skin, but a flannel or linen cloth wrung out of ice-water should be interposed. Some physicians prefer to place the ice-bag over the right iliac fossa, and this practice is often advantageous. In some cases these applications have a better effect when occasionally intermitted for an hour or so, or when the coil or ice-bag is shifted at intervals.

To enumerate the advantages of the Brand or cold-water treatment of typhoid fever, and the statistics on which the popularity of the method rests, would to-day be a work of supererogation; but a few salient facts and figures may not be out of place.

In cases treated by the Brand method from the beginning, before the fifth day, the entire course of typhoid fever is changed. The severe symptoms of the classic picture are wanting; and the patient passes through the various stages in comparative comfort. Brand boldly asserts, on the strength of 1223 cases treated by Jürgensen, Vogl, and himself up to January, 1887, that all cases of typhoid fever coming under treatment before the fifth day should recover. Conservatively stating the results of the analysis of some 35,000 cases reported from all parts of the world, it may be asserted that the cold-bath treatment has reduced the mortality of typhoid fever from more than 20 per cent. to less than 8 per cent., while in 5573 cases collated by Brand it was but 3.9 per cent.

The statistics of Vogl, who reports a mortality of only 2.7 per cent. among 221 cases treated by the strict Brand method, are unusually valuable from the fact that the patients were all of the same type—soldiers of about the same age and condition of previous health. Among 667 cases taken from the same clinical material, in which a combined water and pharmacal—so-called antipyretic—treatment was employed, the mortality during the same period was 7.6 per cent.

It may, therefore, safely be said that, should a routine treatment of typhoid fever have to be pursued, least harm and most good will result from the employment of systematic bathing in cold water after the method of Brand. I am, however, opposed to any routine treatment, and, as I had the pleasure of advocating the Brand system[1] and of employing it according to my then limited facilities while antipyrin was yet in vogue, I do not hesitate now to place myself on record against the extreme views enunciated by some authorities of more recent acquaintance with the method. In severe cases, or in cases that promise to be severe, if seen before the tenth day, systematic plunging in cold water should be instituted at once, and the directions of Brand should be followed with reasonable strictness. The inexpert will do better by following them to the letter, than by attempting modification. The experienced will adapt his directions to circumstances. Between the tenth and the twelfth days it is doubtful whether plunging should be begun. After the twelfth day the inexpert should never begin plunging. Plunging begun earlier will of course be continued or discontinued according to circumstances.

When the course of the disease is essentially mild; when tubbing is dreaded notwithstanding its good effect; when the baths are not well borne; or when facilities for the bath treatment are not available, other hydriatric methods may be tried. Mention may here be made of some of the most useful; they are available in pneumonia, in febrile tuberculosis and the like, as well as in enteric fever.

Sprinkling.—As an antipyretic procedure this may be said to rival tubbing (see chart, Fig. 71). It is better borne by most persons,—although there are exceptions to this rule,—and is particularly well adapted for private practice, as it requires no bath-tub and the patient does not have to be lifted bodily from his bed. The method is as follows: The head of the bed is raised about a foot from the floor; under the mattress to keep it [illegible] a uniform flow toward the foot of the bed, three [illegible] as the bed is wide, are introduced crosswise;

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[1] [illegible] orter," Philadelphia, June 25, 1887.

and the mattress is covered with a large rubber sheet, on which are placed a pillow and a linen sheet. The patient is stripped as for tubbing and sprinkled with water at the desired temperature either from a watering pot (Fig. 72) or, more conveniently, from a tube with rose nozle attached to an irrigating reservoir (Fig. 73). The water as it flows off is received in a pail, or, better, a foot-bath, placed at the foot of the bed, and can be used again and again, the temperature being maintained if necessary by the addition of ice. The temperature of the water and the duration of the procedure are to be regulated according to existing conditions as in the bath treatment; it is usually advisable to employ water at about 10° or 12° F. (say, 5° or 6° C.) cooler than would be used for bathing the same patient under the same conditions. The patient's head is covered with a turban and active

FIG. 72.—SPRINKLING WITH A WATERING-POT; ICE RUB ('ICE-IRONING').

friction is kept up during the entire procedure, exactly as in the case of the Brand method, the mode of action in both being the same. The water should be poured, from not too great a height, chiefly on the abdomen and lower extremities, as the patients find this less distressing and the effect is quite as good. After the sprinkling, the patient is wrapped in a dry sheet covered with a blanket and rubbed dry until reaction has set in. The body-temperature is to be taken every three hours, and if it is found to exceed 102.2° F. (39° C.) in the rectum, repetition of the sprinkling is indicated.

The Wet Pack.—This procedure, which is fully described in the text (see p. 104), is often used as a substitute for tubbing, and has found many advocates. To obtain an antipyretic effect the pack must be renewed at frequent intervals, requiring almost constant manipulation of the patient.

Baruch has abandoned the wet pack in typhoid fever, believing that it exhausts the patient too much. He considers the sheet bath (referred to under the term 'Lakenbad,' page 78), applied as presently to be described, to be in every respect more effective.

The Sheet Bath.—The sheet is laid dripping from water at 80° F. (27° C.) upon blankets on an adjoining bed, couch, or table, and the patient, raising his arms above his head, is snugly wrapped up in it. Water is poured upon successive parts of the trunk, which are rubbed with the flat hand until warm and then cooled by pouring colder water (60° to 50° F.—15° to 10° C.) upon them. When a part ceases to warm up, another is similarly treated, until the entire trunk has been gone over. Baruch states that the sheet bath is second only to the cold tub bath in the treatment of

FIG. 73.—SPRINKLING WITH AN IRRIGATING APPARATUS; ICE RUB.

typhoid fever, and is a good substitute for the Brand treatment when the latter is refused by the patient.

The Towel Bath.—This is another useful measure. The patient is stripped and laid upon blankets; the back is first treated by laying a towel dripping from water at 75° F. (24° C.) smoothly upon it; friction is made over the latter until it warms up, and water at 60° F. (15° C.) is then poured from a cup or pitcher over the warmed surface until it cools. It is then warmed up again by renewed friction, and this is repeated until the part ceases to become warm. The gluteal region is then similarly treated. After the back of the patient has been thoroughly dried by rubbing, the anterior surface of the trunk is, in the same way, cooled, warmed, cooled again, and dried.

The Ice Rub.—This procedure is illustrated in connection with sprinkling. (See Figs. 72 and 73.) Ice cut to a flat surface and held within a piece of gauze or thin cloth is rubbed over successive parts until they are cooled, and the patient is then thoroughly dried and made comfortable.

Ablution, or Sponging.—The patient is divested of his clothes and placed between blankets, or sheets if preferred and in very hot weather, and with a well moistened carriage sponge the whole body is wetted. Long light strokes are used, the different parts being gone over in succession and then exposed to the air. A film of water must be left on the skin for evaporation if the temperature is to be reduced. Simple and well known as this procedure is, certain points in regard to its application in typhoid fever need to be emphasized. Cold water should first be applied to the head, face, and neck. The remainder of the body should then be sponged in the following order: Upper extremities, lower extremities, chest, abdomen, back. The abdomen should be handled lightly, and the patient should not be turned until the time has come to sponge the back. It is best to begin with water at 75° to 70° F. (24° to 21° C.) and reduce gradually; in cases of very great pyrexia, reaching ice-water in the course of ten minutes, and continuing the low temperature for ten minutes; in other cases reaching 50° F. (10° C.) in the course of fifteen minutes; but here, too, individualization is necessary. It is best to expose only that portion of the body which is being sponged, and not to dry the patient until the application is concluded. When the temperature in the mouth does not exceed 103° F. (39.5° C.), the patient may be sponged every third hour. When the temperature exceeds 104° F. (40° C.), sponging must be done every second hour.

These procedures, like the bath, "appeal to the depreciated nerve-centers and arouse them from the lethargy of toxemia," provided that decided chilling is not produced.

