HYPEREMIA

AS A

THERAPEUTIC AGENT

BY

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OF THE UNIVERSITY OF BONN

AUTHORIZED TRANSLATION

EDITED BY

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WITH ELEVEN ILLUSTRATIONS

CHICAGO

A. ROBERTSON & CO.

1905

HAMMOND PRESS
W. B. CONKEY COMPANY
CHICAGO

TO

PROFESSOR CARL BECK, M. D.

OF NEW YORK

THIS TRANSLATION IS DEDICATED

BY

THE EDITOR

AS A TOKEN OF APPRECIATION
OF HIS SERVICES RENDERED THE
SCIENCE OF SURGERY

CONTENTS

EDITORIAL NOTE

In presenting to the English-speaking profession a translation of Prof. Bier's monograph, the editor feels that he has rendered his colleagues a service. He leaves it to the reader to judge of its merits and only adds that the author's remarks contained in his "Conclusion" should be read first, for it really is a preface.

Thousands of physicians in this country have treated many cases with artificially produced active hyperemia without being able to give scientific reasons for whatever successes or failures they may have had with it. Though the editor was probably one of the first, if not the first, in this country to use active hyperemia on a large scale and to contribute several articles to contemporaneous medical literature and though he has followed the subject with great interest, he must admit that he was so overwhelmed by the vast information contained in Bier's work that it was sheer enthusiasm which prompted him to translate and edit the book for his American colleagues.

Prof. Bier, a former pupil of v. Esmarch, to whom the original work is dedicated, is one of the younger surgeons who have become famous on account of their original researches. A master mind like his would give us nothing but what would prove useful to our science and to suffering humanity. One need only read his introduction to realize that here is an authority whose keen philosophical insight, whose learning is exceeded only by his love for his suffering fellow-man. And here it is that he is in sympathy with American medical men who long ago came to the conviction that after all medicine for science' sake is useless, that our profession derives its splendor and glory from the fact that above all else it is humanitarian in character.

One case in the editor's practice will convince the readers of the good he has derived from the book. He was called to attend a recently married woman who for

five weeks had suffered excruciating pain from an acute inflammation of the right elbow-joint. Nothing did her any permanent good, so that the two attending physicians decided that an operation was necessary, when the editor was called in. A diagnosis of gonorrheal arthritis was made. The husband admitted previous infection. Gonococci were found in the discharge taken from the uterus. The suffering of the patient and the mental agony of the husband can hardly be described. Passive hyperemia was tried with so striking improvement that all thought of an operation has been abandoned by all concerned. Thus a piece of rubber tubing was the means of preventing a mutilating, more or less dangerous operation! And the credit is solely due to the author of this work, which hereby is gratefully acknowledged.

That is why the editor sat up long after midnight for many weeks impelled by his desire to convey to others the information which has proved so useful to him.

Attention is called to the German word "Zweckmässigkeit," for which the editor selected the English words "purposiveness" and "rationale" as he saw fit.

In giving the degrees of temperature in centigrade a personal inclination has been followed. The Fahrenheit scale is unscientific and superannuated.

Chapter IV. contains a short resumé of the original and has been rewritten to suit the needs of American medical men.

The numbers in the text in brackets refer to the same number in the "Bibliographic References," which appear at the end of the work.

The editor herewith expresses his thanks to Mr. Carl Friedrich Lampe, of Leipsic, the publisher of the German work, for courtesies shown him and to Dr. Carl Theodore Gramm for many suggestions and revision of the manuscript.

GUSTAVUS M. BLECH.

Chicago, January, 1905.

INTRODUCTORY

It is not so very long ago when not only theologians and a large number of philosophers and naturalists but also many physicians thought teleologically. In all processes which they observed in man during health and disease they asked themselves: why do they occur and of what use are they to the organism? This teleologic conception was at all times deeply rooted in the minds of the people. Proof for this is found in the ancient idea that disease is a fight of the body against an intruded enemy, which, depending on the victory of the former or latter, terminates in recovery or death, and also in the view held by laymen even to this day that fever, inflammation, suppuration, diaphoresis, expectoration and diarrhea serve to remove from the body "noxious and impure matter."

I will endeavor to show that a teleologic standpoint is not only rational and justified but even essential for the observation of things in animated nature. However, these teleologists overreached their mark. To begin with, they committed an error in defending the so-called anthropocentric teleology. Man was put in the center of the universe and for his personal benefit everything has been created. It is for him only that the sun shines and the rain falls; animals and plants have been created to serve him as food; for his delight only nature has been made so beautiful and magnificent. Justly this kind of teleology became the subject of ridicule when it went so far as to explain the ripening of cherries in summer "in order than man should have his refreshment in the warm season." Even the older philosophy opposed this vehemently. But it was principally Darwin's teaching which dealt it the death-blow. Darwin did not lift man from the rest of nature to put him over it, but placed him within it and permitted him to be only one of the innumerable phenomena of nature, of whom one did not

even know whether he would not be replaced by something better and more perfect in the course of tremendous spaces of time.

These older teleologists again erred in that they did not recognize the purposiveness in nature as a simple matter of fact but established it as an explanation for all possible phenomena. They did not trouble themselves to inquire into the deeper causes of things but simply said: This is so and not otherwise, this becomes so and not otherwise because so it is rational. Naturally such a system is most defective and apt to obstruct scientific progress. It is, therefore, not to be wondered at that with the application of exact, scientific inquiry in medicine, these doctrines became ill-reputed. And then it happened, as it usually does when reaction follows collapsing, axiomatic views—with the decadence of the doctrine the good kernel too was dropped, and even to-day the practical physician who confesses to hold such teleologic views, as we shall discuss, is in danger of being called obsolete by such of his professional colleagues who consider themselves exact and scientific investigators.

If these people, however, would become a little more familiar with biology, which must be considered the foundation of practical medicine, if the latter is to rank as a science, it is they who would find themselves to be the backnumbers. To be sure, biology ignores the great fundamental problem, whether the universe and man has an object, a problem, which, as long as thinking man will exist, stirs and will stir the mind, and which undoubtedly never will be solved, and leaves it to the philosopher and theologian. Though it was Darwin's teaching, which dominates modern biology, that most effectively did away with the naive anthropocentric teleology, and though a large number of Darwinists at first declined to entertain each and every teleologic conception, they soon became converted and acknowledged that their idea lacked logic. Because, after all, the very nature of their teaching demands of their followers to be convinced teleologists in regard to the individual organism and the species, and that even of those who otherwise deny purpose in nature and who declare that all phe-

nomena in nature—including man—are but consequences of certain forces of nature. For only a rationally constructed organism, adapted in every direction to the external conditions, can maintain the struggle for existence while nature itself removes everything irrational.

A large number of Darwin's strict adherents have expressed themselves thus and have acknowledged themselves as teleologists by conviction. Some (1) overreaching their mark even asserted that it was Darwin's teaching which first brought to light and rendered comprehensible this limitation of purposiveness to animated phenomena of nature. However, naturalists and philosophers of entirely different schools have thought similarly. Thus Kant, in his Criticism of Teleologic Judgment, discusses the "inner" purposiveness of the organisms while strongly opposing the anthropocentric and "outer" teleology. His teleology, like that of Darwin, is free from the transcendental, for "the manner of mechanical explanation is not excluded by the teleologic, as if they contradicted each other."

Even among medical men the pure naturalists, anatomists and physiologists unreservedly acknowledge man's "inner purposiveness" of Kant and of the Darwinists. Each anatomist when discovering a new part, each physiologist when unearthing a new activity in the body, asks himself: Why is it there and of what use is it to the organism? And he who would think otherwise would justly be considered a peculiar crank. The few remaining embryological data of the normal man which can not be placed in the category of purposiveness prove nothing against the validity of this general rule.

Things are apparently different and more complicated in practical medicine which concerns itself with the sick body and its cure. The single fact that the body is very frequently attacked by disease and that it is able, without the aid of a physician or artificial means, to effect a more or less perfect cure of the majority of diseases, should convince the physician of the presence of rational, natural healing processes. It is evident that this ability, because it leads to a cure of the disease for the welfare of man, can but have the character of inner purposiveness.

It is clear to everyone that the body, under many

obnoxious influences, immediately resorts to rational means in order to remove them. No one will doubt that the violent cough which expels a foreign body lodged in the larynx, the intense vomiting which ejects caustic acids and alkalis, the profuse effusion of tears and the lively spasm of the eyelids removing irritating bodies lodged in the eye, are highly rational arrangements. And yet these means of rescue, as represented by a violent attack of coughing and terrible vomiting, are so disagreeable to the injured man and look so threatening in character, that the naive observer, were he ignorant of the real injury, would look upon them as the real disease, whereas in reality they mean a warding off of the evil.

In those cases the size of the injurious agent makes it easily perceptible to our senses and thus protects us against coming to so fatal and false a conclusion. This was not always the case when the injurious agent is so small and hidden that it could not be perceived at all or only through a microscope, as in the infectious diseases. Even to-day the majority of medical practitioners look upon the fever and inflammation, which follow certain infections as promptly as a cough does when a foreign body becomes lodged in the larynx, as something obnoxious which must be combated, and it is not so very long ago that, with few exceptions, all reasoned in this manner. It is indeed noteworthy that just in our time, in which so much labor and acumen is spent in the analysis of disease into the real causative factor and in life-processes by which the body responds to the injury, we have but lately begun to draw the logical conclusion from that which we have recognized. Modern research has been eminently successful in the incorporation of pathology among biological sciences and has taught us that a considerable portion of the so-called disease-symptoms are life phenomena, which appear with the regularity of a natural law; in other words, that disease is life adapted to altered circumstances. This question now presents itself: Is it possible that the body, in whose phenomena of life during health we are accustomed to observe the most astonishing purposiveness, functionates irrationally during sickness? We must confess that in spite of all the newly acquired knowledge we have gone backward,

for though the older physicians did not command the grand naturalistic experience and equipment we call ours, a natural instinct has led them on the track now generally conceded to be the right one. Who does not know the much cited axiom of Hippocrates: "Fever purifies the body through fire?" And how much labor has it cost to gain adherents to this view, so modified as to be adapted to our modern conceptions! Whoever wants to be convinced in this need only read the great amount of literature on fever which has accumulated during the last half century.

A similar fate to that of the fever has befallen inflammation. After several older physicians had recognized inflammation as a useful process J. Hunter (2), a teleologist, appeared as a zealous defender of this view. He especially emphasizes this in a chapter which deals with the usefulness and purpose of adhesive inflammation and in which he maintains the idea that in a wise way nature has provided the body with rational means of self-defense.

According to Neumann (3), S. W. Sachs, in the beginning of the fourteenth century, framed the views then held on inflammation in these words: "It represents a reaction of the organism for the restoration and assertion of its integrity with increased expenditure of force of all systems."

That the doctrine of the purposiveness of inflammation has been deserted especially during the last decades needs no further substantiation. For almost all practitioners recognized to-day as leaders in their profession have been educated as "antiphlogists," who should combat the obnoxious inflammatory processes, and a large majority still cling to this view.

Of late, however, a great change becomes noticeable. The usefulness of the inflammatory processes has been asserted by many authorities. The merit to have brought to recognition this doctrine and to have placed it on a scientific basis belongs to Leber (4), Neumann (5), Marchand (6), Buchner (7) and Metschnikoff (8), and one will not be amiss in saying that it will soon regain supremacy at least in theoretic medicine, though the majority of pathologists, as Marchand puts it, "have

not yet freed themselves from the conception that inflammation is a deleterious phenomenon *per se.*"

On the other hand, a third life phenomenon of the diseased body, viz., congenital and acquired immunity against infectious diseases, has been accorded almost unlimited recognition as a useful protective measure of the body. It is useless to attempt to discuss these things in the limited space of an introductory, especially since they are as known to every physician as to their discoverer, having aroused a lively interest even beyond medical circles. Though the theories of anti-bodies, alexines, etc., are still assailable and unsatisfactory, and though it can rightly be said that we are yet far from really understanding these natural healing processes, the facts nevertheless remain solid. And what must be plain to everybody is the really astounding purposiveness of them: The very producers of infection which poison and decompose the body mobilize the fighting agents of the body by which their toxines are rendered harmless and they themselves are killed.

Thus we recognize in all processes of reaction occurring in the body in infectious diseases the truth of Pflueger's (9) saying: "The injury is the cause of the removal of the injury." In his "teleologic causal law" this genial man said: "The cause of each necessity of a living being is at once the cause of the gratification of this necessity."

Similar views are contained in Ehrlich's "side-chain theory" on the development of anti-bodies, a theory which has been much recognized and much opposed.

No matter what we may think of the theory, the basic thought that poisonous action and protective action are practically one and the same must be recognized as ingenious and fruitful.

It has generally been acknowledged that the infectious diseases have awakened in us the knowledge that the body itself possesses rational healing agents. To admit this but for one group of diseases is one-sidedness, for an evidently general axiom in nature can not concern one kind of diseases only. Interest nowadays is so prominently centered in the infectious diseases that after a perusal of the newer literature on general pathology one might come to the conclusion that the other diseases

and deformities must step aside, while in reality these diseases represent only a part—though a very large one —of the diseases.

And we can also see in other diseases how the body most perfectly removes sustained injuries, replaces them or at least mends them. I need only remind of what we surgeons expect from nature. After all, surgery in many directions is a mutilating art. We destroy the beautifully and ingeniously constructed joint and out of the remaining bone stumps and soft parts expect a new, imperfect yet functionating joint; we ligate the main artery of a limb in the assumption that the blood will seek the most tangled side passages in the affected territory until in a surprisingly short time an insignificant branch grows to be a main artery.

These examples could be multiplied indefinitely. I scarcely believe there is any other domain of science like surgery in which Lamarck's law of adaptability embraced by Darwin's doctrine could be better studied. For in most of our operations we must expect this adaptability in a rational sense, otherwise our art would, indeed, be in a bad plight.

Naturally, like everything else, the rational way in which the body heals its infirmities has its limitations. Once these are found in the high and complicated organization of the human body. No one expects that an amputated limb grow again, as in salamanders, and on that account reproach nature with lack of purposiveness and retrogression in the development of the higher organized beings.

Then again we know that the individual beings of a species vary in regard to the good and the bad side and that part of humanity, which when taken sick and left alone succumb to the disease, belong to the latter kind of variation. For the very disease is frequently possible only because of a giving way or deficient development of the natural defensive agents, and death from the disease proves that these agents which should be at the disposal of the body are either insufficient or absent. Just in these cases the activity of the experienced physician has to come into play, for frequently it is in his power to strengthen and improve the deficient natural means of

defense. Since time immemorial he has been hailed as the true physician, who has learned from nature her secrets in the healing of disease, who supports her when she is unable to reach the goal by her own efforts, who replaces her when she becomes totally incapacitated and who controls her when her measures become excessive in their action.

Thus things are theoretically. But theory and practice do not always agree and nowhere can this be easier proven than in our own profession. Certainly the cough, in the sense I have mentioned above, is a very useful institution of defense, yet, it can so far overreach the mark and appear in the wrong place as to represent in reality the real evil seriously injuring the patient. In the same way, as explained above, we have become convinced that while inflammation *per se* is a useful process, we are, nevertheless, frequently compelled to combat all or several of the phenomena to which we apply the collective name inflammation, and experience with thousands of cases proves that this frequently is very useful.

Exactly the same holds good in regard to fever.

Nothing, therefore, can be more foolish than to attempt to imitate the processes of nature empirically and without reasoning in the treatment of disease, since we must never forget that frequently the nature of even the best organized being is imperfect and that art often is far more effective than nature. An excellent proof for this is found in the repair of wounds. The physician cures by means of the suture a deep wound, even a yard long, in eight to ten days without any essential danger to the injured and re-establishes the efficiency of the severed tissues in the most perfect manner. This nature can never do, requiring at least months for it and frequently producing an imperfect restoration of the injured tissues, while the patient during the time of healing is exposed to great dangers and inconveniences.

Nature, therefore, in larger wounds does not know ideal wound-healing for the simple reason that the several elastic tissues separate and the main condition for healing by first intention—the apposition of the wound surfaces—is absent.

Certainly our old masters were right when they considered the suppuration of wounds as something useful, for this reason they spoke of *pus bonum et laudabile*. Art had not yet taught them to keep infection out of their wounds; for their soiled wounds suppuration was the natural and useful reaction, for our wounds it is an undesirable addition.

Weak minds, therefore, while imitating the natural processes in the treatment of diseases could certainly produce the greatest mischief, as they would in any other occupation. The physician who has nothing else to offer against all diseases save a drug, the surgeon who knows no other curative agent than the knife, is just as dangerous, and I leave it to the reader to decide who is the greater quack, the naturopathic ignoramus, the prescription writer or the scalpel hero.

Still all this proves nothing against the general fundamental principle of the purposiveness of the natural healing processes and against our duty to imitate them at least then, when in injuries of the body they again and again reoccur with the certainty and regularity of a natural law. In this sense, I am sure, the physician is not only justified in but obliged to acknowledge himself a teleologist. In doing so we do not represent a transcendental standpoint but calculate with a simple fact from experience. Experience has taught us that on the whole the phenomena of life are purposive. We know that many of the so-called disease-symptoms are bodily phenomena of life and we also know that some of the symtoms which we have classified as belonging to the injury in reality represent means of defense against it. It is therefore but logical that we consider all so-called reactions of the body—and I do not intend to maintain that they are all useful—from this point of view in order to make practical use of them when we have recognized them as useful agents of defense.

And why should this teleological standpoint be unscientific? Perhaps because we can not explain it exactly. Where would we land if, in our craft, we demanded explanations for all matters of facts? Even the most exact among our biologists base on equal matters of fact; we all make use of the now popular Darwinistic

terms, known to every layman, such as variation, heredity, adaptability. No one doubts that these things are effective in nature, but no one has explained them; they are purely facts of every-day experience.