Ice Pack.—The patient is stripped and laid on a cot covered with a rubber sheet. An ice cap having been applied to the head, large pieces of ice are disposed along the sides of the body, between the legs, and in the axillæ, and the surface of the body is at the same time rubbed with ice as in the application of the ice rub described above. The ice may be brought into immediate contact with the cutaneous surface or a cold wet sheet be interposed. The patient is kept in the pack until a decided fall in the temperature takes place.

The ice pack is urged by some writers as of great use in typhoid fever and in pneumonia: I have not employed it in either. I have found it serviceable in septic hyperpyrexia when tubbing was not available. It is a popular procedure in hospitals in the treatment of thermic fever and is mentioned in standard text-books as one of the most useful methods at command in cases of sunstroke. On the other hand, the practice is condemned in no measured terms by Baruch,[1] who cites statistics tending to show its inferiority to forcible affusion with ice-water. It is an antipyretic not a stimulating measure.

Whatever may be the method selected as a routine treatment, the general and antipyretic effect will be materially enhanced by the systematic employment of some form of continuous cold application to the trunk or abdomen. My own practice has been described (p. 511). Kellogg advises that when the temperature is high, and particularly when it resists the hydri-

[1] "Hydrotherapy," New York, [illegible] p. 322.

atric measure employed, a large abdominal compress, about one-fourth the size of the body, or four to five square feet for a person of ordinary size, should be applied and changed every twenty to thirty minutes, or as soon as it is appreciably warmed and before it becomes either hot or dry. Baruch, however, insists that in febrile diseases the cooling effect of hydriatric measures is secondary to the nerve-arousing, stimulating effect, and that a continuous cold application is therefore objectionable. In the stimulating compress (60° F.—15° C.), covered with one layer of flannel, the cooling effect is not neglected, but encouraged by evaporation through the thin flannel.

In addition to cooling applications, there are certain **accessory measures** that are not without value in typhoid fever. The patient should be encouraged to drink freely and frequently of cool water, the temperature of which should be that found most refreshing, except that ice-water should not be used. Carbonated waters are especially grateful. The bowel should be cleansed by enema on admission, unless after the tenth day, after which, according to circumstances, a few small doses or one large dose of calomel should be given. After the 'calomel stool,' suitable intestinal disinfectants may be employed. If there be constipation, it should be relieved by enema every forty-eight hours except during the period when ulceration is at its height,—say, from the twelfth to the sixteenth day,—when the bowel should be let alone. Diarrhea should not be interfered with unless excessive, but daily saline irrigation may be found to diminish it by relief of irritation. If, notwithstanding the free use of water internally and externally, the urine is not excreted in sufficient quantity, enteroclysis or hypodermoclysis may be employed, or some mild diuretic given.

Certain **appliances** not described in the preceding pages may for convenience be mentioned here, as they are especially useful in typhoid fever.

Baruch's Portable Hospital Tub.—This tub, 50 or 57 inches long and 27 inches wide, was designed to economize room in crowded hospital wards, and possesses certain advantages over the ordinary six-foot tub. It is made of wood lined with copper, of the shape indicated in the accompanying illustration (Fig. 74). It consists of two parts so arranged that the patient's lower extremities are bent at right angles to his recumbent body, the feet resting upon a double bottom which is filled with hot water. A tube with a funnel-shaped opening (seen in one of the upper corners) gives entrance, and a faucet (the lower one in the cut) upon the posterior aspect gives exit to the hot water. The object of this tub is to afford the patient an easy recumbent position, and prevent the cold water from chilling the feet and producing painful cramps during the bath. Its short and compact form renders it more portable than the ordinary tub, and its height, which is on a level with an ordinary hospital bed, saves much back-strain to the nurses, whose constant attention is required for friction during the continuance of the bath.

Tubs for Home Use.—The stationary bath-tub in an ordinary city bath-room, which contains a water-closet, should never be used. It is inconvenient for the nurses, and oppressive to the patient to be brought into the contaminated atmosphere of so small a room. For private practice the ordinary tin bath-tub, between five and six feet long, which may be obtained at the tinner's or at the large city department stores, is perhaps the best adapted. When for any reason this cannot be obtained, or the patient or his friends will not consent to tubbing, one of the forms of bed-baths, of which several have been devised, will be found convenient.

FIG. 74.—BARUCH'S PORTABLE HOSPITAL TUB.

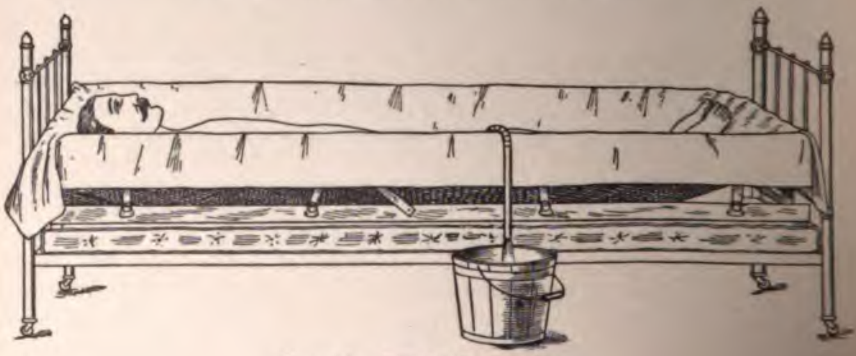

FIG. 75.—BURR'S BED-BATH.

FIG. 76.—BURR'S PORTABLE FRAME FOR BED-BATH

Dr. A. H. Burr's 'portable bath' consists, first,
sheet with rings attached near its margin by elastic tapes;

wooden crib, with fastenings along the lower rail to hold the sheet. This frame can be folded into a compact bundle. A hose with a metal yoke for a siphon, a sponge or wash-rag, and a bath thermometer complete the outfit. The rubber sheet is first slipped under the patient, brought up over the pillow, and tucked up alongside the body. The frame is then unfolded and placed over the patient, so that it rests on the mattress and surrounds patient, pillow, and rubber sheet. The edges of the sheet are then drawn up over the top rail of the crib down to the lower rail and fastened by the rings. This completes a light and perfect tub, capable of holding twenty gallons of water. It can be emptied by siphon in four minutes (Fig. 75).

Dr. U. F. Martin's device for what he terms the 'slush bath' in typhoid fever differs from the foregoing chiefly in the fact that the upright pieces of the crib are provided with several holes so that the side bars can be inserted at different levels and the capacity of the bath thus be increased or diminished. To drain off the water, the rubber sheet is unhooked at the foot of the bed and the water is allowed to flow into a bucket. The procedure consists in pouring water at the proper temperature over the patient and applying active friction to the body; in other words, affusion with friction.

Dr. A. C. Haven's device for a bed-bath is the simplest and least expensive. The materials required are, some clothes-line, a dozen ordinary wooden clothespins, and three yards of table oilcloth. "Tie a loop of rope firmly round the headboard, another round the footboard, and connect by two parallel ropes; attach the oilcloth with clothespins, and you have as comfortable a bath as the most expensive, at a cost not exceeding seventy-five cents. The loops around the headboard and footboard may be dispensed with in metal beds. Four feet of garden hose with a wooden plug in one end makes an excellent siphon."[1]

Dr. Wilmer Batt's portable bath-tub is a more elaborate contrivance. The dimensions of the tub when ready for use are: length, 75 inches; width, 22 inches; depth, 18 inches. The dimensions of tub when folded for carrying are: length, 33 inches; thickness, 9 inches. The dimensions of box containing the frame are: length, 39 inches; width, 8 inches; depth, 3 inches. The tub part is made of heavy canvas covered with rubber, and is seamless. The tub is supported by hooks inserted through the canvas before the rubber is applied. The frame is composed of brass pipe, nickel plated. Both tub and frame can be rendered aseptic by boiling.

The Ice Cradle.—This simple measure for cooling continuously the air about the patient's body or any part of it was proposed for the treatment of pneumonia by S. W. Fenwick.[2] I frequently use it in various febrile conditions, especially in typhoid fever. It is allowed to remain on the bed so long as the temperature in the mouth exceeds 100° F., except when bathing, sponging, or other unavoidable manipulations call for its temporary removal. An ordinary iron frame or cradle, such as is used in every hospital, and sufficiently wide to permit the patient to change his position occasionally without interference, is placed over the patient's chest or abdomen or entire body. [illegible] effect, one or two ice-bags,

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1 "Med. Re[illegible]

2 W. Soltau [illegible], 1891, p. 303.

wrapped in cotton covering, or for general cooling, a row of zinc pails filled with rather large pieces of ice, are suspended from the ridge pole. The bottoms of the pails should be covered with lint to prevent dripping. When ice-bags are used, they are so adjusted as just to clear the surface of the body. Wooden hoops, properly braced, may be used in a patient's house if the iron cradle is not available (Fig. 77).

The patient is stripped; a hot-water can is placed at his feet to prevent chilliness; and the cradle is so covered with a thin counterpane as to leave openings for free circulation of air. Fenwick's statistics show great benefit from this continuous cooling in those cases of lobar pneumonia in which the temperature tends to rise above 103° F.

The Continuous Bath

The continuous bath, otherwise known as **Hebra's water bed**, may

FIG. 77.—ICE CRADLE (PARTIAL APPLICATION).

be mentioned here as having been strongly advocated by James Barr for the treatment of typhoid fever.[1] The tank employed by Barr consists of a wooden box, about six feet long, two feet ten inches wide, and sixteen inches deep, lined with lead, painted, and covered with a thick coating of shellac or white enamel paint. It is provided with a large discharge pipe communicating with a soil pipe leading down to the sewer; the 70 gallons of water which it contains can thus be drawn off in about three minutes. Inside the tank, a light wooden frame fits closely to the sides with sufficient play to be easily moved up and down for the purpose of [illegible]ing the patient

[1] "The Treatment of Typhoid Fever," Lond[illegible]

out of the water and immersing him again. A canvas sheet is fastened to the frame to prevent the body of the patient which it supports from resting directly on the bottom of the tub; at the head there is another strip of canvas about a foot wide on which rests an air-pillow to keep the patient's head above water. If a specially constructed tank is not available, a continuous bath may be improvised with an ordinary bath-tub and a hammock or a stout linen sheet. The hammock can be suspended from hooks attached to the walls or ceiling of the room, and allowed to sag into the bath-tub sufficiently to submerge the patient; or a sheet may be supported by means of a frame with pegs or holes, properly adjusted to the top of the tub. While suitable arrangements are being completed, the patient may be placed on one or more folded blankets in an ordinary tub, or on air-pillows filled with water at the same temperature as the bath. Pillow-cases filled with excelsior, or several large water bags, may be employed in the same way.

Hebra was the first to use the continuous bath in the treatment of various skin diseases, and especially in the treatment of burns. He kept his patients in the bath for weeks and months. In one instance a patient lived in a bath for over a year, during which time he gained fourteen pounds. The continuous bath has also been advocated in meningitis, locomotor ataxia, paraplegia and hemiplegia, intractable sciatica, chronic rheumatism, cutaneous hyperemia, and bed-sores. When the bath is to be employed for a long time, it is well to anoint the skin with vaselin, to avoid excessive maceration.

Technic in Typhoid Fever.—The patient is wrapped in a blanket and completely immersed, except the head. A blanket is better for this purpose than a sheet, because it is a bad conductor of heat, and if a portion of the chest temporarily rises above the water, there is then less danger of chill. The tank is covered with a half lid, to relieve the patient of the weight of the bed-clothing, a rubber sheet, and one or two additional blankets to keep in the heat of the water. The temperature of the water, which need not rise above 94° to 95° F., is readily maintained by dipping out a pailful of the bath water from time to time, and adding either hot or cold water, as required. Barr gives the following directions: So long as the patient's temperature in the mouth is over 100° F. (37.7° C.), the temperature of the tank water need not rise above 90° to 93° F. (32° to 34° C.); but as the body-temperature approaches the normal so should the tank temperature. The patient is kept in this continuous bath during the entire febrile period, and is not even removed, in severe cases, to allow him to move his bowels, a special device being employed to carry off the feces directly into the sewer.

To Make Rubber Coils for Hot and Cold Water.—A serviceable rubber coil can be made by any nurse or sewing woman. The materials required are about forty feet of red or black rubber tubing, No. 20, and a piece of rubber sheeting large enough to extend several inches in every direction beyond the coil when finished, say, half a yard square; or, instead of the sheeting, six strips of tape, half an inch wide and 16 inches long, may be used. The tubing is coiled into a circle 12 inches in diameter for a head or a precordial coil, or into an oval with a transverse diameter of 14 inches and a longitudinal diameter of 11 inches for an abdominal coil. An oblong of about 14 by 6 inches makes a convenient spinal coil. About six feet of tubing are left free for a supply pipe to convey the water by siphonage from a vessel placed above the head of the bed, and another piece of about four feet at the other extremity serves to carry off the water into a pail by the side of the bed. The coil is sewed fast to the piece of rubber sheeting, or to the strips of tape extending from the center to the circumference, after the pattern of a spider's web. As a cooling application to the head or the abdomen, particularly in the case of fever patients when the continuous action of cold is desirable, the rubber coil is much more convenient than the ordinary ice-bag. There is no wetting of the pillow or disturbing the patient to replenish the ice. I desire to emphasize in this connection the great value of the precordial ice-bag (or coil) in the febrile manifestations of pulmonary tuberculosis. It should be used continuously while the temperature exceeds 100° F. (37° C.). If otherwise deemed advisable, the patient, suitably clothed and with the ice-bag in position, may lie on a couch or reclining chair out-of doors. It is also very useful in cases of pulmonary hemorrhage. When nothing else is available ice may be wrapped in a towel, and the bed-clothes protected by several thicknesses of newspaper.

PNEUMONIA

Packing the thorax or the affected side **in ice is strongly** urged by many good observers as a part of the treatment of acute pneumonia, both croupous and catarrhal. My own observation, however, has not led me to regard the practice favorably, and I still employ heat; choosing, according to circumstances, the hot-water bag, the wool-jacket, or the old-fashioned poultice, to be considered in a succeeding volume.

The use of the **ice cradle** has been mentioned.

The rules laid down by Dr. Lees[1] for the use of the ice-bag in pneumonia are as follow:

1. Apply the ice-bag over the dull area, and especially over the *advancing edge* of the consolidation.
2. If the area is large, use two ice-bags at least, or three. Even young children may require two.
3. Expect to find a distinct *local* effect (improvement of percussion note, less bronchial breathing, looser râles) on careful physical examination, after the ice has been applied for twenty-four hours.
4. If fresh areas of consolidation develop, use additional bags. Four, or even more, may be used in a bad case. Correct dosage is as important as it is with drugs.
5. Take the temperature every half-hour for the first three hours; afterward every two hours.
6. Apply hot-water bottles to the feet and legs. For children apply these *before* the ice is applied.
7. Examine physical signs twice daily, and shift the bags accordingly.
8. If pericarditis is present, place one ice-bag over the heart.
9. If the temperature be below 99° F., or the hands cold, or the lips bluish, remove the bags for an hour, then replace them, and use them for two- or three-hour periods, with one- or two-hour intervals.
10. If in a severe case there is a distinct cyanosis, and a rapid, feeble pulse, consider whether leeches (in urgent cases venesection) would not relieve the right heart.

[1] "Birmingham Medical Review," November, 1896.

11. In all cases see that sleep is secured during the first three or four nights. If the relief afforded by ice-bags does not suffice for this, medication is necessary.