To many this introduction to the following discussions may appear somewhat far-fetched, but I consider it as very useful, for I will frequently have to come back to these thoughts in the course of this work, and former experiences have taught me that one must be extremely careful in the expression of teleologic views if one does not want to give offense. Was I not decried in a part of the literature as a mysticist and vitalist because of these views expressed some years ago in a contribution on the collateral circulation! Many physicians become nervous when one at all discusses phenomena of life and their purposiveness, even though it be previously explained that under such phenomena of life are meant physical and chemical processes heretofore not at all understood, while the crudest and most improbable mechanical explanation is good enough for them. It is, for instance, so unusually easy to conceive the blood circulation as a water conduit, thus conveniently gaining a threadbare scientific cover for all possible things, but alas this is false. And so many physicians when they have to discuss the purposiveness of the phenomena of reaction of the body are afraid to openly admit this. In their discussions they put the word purposiveness in quotation marks or believe themselves obliged to apologize for this admission in order to save their standing as scientists. Others acknowledge it but ascribe to it only the value of a "heuristic hypothesis."

I have already said that this is retrogression. For in scientific biology the question whether the organisms and their life phenomena are purposive is not at all discussed, this being accepted as a self-evident fact. Any discussion whatever is limited to the question how this purposiveness of the living beings as established by experience should be explained. The Darwinists do this by selection in the sense of the dictum frequently used by them: "Purposiveness is ability of existence." The vitalists have disputed that this explanation suffices and ascribe the rational forms and arrangement of the organisms to

an as yet mystic force, which, like the old vitalists, they either call Power of Life or like our neovitalists choose some other paraphrase.

I believe that at present Darwin's teaching still offers the best explanation in relation to the etiology, prophylaxis and cure of disease: All men provided with good protective and defensive agents avoid or conquer the diseases to which those less favored in this direction succumb. Each variation in the direction of improvement of these protective agents means a great preference of the individuals for they have the prospect to live longer and to procreate their species. Each variation in the direction of deterioration on the other hand, with the great spreading of opportunities for the acquisition of diseases, leads to a quick extermination of those capable of less resistance. The continued selection permits the species to finally inherit the purposive qualities as a safe possession.

A. GENERAL PART

CHAPTER I

IN ALL IMPORTANT LIFE PHENOMENA HYPEREMIA IS PRESENT

Every organ that functionates is hyperemic during its activity. During every form of growth and regeneration local hyperemia is present and this in a degree corresponding to the rapidity and energy of the growth. The formation of antlers in the deer and the moulting in birds offer the best examples for this.

Generation and procreation are accompanied by the most pronounced hyperemia—that of rut and later pregnancy.

No reaction to foreign substances of any kind occurs without hyperemia, be that substance a crude foreign body or a minute bacterium not demonstrable even with our most powerful magnifying apparatus, a strong chemical poison or a lifeless part of our own body (e. g., blood effused into the tissues). Therefore, I believe I may assert: There is no lesion which the body tries to and is capable of removing or rendering harmless, that produces anemia; it is always accompanied or surrounded by hyperemia. If we, therefore, accept the reactions of the body as useful efforts of nature, we must admit that hyperemia is the most widespread of all auto-curative agents.

The idea that the blood and "juices" heal diseases and that "bad blood and bad juices" are aiding the development and spread of diseases is deeply rooted in the minds of the people. But scientific medicine, too, has formed the conception that the quantity of blood of a part of the body is of the utmost importance for its well-being. I intend to show in the following pages that it has pro-

ceeded one-sidedly. It speaks of improvement of the circulation, removal of obnoxious blood-stasis, improvement in the nutrition of the parts by an increased blood-current and acts accordingly. If we, however, observe how nature works we learn that while it produces in all important processes of the body a local hyperemia in the parts concerned, the same is produced as frequently by a slowing as by an acceleration of the blood-current.

We will later demonstrate that the latter occurs in the functional hyperemia accompanying the activity of the organs, while the former prevails when we have to deal with the removal of obnoxious influences and regeneration of new tissue.

If we, therefore, wish to support the healing activity of the body by increasing the useful hyperemia, we must, if we desire to imitate the processes of nature, in certain cases increase the blood-current and diminish it in others. If we act differently we run the risk of not only doing no good but harm by disturbing rational curative processes. We will, therefore, have to study the action of the body in each disease and utilize it as a guide for our intervention. For while in many cases the various forms of hyperemia have the same effect, in others hyperemia and hyperemia are totally different things.

Differences of the utmost importance, physically as well as chemically, exist between the rapidly flowing stream of arterial blood and the sluggish one of more venous blood. Although our knowledge of the blood is as yet very limited, we know that the former is rich in oxygen, poor in carbonic acid and free alkali, presenting a comparatively mobile fluid, the latter, chemically, has just the opposite characteristics and is a tenacious, sticky fluid. We further know that the rapidly flowing blood retains its liquidity and component parts which it carries along, while the slowly gliding blood sends them out into the tissues, where they can unfold their activity.

We must, therefore, always bear in mind that the production of various forms of hyperemia represents a collective conception of many physical and chemical changes.

It must be added that the various forms of hyperemia

can not be strictly differentiated, as they pass unnoticeably from one into another, particularly, as we will yet see, since the body knows how to transform an originally rapidly flowing blood-stream into a slow one, by means of certain stimuli, the nature of which is unknown, but especially so by irritation through inflammation. Nevertheless, I prefer to adhere to the conception of hyperemia rather than attributte the useful and curative properties to certain single components of the blood, which is altogether based on theories not proven.

CHAPTER II

ARTIFICIAL PRODUCTION OF HYPEREMIA

More than eleven years ago I began to intentionally subject lesions to hyperemia in order to cure them and have widened my experiments, which at first were limited to tuberculosis. I have gained a wide experience in regard to the effect of hyperemia on physiological and pathological processes, which I present in this work.

When I speak of hyperemia in the following discussions, I mean local hyperemia only. To avoid confusion I mention that, following the usage of the language, I call a part of the body actively hyperemic when its vascular net is flooded by a larger quantity of blood, while more blood flows in; passively hyperemic when its vascular net becomes more full on account of a diminished venous outflow (stasis hyperemia). On the whole it can be said that active is equal to arterial, passive to venous hyperemia. But even here we have exceptions. In heart troubles we have passive hyperemia of the lungs, yet it is arterial (in consideration of the kind of blood: arterial—rich in oxygen and poor in carbonic acid), for the respiration brings oxygen to the blood dammed in the capillaries of the lungs and takes away carbonic acid. In such cases a venous hyperemia can be conceived only when lack of compensation is so pronounced that life is in great danger. This my conception of the arterial hyperemia of lung stasis has been disputed in many quarters. I regret that it is impossible for me to accept the objections. In my opinion, lack of reflection only makes possible the conception of a venous hyperemia in lung stasis. Even in pronounced disturbances of compensation the blood in the capillaries of the lungs is more arterial than in the capillaries of any other place in the large blood cycle.

But these are thoughts which are only to be considered when we discuss an explanation of the effect of one or the other kind of blood. Where we aim at practical ends we can generally place active for arterial and passive for venous hyperemia, a liberty we will take advantage of in the course of this work.

CHAPTER III

PRODUCTION OF ACTIVE HYPEREMIA

Active hyperemia can be produced in very different ways. As is well known physiologists make extensive use of division of vaso-dilating nerves (especially sympaticus division). Strictly speaking these experiments are not pure, for the division of the nerves produces besides the hyperemia a good many injuries, probably more than we realize for much can escape our critical investigation. But all aside, this kind of hyperemia can naturally not be considered for therapeutic purposes.

Von Esmarch's artificial anemia, develops very pronounced hyperemia—the so-called reaction hyperemia—like after any temporary cessation or even decided slowing of the blood-current (10). But it also can not be used for our purpose, for, first of all, the method is too painful and then the hyperemia thus produced lasts only a short time, which leaves it out of the question as an agent for the treatment of such diseases which can be influenced by hyperemia.

Increased activity of bodily parts, especially of the muscles, friction, massage and electricity produce decided active hyperemia. A good deal of the efficacy of these effective therapeutic agents is probably due to the production of hyperemia.

We have at our disposal a large number of chemicals—all the rubefacientia—with which to produce hyperemia. On the first glance at the reddened area no doubt seems left that we have to deal with an arterial hyperemia, in accordance with the old medical rule: *Ubi stimulus ibi afflŭxus*, still this does not appear to me as proven. All these remedies produce inflammation, and we know that in this, after a transient acceleration, occurs a slowing of the blood-current. I will come back to this point later on more fully.

For practical purposes, the most useful agent for the production of local active hyperemia is warmth. It has been employed in medicine for thousands of years without realization of the fact that the active hyperemia produced by it is the most prominent, if not the only curative

property. The body protects itself against excessively high degrees of heat by two means: first, by vigorous evaporation of sweat and, second, by a voluminous flooding of the heated part with rapidly flowing arterial blood. The latter, therefore, acts like a cooling current. It is principally this accelerated blood-current which we very much desire, for, in my opinion, it is the real curative agent in most of the diseases which are favorably influenced by heat.

Warmth can be applied to the diseased part in many ways, e. g., hot compresses of linseed, moor, mud, radiating heat, hot sand in the form of specially constructed thermophors, and finally hot air.

The highest degrees of heat can be borne only when the last named is employed, for the simple and natural reason that air is a very poor conductor of heat, possesses a very limited capacity of heat and the vigorous evaporation of sweat protects the subjected parts against burns. Thus far the matter is very plain and in the manner of laymen it is astonishing that so high degrees of heat as we are able to apply to the human body without injury, are borne. On the other hand, it is less plain how the hot air produces a more decided arterial hyperemia, which is evidenced by the intensely and equally bright reddened limb and the greater curative effect than the other named remedies. (I do not include among them radiation with electric light, because I have no experience with it.) If the arterial hyperemia really is the natural protective and reactive process against the obnoxious effect of high degrees of heat, as I accept it, one would conclude that any form of heat, provided it be applied as high as the limit of toleration permits, would produce an equally vigorous hyperemia.

But it must not be forgotten that the human body, with all its so-called reactionary processes, in the first place is arranged and exercised according to the natural relations by which it is surrounded. Now our body must continually adapt itself to the widest variations of temperature of the air, while it is but rarely exposed to the variations of heat of other substances with which it comes in contact. If it be packed with heavy, hot substances (moor, linseed poultice, thermophors), the pres-

sure on the smaller vessels might impede the celerity of the blood-current. I suspect that hot water does not produce a purely active hyperemia but that it belongs to the remedies producing slight inflammation, which puts the small vessels and their contents in a condition entirely unknown to us, that in spite of dilatation of the small vessels does not produce an acceleration of the blood-current or at least not as much as we would anticipate according to known physical laws. The following simple experiment shows that though hot water, as well as hot air, produces intense hyperemia the results are different: I place my right forearm in hottest possible air (105° C.) and my left forearm in hottest possible water (44¾° C.), leave them there an equal time, and place both limbs, after their removal, alongside each other. The red left forearm shows a bluish shade, the right is much brighter and has a yellowish tinge. The difference is so plain that every observer can recognize it at once. For the rest, the hyperemia visible on the skin appears rather more intense on the hand taken from the hot water than that from the hot air. The latter, therefore, evidently produces a greater acceleration of the blood-current and for this reason gives to the limb the higher arterial color. It is probable that the swelling of the skin by the water presents a chemical change of the tissues and thus a slight inflammatory circle, for which reason I have frequently substituted hot physiological salt solution but without causing any change.

But after all, these are theoretical views and we are here, as everywhere, left to our practical experience. This seems to prove to me that among all thermic agents hot air is by far the most useful and that it produces the most intense active hyperemia. Next to it in effect the hot sand-bath might be counted. As my experience with active hyperemia is almost exclusively limited to that produced by hot air and as this method of applying heat is universally the most practical and effective I will essentially confine myself to it.

Hot air, of late, has been made extensive use of for therapeutic purposes. That the hyperemia produced by it is the essential thing, has until recently been neglected, nay, even denied, and this is sometimes done even now.

Thus at the fifteenth congress of internal medicine in the exhaustive discussions on the treatment of chronic rheumatism not a word was said in regard to it being the hyperemia which was effective in the recommended treatment by heat, though I had emphasized that long ago. A year later at the same congress, Tallerman's hot-air apparatus was exhibited and though Mendelssohn discussed it at great length, my explanation of the effect of hot-air therapy was not mentioned by the lecturer, yet in the previous year I had again called attention to it. During the discussion Bäumler was the only one who briefly mentioned my explanation at this congress.

Since ages the external application of warmth has been counted in medicine among the agents which lead blood from the depth to the surface. Observing the pronounced reddening of the skin after its use, it was concluded that the dilatation of the superficially situated vessels "decongestionated," as it was termed, the deeper parts overfilled with blood. François Franck (12), in a much-talked-of work on "Revulsion," has attempted to give this opinion a scientific basis and hydrotherapy—in the widest sense—which is prominently concerned with the application of stimuli by cold and warmth, has unreservedly appropriated his view and transferred his views to the stimuli of temperature, although Franck talks only of "stimulating inunctions, sinapisms, cupping glasses, ignipuncture and vesicantia."

Franck demonstrated that skin stimulation was followed by contraction of the vessels of the viscera and by dilatation of those of the superficial parts and that by reflex. Irritation of the skin is said to produce a stimulus of the vaso-constrictor nerves of the former and at the same time of the vasodilator of the latter. In this manner, according to Franck, are explained the effects of revulsion. They have "decongestionating" influence and draw the blood which stagnates in diseased viscera towards the surface. He thus gave the apparently indisputable scientific explanation not only for the effect of numerous chemical skin-irritants which have been in use since very ancient ages, but also of the many forms of thermic influences, which should be effective in deep parts.

This explanation interests us here very little, as we have but little to do with such extensive distance effects (from the skin into the depth of the viscera). On the first glance it appears very evident, for, as we have long known from physiology, an extensive hyperemia of the external parts is possible only when the viscera give the blood for it and vice versa. But Franck's experiments are by no means convincing. For the purpose of measuring the variations in the volume of blood he has placed the kidney in a volumetric apparatus. But if the abdominal viscera are exposed their vessels change from the normal, as I can assure from a wide personal experience and as is evident from other examinations (13), and one is led to erroneous views. And how much more must this be the case when a whole kidney in connection with its vessels is placed in an apparatus. For this reason it appears to me very bold to draw such far-reaching conclusions from such crude experiments, which have no bearing to the natural relations.

Let us, nevertheless, accept as correct this effect in relation to skin and viscera, which is also treated in older physiological works. It is hazardous and entirely false to apply these views to parts which are situated close to each other. Thus Franck's experiments have been cited as proof for the old view that reddening of the skin of a limb frees the deeper parts, e. g., muscles and joints, from an obnoxious hyperemia. This is a fundamental mistake which has given cause to the wrongest possible views. The agents known as rubefacientia act into deep parts by producing hyperemia, and this we will discuss in detail in a subsequent chapter. I have, therefore, always taken the view that the hyperemia produced by heat is not limited to the skin depleting the deeper parts but, on the contrary, occupies the entire thickness of a limb which has been exposed, provided the heat was intense enough. My assistant, Dr. Klapp, (14) has even proven that it continues from the surface to the viscera: he put the abdomen of a rabbit in a hot-air apparatus, exposed it for some time to intense heat, opened its abdominal cavity immediately on removal of the animal from the apparatus and regularly found a hyperemia of the entire abdominal

wall, the serosa of the intestines and of the centrum tendineum of the diaphragm.

Plethysmographic examinations prove that warmth enlarges the contents of limbs encased in the apparatus and that cold diminishes it (15). Evidently these differences are but due to the changing volume of blood. Unfortunately these experiments offer no explanation whether the hyperemia which swells the heated limbs is limited only to the superficial parts or whether it also spreads into the depth. Thus Sarah Amitin thinks it possible that in spite of the increase in volume produced by the warmth this agent may deplete the deeper vessels.

The most important and decisive proof that heat favorably influences diseased deep parts by hyperemia and not by the so-called "decongestion," is the fact, discovered by me and which I will more fully dwell on in this work, that on the contrary a stasis hyperemia, the removal of which was considered essential, repeatedly shows the same effect as the heat, which is believed to be a derivans or revulsive agent. In this, therefore, utterly false conceptions have been entertained.

The hydrotherapists think that thermic stimuli influence the distribution of blood by reflex. I have already mentioned the experiments by François Franck. They also call attention to the certainly interesting experiments by Brown, Sequard, Schüller, Samuel, Winternitz and others. They have even asserted that they are able to influence certain internal bodily parts from certain places on the skin. Leichtenstern, in his Balneotherapy, and Matthes, in his text-book of clinical hydrotherapy, have sharply opposed partly the correctness of the experiments, partly the justification to make use of them for practical purposes. And, indeed, anyone who has performed similar physiological experiments like those under consideration will assent that Matthes is right when he denies the large majority of these experiments any value of proof. In this domain prevails a great deal of arbitrariness in the establishment and interpretation of physiological experiments. We will occupy ourselves with these only so far as they here interest us, viz., that the phenomena produced by hot air on such bodily parts as have been exposed to it have been placed under the category men-

tioned above. Whether really in hyperemia produced by hot air the reflexes play any role no one knows. But we are positive that hyperemia in its entire extent can be produced without the medium of the nervous system. This is proven by the following experiment: I placed a young white pig* under deep ether narcosis and dissected the femoral artery and vein of one hind leg clean out of its sheath. I then cut through all other soft parts and ligate all bleeding vessels. The limb now is connected with the rest of the body only by the bone and the two main vessels; all nerves especially are severed. I then placed the limb in a hot-air apparatus and observe that the hyperemia appears exactly in the same way as in the other normal limb. The hyperemia disappears also just as rapidly, provided burns have been avoided. All three degrees of burns can be produced in the dissected leg.

Lewaschew (16) flooded amputated extremities with defibrinated blood and established that warmth produces dilatation and cold constriction of the vessels and that the rapidity of the outflow was influenced accordingly. Unfortunately I can not recognize these experiments as offering proof. I have already explained in an earlier contribution (17) that the flooding of amputated parts of the body with blood freed from fibrin under a constant pressure leads to opposite results and that these experiments for this reason can not be made use of.

Pietrowski (18) found in plethysmographic examinations that even parts of the body from which the nerves have been removed have retained irritability of the vessels. The same has been established also by other experimenters.

I myself have demonstrated that the so-called reaction hyperemia, which appears after artificial anemia, is entirely independent of the central nervous system (19).

Goltz and Ewald (20) show magnificently that the innervation of the vessels is independent of the central nervous system. The vessels of a dog from whom the largest part of the spinal cord has been removed piece-

*The pig is the best animal for examinations of the distribution of blood. The white skin enables us to recognize any change in the volume or kind of blood with ease.

meal retain the faculty to constrict or dilate in accordance with the nature of the external stimulus used.

It is therefore positive that hyperemia by heat can occur solely through local influences on the vessels without the agency of the central nervous system or the nerve trunks. Whether there exists an immediate stimulation of the wall of the vessel or whether Goltz is right in accepting vessel ganglia (which so far have not been discovered) remains to be seen.

Finally it is not even undisputed that the heat produces an active hyperemia for Winternitz and his pupils consider it a passive hyperemia. It seems to me that a glance at the skin of a white creature (man or pig) which, for example, has been exposed to intensely heated air for some time, would leave no doubt that there can be anything else but an arterial hyperemia, for the developed redness is possibly higher and more vivid than that following artificial bloodlessness and of this we know that it is an arterial hyperemia with extraordinary acceleration of the blood-current. However, I have tried to support this view by several experiments: I place the leg of a dog which is anesthetized with ether in a hot-air apparatus for half an hour and render the extremity very hyperemic. On opening the previously dissected femoral vein blood flows from the vein in lively pulsations. This is a repetition of a well-known physiological experiment to demonstrate the acceleration of the arterial blood-current. The bright red of the venous blood as compared with that of the other leg should be striking. In two experiments I could not establish this. In spite of the ether narcosis the blood of both veins was bright red. But in the leg which was not rendered hyperemic the flow of the blood in pulsations was absent.

The following experiments will plainly show that a rapid blood-stream is indeed necessary for the endurance of high degrees of heat, playing the role of a cooling stream for the heated limb.

I place my arm in a hot-air apparatus and heat it slowly. When the thermometer shows 114° C. I can bear the heat very well; at 115° C. a disagreeable burning sensation under the nails appears. The temperature between

114° and 115° can be borne for some time without difficulty. During this the limb perspires moderately.

Now the same limb, with a rubber bandage attached to the arm, which produces a moderate stasis hyperemia, is placed in the same apparatus in the same position, and heated in the same manner. At 98° a smart burning under the nails appears. Somewhat under this degree the heat can be comfortably borne for some time. Here too the arm is moist from perspiration.

If I produce in the same extremity a pronounced stasis hyperemia so that the radial pulse can be plainly felt and place it under the same conditions in the hot-air apparatus I have reached at 78° the limit of endurance.

Inasmuch as many experiences show that a venously hyperemic limb shows rather an increased amount of perspiration it can be but the diminished current-rapidity of the blood which is the cause of the greater sensitiveness to the heat; we have slowed the cooling current in this case which together with the perspiration protects against burns.

To make doubly sure I have also made the counter-test: I render my arm bloodless by constriction for sixteen minutes. On loosening the bandage appears the enormous reaction hyperemia, fully known to us surgeons as a great acceleration of the blood-stream. The limb is now placed under the same conditions in the same apparatus as before, previously heated throughout to 145°. The limb bears this heat very well and perspires freely. I remove the arm from the apparatus, wait until it has entirely paled and replace it while the thermometer still shows 145°. The heat can now be borne only for a few seconds, then it must be withdrawn on account of the unbearable burning sensation.

In this category come also the following observations: I expose my pelvis in a hot-air apparatus to a degree of heat which can just be comfortably borne. If I now produce retro-stasis by holding the breath and forcible expiratory pressure while nose and mouth are closed, the heat becomes unbearable; the burning sensation disappears as soon as respiration is resumed.

If I make the same experiment with my arm I feel the

following: In the beginning of the pressure the heat is plainly less felt, gradually this relief gives way to a sensation of burning. Immediately after the resumption of respiration appears a greatly increased sensation of burning which again quickly disappears.

All these experiments have been tried by one of my assistants with like success.

That the rapid blood-current is a protective agent against burns is brilliantly demonstrated by the following experiment: I place my arm, on which a slight stasis hyperemia has been produced by means of a rubber bandage, for one hour, in hot air which can be comfortably borne. After paling of the hyperemic skin remains a beautiful net of red stripes which can be recognized without difficulty as corresponding to the network of the small superficial veins of the skin. The larger subcutaneous veins have not marked their course. The red stripes disappear after about twelve hours.

Here we have, therefore, a case of very slight burn exactly in the course of the small veins of the skin, in which on account of the insignificant stasis the blood-current has been slowed. A better proof for the correctness of my view that the blood-current represents a cooling stream no one will demand. I have for this reason abstained from difficult physiological experiments the results of which may nevertheless be neither certain nor plain. Such experiments have been made by Balli (21) with v. Kriess' flame-tachygramm. He measured with it the rapidity of the blood-current in the human arm which he had placed in a plethysmograph with hot water of variable temperature. He found that heat enlarged the pulse of the stream while cold lessened it.

I add that animals which do not at all visibly perspire but evaporate a little through the skin and produce the regulation of bodily heat by means of the more or less accelerated respiration, such as the dog, tolerate at least the same degrees of heat as does man, of which I have been doubtlessly informed by experiments. I placed limbs of dogs in the hot-air apparatus. They remained dry but were rendered hyperemic. In earlier experiments I have noticed that in dogs of a dark skin the intense reaction hyperemia after artificial bloodlessness can not be noticed.

If I however exposed these dark-colored limbs to intense hot air I could not remain in doubt concerning the enormous hyperemia. This in such animals is no doubt for this reason so developed, because the cooling blood-stream must replace the lacking perspiration.

Considerable curative effects have been ascribed to the rich perspiration which follows the application of even local heat. For in many of such diseases which, in my opinion, are favorably influenced by the reaction hyperemia of heat, general sweat-cures had been instituted for ages, so, for example, in the stiffened joints of chronic rheumatism, arthritis deformans and especially in dropsical effusions of the joints. In the latter the idea prevailed that by the dehydration of the entire body the effusion could be made to be absorbed.

I am not so one-sided as to deny that perspiration may prove a great role in absorptions in the body, I even do not want to assert that this could not be useful in the affections cited. But the perspiration, especially in the affections which are here of interest to us and in which we make therapeutic use of purely local heat, certainly plays but a secondary part. I have proven this by improving with the hot-air apparatus stiffened fingers singly, in the heating of which there can be no thought of an essential loss of sweat. Therefore the general employment of heat is the agent that is the most effective.

With general hot sand-baths a loss of body weight up to 3 kg. has been reported, while Mendelsohn (22) experienced a loss of only 750 g. after subjecting his arm for one and one-half hours to a hot-air bath of 120°, Krause (23) observed on a female patient on whom he used hourly a hot-air apparatus in seven days 270-500 g. daily. Experience, however, teaches that in the above-named diseases just this local application of heat is the most effective. Now it is impossible to take the view that local losses of sweat remove absorbable obnoxious substances from its immediate vicinity, in the same sense that the old physicians thought the materia peccans was removed by a derivans.

The following statements by Schreiber (24) appear to me as of importance here: The secretion of sweat begins

to be stimulated at low degrees of heat (45-50° C.), at 60-70° it is increased and at higher degrees it frequently becomes less and occasionally disappears at 80-90°, so that the skin feels smooth and dry. Schreiber is of the opinion that this dryness is not only the consequence of the rich evaporation but that on account of the over-stimulation and exhaustion of the nerves of the sweat-glands really less sweat is excreted. On the other hand he admits that with increasing heat the hyperemia becomes more intense and that this reaches the maximum at the highest degrees of heat. Schreiber thinks that for the production of rich perspiration lower degrees of temperature are sufficient and doubts the necessity of obtaining the most intense hyperemia.

If I compare with this my own experience, I must remark that to me, too, it seems that the greatest amount of perspiration does not occur at the highest degrees of heat; however, I do not recollect to have observed the dry and shining reddened limbs described by Schreiber as following the effects of high temperatures. Now coinciding experience points to the fact that in order to obtain good effects high temperatures are necessary and good results have been obtained with them after lower degrees which produce an equal amount of perspiration but not as intense an hyperemia have failed. As, therefore, of both reaction processes, perspiration and increased blood-current, the latter only has become increased with the higher temperature it only can be held responsible for the better effect. I, therefore, do not agree with Schreiber who says that the intense hyperemia is not necessary. Certainly the heat must not rise enough to cause burns, for these probably would stop the active hyperemia. They lead to inflammatory conditions in the skin which possibly are followed by a slowing of the blood-current.

The fact that in chronic stiffened joints such of them which have not been exposed to heat have improved at the same time as did those which have been thus treated, has been argued against the hyperemia as having the decisive curative properties in affections subjected to hot-air therapy. At first glance it would seem to speak for a general effect of the locally applied heat, influencing the entire body. This conclusion is positively reached by

Walsh (25), honorary medical officer to the Tallerman free institute in London. Walsh observed the improvement of an old case of chronic eczema of both hands, which had defied all possible methods of treatment although only the right hand has been treated with the Tallerman hot-air apparatus. He even believed that a stiff elbow-joint could be improved or cured from local hot-air treatment of a leg and ascribes this to the general effect of the local hot-air bath which manifests itself in perspiration, rise of pulse and bodily temperature. I doubt very much that this view is correct and though I myself, like many others who make use of this method of treatment, have seen that individual joints which have not been treated have improved, the effect was never as pronounced as in those which have been treated and very frequently it was absent altogether. Nevertheless the fact remains but it can be explained more naturally in a different way: We know that each decided heat-effect on external parts of the body draws blood from the viscera to these parts. Therefore, when we have a decided influence of hot air on a part of the body all other limbs and superficially situated parts participate in the increased flooding of blood. We further know that in multiple lesions if one of them has been removed the others may improve. We surgeons know this in tuberculosis and each of us has seen how an individual has recuperated against all expectation from a grave case of pulmonary consumption after, for instance, the removal of a leg on account of advanced tuberculosis of the knee-joint. Thus I have also observed that in chronically stiffened joints such that were not treated have improved when I subjected the worst among them to stasis hyperemia. Just such an experience proves best that we do not have here to deal with a general effect of locally applied heat but, in one as in the other case, with effects of hyperemia.

The observation of Chrétien cited by Walsh, who has seen in a case of gout after the treatment of a gouty joint with hot air an increased excretion of uric acid from the kidneys, does not speak, as Walsh thinks, for a distance effect on these organs, but all the more for an

effect by hyperemia. I will soon show that active hyperemia, produced by heat, has absorptive powers of a high degree. Like all other pathological substances, the hyperemia will wash away the urinary salts accumulated in the joints and cause their excretion through the kidneys.

The decisive proof that really the hyperemia and not the other phenomena which accompany the application of heat, is the effective agent, can again be concluded from the fact that all possible forms of hyperemia produced in a different manner, which have no general effects at all, act similarly.

I must remark right here that it seems to me as if the influence of heat on the entire body and on single parts has not been sufficiently separated. It is evidently something entirely different when I place an individual in a hot-air or sand bath up to the neck or only an arm. In the former case an enormous amount of blood is drawn to the skin which naturally must be furnished from deeper parts, in the latter we have a sufficient quantity of blood to render the limb hyperemic throughout its entire thickness.

CHAPTER IV

APPARATUS FOR THE TREATMENT WITH HOT AIR

(By the Editor)

Probably Professor Bier was the first (26) to construct hot-air apparatus for the treatment of local affections by means of arterial hyperemia. He has made use of such apparatus since 1891. *Clado* (27) constructed an oven from hot bricks which, however, was so clumsy that it found no imitators. Bier learned of this later through the literature. Clado put extremities afflicted with tuberculosis into the oven with the view of destroying the tubercle bacilli by heat. The air in the oven had a temperature of 130° C. and below the layer of cotton 110° C. Bier is undoubtedly entitled to priority because Clado had not yet published an account of his work when he first constructed and used his apparatus, which is very simple indeed. In principle it is patterned after Quincke's cabinet for the entire body. Heat is obtained from a Quincke chimney which has been modified to permit the regulation of its height, similar to the apparatus used by chemists. The plate on which the lamp rests can also be raised or lowered at will. Bier prefers a Bunsen gas burner with a stop-cock by means of which the heat can be increased or diminished.

Where no gas can be had alcohol is to be used as fuel. After experimenting with a variety of lamps Bier decided on the simplest form of alcohol lamp—a large container with a wide wick. The heat is regulated by raising or lowering the wick or by changing the position of the lamp.

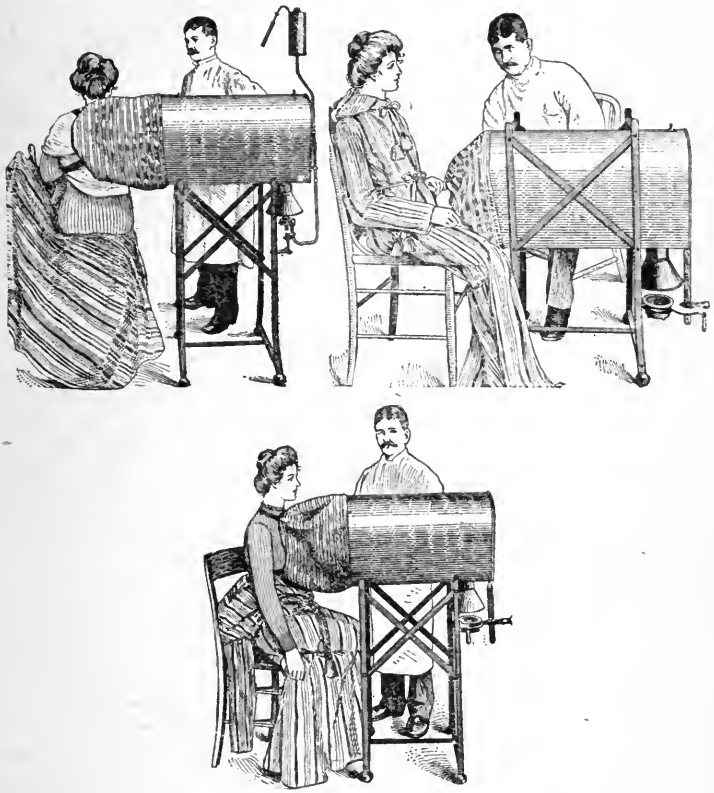
Bier's hot-air apparatus is practically nothing else than wooden boxes with openings for the insertion of the various limbs or parts of them. They have on the top openings for a thermometer and for the purpose of ventilation. The chimney carrying the heat into the box is attached to an opening at the bottom. Cuff attachments are used when the heat is carried to a region which can not be placed in the box, such as the shoulder-joint, back,

thigh, etc. Several boxes are needed to suit certain single joints and regions, though the inventor has also devised a "universal" box. The wood is rendered fireproof by saturation in chemicals.

Bier's hot-air apparatus has been imitated, modified

or improved by several physicians. All these are mentioned and criticized in the original, but as they are but little known and used, if at all, in this country, the editor thought best to publish a short resumé only for the sake of completeness.

In Germany the best known hot-air apparatus is that made by *Krause* (28). Bier says it has many shortcomings. Wilson (29) describes an "oven" similar to that of Krause. As an innovation a salt mass is placed in the "oven" to absorb the sweat and thus to keep the interior



dry. *Reitler's* (30) apparatus is scarcely different from Krause's model. He makes use of a shallow dish with powdered dehydrated calcium chloride for the absorption of evaporated sweat. Roth (31) improves the Krause model by the insertion of an asbestos cylinder. He also recommends an apparatus which he calls "polytherm,"

intended for the various extremities, but which is similar to Bier's "universal" box (32).

The successes obtained with *Tallerman's* apparatus are

Figs. 1 and 2.

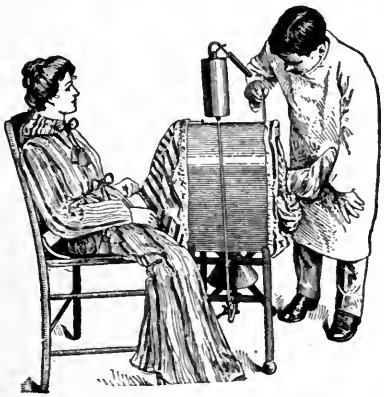
Illustrating the Betz Arm and Leg Hot-Air Apparatus as applied to extremities and bodily parts.

responsible for its widespread popularity. Tallerman's apparatus, however, did not exist when Bier first published (33) his invention in January, 1893, after having used his hot-air boxes about two years. In two additional publications (34) Bier proves this conclusively.

Tallerman's apparatus is clumsy and expensive, looking more like steam kettles. It is heated by a large number of gas flames. Asbestos lines the interior of the apparatus to prevent contact of the extremities with the

Fig. 3.

Betz' Knee Hot-Air Apparatus.



heated walls. Bier sees no advantage in Tallerman's apparatus over his or similarly constructed apparatus. In this the editor fully agrees.