12. Pneumonia treated vigorously with ice within twenty-four hours after the rigor may sometimes be aborted.

The Chest Compress.—The full bath in pneumonia is very distressing to the patient by reason of dyspnea, pain, and cough. Baruch has therefore abandoned it in adults in favor of the chest compress. The rectal temperature is taken every hour when the patient is not asleep. So long as the temperature registers over 100° F. (37.7° C.) a compress made of three folds of old coarse linen wrung out of water at 60° F. (15° C.) is wrapped around the chest from the clavicle to the umbilicus. It should be long enough to lap over one inch in front, and so slit in its axillary portion that it may rise easily up to the clavicle without leaving rough folds in the axilla. This compress is smoothly wrapped around the chest and covered by one layer of thin flannel, an inch wider and longer. In the case of young children, who are easily lifted, a full bath of moderate temperature (95° to 80° F.—35° to 26.5° C.) is more convenient and does not distress the little patient; affusions of water at a lower temperature (70° to 60° F.—21° to 15° C.) are most useful in bronchopneumonia with obstruction, because pleurisy is usually absent, and the shallow breathing and deficient oxygenation due to bronchial obstruction are greatly relieved by the agitation, crying, and coughing incident to the procedure.

The effects of the chest compress may be materially modified by changing the manner of its preparation. If, for example, the body-temperature is not very high,—say, from 100° to 102° F. (37.7° to 38.8° C.),—the compress may be more thoroughly wrung out, so as to make the impression of cold more brief, reaction more rapid and less enduring. If the temperature is high,—103° F. (39.5° C.) or above,—the water temperature may be raised to 65° F. (18.5° C.), and more water may be allowed to remain in the compress, thus rendering the reaction slower and more enduring, and abstracting more heat. In the first instance the application will be more stimulating, in the latter more soothing and antipyretic.

LARYNGITIS AND PHARYNGITIS

The Throat Compress.—The usual method of applying this compress by folding a handkerchief or napkin into a narrow bandage and winding it around the neck is faulty. Such a compress is displaced in a very short time by the movements of the patient, air enters freely from above, and the compress dries rapidly, thus defeating the object for which it is applied. When it is intended to treat some tracheal or laryngeal trouble, if one end of the bandage be well wetted and covered over by the other end to delay evaporation; or if a mass of absorbent cotton, or a handkerchief folded four-square be wetted and covered with a dry handkerchief, it will often suffice. I desire to emphasize here the good effects of th[illegible] forms of throat compress in subacute and even chronic irrit[illegible] well as in the acute form. The action is enhanced whe[illegible]counter-irritation, as with spirit of camphor. When i[illegible]ent of tonsillitis, diphtheria, and other pharyngeal af[illegible] throat compress should be applied as follows: A piece [illegible]ngth to reach from below the ear on one side to the same point on the other, is folded into a compress of four layers. A piece of flannel, 8 by 24 inches, provided with a slit for each ear, is also made ready. These bandages are fitted by actual measurement to the patient's head, so that they may pass under the chin from ear to ear. The linen compress is now wrung out of water at 60° F. (15° C.) and laid upon the middle of the dry flannel bandage. While the wet bandage is placed under the chin, the flannel bandage is unrolled from the top of the head and passed over the right side of the head, the right ear being made to protrude through the slit, and then passed under the chin to the left side, where the left ear is also allowed to protrude. The entire bandage is now firmly drawn over the head and secured by pins (Fig. 78). Two sets of bandages are required, one being allowed to dry while the other is in use.

THERMIC FEVER AND HEAT EXHAUSTION

Hydrotherapy is universally employed in the treatment of conditions, whether of exhaustion or of hyperpyrexia, resulting from exposure to excessive heat, combined usually with overexertion and too often with alcoholic abuse. The indications are unmistakable. In sunstroke or thermic fever the excessive temperature must be reduced as speedily as possible if life is to be saved. Hospitals are provided with tents containing couches covered with rubber sheets and within reach of water connection. The most convenient method of applying water is with an ordinary hose, so-called **slushing.** When a patient suffering from thermic fever is brought to the hospital, he is at once divested of his clothing and placed on one of the beds in the tent, and a stream of cold water is played on him until the temperature begins to fall. As the decline is usually rapid, it is advisable to stop before the temperature goes below 101° F. (38° C.). If the patient fails to respond to this treatment within a reasonable time,—say, half an hour,—he should be tubbed in water at 75° F. (24° C.), rapidly reduced to 60° F. (15° C.), vigorous friction being applied as in the case of a typhoid fever patient. The tubbing must be repeated every two hours, if necessary to control the temperature. In the intervals, **ice-bags** or **ice-water coils** may be applied to the precordium and the abdomen or the **ice cradle** utilized. **Sprinkling** with very cold water may be substituted for the tub-bath. With it is combined the process of 'ironing' with ice, already described under the term **ice rub,** in which a flat piece of ice is passed rapidly o[illegible]

FIG. 78.—THROAT COMPRESS. CORRECT AND INCORRECT APPLICATION.—(*After Baruch.*)

and back. Another measure much used, but of inferior efficacy, is the **ice pack,** either alone or in combination with sprinkling, slushing, and tubbing. The ice must be shifted about during the pack, though there is little danger of freezing a part which is 110° F. **Ice-water enemas** are also employed.

In **heat exhaustion** the indications are equally clear. Cold applications are of course useless, and even harmful. The temperature in this condition is subnormal, hence tepid or warm baths and warm applications, such as the **hot wet pack,** are in order. Care must be taken not to bring on excessive reaction. In addition to hydriatric measures, stimulation with alcohol, strychnin, and other drugs must also be resorted to. Convulsions must be promptly relieved by chloroform inhalations; **hot saline infusions** by rectum or skin, or into a vein, may be useful.

APPLICATIONS OF HEAT

Acute Eruptive Fevers.—Except in cases exhibiting very high fever I have seen better results from **warm or hot baths** (85° to 100° F.) than from cold or cool baths in the eruptive fevers of children, and in the measles of adults. Especially in the prodromal stages, and in cases of delayed or incomplete eruption, does heat seem useful. Hot drinks are also to be given. Comegys, of Cincinnati, advocated repeated hot baths in scarlatina, even when pyrexia was marked. When the temperature reaches or exceeds 41° C. (106° F.), however, I prefer tepid or cool ablution (80° to 70° F.); and in cases of persistent elevation, often make use of graduated tubbing, as in typhoid. In some instances, a tepid bath (85° to 90° F.) for four or five minutes, followed by a cold ablution (50° to 60° F.) of the same or briefer duration, is even better.

Cholera.—In that rare disease, winter cholera of temperate climates, of which I have seen one case, persistent application of **heat externally,** with **hot irrigation** of the bowel, seemed to save life. In the absence of personal experience with cholera Asiatica, I can only call attention to the fact that in place of the cold frictions and the like advocated by Dr. Buxbaum, many authorities prefer hot infusions, hot irrigations, and a high degree of external heat applied by any available means. For example, patients well wrapped in blankets have been placed in beds of 'setting' lime to impart heat to the body during collapse. Unquestionably, from a theoretic standpoint, it is preferable to excite therapeutic reaction by means of cold applications, if time permits—which means that collapse is not to be waited for. Brief hot packs or hot baths, followed by cold rubs until reaction sets in, would thus seem to combine the advantages of both methods; and, in fact, I have seen these measures in combination with hot irrigations and saline infusions do much good in cholera morbus and cholera infantum.

To Prepare the Hot Wet Pack.—One of the difficulties in the employment of the hot wet pack is the wringing out of the blanket, which is of course too hot to be handled with comfort with bare hands. A useful and simple device to obviate this difficulty, and the manner of using it, [illegible] ompanying illustrations (Figs. 79 and 80). A piece of [illegible] about half a yard long and ten or twelve inches [illegible] nd to a short stick—a piece of broom handle will [illegible] k towel, and a wringer is thus obtained with [illegible] wrung out thoroughly without danger of scalding one's hands. A single blanket is dipped into boiling water; or perhaps a better way is to twist it up and roll it, twisted, into a large bowl or basin, then pour over it a kettleful of boiling water. The hot blanket, when wrung out, is applied directly to the patient's skin, while it is very hot, care being of course exercised not to scald him. It is then covered with a dry blanket, and outside of that with a large rubber sheet; or the dry blanket may be omitted or placed outside the sheet. The essential thing is to make sure that the air is excluded. The patient is allowed to sweat for about twenty minutes, when the pack is removed and the body rubbed dry

FIG. 79.—PLACING THE HOT BLANKET IN THE WRINGER.

with a warm towel. The patient should continue to lie between blankets for an hour. Additionally to the uses of the hot wet pack stated in preceding pages, it may be noted that for sciatica and neuritis Baruch recommends highly a compress of several thicknesses of old blanket wrung thoroughly out of boiling water. The patient is loosely wrapped in blankets, the painful part covered with flannel, and over this is laid the steaming hot compress, which is secured by a flannel strip. The compress is to be renewed every ten minutes until the patient perspires, when he is allowed to continue in the pack an hour.

Hot-air or Vapor Bath to Induce Sweating.—A method of giving a hot-air bath in bed is shown in figure 81. The patient is stripped and laid upon a blanket or blankets with a wet compress or an ice-cap upon his head. Two large half hoops to support the coverings are placed crosswise on the bed. These should preferably be of metal; but trundle, or barrel hoops, protected by flannel wrappings, may be utilized in an emergency. An alcohol lamp on a stand or tripod, an oil lamp, or other convenient heat generator is placed at the foot of the bed, and hot air is conveyed by means of an elbow of stovepipe resting on the metal hoops and covered by a blanket and sheet. The illustration shows a long horizontal section of pipe, which is desirable but not imperative. The coverings should be well tucked in to

FIG. 80.—WRINGING OUT THE BLANKET.

retain the heated air and exclude cold air; leakage will always be sufficient for safe circulation. Steam may be generated in a large kettle and conveyed about the patient in a similar manner. In the Philadelphia Hospital, particularly in cases of acute nephritis and of uremia, I have given the patient a hot tub-bath in water at 108° F. (42° C.) for ten to fifteen minutes, and then placed him in the hot-air bath; thus inducing profuse perspiration when other means have failed. Sweating may be favored by having the patient drink a pint of hot fluid (tea, lemonade, or water) just before leaving the tub, when consciousness is preserved, or by a hot saline enema when the patient is unconscious. Often, the hot-tub bath, or even a hot mustard foot-bath, with the hot drink, and followed by a hot blanket pack with hot cans about the patient, will suffice, without the hot-air bath, to produce sweating.

'Simpson' Sweat Bath.—As practised at the Philadelphia Hospital, the patient is divested of clothes and placed between blankets, the mattress being protected with a rubber sheet. Hot-water cans or bottles are then filled with nearly boiling water and some squares of flannel or old blanket are wrung out of very hot water and wrapped around the cans. These are then placed around the patient; a single blanket being interposed between the cans and the cutaneous surface. The greatest care is necessary in the case of delirious, unconscious, or extremely restless patients to prevent the occurrence of a burn. After twenty minutes the hot-water cans are removed, and the patient is well dried with a warm towel.

Additional uses of these sweat baths to those mentioned in preceding pages are, to abort a coryza, or even an attack of influenza; to

FIG. 81.—METHOD OF GIVING HOT-AIR BATH IN BED.

render less severe an attack of acute bronchitis or bronchopneumonia, or even of lobar pneumonia, when the patient is seen early; to avert grave complications in severe cases of acute laryngitis; to relieve edematous conditions in the lungs or elsewhere, especially general anasarca; and to promote rapid elimination in cases of metallic poisoning or of syphilis, especially when late syphilitic lesions, such as cerebral gumma or optic neuritis, are treated coincidentally with large doses of mercury by inunction, by inhalation, or subcutaneously.

Local Shock Baths.—Two large carriage sponges with two basins, one filled with very hot water, the other containing a lump of ice, are the appliances required. The bath consists in alternate sponging of the part with hot and cold water; it should last about twenty minutes and should terminate with a cold sponge. It stimulates and improves the nutrition, its action being similar in kind to that of a Scotch douche. The chief indication for a local shock bath is neuritis. It is also useful in sprains and to reduce pain and swelling in injuries about joints. In the case of the foot or ankle, the member may be placed alternately in a basin of hot water and a basin of cold water. Similarly hot and cold water may be poured from pitchers at any height desired.

The Hot Alcohol Sponge.—This is invaluable in cases of insomnia, particularly when resulting from alcoholism. Equal parts of alcohol and boiling water are to be used if obtainable; if not, half the proportion of alcohol will do. The entire body is sponged for ten or fifteen minutes with a somewhat firmer stroke than is used when reduction of temperature is desired.

IRRIGATION OF HOLLOW VISCERA

Irrigation of the Colon.—The double-current method of irrigating the rectum and colon is said by Kemp[1] to possess distinct advantages. The temperature of the solution, and its quantity as well, are readily controlled; the fluid does not cool since fresh hot fluid is constantly taking the place of the cooler which passes out; the desire to defecate and the straining to overcome the resistance of the sphincter can be relieved at once by checking the inflow and allowing a freer outflow. In

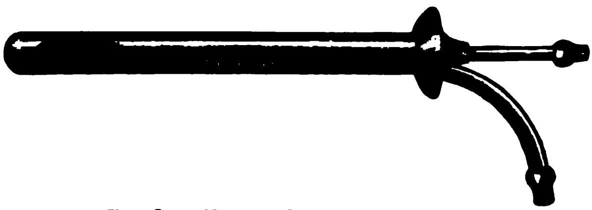

FIG. 82.—KEMP'S RECTAL IRRIGATOR.

this way a prolonged irrigation, lasting an hour if desired, may be given. In diarrhea continuous irrigation appears to clear out the intestinal tract more rapidly by allowing the small intestine to evacuate its contents continuously into the lower bowel. Tympanites is more readily relieved than by any other method, as the gas is carried off by the return flow instead of collecting behind the injection, as often happens when a single tube is used.

There are several good instruments on the market. Kemp's irrigator is made on the principle of a tube within a tube, the central tube, which is connected with the supply pipe, opening at the apex of the instrument (Fig. 82) and passing through a cap which, when screwed in position, closes the outer extremity of the outer t[illegible] is attached the discharge pipe, opening into the outer [illegible] h two lateral fenestra. The irrigators are ma[illegible] ubber. A simple method of improvising a dou[illegible] ws: Two catheters, one of larger caliber t[illegible] or about two-thirds of their length with [illegible] will adhere sufficiently to be introduced. [illegible] may project

[1] "Enteroclysis, I[illegible]

one or two inches above the larger, so that the inflow will be on a higher level than the outflow, and a longer projecting portion remains externally for an outflow. The eyes of the catheters should be directed laterally outward. This improvised irrigator is passed through a perineal pad of gauze or cotton, covered with oiled silk or a piece of oil-cloth or a dress shield, and then inserted in the bowel. The pad keeps the fluid from running out of the bowel, even if there is incontinence. If only drainage-tubes are at hand, the rough edges can be trimmed off, and then, by heating over a flame and wiping quickly with a moistened finger or cloth, a smooth and rounded edge and 'velvet eyes' can be obtained.

The usual method of administering a colon irrigation is by means of a colon tube, which should have fairly thick walls and be as large as can conveniently be passed, thin tubes and those of smaller caliber being apt to kink and double on themselves. I usually employ the long tubes made for siphoning the stomach-contents. It has been objected that with the ordinary colon tube, which is at most eighteen inches long, it is impossible to enter the colon. This is probably true, and the longer tube is not, as a matter of fact, made to penetrate any further than the sigmoid flexure; but even with a penetration of but seven or eight inches, with the patient on his left side or preferably in the knee-chest position, the method is clinically satisfactory in the usual run of cases. Kemp has abandoned the use of the colon tube altogether, and believes that the descending colon can be reached more easily with a five-inch irrigator provided the patient be placed in the proper position, with his hips elevated.

Certain precautions should be observed before and during the introduction of either instrument. The fluid is to be allowed to flow through the tube so as to force out all the air and the flow is then checked. As the tip of the tube passes through the sphincter into the bowel, the flow is started so as to force the mucous membrane away from the irrigator and fenestra. In this way also the entrance of the tube is not interfered with by the resistance of the mucous membrane. The tube should be warmed and well lubricated, and with the tip directed toward the sacrum it is inserted with a gentle rotary movement—not forced in. In withdrawing the instrument it should be rotated slightly, first in one direction and then in the other, to prevent the mucous membrane from catching in the eyes, or to free the tube if this accident has occurred.