Mention is made in the original of Kellogg's (35) elec-

tric light cabinet, with which undoubtedly American readers are more or less familiar. The light *per se* seems to be the therapeutic agent wanted by its discoverer and while the series of incandescent lamps necessarily radiate heat, Kellogg's apparatus can scarcely be counted among the hot-air apparatus.

Bier speaks favorably of *Frey's* air douche. Air forced

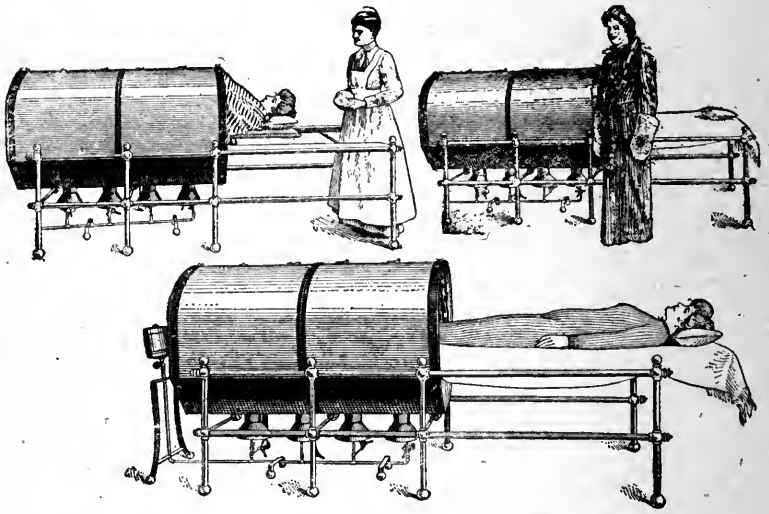


Fig. 4.

Betz' Body Hot-Air Apparatus.

by an electric motor fan passes through two systems of piping, one of which can be heated up to 200° C., while the other can be cooled by means of ice and common salt to —10° C. By a simple device the temperature of the air can be regulated and kept even. *Frey* in several contributions has written extensively on the subject (36). *Taylor* (37), on a similar principle to Frey's air douche, has constructed a very complicated apparatus which he has called "electro thermogen," for the treatment of neuralgia.

The author has had no experience with the last two

named but believes them to be useful. As they require electricity and as they are very expensive they are hardly adapted for private practice but should be found in thoroughly equipped hospitals.

Here in America several firms have tried to introduce several makes of hot-air apparatus. The editor remembers that Tallerman's apparatus was to be obtained on a rental only. Other apparatus are too clumsy and expensive to be adopted by general practitioners.

Betz' hot-air apparatus has become so popular that a description of it is scarcely necessary. In principle it consists of metal cylinders, lined with asbestos. At the bottom is a large opening into which is inserted a short pipe terminating into a funnel. The top has two openings: one for a thermometer and one for the purpose of ventilation. The Betz apparatus has an ingeniously constructed heat carrier, placed on the bottom of the interior which distributes the heat evenly throughout the cylinder. The arm or leg can be inserted and rests on a hammock. When it is desired to direct the heat toward a large joint or region of the body, cuff attachments are used, which also prevent the heated air from passing out. The heat is obtained from either a gas burner, alcohol lamp or a specially constructed gasoline burner. These burners are so constructed that they can be easily regulated in regard to the intensity of the flame. The burners themselves can be raised or lowered.

Betz' apparatus is comparatively inexpensive and durable. The arm and leg apparatus is practically a universal hot-air apparatus. A special apparatus has been constructed for the knee-joint.

Figs. 1, 2, 3 and 4 illustrate the Betz apparatus. Special descriptive circulars can be easily obtained from the well-known makers of surgical instruments, hospital apparatus and therapeutic appliances, Frank S. Betz Co., Chicago.

CHAPTER V

LOCAL AND GENERAL EFFECTS OF HOT-AIR BATHS ON THE BODY

I do not intend to discuss here the therapeutic properties of hot-air baths, as I will describe these later in connection with other methods for the production of hyperemia, which either act alike or because they produce different forms of hyperemia, occasionally have the opposite effect. All I am at present concerned in is to discuss the changes which the treated part or body undergo when subjected to the influence of hot air. A limb placed in the hot-air cylinder described above usually commences to feel moist at a temperature of about 50° C. At 60-70° it commences to perspire more freely. If the limb be exposed for some time to a temperature of 100° the perspiration is so free that it falls from the limb in drops. If the heat be raised higher still up to the point of endurance (114°) perspiration apparently becomes less; in this I agree with Schreiber. However I am not so sure whether, as is the opinion of Schreiber, the intense irritation of the sweat-producing apparatus produces a diminution of the perspiration in a form of paralysis, or whether the greater evaporation simply removes the sweat. At any rate, as far as I can remember, I have never observed the bright red dry limbs which he has seen after the use of high degrees of heat.

My arm becomes slightly and unevenly red after a prolonged exposure to air at about 70°, at 80-100° the color becomes more pronounced and if I heat the air to the point of endurance enormously so and evenly. We can establish it as a rule that the hyperemia gradually increases with the degree of temperature and length of application (provided an hour is not exceeded).

If burns are avoided the entire process is by no means unpleasant, on the contrary the heat affects the limb agreeably.

After the bright red, perspiring limb is removed from the apparatus, dried and dressed, the pleasant effect remains for some time and occasionally this sensation of

increased temperature remains in the treated limb for hours. Measurement with the surface thermometer shows objectively a decided after-effect.

It can regularly be demonstrated that that part of the body which has been exposed to hot air has an increased temperature of the skin an hour or more after removal from the apparatus. It goes without saying that the measurements should be made on the same identical places under equal conditions. I cite the following cases as examples:

Part of Body and Disease.	Temperature before Treatment.	Immediately after Treatment.	½ an Hour Later.	1 Hour Later.	1½ Hours Later.
Pelvic and lumbar regions (lumbago)	34.8°	36.2°	35.9°	35.2°	34.8°
Second measurement	34.9°	36.0°	35.8°	35.4°	34.8°
Knee (hydrops genu)	34.6°	35.8°	35.5°	35.1°	34.6°
Second measurement	34.5°	35.6°	35.5°	35.0°	34.4°
Leg (edema)	34.2°	35.9°	35.5°	34.8°	34.1°
Pelvic and lumbar regions (sciatica scoleotrica)	34.9°	36.1°	35.6°	35.4°	34.8°
Second measurement	34.6°	.....	35.7°	35.4°	34.7°
Third measurement	34.9°	.....	35.6°	35.3°	.....
Fourth measurement	34.8°	36.2°	35.8°	35.6°	.....

In all these cases the diseased parts were exposed for one hour to a temperature as high as could be borne without discomfort.

Aside from these local effects the patient's body experiences also general ones. As an example, though only the forearm be exposed to heat the entire body sweats, in one more, in another less. Personally I sweat but little throughout the body while my forearm is under treatment, while others, especially obese or weak persons, sweat considerably. On the whole, in otherwise healthy individuals the general phenomena are relatively insignificant, as compared with other forms of high degrees of heat, and this is the unanimous conclusion from experience. Thus Krause found an increase of bodily tempera-

ture of ½° to a maximum of 1° and of 5-8 pulse beats; Reitler an increase in respiration of 3-5 and of the pulse of 10-20; Mendelsohn, in spite of a two-hour effect on the forearm of air heated to 140° (?) found an average rise of bodily temperature of 0.4-0.6°, the pulse accelerated by 4-8 beats. Other observers report similar observations. My own observations in regard to the bodily temperature undertaken in 1891, show similar results at a temperature of 105°. However, when heating larger parts (pelvis), I have frequently observed a decided acceleration of the pulse.

For some individuals the treatment is not entirely harmless, and below I will discuss the obnoxious and disagreeable consequences which the procedure may have.

Not infrequently slight burns of the first and second degree occur without the patient noticing it. This is probably due to the fact, as I will demonstrate later, that the intense hyperemia reduces the sensibility to such an extent that the pain due to the heat is not noticed. These burns are usually insignificant and heal rapidly.

Very often, after prolonged application of hot air, one may observe dirty brown discolorations of the skin in the form of spots and network. Evidently this is decomposed blood coloring matter due to insignificant burns. That the latter lead to disintegration of the red blood corpuscles is known from the experiments by Lesser (38) and others. Frequently this discoloration follows the course of the small veins of the skin, in which the blood, on account of the slow stream is mostly exposed to the influence of the heat. Evidently the red blood corpuscles of some individuals are weak, for while some do not get these spots at all, others in whom no burns in a clinical sense can be observed show such widespread discolorations that the skin of the treated area looks marbled. This looks very ugly, but we may console the patient with the assurance that these spots will disappear slowly but surely without any treatment.

Really harmful consequences from extensive decomposition of blood, which theoretically would seem possible, I have never seen.

A disadvantage, from which hot-air therapy can not

be freed, is the fact that it makes large demands on the general strength of the patient, especially when extensive surfaces are subject to hot air. In anemic persons treatments are followed by headache, exhaustion and lassitude. I have not infrequently observed palpitation of the heart. Others have reported even fainting spells. However, these unpleasant after-effects are not frequent. They can be minimized or altogether avoided by applying in such individuals, cold compresses to the head during the treatment, avoidance of unusually large surfaces and by permitting the patients to rest before and after treatment, in short, the usual precautions customary in vapor and sand baths. The length of each seance should be carefully regulated, beginning with short ones and increasing the duration gradually. The choice of the time in the day is not without importance, which in each individual case must be determined by experiment.

If in spite of these precautionary measures these symtoms still occur, it is best to abandon the hot-air treatments and to change with one of the other processes for the production of hyperemia which we will later discuss, and which, though acting similarly to hot air, are less effective constitutionally.

Naturally chilling should be avoided. As already mentioned, the bodies of some men sweat considerably even when only a part of an extremity is exposed to hot air. Such individuals must be rubbed dry, if possible the clothing should be changed and they should remain for at least an hour in a warm room, and rest. If the patients are compelled to go into the free air sooner, they should at least take some exercise. These are well-known rules in hydrotherapy.

Hot air should not be employed too long. In the largest majority of cases we limit it to one hour. Only exceptionally in stubborn joint effusions, we allow the use of this remedy twice daily for one hour, when needed. At first I used hot air excessively for many hours daily in tuberculous affections of the extremities. This eventually leads to an hyperemia which does not disappear during the intervals and even to edema. Granulations dry up superficially but under the dry cover they become so strongly hyperemic that serious hemorrhages are apt to

occur. In 1891 I treated a large tuberculous ulcer eight to ten hours daily with air at 100°. The intensely hyperemic granulations twice bled so profusely that I could stop it with difficulty by means of compression and elevation.

Finally I will mention that hot-air therapy, as may be expected from so effective a process, influences appetite and metabolism. While some individuals are not at all influenced by it, others complain of lack of appetite and with these the treatment should never be instituted close to or after a meal. Others again get a good appetite and a strong desire for food. Thus, I recently treated a gentleman with hot air applied to the pelvis, who became enormously hyperemic and perspired freely. He was very much astonished at the pronounced appetite which he experienced after the treatment. On the other hand, thirst appears less than one would expect, a phenomenon with which we are acquainted in the employment of other methods of heat, which produce perspiration.

CHAPTER VI

PRODUCTION OF PASSIVE HYPEREMIA

It required a good deal of discussion on my part to establish that the application of heat in the manner described is the best means of producing active hyperemia, and it required detailed proof that the hyperemia is the essential effective curative agent in the affections of interest to us, because the influence of this remedy was always altogether differently conceived. In the measures we are about to describe no one will be in doubt that they act solely by hyperemia and that it is a passive hyperemia which we produce. On the other hand, with some of the agents (cupping glasses and suction apparatus) it is doubtful whether they produce an arterial or venous hyperemia. At any rate, it is sometimes a matter of view whether we should call a hyperemia arterial or venous, as they unnoticeably blend one into the other. In the largest majority of cases, however, one can not be in doubt as to the kind of hyperemia.

Passive hyperemia has already been employed by me for purpose of nutrition and in the cure of bone fractures which would not knit, and if the widely used expression "Bier's stasis" is to mean that I have introduced the technic of stasis hyperemia and this name is used even in the treatment of bone fractures, I must decline this. Much rather can I claim for myself the introduction of hot-air apparatus, which are often named after Tallerman, because mine were present long before his and further because mine, for general use, are much more useful and practical and for this reason have been widely adopted either in their original form or in one of their numerous modifications.

But except for bone fractures and for attempts at nutrition, before me no one has employed stasis hyperemia, nay, warnings have been uttered against blood-stasis in the affections for which I have recommended it, the main duty of the physician having been interpreted as one to remove and combat the inflammatory stasis hyperemia by means of the so-called antiphloglosis. This idea is so deeply rooted in the minds of modern physicians

that the majority of them even to-day have an antipathy against the employment of this remedy and for this reason it is used in but few places. But I am convinced that it has a great future and that the time is not very far distant when physicians will appreciate that the employment of this form of hyperemia is not only useful in a large number of affections but also based on logic and science.

And this much I must claim for myself, that I have pointed out to therapy an entirely new avenue and have originated the teaching of the rational employment of hyperemia, which heretofore has not even been mentioned, though used unconsciously.

It seems that the first to have hit upon the idea to make use of artificial stasis hyperemia in insufficient callus formation was Ambroise Paré (39). In the thirtieth chapter of the thirteenth book of his works he at first recites the remedies for the reduction of callus when too large. These consist in diminishing, dividing and astringent substances. "If, however, the callus is too small and undeveloped in consequence of the bandage being too tight or because the limb has been too long at rest without exercise or the nutrition of the patient was insufficient, the bandage has to be taken off and entirely removed from the fracture. Instead a different kind of bandage should be applied beginning at the root of the vessels, if on the leg close to the inguinal region, if on the arm near the shoulder and reaching nearly to the seat of the fracture. For by this remedy the blood is squeezed out and compelled to flow to the injured place."

I do not know whether Paré's idea to effect nutrition and callus formation by means of artificial stasis hyperemia has found followers. Probably it has been entirely forgotten, which is natural, to judge from the brevity and lack of clearness of the contribution, until Nicoladoni (40) described in the year 1875 v. Dumreicher's method, which he recommended for threatening pseudo-arthroses without being acquainted with Paré's experiments. v. Dumreicher's idea, to use Nicoladoni's words was: "Perhaps we will succeed in reaching our goal if we are able to send a larger quantity of nutritive material to the threatened place. If we can still more fill the vessels and if the tissues are in a condition fit to take up the material

of which we now have an abundance, an artificially produced and permanently maintained hyperemia *per se* will exercise a powerful stimulus on the tissues and tissue elements which participate in formation of callus in accordance with the relation of added nutrition to function, so well known to each of us. A method which has this as its aim fulfills also another indication, viz.: that the once stimulated production receive continuously material to carry out the construction of callus until finished."

In principle Nicoladoni produced hyperemia exactly as we produce it even to-day, namely, by means of an incomplete v. Esmarch bloodlessness with rubber tubing loosely applied over the seat of fracture, while that part of the limb situated below the fracture was bandaged with a flannel bandage. He, however, considered v. Dumreicher's original method more effective, which is carried out in the following manner: The limb below the fracture is firmly wrapped by a flannel bandage with the view of damming the arterial blood-stream and of directing it away from the bandaged part towards the place of the fracture. Here stasis hyperemia is produced by wedge-shaped compresses placed above and below (Nicoladoni speaks only of fracture of the shinbone) with their broad ends turned toward the bone fracture. A bridge in the form of a wooden splint presses the wedges tight against the bone while a firmly drawn roller bandage keeps the whole in place. The wedges produce an intense hyperemia in the place of the fracture free from the pressure, embracing, as Nicoladoni has demonstrated, the entire bone down to the marrow.

Except in threatened pseudo-arthroses this process has also been successfully employed in order to more quickly fill bone cavities.

Nicoladoni, in different places, points to the similarity of the phenomena produced by this method with acute inflammation not limited to the development of a simple edema but similar also in the hardness of the swollen tissues produced by inflammation.

Although Nicoladoni has thus described in detail the effect of stasis hyperemia on the development of callus and bone regeneration in bone cavities, apparently the

usefulness of this procedure has not been recognized but fairly neglected. Bruns (41) in his book on bone-fractures, cites in the year 1886 only five cases in which v. Dumreicher's method had been employed.

But in the same year appeared an elaborate contribution by Thomas (42) on the effect of stasis hyperemia on bone fractures with retarded callus formation. He narrates fourteen cases in which he has employed this method.

In the first few cases he simply applied a tourniquet above the seat of fracture and let it remain for only half an hour daily. Later, however, he used prolonged hyperemia and attempted to confine it especially to the place of fracture by applying a rubber bandage above and below so firmly that stasis developed in its region. He depicts the method by an illustration. In order to increase the hyperemia Thomas let the limb hang down.

Of the fourteen cases, Thomas treated but four with stasis hyperemia exclusively. In the other ten cases he used besides an older method of percussion, viz., he percussed the fractured ends at intervals of a few days to months with a hammer covered with rubber, while protecting the skin against injury with a layer of felt. He intended to excite an inflammatory irritation by this percussion and from the histories it can be seen that he was successful in this. He produced by it swelling and frequently bloody discoloration in the region of the fracture; that he proceeded energetically can be concluded because he frequently undertook this operation under ether anesthesia. The excellent results which Thomas achieved in several grave and hopeless cases make it apparent that the combination of these two remedies is very useful.

Thomas successfully utilized this procedure, which he terms "damming," in two cases of recent fracture of the patella and in one case in which the quadriceps tendon was torn.

Thomas does not mention v. Dumreicher or Nicoladoni and wrongly thinks he is the inventor of the method, as he expresses himself in several places.