The patient may be placed in the dorsal position, or on either side, with the hips elevated and the shoulders at a lower level. In the dorsal position a douche pan or a Kelly's pad will add to the convenience of the procedure, or a trough may be extemporized with a rubber sheet and used in any position. The most satisfactory position, however, is the knee-chest; it insures the entrance of the fluid into the colon and is not more fatiguing to the patient than any other.

The chief object of intestinal irrigation is to effect a thorough cleansing of the bowel. Except in those cases in which the thermic factor enters into the question, when the character of the fluid is of secondary importance, the irrigating fluid usually employed is the clinical saline solution—a dram of sodium chlorid to each pint of water. If desired for any reason, however, whether to allay irritation or to introduce an active antiseptic or solvent agent, the solution may be medicated. Thin soap emulsions are often used, and are to be preferred when volatile oils are to be added. Of the latter, turpentine is the most common, in the proportion of a fluidram to the pint. The oils of peppermint or cinnamon are often used in the dose of 5 to 15 drops to the pint. Potassium permanganate up to 10 grains in the pint, and mercuric chlorid in the strength of 1 : 10,000, are among the antiseptic solutions commonly recommended. Formaldehyde, not exceeding one minim of the 40 per cent. solution to the ounce of irrigating fluid, and rarely reaching this strength, may be used on occasion. Silver nitrate solutions not, as a rule, exceeding in strength 8 grains to the pint of water may be used if there are old dysenteric ulcers; they should always be followed by saline irrigation. The **quantity** of fluid to be used depends altogether on the indications to be met in the individual case; as a rule, it should not be more than two quarts nor less than a pint.

The **indications** for the employment of colonic irrigation are generally familiar; they embrace practically all morbid conditions of the intestinal tract in which a thorough cleansing is desired for the purpose of removing irritating substances and enabling the mucous membrane to resume normal function; thus, in acute and chronic diarrhea and dysentery, in mucous enteritis, in certain cases of typhoid fever, in cholera, in certain cases of intestinal hemorrhage, and similar conditions. By utilizing the thermic element it may be employed also to combat fever, on the one hand, and to supply heat, as in cases of shock, or, locally, to allay spasm and dissipate congestion. According to Hyde, rectal irrigation is of distinct value as a substitute for vaginal douching in young girls; in leukorrhea; in acute and chronic ovarian and tubal lesions, with the exception of pyosalpinx; in intestinal paralysis following sepsis; after pelvic operations, to relieve abdominal discomfort or tympanites. Continuous irrigation for half an hour to an hour is indicated in shock and in uremia. A large quantity of fluid is employed; and from a pint to a quart may be kept continuously in the bowel by pinching the outflow tube and regulating the inflow, and by watching the quantity of fluid in the fountain syringe. The temperature of the fluid in these conditions should be between 110° and 120° F. (43° to 48° C.). If it is desired to increase renal secretion without increasing pulse-tension or temperature, fluid at 100° to 104° F. (38° to 40° C.) should be employed. The same treatment is warmly recommended in diphtheria, and may be used in conjunction with antitoxin, providing the irrigation does not follow too closely on the injection of antitoxin. If the irrigation is given four or five hours after the injection of antitoxin, the latter will not be eliminated before its effects are secured, and yet the renal congestion is relieved and the elimination of toxins accelerated. In fecal impaction the obstructing mass is first dissolved by an enema of hot oil. The patient rests for an hour, with a hot application on the abdomen, after which the irrigation is made; and this method is continued until the obstruction disappears. Robertson, of Warren, Pennsylvania, states that crude petroleum is the best solvent of impacted feces, and this material is commonly employed by physicians in the 'oil regions.' Constipation in typhoid fever yields to hot oil enemas, with the least amount of distress to the patient and danger to the integrity of the bowel. In intussusception good results are reported by some authorities, while others deny its usefulness and believe that the condition always demands surgical intervention. In any case the procedure must be emplov with caution, avoiding excessive pressure and increasing the height fountain syringe very gradually. Congestion, acute inflammati chronic enlargement of the prostate gland, and prostatorrhea have been treated with success by continuous rectal irrigation. Both heat and cold have been employed; the best results seemingly being obtained with prolonged irrigation—in some cases even to an hour. Gout, lithemia, some forms of anemia, diabetes of intestinal origin, and many vague disorders dependent upon absorption of toxic material are sometimes corrected, or at least improved, by systematic cleansing of the intestinal tract. In cases of intestinal hemorrhage, as well in typhoid fever as in other conditions, it is often useful to wash the bowel with water as hot as can be borne (110° F. or more), containing 120 grains of pure calcium chlorid to the pint. Only when hot water fails to do good should ice-water be substituted. After the cleansing, a suppository of opium and belladonna should be inserted.

Gastric Lavage.—In the original and simplest apparatus, an esophageal tube of flexible rubber, about 28 inches long, with blunt double-eyed extremity, and from one-fourth of an inch to a little less than half an inch in diameter,—practically an enlarged catheter and made of similar material,—is attached by a small section of glass tubing to a soft rubber tube of about one yard in length, in the free extremity of which a glass or rubber funnel of from six to eight ounces capacity is inserted. Long rubber tubes with funnel attached, some having a bulb in their course to facilitate siphonage, and tubes with single lateral eyes, with multiple small perforations, and with a single central opening are now furnished, and each form has its advocates. The patient sits or stands, facing the physician. The esophageal tube, having been dipped into warm water or warm milk, is placed within the entrance of the esophagus and is then propelled by successive steps into the stomach; the process being facilitated by efforts at deglutition on the part of the patient. Many patients learn to introduce and swallow the tube without assistance. A mark on the tube shows when a sufficient length has been introduced; say, eighteen or nineteen inches. The funnel is then elevated to the level of the patient's forehead, and from a pint to a quart or more of the lavage solution is slowly poured in; the glass junction-tube permitting its passage to be watched, and obstruction or attempted regurgitation to be detected. The patient's sensations will indicate when a sufficient quantity of the solution has entered the stomach. As the last portion of the liquid is disappearing from the funnel, the soft rubber tube is pinched near the junction with the funnel, the latter is rapidly inverted over a receptacle placed on the floor, and the contents of the stomach are thus removed by siphonage. This is repeated until the fluid returns clear.

The first introduction of the tube, and possibly the second, will occasion dyspnea, often nausea and retching, rarely vomiting. These effects, though partly physical, are chiefly psychic, and will disappear with tolerance; the dyspnea may quickly be checked by insisting on full inspirations. Nausea is overcome as soon as the fluid enters the stomach, floating the tube away from immediate contact with the mucous membrane. In highly neurotic subjects it may be well to prepare for the operation at first by administering full doses of bromids. In rare cases a local anesthetic must be used.

Sometimes during the withdrawal of the solution solid particles of food may become impacted in the eyes of the tube and the flow of liquid will cease. A little more fluid must then be introduced, both to wash away the obstruction and to reestablish the siphon current. If the tube is pushed too far into the cavity of the stomach, it may curve upon itself and the siphon will not work. Withdrawal of the tube for a few inches will remedy this.

When lavation alone is the object of the procedure, a weak alkaline or saline solution is employed; a dram of sodium sulphate, sodium chlorid, sodium borate, or sodium bicarbonate in each pint of water at about 100° F. (37.5° C.). Should it be considered necessary, however, various sedative or antiseptic medicaments may be added to the lavage solution. Among those recommended are resorcin (one per cent.), boric acid (one per cent.), creosote (one per cent.), carbon bisulphid (one part of a solution containing fifteen grains to the quart, to two parts of water), charcoal powder (two to four tablespoonfuls), chloroform water (saturated), bismuth subnitrate (two tablespoonfuls to the pint—Dujardin-Beaumetz's 'milk of bismuth').

Lavage should be performed when the stomach is practically empty, and for that reason many prefer the hour of rising in the morning. Late in the afternoon is sometimes more convenient. In an ordinary case lavage should be done every day or every other day for about two weeks, after which the intervals between successive washings may be lengthened, and finally the process entirely omitted. When for any reason lavage cannot be carried

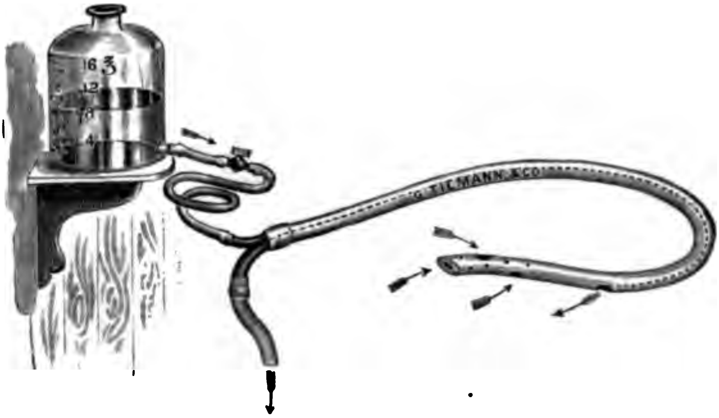

FIG. 83.—HEMMETER'S IMPROVED RECURRENT STOMACH-TUBE.

out, the slow sipping of a pint of hot water one hour before meals (or before breakfast or dinner only) will sometimes prove an efficient substitute. Sodium phosphate may be added to the water if necessary.

Stomach douches and various appliances for irrigating and spr
stomach, utilizing stationary reservoirs of glass and rubber and
tems of valves and stop-cocks, have been devised. These are,
more elegant, more accurate, and more convenient than the origi
A good form of recurrent stomach-tube is illustrated in the
ing cut (Fig. 83). The tube and funnel are, however, sufficient
purposes and have the advantage of simplicity, the necessary te
acquired readily. Lavage may be employed to empty the stom
of poisoning, or of obstinate vomiting, or when the stomach ca
itself into the duodenum. It is most useful in cases of dila
stomach, in which delayed digestion, with retention and ferm

contents of the viscus, gives rise to distressing symptoms. It is applicable in all pronounced catarrhal conditions; in some cases of gastralgia; in cancer of the stomach, as a palliative; and in the chronic gastritis of drunkards, even if there be some hematemesis. It is indispensable in hyperchlorhydria. In actual ulceration of the stomach it is usually counterindicated, though in some cases, used with caution, it is of service in removing clots and facilitating healing. Lavage has been successfully employed in the treatment of ileus. This result is explained by Kussmaul on the theory of relief to the tension above the point of constriction, caused by gases and accumulated feces; with concomitant restoration of normal peristaltic action. It should always be employed as a preliminary to surgical operation in cases of intestinal obstruction, in which category strangulated hernia is to be included, for, in its absence, the vomiting sometimes induced by ether may turn the balance against recovery.

Gavage, or forced feeding, is the utilization of the stomach-tube and funnel for the introduction of liquid food. As much as a quart at a time may often be introduced. Milk, previously peptonized if necessary, and of course heated, is the basis of the nutritive mixtures employed. To this may be added meat-powders, eggs, or farinaceous powders. It is especially applicable as a method of superalimentation in tuberculosis, but is also employed in other wasting diseases, with insane patients who refuse food, and when swallowing is difficult or painful. It may usefully follow lavage.

Irrigation of the Bladder.—A number of two-way catheters are to be found in the shops. In the ordinary method with a fountain syringe or funnel and a single-current soft rubber catheter, the connection between the syringe and the catheter should be made by means of a Y piece to provide a separate channel for the outflow. The irrigating fluid should be introduced in small quantities and under rigid aseptic precautions, the bladder having been emptied previously. But little force should be used and the water should be allowed to flow out immediately, without, however, pressing on the viscus so as to avoid the irritation produced by forcible contraction of the bladder upon itself. A convenient device for irrigating either the urethra or the bladder is that of Dagget. The instrument, which is Y-shaped, is first introduced into the urethra and then connected with the tube from the syringe, the outlet being stopped with the finger. The fluid gradually distends the urethra and finally enters the bladder; as soon as the latter is filled the supply pipe is compressed with the fingers and the fluid is allowed to escape. The use of this instrument obviates the danger of urethral fever, which is likely to develop when catheterization has to be practised daily.

In addition to cystitis the conditions in which irrigation of the bladder is indicated are atony of the bladder and paralysis of the bladder associated with paraplegia, locomotor ataxia, and other nervous diseases. Very hot irrigation, 118° to 122° F. (47.7° to 50° C.), is useful to control hemorrhage from the bladder, a cold application being made to the abdomen at the same time.

Vaginal Irrigation.—A fountain syringe, a rubber tube, and a glass or hard-rubber nozle are the instruments required. The 'household syringes' now obtainable in all shops are supplied with various forms of nozles, of which the rather large grooved cylinder with lateral perforations is to be preferred, except in the comparatively trivial ailments of the unmarried. The woman lies on her back with the hips elevated and the buttocks supported on a rubber (Kelly) sheet-pad or douche-pan to catch the return flow. The nozle of the syringe should be introduced behind the cervix, to avoid injecting the fluid into the uterine cavity. The value of vaginal irrigation as a cleansing procedure, with or without the use of antiseptic or astringent drugs, need not be enlarged upon; and its general usefulness in gynecologic practice has already been alluded to in the text and in the article on irrigation of the colon. Hot irrigation lessens uterine excitability and contractility; cold irrigation has the opposite effect and aggravates neuralgic and other pelvic pain; it is therefore very little used. Hot irrigation is employed to relieve pain and to promote the absorption of exudates; it is useful, also, in chronic metritis and endometritis, and in ovarian and tubal disease. I have observed persistent hot douching bring about recovery in cases of nonsuppurative inflammation in and about the uterine appendages, even after it had seemed best to discuss with a gynecologic surgeon the propriety of operation. Very hot irrigation of the vagina is useful in cases of menorrhagia and in certain other forms of hemorrhage in which surgical intervention or packing is not required. Calcium chlorid may be added to the water, which must be as hot as can be borne, even so high in temperature as 125° or 130° F. (say, 51.5° to 54.5° C.). If the application is continued too long, paralytic phenomena with venous congestion of the uterus are induced. Prolonged hot irrigation is thus useful in the first stage of labor to dilate the cervix and relax the perineal muscles. Pregnancy is not a counterindication to the employment of vaginal irrigation, provided the application is made with due care. Vaginal douches before and after parturition are used under certain circumstances concerning which all obstetricians are not agreed.

Intrauterine Irrigation.—Double-current or irrigating sounds have been devised by Kellogg and others for intrauterine irrigation. The rate at which the water flows through the instruments is readily regulated by compressing the outflow tube; and by allowing the water at the outlet to fall on a thermometer, the temperature may be kept under constant observation and regulated at will. The necessary aseptic precautions must always be observed strictly. The fluid employed in this, as in most other forms of irrigation, is the clinical salt solution, which is less irritating to mucous membranes than pure water. If desired, the fluid may also be medicated with various antiseptic and other substances—mercury bichlorid, boric acid, and potassium permanganate, in suitable strengths, being the substances in most common use. The cavity of the uterus is irrigated in connection with curetment and other operations on the interior of that organ, and after labor when blood-clots or portions of the membranes are retained. Adrenalin chlorid (1 : 4000) and calcium chlorid (1 per cent.) might be added when a decided hemostatic effect is desired. Irrigation is also employed in catarrh of the cervix and endometritis, in subinvolution, and in conditions associated with relaxation of the uterine muscle.

Eye, Ear, and Nose.—For the sake of completeness only, cleansi and medicinal irrigations of the eye, ear, and nasal cavities may mentioned; but need not here be dilated upon.