In the following year Helferich (43) recommended anew the stasis hyperemia to increase deficient callus

formation and in general to stimulate bone regeneration and bone growth. He produces hyperemia in the manner described by Nicoladoni as less effective, by loosely placing above the diseased place of the bone a piece of rubber tubing, but firmly enough to create below a vigorous venous hyperemia. In order to limit the stasis to the diseased portion of the limb a bandage is applied up to it. Helferich lets the limb hang down in order to make the hyperemia intense. Rightly Helferich points out that this method is simpler than the complicated one of Dumreicher and that the peripheral of the two rubber bandages which Thomas applies is superfluous.

He reports eight cases of retarded callus formation in which he has successfully employed stasis hyperemia exclusively, and three other cases in which he previously nailed together the fractured ends. We will later on more fully discuss his experiments to stimulate bone growth by the same agent.

CHAPTER VII

PASSIVE HYPEREMIA OF THE LIMBS BY A STASIS BANDAGE

This, in practice, is the most important process and has early been employed for the cure of pseudo-arthroses.

The rubber bandage is to be applied above the place which is to be rendered hyperemic, in several turns covering each other, firmly enough to compress the weaker walls of the veins but not the stronger ones of the arteries. Depending on the firmness of the application we can produce any degree of stasis hyperemia varying from the mildest to the most intense form. The changes which take place in the extremities thus subjected to stasis I can best describe by some experiments on myself.

I apply to my left upper arm a stasis bandage so as to produce a mild passive hyperemia. The bandage is applied only firmly enough so as not to produce any inconvenience and that in attending to one's customary occupation it is forgotten.

First the subcutaneous veins of the back of the hand swell, next the large, subcutaneous veins on the flexor side of the forearm. The skin of the arm gradually assumes a bluish color, while the palm of the hand and the extensor side of the elbow assume a rosy color. The back of the hand and fingers are generally bright red. In the skin of the palm one can observe numerous circumscribed white spots varying in size from a millet to a lentil. These can also be found sparingly on the back of the hand. On careful inspection one can plainly observe the otherwise invisible neat net of the veins of the cutis.

After three hours the skin of the forearm is equally blue-red. The fingers, the region of the elbow and the back of the hand are bright red, the last, however, is blue-red around the larger vein trunks. The white spots on the skin of the palm are faded and can scarcely be seen. The large subcutaneous veins are less prominent, the net of superficial cutaneous veins begins to fade. Prolonged, strong pressure with the finger on the back of the hand demonstrates an incipient edema. The pulse is full and forcible, rather stronger than in the other arm.

The treated limb is more susceptible to cold than the other one. Pressure with the finger blanches the skin everywhere, and becomes refilled immediately with venous blood. Friction produces even in the bluish discolored places the most vigorous arterial bright red, which remains for quite a while.

After the bandage has remained *in situ* ten hours the increasing edema becomes striking. The largest circumference of the left forearm is 2 cm. more than previous to the institution of the stasis. The impression from the finger remains. After twenty hours, arm and back of hand are equally swollen by edema, the largest circumference now being increased by 2¾ cm. The skin of the fingers, of the palm, the back of the elbow and wrist joints are still bright red, the rest of the skin bluish red. The subcutaneous veins are but faintly visible, no more so than on the untreated arm. They are not only covered by the edema but they can not be felt any more like in the beginning as tightly stretched cords. Forcible friction on a bluish red place produces even now a decided bright arterial redness.

That there exists no crude obstacle for the return flow of the venous blood is evident from the fact that when I stretch my arms (the well-known experiment of the flow of venous blood toward the thorax) the arm blanches almost immediately.

Immediately after the undressing both arms feel equally warm. After remaining undressed for some time the treated arm feels somewhat colder. After a prolonged exposure to cold (+ 2° C. with wind) on the uncovered back of the hand of the treated extremity appear vermilion spots, which disappear on pressure with the finger and reappear immediately.

This degree of stasis on a healthy arm produces little or no reduction of the temperature of the skin.

An experiment on my arm shows:

Previous to stasis	31.8°
Ten minutes later	31.0°
After an hour	31.9°
After about 1½ hours	32.5°
Immediately after the removal of the bandage after 1¾ hours	32.2°

If the rubber bandage is applied just as firmly on an inflamed extremity the consequent conditions are generally more pronounced and this in proportion to the intensity of the inflammation. As is well known all inflamed limbs are warmer at the affected place. Even in chronic tuberculous inflammations this increase of temperature is considerable. The differences, as compared with the same place of the healthy limb, range between 1-3° C. and more in favor of the affected part.

I remark that the comparative measurements must be undertaken in exactly symmetrical places and under equal conditions. One must not, for instance, place the two uncovered extremities alongside each other and then proceed to measure first the one and then the other, because the latter in the meantime has cooled off. The former also is important, because different places of the same part of the extremity have normally a variable temperature.

Thus, for reasons easily understood, the skin of the palm is always warmer than that of the back of the hand.

In contrast to this moderate stasis hyperemia, which is the one mostly employed in practice, I now proceed to describe the phenomena produced by a firmly applied bandage. *Anspitz* (44) has excellently and minutely described them in 1874. The observations made by me on myself and on one of my assistants are almost totally in accord with those made by Anspitz. I differ from him only in the interpretation of the phenomena in many points.

I apply to my left upper arm a rubber bandage so firmly that it produces the strongest possible venous stasis. Below the bandage I feel the pulsating, beating artery. Even after two minutes the subcutaneous veins swell very much and the skin becomes livid, its shade being bluish to grayish red. In the palm one can observe several bright red spots, while on the posterior side of the elbow, on the back of the hand and on the radial side of the forearm below the stasis bandage appear vermilion and yellow spots. The vermilion spots increase and enlarge and become confluent so that after seven minutes the largest part of the skin is vermilion. The bluish red-

ness remains longest in the middle of the flexor side of the forearm and on the back of the hand. Pressure on the vermilion skin produces a white spot which immediately after the cessation of pressure reassumes its color. On the flexor side below the stasis bandage develop numerous carmine red points (small hemorrhages). In the arm appear sensations of heaviness, fatigue, prickling and cold and warm alternately. The fingers feel cold. After twenty minutes the skin of almost the entire constricted arm becomes vermilion; the blue-colored places have still more receded. By friction on the back of the hand a vivid bright hyperemia can be produced. The skin does not assume a rosy hue but has a decided shade partially yellowish, partially copper-color. The point-like hemorrhages increase. The tightly stretched subcutaneous veins are less visible and perceptible to touch. Yellowish white spots develop in the palm and on the tips of the fingers. The limb becomes numb and cold to the feel, but subjectively one has a sensation of warmth in the arm.

In the course of the stasis the skin of the palm becomes ashen gray, interspersed by vermilion and white spots. The vermilion spots become white on pressure with the finger and then one can see on that place numerous point-like hemorrhages; after cessation of the pressure, the vermilion color reappears rapidly.

After forty minutes the intense stasis produces an intolerable sensation of pain, so that the bandage must be loosened. I at once experience a decided sensation of cold in the arm and a feeling as if it were faradized. These sensations are most pronounced in the tips of the fingers. The skin in the part of the limb which has been constricted commences to assume a rose color in about the same degree as is observed in artificial bloodlessness which had been employed for three to four minutes, only the fingers remain deathly pale for a little while, similar to that observed in some individuals after a cold bath. One and one-half minutes later they become bright red and in the entire limb appears a sensation of warmth. Even three-quarters of an hour after the removal of the bandage I still have a sensation of stiffness of the muscles and fatigue in the arm. In the skin one can see numerous

carmine red point-like hemorrhages. After twenty-four hours these blood-points have faded and appear bright to yellowish red. The skin of the constricted extremity shows a decided yellowish brown color, particularly so in the bend of the elbow and below. This discoloration is in sharp contrast with the place where the lowest margin of the stasis bandage was applied. After two days the yellow color of the arm has faded considerably. The blood-points can only be recognized on careful inspection as yellowish brown spots. After four days everything has disappeared; the skin appears normal.

During the experiment the temperature of the skin has fallen rapidly. Previously it was in the palm 32.2°, five minutes after the institution of the stasis 30.9°, after fifteen minutes 30.0°, after thirty minutes 29.0°. The limb swells rapidly; as early as ten minutes after the appearance of the stasis the circumference of the arm has increased 2 cm. Edema appears but to a slight degree after a duration of the stasis of thirty to forty minutes.

I differ in the interpretation of the phenomena in essential points from Anspitz. First of all, that physician believes that this intense stasis is limited to the skin and that the deeper veins are compressed not at all or inconsiderably. This is an error. Not only the intense but the above described moderate stasis affects the deepest veins (probably principally by means of the compressed main trunk). Of this one can be convinced by applying lightly a stasis bandage above deep operative wounds. We frequently observe that an intense stasis hyperemia continues into the very depths of the limbs, when in operation an incorrectly applied artificial bloodlessness gives way, and we thus get the same phenomena which I have just described under intense stasis. This hyperemia even reaches the very bone, for one can observe an increased flow of venous blood from the medullary cavity of the sawed or chiseled through bone.

I have described some time ago (45) that in total obstruction to the return flow of venous blood a part of the stased blood goes back through the bone, the vessels of which naturally are not concerned in the pressure of the constricting subject. We therefore succeed in render-

ing hyperemic, by means of the stasis bandage, the very bone into its marrow.

Anspitz thinks that the vermilion spots which appear in intense stasis are produced by blood coloring matter which enters the tissues; that the latter plays an important role I consider probable. We know through *Stricker* and *Cohnheim* that hemorrhages occur *per diapedesin* in intense stasis and we observe point-like hemorrhages and—what is still more important—yellowish discolorations of the skin of the entire area subjected to hyperemia, which can develop only through coloring matter of the blood.

Whether, however, this is the only reason for the appearance of the vermilon color remains doubtful to me, for we can observe the same redness appear on the skin from short exposures to cold, which leads to a considerable stasis of the blood but not to a discoloration of the skin. I also could not convince myself as to Anspitz's statement that pressure with the finger does not cause the vermilion color to disappear; in my case pressure always produced a white spot, which quickly again became red. I therefore leave unestablished the cause of the development of these vermilion spots and only remark that they are, when apparent in large numbers in an extensive area, the perceptible evidence of a very intense and excessive stasis.

As an explanation for the white spots Anspitz cites partially mechanical reasons, partially Samuel's *Itio in partes*. I explain them differently. I have already stated that arteries and especially capillaries of external parts of the body fight against venous blood which becomes stased in them and push it forward in the direction of the veins by means of motions of their own. Only in this way can it be explained why the arteries are empty in corpses and in extremities rendered "bloodless." It is evidently erroneous to attempt to explain this by the elasticity of the arteries. I have frequently convinced myself that not only the dead artery in the corpse but also the living, larger artery of the "bloodless" limb is flat, though it should be round, if an elastic contraction had expelled the blood; the artery furthermore gapes

wide open when cut through, though it is empty or contains only traces of blood.

v. Esmarch's "bloodlessness" as generally applied—bandaging of the elevated limb—is virtually no real bloodlessness, for it permits the blood found in the limb to remain in it. In spite of this the limb looks afterward deathly pale. If, however, an extremity is constricted without undue haste with a v. Esmarch bandage while the limb is in the horizontal posture, the normal amount of blood would remain within, because the first turns of the bandage compress the veins in front of the arteries. If one now observe this extremity it can be seen that the subcutaneous veins, which previously were small, swell considerably, while the rest of the skin becomes pale; this happens even when the limb hangs low, and in surgical anesthesia when muscular movements as a propelling power for the blood are excluded. The arteries and veins, therefore, have squeezed out the blood which has become venous and forced it into the veins.

The same white spots which we have noted above in intense stasis, can be produced in a greater measure and more numerously by the following experiment: I produce on a man with very white skin a moderate stasis hyperemia by means of a few turns with a rubber bandage applied to the upper arm until the color of the skin becomes bluish. Additional turns of the bandage made firmly now shut off the arterial flow and I let the limb hang down. Originally blue, it now becomes checkered. In the blue parts intensely white spots appear. After fifteen minutes the white spots predominate on the upper arm, the blue spots on the forearm. In spite of the dependent posture the white spots do not lack even in the extreme tips of the fingers. In my opinion it does not suffice here to accept merely a contraction of the smallest arteries through the stimulus of the venous blood, for because of the pronounced whiteness of the spots the capillaries too must have been participating. Those interested in further proofs for this I refer to my repeatedly cited contribution on the development of the collateral circulation. We see, however, from the last experiment that arteries and capillaries can further the venous blood by means of motions of their own and which they

do more or less in proportion to the venosity of the blood. I only wish to remark *en passant* that this property represents an extraordinary support of the circulation of blood in affected parts of the body.

Finally the observation is of interest that one can in extremities which are in a moderate stasis hyperemia and are at the same time rendered venously hyperemic, produce by means of friction the most pronounced arterial hyperemia, and that this is not entirely lacking even in intense stasis. These observations also point to an independent activity of the vessels.

The vivid, bright redness which appears after loosening the bandage in intense stasis hyperemia, is identically the same phenomenon which we observe as a so-called reactive hyperemia after artificial bloodlessness and which for a long time was accepted as a pressure paralysis of the vaso-motor nerves. I have already convincingly proved in detail that it means something entirely different and that it appears after any desired interruption or even limitation of the arterial flow. This vivid hyperemia is the expression of oxygen hunger of the bodily parts which for some time have been poorly or not at all fed with arterial blood, as a useful process of reaction. That it also occurs after this grave stasis hyperemia is proof that an impoverishment of oxygen has taken place in the constricted limb.

Intense stasis, therefore, is a very dangerous and obnoxious agent for the limb concerned. Because it leads to a considerable reduction of the temperature. I have called it cold stasis. For this reason I have never employed it in practice. It is nevertheless possible that if employed for a short period it could be used for therapeutic purposes. That, if employed for some time, it would be obnoxious and dangerous, needs no further explanation. We employ, however, for a short time during the day a form of stasis hyperemia, which, as I will later on describe, stands between it and the above described moderate stasis.

In the majority of cases I have employed stasis hyperemia in this manner: A so-called "cured" or elastic (woven) rubber bandage is applied above the seat of affection of a limb in several turns firmly enough to

produce the symptoms mentioned in the beginning of this chapter under "moderate stasis." The end of the bandage is fastened with a safety pin. To prevent pressure from the bandage it should be lined with a muslin bandage (Scarcely necessary if a good rubber bandage

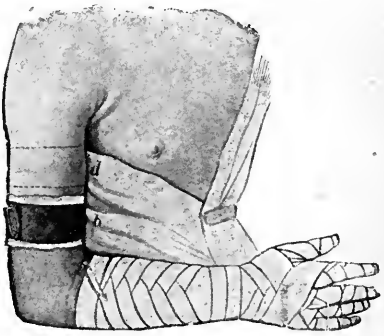


Fig. 5.

is selected.—*Ed.*). For this same reason the place of bandaging is to be changed (Fig. 5). If in continued stasis the bandage has been applied in the morning at *ab*, it is placed in the evening at *cd* and returned the following morning to *ab*. Even when the stasis hyperemia is used for a short time daily one will do well not to always select the same place for purpose of constriction. In order to prevent blood-stasis in such bodily parts not in need of it, the part of the limb situated peripherically from the lesion is best enveloped with two or three layers of a linen or flannel bandage.

I have employed this form of stasis in the large majority of the cases I have treated, continuously with but short interruptions or at least in the beginning continuously and later with prolonged interruptions. But one must anxiously watch that the above described hot stasis is maintained, that the congested limb never feels cold to the touch or even shows the vermilion spots described above. Furtherfore, this form of stasis must never produce inconvenience, pain or hyperesthesia in

the treated limb. The patient who wears the bandage must suffer so little difficulty from it that while following his usual occupation he forgets its presence. All the same one succeeds in producing a vigorous hyperemia with edema especially in inflamed parts of the body.

Of late I have entirely abandoned this method of application in the treatment of tuberculosis, for it requires constant and anxious supervision to make sure that hot stasis is maintained. Furthermore, as I will discuss later on, it undoubtedly leads to changes for the worse in this disease, if a chronic edema appears, which is artificially maintained for a prolonged period.

I will here add another observation which I have made not infrequently after a prolonged application of stasis: If the remedy is stopped the previously hyperemic limbs are strikingly pale, if they have not received a yellowish hue due to small extravasations of blood. We see here the occurrence of a reaction following prolonged and frequently venous hyperemias, similar to the one known to us for a long time as following arterial hyperemia. As is well known, people whose skin is much and frequently rendered hyperemic by heat stimulus, such as bakers, stokers, glass-blowers, are very pale when away from their work. I do not want to attempt to explain this but point only to the fact.

Instead of the more or less lasting stasis, I now but employ, at least in tuberculosis, the interrupted stasis with variably long intermissions. Generally in tuberculosis I do not allow the stasis to last more than twelve hours daily and see to it that the developed edema is removed until the reapplication of the bandage. Lately I do not permit the appearance of a demonstrable edema at all, and in tuberculous joints apply for one hour daily a more vigorous hyperemia, the course of which follows: The bandage is so firmly applied that a vigorous stasis hyperemia is produced. The subcutaneous veins swell strongly, the skin becomes bluish red and at about the end of the hour occasionally a light prickling sensation appears in the limb. Real inconvenience or pain, on the other hand, must never occur. The peripheral part of the extremity during this short period of hyperemia is not enveloped. The process has the advantage of great

simplicity and safety. Even if one commit here a technical error, mischief can never be produced, as even after an intense hyperemia of one hour's duration lasting injuries do not occur.