LOUTROTHERAPY

Artificial Carbonated and 'Nauheim' Baths

For the **carbonated bath** continuous evolution of carbon dioxid gas is necessary; for the **Nauheim bath** this must take place in a warm brine solution. Attempts have been made to utilize **liquid carbon dioxid.** It is difficult to secure solution of carbon dioxid in hot water, or to heat the cold carbon dioxid solution (*e. g.*, soda water) without expelling the gas; hence it has been proposed to overheat the water or brine solution, and then to admit highly charged, cold, carbon dioxid water in such quantity as will yield a mixture of the strength and temperature desired. However, no simple and easily managed apparatus that can be availed of at the patient's home has yet been placed upon the market, and for domestic use, therefore, the **extemporaneous generation of gas** is necessary. In the older and cruder method, still largely used in Europe, sodium bicarbonate is acted upon by sulphuric or hydrochloric acid. American physicians prefer to use **acid sodium sulphate** (sodium bisulphate), which is equally efficacious and, as a solid, is more easily handled. The ingredients for carbonated baths have been placed upon the market in convenient packages by Mr. H. A. Cassebeer, of New York, and the Triton Salt Company, of the same city. Eight parts of sodium bicarbonate will neutralize twelve parts of sodium bisulphate, but it is desirable to keep the alkali in excess—among other reasons, for the protection of the tub. The commercial package contains about 32 ounces of sodium bicarbonate, and an equal quantity of bisulphate made into cakes of 4 ounces each. These quantities, in a bath of forty gallons, will yield about 250 c.c. of carbon dioxid to the liter. The quantity of gas evolved may be increased by adding bisulphate. Carbonic acid gas cannot, however, be held in a solution of constant composition when exposed in a tub, and this applies to the natural carbonated waters as well as to the artificial bath. Although the Nauheim springs contain from 550 to 1300 c.c. of gas to the liter, yet so much is allowed to escape before the bath is given that it is quite probable that the artificial bath, prepared as stated, is fully equal in strength to the natural bath, as it likewise seems to be in therapeutic efficiency.

Preparation and Administration of the Bath.—The **brine solution** at Nauheim contains from 2 to 3.5 per cent. of salts, of which about 82 per cent. is sodium chlorid, and about 8 per cent. calcium chlorid. To prepare the brine solution for the artificial baths, these or other salts may be used in any strength desired. Many American physicians content themselves with sodium chlorid; others use sea-salt, believing that the iodin and bromin have therapeutic value; still others prefer the Nauheim crystallized salts.

The tub should contain from forty to fifty gallons of water of the temperature desired, usually from 97° to 90° F. (say, 36° to 32° C.); this, as well as the saline constitution and percentage, the carbonic acid charge, and the duration of the bath, being adapted to the needs of the individual case. The brine solution is first made, and then the sodium bicarbonate in convenient packages is deposited at four places in the tub, roughly corresponding to the shoulders and ankles of the patient when he shall be immersed. The acid cakes are deposited in the neighborhood of the alkali—and, unless the tub is of wood or porcelain, upon squares of tinfoil. Evolution of gas begins at once, and is allowed to progress for two or three minutes, so that the water shall be well charged before the patient enters. When it is desired to limit the action of the gas to a portion of the body, the alkali is placed near the part to be acted upon, and acid cakes are added successively. In this way a local application may be quite prolonged.

The general **duration** of the bath in cases of cardiac and renal affections is from five to eight minutes; but this is to be governed in each instance by the effect, which in serious cases should be watched by the physician, or in others by a highly skilled attendant. To some patients it is well to give the bath at night, and to follow it with brief, gentle massage, as the combination tends to promote refreshing sleep.

A course of **graduated baths,** usually twelve in number, may extend over a period of from four to six weeks; after which the treatment may be intermitted for twelve weeks or more. Such a course may begin with weak saline baths; the third or fourth bath may be mildly carbonated; while the twelfth will reach a high degree of saline percentage and of gaseous charge. The quantities set forth in the table that follows do not constitute a rigid and invariable routine, but are to be taken as illustrative.

For 40 gallons of water:

	Brine		Gas	
	Sodium Chlorid	Calcium Chlorid	Sodium Bicarbonate	Sodium Bisulphate
Bath 1,	60 Ounces	6 Ounces	— Ounces	— Ounces
" 2,	72 "	8 "	— "	— "
" 3,	84 "	9 "	— "	— "
" 4,	96 "	10 "	8 "	8 "
" 5,	108 "	11 "	16 "	16 "
" 6,	120 "	12 "	24 "	24 "
" 7,	132 "	12 "	32 "	32 "
" 8,	144 "	12 "	40 "	40 "
" 9,	156 "	12 "	48 "	48 "
" 10,	168 "	12 "	48 "	56 "
" 11,	180 "	12 "	48 "	60 "
" 12,	192 "	12 "	48 "	60 "

On the days intervening between baths, the **gentle resistance exercises** known by the name of the Brothers Schott may carefully be employed. (See Volume VII.)

PHOTOTHERAPY

Refrigerated Light

Doctor Fouveau de Courmelles, of Paris, with the help of M. G. Trouvé, the electrician, has devised an apparatus, exhibited in December, 1900, to which he has given the name of **Fouveau-Trouvé** [illegible] **radiator.** Depending on refrigeration to exclude the heat [illegible] with the cupric solution, and differs from Finsen's apparat[illegible] ant particulars, not the least of which are its simpli[illegible] low cost. It may be used with direct or reflecte[illegible] tric light. A feeble electrochemical source is can be used within mucous cavities as well as [illegible] tion is made use of, the source of light is pl[illegible] reflector, so that all the rays are utilized. The compressor, which is an integral part of the apparatus, consists of two discs of quartz, of variable length and area, according to the regions to be treated, thus avoiding lenses, which not only themselves absorb light, but also diminish its activity by their multiplied double refraction. When the external surface is to be treated, the patient leans against the compressor, thus dispensing with the services of an attendant. Between the discs of quartz, cold water is allowed to circulate. The carbons may be placed directly in front, as the much-vaunted oblique position has no advantage; but to obtain the best

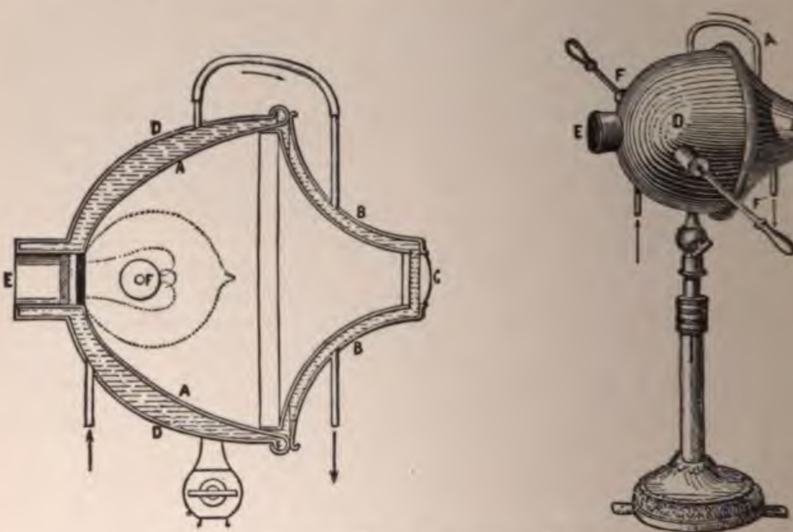

FIG. 84.—FOUVEAU-TROUVÉ CHEMICAL RADIATOR.

A, Parabolic reflector. B, Prolongation of the cone of concentration. C, Quartz chamber and compressor for utilizing the chemical rays. D, Refrigerant outer covering. E, Opening for utilizing the direct rays, and to enable the operator to see and regulate the arc. F, F, Carbons (distance can be regulated at will) or incandescent lamp. G, Extensible, folding base of apparatus.

possible effect, they should be placed exactly at the focus of the mirror, and should be of the best quality. The water which circulates between the quartz discs must be clear, so that it may not absorb the chemical rays.

It is claimed for this apparatus, as compared with Finsen's, that the cost of installation is reduced from 4000 francs to 400 francs; that the cost of a single sitting is insignificant; that the length of the sitting may be reduced from seventy-five minutes to ten minutes; and that the surface [illegible] at a single sitting may be increased from one cubic centimeter [illegible] cubic centimeters at will.

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