This form of stasis is not to be pushed so far that the above described vermilion spots occur. As a rule a demonstrable edema also does not appear during the short duration of the application. Fig. 6 illustrates this

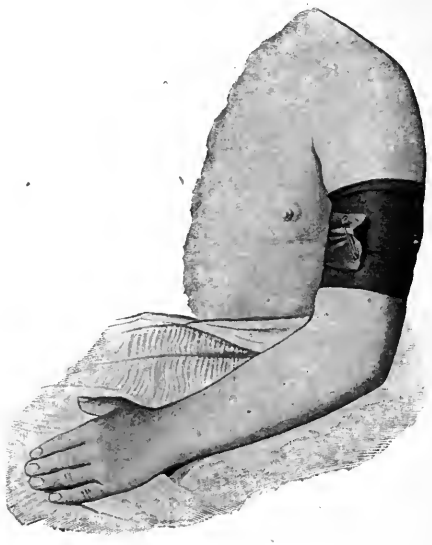


Fig. 6.

method of stasis, which we now apply in tuberculosis and which I will later describe in greater detail. One can see that the method is simplicity itself. It is fairly immaterial where the stasis bandage is applied as long as it does not come too near the diseased joint. Thus, for instance, the bandage can be applied to the upper arm in disease of the wrist-joint.

In this method I usually apply the stasis bandage as is shown in the illustration, in such a way that its turns do not cover one another, but surround a larger part of

the limb. The elastic bandage then produces no difficulties whatever.

I have so far been unable to render the hip-joint hyperemic by means of elastic ligation, but the method can be successfully employed on the shoulder-joint, thus, with the exception of the hip-joint, every joint of the extremities can be treated with this remedy. I describe the technic of stasis of the shoulder-joint (Fig 7.):

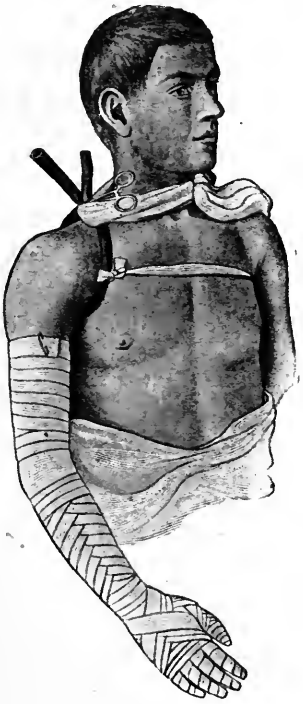


Fig. 7.

Apply loosely around the neck a cloth folded like a tie. A piece of thick rubber tubing is applied from the axilla around the shoulder, one end of which is led below the tie of the neckcloth, the other end outside to it and around, pulling it so firmly that a strong venous

stasis develops in the arm. The rubber tubing is fastened above the cloth with a pair of forceps, which at the same time prevents the tubing from sliding off. To prevent pressure from the tubing, a strip of soft felt or cotton is placed below it (this is not shown in the picture). In order to render the entire shoulder-joint hyperemic, two strings are attached to the front and rear of the tubing and knotted in the healthy axilla, while pulling firmly (see illustration). In women it is practicable to attach a ring to the corset on the healthy side and to fasten the strings to it. These strings are absolutely essential because without them the rubber tubing would not grasp enough over the joint. If we have to deal with tuberculosis of the shoulder-joint, which is to be treated with stasis but for a short period daily, the enveloping of the healthy part can be dispensed with.

Under no circumstances should the treatment of the shoulder-joint by stasis be continued over twelve hours daily and even then one must allow intermissions several times during the day because the tubing, the place of which can of course not be changed, would produce harmful pressure.

Generally stasis hyperemia can be much easier produced on the upper than on the lower extremities. The legs of fat women occasionally offer difficulties. Frequently an insufficient stasis hyperemia can be made very vigorous by first applying the rubber bandage so firmly that a complete bloodlessness is produced, which should be allowed to remain for four or five minutes. Now the bandage is loosened enough so that a strong reaction hyperemia develops when the same bandage is used as a stasis agent, which keeps back the blood. Or the affected part can be painted with tincture of iodine so long until an intense inflammation of the skin is produced. The stasis bandage then produces a vigorous hyperemia in the inflamed area.

Naturally blood-stasis is always accompanied by a lymph-stasis. Occasionally one can now observe a form of stasis which I have designated as "white." There exists considerable edema, while the hyperemia is insignificant. The limb looks edematous, shining and white. I have explained this as a predominating lymph-stasis. I can

pass this over, because this phenomenon is very rare and will but add that according to my certainly limited observations, it is ineffective.

Objections have been made to stasis hyperemia: that especially in inflammations it is inconvenient, painful and dangerous. If this method is to be adopted in practice it must be freed from these reproaches. First of all, as I have already repeatedly done, I call attention that any stasis hyperemia which produces decided inconvenience or pain, is false. On the contrary, we will yet learn that the pain-relieving effect of this remedy is one of its prominent properties. I therefore repeat: Whoever produces pain with stasis hyperemia instead of relief does not know how to handle it. Exceptionally cases occur in which, to judge from conditions, one would expect a favorable effect from the remedy, in reality, however, pain and trouble are aggravated. We then have a case not suitable for this remedy. Another remedy should be chosen.

The fear has been expressed that the rubber bandage would produce decubitus at the place of application or even lead to gangrene of the entire constricted part of the extremity. The former I have observed in the beginning when I made use of rubber tubing for the production of hyperemia. Since I use a soft, wide rubber bandage and carefully see to it that when the skin on the place of application becomes irritated, an intermission is made until the skin is healthy. I have seen no more decubitus. If the rules I have laid down for the application of stasis hyperemia be followed even approximately, gangrene of the extremities subject to stasis can be entirely excluded. I am in the habit of advising assistants, nurses and patients that a stasis bandage remaining for a prolonged while, must *never* produce pain or paresthesia in the limb, otherwise it must be loosened immediately. I also tell my assistants that only the patient himself knows whether he has pain and that they must never be misled into replying: "You are delicate; you must stand this; the bandage is not too firm."

I can therefore assert that those dangers are imaginary and present only in the crudest ignorance of technic. If

one, however, uses remedies which one does not know and control, these are almost always dangerous.

If a stasis bandage be applied to one place for a long time and the same place of the limb is chosen for constriction, naturally atrophy of the muscle will occur. For this reason the place of bandaging should be frequently changed. Nevertheless, when the remedy has been employed for years atrophy can not altogether be avoided; it remains, however, insignificant if the place of constriction is frequently changed and disappears spontaneously after the cessation of the treatment.

I myself had at first to reproach the stasis hyperemia with the occasional production of hot suppuration and erysipelas in "open" tuberculosis. I reported several bad cases of this sort. I can now assure that they all were the result of a then wrongly employed technic. I then made use of a too vigorous stasis hyperemia, which led to chronic edema. As we know from experience, the latter favor the occurrence of acute inflammation. Meanwhile, we have developed the technic of stasis hyperemia for inflammatory affections to such a degree that this danger is entirely avoided. On the contrary, I will yet demonstrate that the method of stasis practiced by us favorably influences the course of many acute inflammations, even that of erysipelas. Thus, since my detailed contribution on this danger in 1894 I have observed but once the addition of an acute inflammation to an open tuberculosis which was due to the treatment, and this only lately, when we again were occupied with the introduction of a new technic (suction apparatus for the production of hyperemia in tuberculosis) and had to learn from failures. I will relate this case in the course of this work.

Things are similar with the other unfavorable observation made by me, the appearance of stasis ulcers under the influence of hyperemia. These, too, are due to faulty technic.

I am therefore pleased to be able to assure that the only danger from stasis hyperemia, which I at first had to recognize as existing, and which I myself was the first to observe and report, was purely due to an error of technic which can be easily avoided.

Though I have employed stasis hyperemia for months

and years, I have never seen the occurrence of varix peripherically from the place of constriction. This is the best proof for the view already expressed elsewhere that varix is not due to stasis alone, but that there must exist in addition an affection of the wall of the vein.

To this may be added the observation described in the first part of this chapter that the subcutaneous veins which have at first become tightly stretched by the stasis bandage, after a few hours begin to contract so that they scarcely appear dilated.

Theoretically considered, one would easily imagine that prolonged stasis hyperemia embracing larger areas of the body would produce a decomposition of blood, which may lead to undesirable consequences, for in stasis hyperemia numerous red blood discs which exude into the tissues and perhaps such in the vessels themselves perish while important chemical changes take place in the stased blood.

Landois (46) says in his text-book of physiology that the red blood discs of carbonic acid blood dissolve the easiest, but remarks in his Transfusion of Blood (47) that while carbonic acid blood dissolves easily, the objection that the blood containing carbonic acid was perhaps already in partial dissolution is to be decidedly rejected, for if carbonic acid blood of animals is arterialized it again becomes less soluble.

E. Grawitz (48) mentions that in highly concentrated stasis blood in heart troubles, while there is a disturbance of compensation the hemoglobin is loosely attached to the stroma and thinks it probable that in such cases a greater decomposition of the red blood corpuscles takes place in the liver.

Chvostek (49) found the serum of stasis blood taken from a constricted finger—which, however, lasted but ten minutes—free from hemoglobin.

That in stasis hyperemia, which we make use of for therapeutic purposes, decomposition of blood frequently does take place, is proved by the slight yellowish color of the skin which appears after a prolonged application of the remedy.

This frequently is not lacking even when the stasis has been employed for a short period daily and in a

moderate degree, occurring especially in inflamed parts of the body. As we generally maintain more prolonged and more intense stases than those had in view by the above-mentioned experimenters, it is doubtful whether we occasionally do produce greater decomposition of blood. If this, however, were so, we should be able to easily demonstrate them; for we know from experience, gained from transfusion of foreign blood and from a series of diseases, characterized by immense decomposition of the blood, that in such cases liver and spleen are not sufficient to take up the decomposed blood, but that albumin and in pronounced decomposition also hemoglobin, appear in the urine. Furthermore, these cases have fever, which as a rule starts with a chill.

Among the large number of cases which we have treated with stasis hyperemia, we have but once observed such a thing. It was a weak, small boy, who always showed high fever and albuminuria whenever treated with the stasis bandage applied to the thigh, though his general condition remained undisturbed. Both symptoms appeared soon after the application of the bandage and quickly disappeared as soon as it was removed. Besides, these phenomena have not done him the least harm. Probably in this case we had to deal with a weakness of the red blood discs, or perhaps also other components of blood as it occurs in that puzzling disease known as paroxysmal hemoglobinuria, in which the slightest external causes, especially cold, produce pronounced blood decomposition, which may follow a course resembling malaria. As is well known, albumin and hemoglobin have been found transitorily in the urine after cold baths (50).

Reineboth (51) and Reineboth and Kohlhardt (52) found that in rabbits after chilling (immersion in ice-water for five minutes) hemoglobin is given off to the serum without it passing into the urine. It is said to be taken care of in the liver and spleen. The correctness of these experiments is disputed by E. Grawitz (53).

The following experiment, which I have made on myself for several consecutive days with the same result, would seem to prove that generally an extensive stasis

hyperemia would not produce so decided a decomposition of blood as to make it a matter of importance, demonstrable by fever, hemoglobin and albumin in the urine: I applied high on both thighs a stasis bandage so firmly that the above-described intense stasis hyperemia was produced, i. e., the superficial veins became prominent, the limbs bluish red, swollen, showing vermilion spots. I succeed in this on myself excellently. After a short time a sensation of pricking, numbness and fatigue in the legs occurs, and finally pain, so that it requires the exertion of a maximum of will-power to stand the extensive stasis more than one-half hour. In addition, phenomena plainly show that much blood is taken from the rest of the body; the pulse becomes small, increases from 68 to 88; respiration is deeper, there is a sensation of lack of blood in the head and inability to think. After forty-five minutes the stasis bandages are loosened and all the phenomena immediately disappear. On the skin can be seen the above-described carmine red hemorrhagic points. I could never demonstrate after these experiments albumin or hemoglobin in my urine nor a regular influence on the temperature. My general condition was never disturbed by this enormous hyperemia (which certainly would never be employed for therapeutic purposes), although I repeated the experiment for five consecutive days.

Nevertheless, there possibly was a destruction of red blood discs. But a not too extensive decomposition of these does not lead to the appearance of either hemoglobin or albumin in the urine, and in this my experience with transfusion of foreign blood agrees with Reineboth and Kohlhardt.

CHAPTER VIII

HYPEREMIA BY SUCTION APPARATUS

The most magnificent and extensive hyperemia can be produced in the extremities by means of Junod's boot, or apparatus constructed on the same principle. Junod's large cupping glasses and cupping boots in their time produced quite a sensation in the medical world, but have been forgotten, so that undoubtedly the majority of physicians have no knowledge of their existence. I deem it therefore advisable to describe somewhat fully these apparatus, which, in my opinion, will again play a role in medicine, though in a different way than their inventor and his imitators intended. Junod (54) presented to the French Academy of Sciences, in 1834, his experience and experiments with the application of thinned and thickened air to the entire body or to single portions of it. In 1838 he (55) described in a new essay improvements on his apparatus, and in 1841 he made a report to the Academy, consisting in the narration of several cases treated with his apparatus (56). Others made extensive use of Junod's apparatus and soon several contributions on their efficacy were published, among which Ficinus' (57) "The Hemospasia" is the most exhaustive and detailed. In the following description I will therefore principally follow the statements of that physician.

Inasmuch as the large apparatus of Junod, which act on the entire body, and the appliances intended for the limbs, which force compressed air into the boots, are of little interest to us, I will limit myself to the description of the suction apparatus—the earlier well-known "Junod's boot."

At first Junod prepared four glass and copper cylinders for the four extremities. To insure an air-tight fit to the variable thickness of the limbs the open end of each cylinder had four attachments of variable width and form. Besides this a broad rubber ring, fastened to the attachment and which was fastened with a bandage to the extremity, served to shut the air. The cylinders intended for the lower extremities had the form of a boot. They

were supplied with a manometer and a thermometer. The latter served to measure the temperature of warm vapors, which Junod occasionally made to enter his apparatus in order to produce a more intense hyperemia. The air in the interior of the apparatus was thinned by means of a small suction syringe.

Junod has briefly described the effect of his apparatus as follows: "If the atmospheric pressure over the extremities is diminished, the skin swells and becomes red and the limb soon increases in circumference. The inflowing blood spreads an unaccustomed warmth in it, the excreted moisture quickly evaporates and deposits on the walls of the cylinder. This operation leaves behind for a short while a sensation of stiffness and numbness, which soon passes away. If warm vapors are employed at the same time the effect of the thinning of the air is still more pronounced. Among general phenomena are observed a sensation of ease in the head, the face pales, the pulse of the temporal artery becomes slower, small and disappears perhaps entirely. There is an inclination to faint. At the same time respiration becomes shallow, the activity of the intestines is diminished and nausea develops. Finally perspiration covers the entire skin."

The description of these general phenomena shows that Junod made energetic use of his apparatus so that a good deal of blood was taken from the circulation.

Later Junod described some improvements on his apparatus, which essentially relate to the convenient and perfect air-tight closure. He discarded the four attachment pieces and fastened instead to the open end of the apparatus strips of strong cotton material which in changeable numbers turned inwards enabled the fitting of the apparatus to the limb; over this was fastened a cuff of caoutchouc, which was pulled over the limb, hermetically attaching itself to it when the air in the apparatus was thinned.

In 1843 Junod (58) again published an essay which treats on the value of hemospasia (the name hemospasia, according to Ficinus, was introduced by Bonnard—*αἷμα*, blood, and *σπάω*, suck). He asserts that derivative and revulsive therapy has reached an undreamed

efficacy on account of his apparatus. There is scarcely a disease against which he does not consider hemospasia indicated and useful.

Junod had already spoken of the value of fainting, which could be produced with his apparatus by drawing the blood into the extremities. He states that he has been consulted by surgeons to artificially produce syncope. During this syncope operations could be performed painlessly, while dislocations could be easily reduced because of the relaxation of the muscles. He also believed that an artificial syncope in certain diseases could be advantageous.

Naturally the external air pressure, while the air within the apparatus is thinned, permits it to wander up along the extremity or to draw it in more firmly. To prevent this Junod put in the interior of his apparatus partitions and belts, against which the hand or foot could press for support.

It is worthy of mention that Junod repeatedly emphasizes that his apparatus are entirely harmless and states that his boot can be utilized even in varicose veins, for the apparatus dilates only the capillaries; the veins of the skin do not dilate after the removal of the apparatus, but contract.

Junod's apparatus were soon employed by many and recommended. In 1838 Erpenbeck (59) described an apparatus almost identical with Junod's boot. This was constructed of tin; the endings were produced by lined leather cuffs or by different large neck parts, which could be slipped over the apparatus. This apparatus does not offer anything essentially new. Erpenbeck, too, regards it simply as a revulsive and derivation agent. He is silent of the fact that Junod has already employed the same apparatus for the same purposes. In a second contribution (60), he describes the experience he has gained with his apparatus and informs us of an improvement on it that he establishes an air-tight closure by fastening an ox-bladder which he ties to the leg and the apparatus. Furthermore, he gives an adventurous description of how he imagines the reduction of a dislocated thigh with his apparatus.

The air is rarified by suction with the mouth. Erpen-

beck asserts to have observed all the phenomena as given in Junod's description, including the pallor of the face and the syncope.

Ficinus introduced some modifications of Junod's apparatus. On account of the lessened expense, he made his apparatus, like Erpenbeck, from tin and utilized a long rubber cuff, for the end which he fastened to the leg by means of cured rubber bandage. The other changes concern the suction pump and manometer. As we are not in need of a manometer and as we make use of a new and far better pump, we can pass them over. It can be said of Ficinus' apparatus, too, that they hardly represent an improvement over those of Junod.

In accordance with the views then held, Junod's apparatus and their imitations were used solely as revulsiva and derivantia; that is to say, it was attempted to send the alleged accumulation of blood in diseased places toward healthy parts. Magendie, the reporter of the French academy on Junod's apparatus, maintains that every physician must value this invention as a great boon, as it enables us to combat the congestion of blood toward noble parts or its transpudation into the tissues by deviating it toward the extremities without lastingly withdrawing the blood from the body. Junod himself has given this as the purpose of his apparatus and all those who used them started from these same views.

There was no shyness shown in the utilization of the apparatus, which, according to the description, were employed in the most energetic manner. This could be risked because the blood was drawn toward healthy parts. Junod himself mentions only reddening of the skin and swelling of the limb which is treated in his apparatus, but admits that this swelling, which feels firm and hard, remains. The illustrations given by him and Ficinus of limbs so treated prove that the swellings were indeed considerable. The swelling remains for several days and disappears gradually, while the skin of the limb assumes a greenish yellow and green color; that is to say, the apparatus has been so forcibly employed that it leads to extensive hemorrhages. It is further described that there appeared numerous point-like

hemorrhages, especially at the hair, and red, blue and yellow streaks in the skin.

From the following contributions, too, is evident how far hemospasic was pushed: Ficinus says that in his apparatus "the foot is forcibly pressed against the bot-

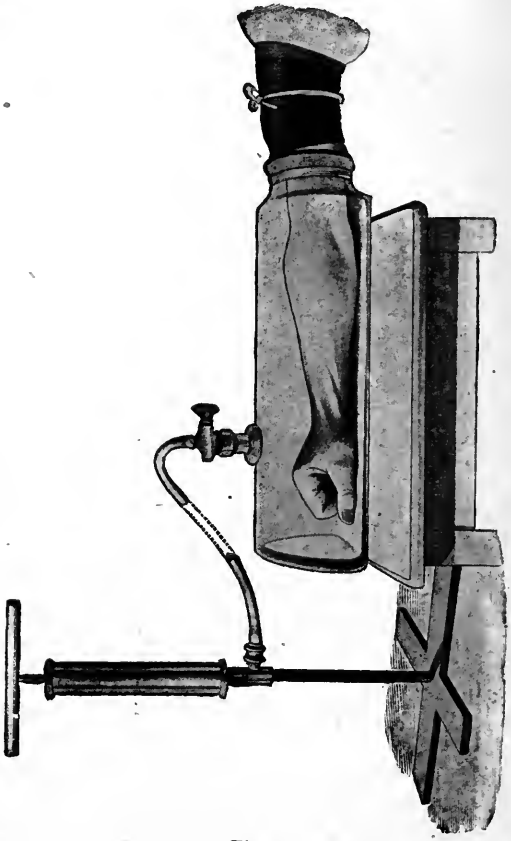


Fig. 8.

tom, to which it appears like glued. Some fear the leg might become fractured under the burden of the atmosphere." As other consequences, he cites a sensa-

tion of numbness, pricking and lancinating sensations, vigorous tension of the skin, especially in the upper part of the limb within the boot. If it is an arm, a sensation of weakness and exhaustion in the muscles remains even during the following day. Once he observed in a large toe a sensation as if it had sustained a contusion for fourteen days. The thinning of air which was necessary to produce such an effect was one-seventh to one-third of an atmosphere.

I have imitated Junod's apparatus so modified as to produce hyperemia in diseased parts. For such a purpose it is evident that the above-described effect must never result. We desire to produce hyperemia only, not hemorrhages; we want to succeed in getting a swelling of the affected parts, which should disappear soon after removal of the apparatus and not remain for days. I will first of all give a description of the apparatus now used by me.

I make now use of glass apparatus exclusively. They have the advantage of enabling one to observe the color and swelling of the limbs, aside from the fact that they are cheap and easily cleansed. I use three sizes of glass apparatus. The smallest size is for thin arms (Fig. 8), the next is for thick arms and legs of children, the third for the legs of adults. The upper end of the apparatus terminates into a narrow neck, the width of which corresponds to whatever purpose it is for and by which attachment to the extremity is made easy. In order to make the attachment air-tight, a cuff of good Para rubber is fastened to the neck. A book-binder is ordered to glue it to the glass, around which is wound twine which also is glued on.

After the limb is placed in the apparatus, the cuff is wound to the extremity by means of a rubber bandage, but not firmly enough to produce a decided hyperemia of the limb within the apparatus. One can easily learn to obtain an air-tight seclusion without producing at the same time hyperemia.

Next the air within the apparatus is thinned by means of a suction pump. One can make use for this of the small pump designed by Junod but I prefer the larger pump used by bicycle dealers for the inflation of tires

save that the position of the valves is changed so that the pressure pump is converted into a suction pump (Fig. 8).

As can be seen in the illustration, the pump is connected with the apparatus by means of rubber tubing. The connection is made with a rubber stopper which fits hermetically into the opening of the apparatus. The stopper is bored through by a stop-cock which can be opened and closed at will.

The treatment of the affected limb is carried out as follows: The air is thinned to a degree which can be borne by the patient without complaint. Besides, the intensity of the obtained hyperemia is observed through the glass. If the desired intensity has been obtained it is kept up for several minutes by closing the stop-cock, or, should this not be air-tight, by pumping slowly. Then the rubber stopper is removed, which permits the egress of air, and after an interval of from twenty seconds to one minute, the thinning of the air is again undertaken and hyperemia produced.

On account of the external air-pressure the Para rubber cuff is forced into the apparatus like a blown sail and at the same time the extremity is strongly forced into the cylinder. As we do not desire the pressure of the affected limbs against the walls of the apparatus, the patient must attempt to pull out the limb while holding fast to the apparatus.

I make use of the apparatus described for the legs and arms up to the hip and shoulder-joint respectively. For these two joints we have so far not succeeded in making suitable suction apparatus. However, it is possible that the difficulties will be overcome yet. Each part, from the middle of the thigh and upper arm to the ends of the toes and fingers, can be rendered hyperemic in these cylinders. To be sure, the entire leg and foot are rendered hyperemic when, for instance, it is intended to treat the knee-joint only, but as the hyperemia is not very intense and of but short duration, this does no harm; syncope or other disagreeable phenomena are not produced by it. If one desires to limit the hyperemia the peripheral portion of the extremity should be tightly bandaged. In such cases, however, the thinning of the

air must never be sufficient to produce a cutting of the margin of the bandage in the skin, thus producing effusion of blood. This pronounced rarefication of air need not be considered, as it is of no purpose in our work; besides, the bandaging of the extremity is indicated but very rarely.

For the purpose of rendering hyperemic limited portions of an extremity, I have constructed glass cylinders open at both ends, which are provided with Para rubber cuffs. Such an apparatus for the knee is depicted in

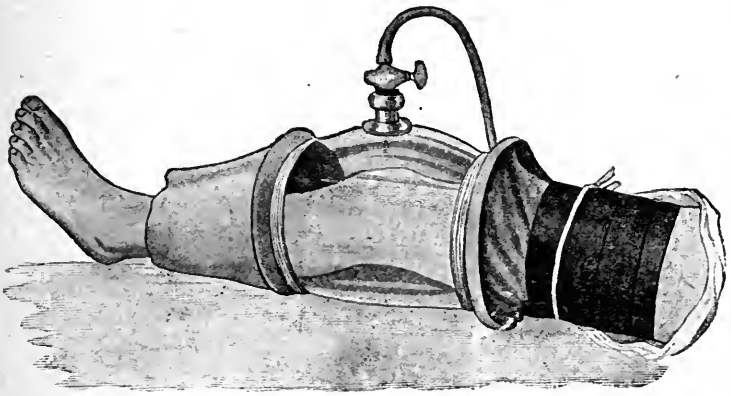


Fig. 9.

Fig. 9, which needs no further description. (In the illustration only the upper cuff is shown fastened by a rubber bandage. The lower one is left loose in order to better illustrate it.)

On account of the thinning of the air, which forces the limb into the cylinder from above and below, the joints become curved in the apparatus.

In a similar manner suction apparatus can be constructed for any part of the limbs below the hip and shoulder joints. On the whole, however, they can be dispensed with, because they are too complicated and because the double attachment makes an air-tight exclusion more difficult to obtain. We have ceased to use rubber cuffs because they do not adhere to the limb as well as those made of the pliant Para rubber material.

The changes taking place in the treated part can be nicely observed through the glass. As a rule, the intense forms of hyperemia are not obtained in the first few seances which appear without difficulty after repeated applications.

If the bandage around the cuff is not wound so tight as to itself produce a hyperemia, the limb placed in the apparatus has a normal color previous to the thinning of the air. After a few pumps it swells a little and reddens vividly. Frequently each suction produces a moist fog which emanates from the limb, which is absent in some instances. As a rule, a moisture forms on the inner walls of the apparatus and occasionally becomes so dense that the glass is rendered opaque, so that the treated limb can not be observed.

On continuing the thinning of the air, blue streaks appear in the red skin or the entire skin assumes a bluish hue interspersed with numerous vermilion spots, similar to those with which we have become acquainted in connection with intense stasis hyperemia.

The oftener the apparatus is used the more magnificent becomes the hyperemia. It appears in an intense form in tuberculous extremities, which sometimes assume entirely different forms on account of circumscribed swellings. The increase in the volume of the extremities can become so pronounced that they can be removed only by the use of great force from the narrow neck of the apparatus into which they have been squeezed by the external air pressure. If the air was considerably thinned the hair follicles are sucked out, so that the limb appears with a "goose-skin." The effect of the thinned air on open ulcers and fistulæ will be discussed later in connection with the use of the apparatus in tuberculosis.

Even in normal skin, extreme thinning of the air produces point-like hemorrhages and numerous vermilion spots. The patient states that the skin feels tense, sometimes so much so that he is afraid the skin may burst. In the limb appears a sensation of pricking "as if one were treated with electricity." When the thinning is pronounced the joints, particularly the wrist, begin to

pain and one has a sensation as if the ends of the joints were separated by a strong pull.

A sensation of warmth develops in the hyperemic limb, which remains for hours after the treatment. Objectively an elevation of the surface temperature can be demonstrated. As an example, an ankylosed knee-joint showed an increase of 2° C. nine hours after removal from the apparatus.

Patients suffering from chronic rheumatism state that the affected joints which heretofore were cold to the feel, became warm after treatment and remained so during the intervals. Considerable increase of surface temperature can be observed, especially in tuberculous joints subjected to the treatment. One can therefore see that the dilatation of the vessels has a prolonged effect.

As already said, the most intense forms of hyperemia must never be produced on our extremities with the suction apparatus, because we would injure rather than do good. The appearance of hemorrhages in the tissues and of too many vermilion spots must be avoided, as they are the sign of a decided disturbance of circulation. A few spots, however, can not be avoided in effective applications of the apparatus.

It is important to decide which form of hyperemia is produced by these suction apparatus. Without doubt the thinned air first of all affects the capillaries, because their walls are the most yielding, and then the veins. The strong elastic walls of the arteries in all probability are but little influenced. If we accept this as correct, we should surmise at first glance that a dilatation of the current bed while the inflow remains the same produces a diminution of the current. I have demonstrated in my above-mentioned contribution on the collateral circulation that this apparently clear conclusion from a physical standpoint is a false conclusion when considered in connection with the conditions of the living body. Experience shows that a dilatation of a certain area of capillaries is, on the contrary, associated with an acceleration of the blood-current in the concerned area. The diminution of the resistance to the blood circulation which is following the dilatation is so enormous that the diminishing effect of the dilated bed need not even be

considered. Generally we can say, local dilatation of a certain capillary area, provided the heart action remains the same, is associated with a considerable acceleration of the blood-current—a fact, by the way, which overthrows a whole series of speculations theoretically built up by some hydrotherapists.

Nevertheless there is no doubt that the suction apparatus used in the above-described mild way in the majority of instances produces stasis hyperemia, as can be seen from the description. The reason for this is found in the hindrance of the venous return flow. As soon as the air in the interior of the apparatus is thinned, the external atmospheric pressure forces the cuff against the limb. This is still more increased because the cuff is fastened with a rubber bandage. Both act then as a stasis bandage. From the description which we have given of Jûnod's apparatus it is evident that the older physicians produced with the suction the most pronounced stasis hyperemia.

The following experiment made on myself, however, proves that with the same apparatus in certain degrees of thinning of the air, in consequence of the diminution of resistance in the capillaries, undoubted arterial hyperemia can be produced: I place my arm in a glass suction apparatus and fasten the cuff with a rubber bandage. It appears that from it alone a slight stasis hyperemia appears in the limb. On intense thinning of the air appears a dark hyperemia of the skin, the superficial veins swell and a pricking sensation occurs in the extremity. Gradually in the darkened skin the well-known vermilion spots of stasis hyperemia appear here too. All these phenomena become more pronounced as the thinning of the air is increased. The extremity increases in size and "sweats" considerably. The impression prevails that the blood has stagnated in the swollen extremity. That this is really so is proved by the decided reaction hyperemia—arterial—of the limb which appears twenty minutes after removal from the apparatus. For this reaction hyperemia is the best measure for the impoverishment in oxygen by its duration and intensity as I have described it in detail in former contributions.

I now place the arterially reddened arm in the apparatus, apply the bandage less tight and thin the air but little. An enormous bright red hyperemia appears and I experience in the limb a sensation of intense warmth. The arm "sweats" considerably, so that the walls of the apparatus become moist, while one feels as if the limb was in a moist, warm atmosphere. The evidently intense arterial hyperemia can be comfortably maintained for twenty minutes, when the experiment is terminated.

Because one can produce with the suction apparatus active and passive hyperemia, I have designated the hyperemia produced by it "mixed." The expression, I admit, is not a happy one.

These apparatus are indicated in all affections which are suitable for treatment with hyperemia, but I have not risked their use in acute inflammations. In the clinical part of this book, I will describe their use in the individual affections. They are extraordinarily convenient and there should be a demand for them. Certainly I admit that they can be considerably improved.

CHAPTER IX

HYPEREMIA BY DRY CUPPING

The dry cupping glass can well be employed for the purpose of rendering hyperemic superficially situated lesions. The air within the glass may be rarefied either by igniting a little alcohol placed within, when it should be applied, or by attaching to its top a stout piece of rubber tubing, through which the air is thinned by means of a suction syringe like in Junod's apparatus.

At first I made extensive use of dry cupping glasses for the production of hyperemia and employed giant apparatus shaped to suit various large portions of the body. I have used these apparatus especially for the treatment of lupus. Now I scarcely use them at all, for the reason that, first, the larger cupping glasses can not be made to stick more than a few minutes and, second, because excision is a far more certain and better remedy in small lupus. That cupping glasses are not suitable for an extensive lupus of the face is obvious. (The Finsen light is now a recognized and efficient remedy for lupus.—Ed.)

The cupping glass if attached to a healthy skin produces, to judge from the bright red color, arterial hyperemia; occasionally when an intense effect has been achieved we observe an evidently venous hyperemia. On the other hand, when placed over skin affected by tuberculosis, according to my experience, it always produces a dark, venous hyperemia. For this reason I have earlier counted it among the agents which produce a mixed hyperemia. The hyperemia produced by the cupping glass is perhaps the most vigorous that we are capable of producing. If placed over an ulcerated part of the body it sucks in blood or serum, frequently both at the same time. According to what has been said, the cupping glass as an agent for the production of hyperemia has so far but little practical importance. Nevertheless, I think it possible that there are diseases in which it may render good service. Unfortunately we do not know how this apparatus affects the deeper parts.

It has been accepted as self-evident that it removes congestion and frees the deeper tissues of blood-stasis. This has not at all been proven. On the contrary, I even think it probable that this agent, too, produces hyperemia way into the deeper layers.

CHAPTER X

OTHER AGENTS FOR THE PRODUCTION OF HYPEREMIA. "DERIVANTIA."

For thousands of years the so-called skin irritants have been used against all possible affections. Although at times they have been employed more or less extensively, they have never been entirely abandoned and even to-day, when their effect is much disputed, many physicians make use of them and they are also popular family remedies. The skin irritants are divided into rubefacientia (reddening), vesicantia and pustulantia (producing blisters and pustules), and suppurantia (tissue-destroying and pus-producing). From the large number of such remedies I mention iodine, alcohol, opodeldoc, tincture of arnica, turpentine, pitch, tar, Spanish fly, croton oil, tartarus stibiatus, silver nitrate, strong alkalis, strong acids. The very old view, that these agents draw bad juices from the diseased parts, has retained its hold to this day. Of late, however, it is the blood which is considered to have accumulated in too great a quantity or in a bad condition in the affected parts, which should be diverted to healthy parts in order that it may favorably influence the diseased ones. For this reason, these agents were named derivantia or revulsiva—deviating agents. For centuries—even Hippocrates and Galen made this difference—a derivans was the name given to an agent which would deviate bad juices or stagnant blood into the immediate vicinity, while those which led them toward distant parts were designated as revulsiva. If the skin over a diseased wrist-joint is painted with iodine, it is a derivans. If, however, a mustard plaster is applied to the calf of the leg for inflammation of the lungs we speak of a revulsivum. It is noteworthy that the literature on these old remedies, which according to Bartels (61) are used by the diverse primitive tribes, is very meager and few physicians have taken the trouble to physiologically explain their therapeutic action. I will cite briefly the most important contribution on this subject which I have been able to find. We will discuss first the revulsion, which plays such a great

role in hydrotherapy, though under a different name. This point, it seems to me, is important for a better understanding of the subject matter, although in this work we are more concerned with local than distant effects.

Naumann (62) was the first to attack the revulsion in the sense of diversion of blood and bad juices. He made the following experiment: He amputated one of the hind legs of a frog, leaving the sciatic nerve intact after the animal was killed, by severing the spinal column from the head, avoiding loss of blood. The extremity was, therefore, connected with the rest of the body only by the sciatic nerve. When Naumann stimulated this leg with the faradic current on any desired place, he found this agent to have an intense effect on circulation of the blood, no matter whether he observed under the microscope the mesentery, the lungs or the web. Weak stimulation produced an acceleration of the blood-current and increased activity of the heart; strong stimulation resulted in a diminution of the blood-current and weaker activity of the heart. Similar results were obtained by him when he made the experiment on warm-blooded animals (bats), the blood circulation of which he observed in the wing-membrane. Other skin irritants had the same effects.

Naumann also made experiments on living human beings, the proof of which, according to our modern knowledge of physiology, avails us little. For this reason I will omit them. Naumann drew from these experiments the conclusion that a hyperemia accompanying the irritation of the skin need not be considered and that a diversion of blood from deeper to superficial parts, as was generally accepted, does not exist. The curative effect of the epispastics is produced by reflex by means of the central nervous system. For this reason the place of irritation is of no moment and the success of the agents depends on the intensity of the cutaneous irritation in so far as weak stimuli increase the activity of the heart and blood-vessels in the entire body, while strong stimuli diminish it. These observations were more fully dwelt on by Naumann in later contributions (63). He found that the changes produced by a prolonged application of a skin

irritant remain for some time after the cessation of the irritation. He furthermore asserts that the skin irritants influence the bodily temperature which we may here omit as of no interest to us.

Schüller (64) also contributes an article on revulsion by skin irritants. He trephined rabbits and observed the vessels of the pia through the uninjured dura mater. On covering the largest portion of the abdomen or back of the animals with mustard plaster, he observed, aside from some other changes which do not interest us, that the arteries dilated regularly in the beginning of the effect of the agents. For ten minutes the vessels varied in their caliber to contract afterwards, remaining in such a condition lastingly. The entire brain shrunk. The mustard remained half an hour and was then washed off, but even after its removal the vessels remained contracted for one and one-half hours. During this condition so powerful a remedy as the inhalation of amyl nitrate produced with difficulty in a less degree than that accepted as normal, a dilatation of the contracted vessels. Schüller is of the opinion that these phenomena are neither due to a reflex stimulation of the vessels of the brain alone nor to the "depleting" effect of the mustard plaster alone. He believes that in the beginning of the effect of the remedy a paralysis of the vaso-motor nerve fibers is produced by reflex from the skin, which causes the moderate dilatation of the vessels. If the effect of the mustard oil is continued, the developed intense hyperemia and the edema of the skin diminish the lateral pressure in the rest of the circulatory apparatus, or at least diminish the relative quantity of blood in it, therefore being able to also diminish the volume of blood in the brain vessels. Schüller does not wish to exclude reflex effects of the oil even in the later stages of its activity.

On the whole Schüller explains the effect of the mustard plaster by revulsion in the sense used by the old physicians. In the same year appeared a larger contribution by the same author (65) in which he considered the effects of the employment of water on the skin, which can be considered here only in so far as both cold and heat belong to the stimuli of the skin. The result ob-

tained by Schüller briefly related, is as follows: Application of cold water to distant parts of skin produces a dilatation, that of warm water a contraction of the vessels of the pia. Schüller believes that reflex influences of the cutaneous nerves play in this but a secondary role, and that, if anything, they prove an obstacle. The changes in the brain vessels he believes to be essentially due to contraction or dilatation of the circulatory apparatus in the skin.

I can pass over the practical conclusions which Schüller has drawn from his experiments for hydrotherapy, as they do not belong here. Schüller's experiments in hydrotherapy play a great role. His experiments have been utilized for the explanation of certain effects of water and basing on them certain laws for the application of water have been fixed. Winternitz (66) mentions them with praise and believes himself able to prove their correctness with plethysmographic experiments, showing the influence of the quantity of blood of one bodily part on another through heat and cold effects.

Matthes (67) estimates the value of Schüller's experiments as of little value. He says that they are so uncertain "that this kind of physiological experimentation scarcely deserves being considered as a scientific observation."

To this may be added the experiments of François Franck, described in Chapter 3, which too have been used for the explanation of the curative effects of water. I can pass this over, as I have already recited my scruples about the value of these experiments, as they lead to contradictory views on the local effect of heat.

Taken all in all, we can see that even to-day the distant effects of stimuli, cold and heat included, are not established scientifically and that we are compelled to rely solely on experience. In this respect we are not any farther than were the old physicians with their views on venesection and Junod's hemospasia, and finally we come back to the old revulsion, which appears here in a modern dress. While before the change in the distribution of blood was explained mechanically, we try to do so by vaso-motoric influences.

This uncertainty of explanation is well represented

in Samuel's (68) noteworthy experiments, which must be mentioned here. This physician showed that croton oil applied to the ear of a rabbit produces no inflammation as long as the other ear or even the extremities are kept immersed in cold (below 15° C.) water. Samuel was able to avoid inflammation for twelve hours, and even after the removal of the rabbit from the water he found that the inflammation was less intense than under normal conditions. If he made use of scalding instead of croton oil he could not suppress the phenomena of inflammation by means of cooling, but they were less pronounced.

We could comprehend these experiments if we could interpret the absence of inflammation as a reflex effect. But Samuel himself proved that this is not the case, for he obtained the same phenomena when he cut through the sympathicus on the crotonized ear and the nervus auricularis major and minor on the one subjected to cold. The noteworthy facts so far are entirely unexplained.

While it is easy to understand that the interpretation of the distant effect of skin stimuli is extremely uncertain, because we are so little familiar with the concerned physiological conditions, one would believe that the local effect of these remedies has been studied thoroughly, and that there can exist no difference of view in regard to the changes objectively perceptible in the region of the application. But this is not the case. The experiments undertaken for the investigation of the old doctrine of revulsion are extremely meager and the individual results contradict each other in a great degree.

Zülzer (69), contrary to Naumann, accepts the theory of a simple derivation of the blood by mechanical causes from deep to superficial parts, when the latter are attacked by skin stimuli. He concludes this from the following experiment repeatedly tried:

For fourteen days the shaved back of a rabbit was daily painted with cantharidin collodium. On section the skin on the affected side was suppurating and cicatrized, the blood-vessels below the skin greatly dilated and filled with blood. Subcutaneous fat had disappeared. The superficial muscles were considerably hyperemic, containing hemorrhagic places. The deeper muscles, how-

ever, were extremely pale, as compared with those of the healthy side, as were also the chest wall, on the inner surface of which the difference was still more prominent. The striking diminution in the blood volume extended to the musculature of the thigh. On frequent repetition of the experiment even the lung of the affected side appeared strongly anemic, as compared with that of the healthy side. In the vicinity of a seton he found equal conditions, superficially hyperemia, in the depth anemia.

Schüller (70) found the skin of rabbits which he had treated with mustard plaster, including the areolar tissue, hyperemic and very much swollen "to a tough, jelly-like mass." The deeper parts he does not mention, but he states that small mustard plasters which he applied to the ear and back of the animals, produced no dilatation of the vessels in the pia.

Schede (71) examined a number of skin irritants, especially the tincture of iodine, as to their local effects on the tissues. He demonstrated that the tincture of iodine, when only painted on the skin, produced the extravasation of migratory cells and edema not only in the skin, subcutaneous areolar tissue, muscles and muscular interspaces, but the former he found also in the periosteum and even demonstrated inflammatory irritation in the bone marrow and phenomena of granulation in the cells of the epiphyseal cartilages. As we do not know of any such phenomena of inflammation without a previous and accompanying hyperemia, we can conclude that tincture of iodine applied to the skin renders hyperemic the tissues to the very bones.

Of late Wechselberg (72) has treated the same subject. On applying with a brush tincture of iodine or other irritants for several consecutive days to the skin of the thigh of a dog, he found an intense hyperemia and edema of the skin and the subcutaneous areolar tissue and in the majority of cases also of the musculature situated below. In this respect mustard oil had a more decided effect. In all cases, furthermore, there was a decided cellular infiltration of the deeper layers of the cutis and of the subcutaneous areolar tissue, which as a rule extended into the musculature. The strongest effect in this respect is obtained from croton oil, the weakest

from tincture of iodine. In all experiments, with the exception of those made with mustard oil, is found the remark: "No positively demonstrable anemia of the deeper parts." In spite of this Wechselberg, basing on totally unproven theoretic calculations, surprisingly concludes that the skin irritants produce anemia of the deeper parts.

In my opinion such experiments as those of Zülzer and Wechselberg lead to no result. I consider it impossible to decide by macroscopic examination of deep parts in sections as to their volume of blood, especially in the muscles of rabbits in which the reaction hyperemia following artificial bloodlessness can hardly be seen, as I have become convinced in my own experiments. In such things we surgeons have an entirely different experience, which proves more than those physiological experiments. I have always found that in deeply situated foci of inflammation the cut through the skin is bloodier than in a normal body. Thus I have even expressed my suspicion, when in an exploratory laparotomy the wound of the abdominal wall bled freely, that we will find in the depth of the belly an inflammatory condition, and as a rule I was right. And yet we have here to deal with vascular areas which are related only when we have insignificant adhesions: In accord with this I have frequently found the temperature of the skin in deeply situated chronic inflammation (tuberculosis) elevated one or more degrees. Is it possible that an inflammation in the depth affects the surface differently than if the reverse is the case?

Besides this, other experiences speak for it that the stimulus of inflammation renders hyperemic neighboring regions. A deeply situated panaris of the palm causes reddening and edematous swelling of the back, and under certain conditions even of the entire forearm. I have of late learned how far a purely chemical inflammation may extend from the place of application: I injected a pseudoarthrosis of the thigh, which had resisted all sorts of treatment including suture of the bones and injection of tincture of iodine with oil of turpentine, and caused it to heal quickly. But an intense reaction developed. The leg became edematous from the toes to the

inguinal fold, became everywhere very hot and remained in this condition for several days. These conditions were experimentally investigated by *Samuel* (73) in a contribution which is a masterpiece in macroscopic observation and in which the author comes to very similar results. He produced an inflammation of the upper half ear of a rabbit by scalding with water of 54° C. An inflammatory lesion develops immediately, limited by a sharp line corresponding to the extent of the causative factor. Soon, however, the inflammation spreads over the entire ear, even farther over the skin of the head and back. The skin is edematous, reddened and hot to the feel. These phenomena reach their maximum after eighteen to twenty-four hours and disappear then gradually.

In my opinion the differentiation of various effects of revulsion on deeper and less deeply situated parts can but lead to confusion. For what is deep and what less deep? If we, for instance, apply tincture of iodine to the skin over a pseudoarthrosis of the thigh, we can undisputedly speak of a deep part, and in accordance with that view we render the bone anemic; if we apply the iodine to the skin over a pseudoarthrosis at the lower end of the radius, we have to deal with a superficial part and we render the bone hyperemic. Therefore, in both instances we would produce directly opposite results.

On careful consideration we can see that whenever we apply these theories we come to contradictions. For the derivantia have proved themselves effective for lesions situated below the skin or mucous membrane and these in accordance with the undissented views of the experimenters must be regarded as superficial which also are rendered hyperemic. Therefore they are not concerned in the intended revulsion.

I believe that the effect of revulsion depends principally on hyperemia and conclude this first of all from the fact that it has, as a rule, the identical effect as that observed from our agents for the production of hyperemia. Their pain-relieving effect, which has been disputed by no one, is striking; even the opponents of these remedies have had to admit this and for explanation resorted to

the convenient excuse that this was due to suggestion. We will, however, later on show that any kind of hyperemia, active as well as passive, has a pain-relieving effect. Inasmuch as the derivantia are agents producing inflammation and as inflammation produces a slower blood-current, we will have to compare their effect with that of passive hyperemia. And both really have identically the same effect. The derivantia have been used against inflammation and pseudoarthrosis as resorptive and dissolving agents and we will see later on that passive hyperemia has the same and active hyperemia some of the effects. This superb uniformity in the effects is by far more convincing than those uncertain physiological experiments which led to so variable results among the observers.

After I had asserted that the favorable effect of the derivantia and especially of heat on diseased parts is not due to the production of anemia but hyperemia, Buchner (74) explained in the same sense the good results obtained from the treatment of infectious diseases by means of Salzwedel's alcohol dressing. I have no doubt that alcohol, especially in the form of Salzwedel's dressing, belongs to the class of derivantia, and this has been customary for some time, irrespective whether the alcohol was applied pure or in the form of a tincture with the addition of some other skin irritant; nevertheless I do not agree with the experiments cited by Buchner as proof. His experiments are weak, because it is quite a different thing to produce hyperemia by the hypodermic injection of alcohol and to assert that the drug applied to an uninjured skin produces the same result in the deeper tissues. If this were really so, with the exception of normal saline solution and artificial blood serum, there would scarcely be a liquid remedy which would not produce hyperemia. They all are irritants which, when injected into the tissues, finally produce inflammatory hyperemia. It is just as false to conclude from the increased blood pressure, observed by Buchner and his collaborators, a hyperemia or an acceleration of the blood-current, for we know from a rich physiological and clinical experience that often extreme local anemia and diminution of the blood-current is associated with in-

creased blood pressure while enormous hyperemia and acceleration of the blood-current is accompanied by a lessened blood pressure.

An experiment made by Heinz (75) seems to me to offer better proof for the hyperemic effect in the depth by the alcohol dressing. This experimenter demonstrated by means of thermo-electric needles a temperature increase of 0.15 to 0.25° C. in the pleura after the application of an alcohol dressing to the external skin of an animal. The application of the actual cautery to the skin is also counted among the derivantia. This too is an ancient remedy which occasionally has been forgotten, but again and again restored to its place and of late again made popular by Rust. Even to-day it is not entirely forgotten as a "derivans" and is used against painful and stubborn inflammation of the vertebræ, in which the skin is cauterized at both sides of the cornua. That this remedy produces an intense hyperemia of the skin goes without saying; that a hyperemia is produced also in the depth is probable, for if the burn does not remain aseptic and the wound is healing "below the scar," a prolonged inflammatory hyperemia will be the natural result. This will be especially the case if suppuration be maintained, as has been the custom, by the introduction of peas or by the application of cantharidin collodium.

Two comparatively new contributions consider the effect of the cautery on the blood volume in the deeper vessels. Wolter (76) reports the post-mortem finding in a case of tetanus, in which Busch, two days before death, burned two strips alongside the vertebral column with the cautery in order to effect the spinal cord. "On section the musculature of the back was of a dark brownish color, soft and flabby, the veins in the vicinity of the spinal column intensely hyperemic. The space of the spinal canal exterior to the dura was filled with a loose blood coagulum. It made the impression as if a delicate stratum of connective tissue was strongly infiltrated with thin blood mixed with serum. The dura mater was strongly imbibed, the pia mater decidedly hyperemic and somewhat edematous." Wolter then experimented with rabbits and found that when he cauterized the skin at the sides of the spinal column not only the muscles below

the skin, but also the spinal column, the meninges and even the cord itself became hyperemic.

Schwering (77) confirmed Wolter's experiments. He found with the same experiments hyperemia reaching the meninges. Among three experiments he found once, after cauterizing a strip 5 cm. long and 2 cm. wide over the skin in the region of the stomach, that the abdominal wall and the anterior wall of the stomach were hyperemic. "At some distance from this hyperemic place, however, the wall of the stomach was plainly anemic."

In the other experiments Schwering could not confirm Zülzer's statement concerning the production of anemia in the depth by the derivantia. Nevertheless, he surprisingly draws the conclusion from the finding in the stomach that the cautery, like all derivantia, "produce in the immediate vicinity hyperemia and somewhat farther away hyperemia."

I have already mentioned above that I place very little value on the post-mortem findings as regards the volume of blood of individual bodily parts. Nevertheless, the former find is of greater value than the latter because on cutting into hyperemic organs the blood flows easily and besides one never knows when muscles and viscera did not express the blood in the contractions before death. But, in my opinion, quantities of blood can be found even in places where it was absent before death and the uncertainty of these experiments is evident from Wolter's statement that he has found hyperemia extended to the spinal canal even in the healthy control animals. For me the only proof for hyperemia in the depth following the application of the cautery to the skin is the post-mortem finding of the patient reported by Wolter. Here, below the burn, in the spinal canal was a turbid blood coagulum, the dura mater was imbibed, the pia mater edematous. The cautery, therefore, has produced in the depth changes, which all strong derivantia produce, namely, hemorrhages and phenomena of inflammation which could be neither post-mortem appearances nor artificial products. I scarcely need to add that I also consider the actual cautery, this most powerful of all derivantia, as an agent producing hyperemia. A consideration of the moxæ, setons and fontanelles, which belong to the

same class, would require too much space. I only remark, in order not to be misunderstood, that I do not mean to deny reflex action of the derivantia and revulsiva on distant parts and I admit that there exists a possibility to thus produce cures. Nevertheless, we must be content with mere suppositions. However, I believe to have positively proven one of the possible curative effects of the derivantia, namely, that their main effect is the production of hyperemia in the affected parts. In this respect they do the opposite as indicated by their name.

Even the effect of some internal remedies, in part, at least, depends on the production of hyperemia which they produce on certain bodily parts. We know of salicylic acid that it produces a decided hyperemia of peripheral parts. Thus is explained the reddening of the skin, sweating, tinnitus aurium and disturbances of vision observed from its use. A similar effect is obtained from alcohol. Tartarus stibiatus, taken internally, produces in addition to reddening of the skin and exanthemata enormous hyperemia of the mucous membranes. I believe it possible that the favorable influence of salicylic acid in acute articular rheumatism is based on this ability to produce hyperemia, for we will see later on that the production of artificial hyperemia of the joints affected with the disease also quickly relieves the pain and swelling. With this theory agrees the fact that salicylic acid as a remedy producing hyperemia only in peripheral parts, has an effect only on affections of the joints, leaving unaffected inflammation of internal organs, especially inflammation of the pericardium which it neither prevents nor removes.

I already stated that massage and electricity, in addition to other effects, also produce hyperemia. In explaining the favorable influence of these remedies on disease hyperemia must also be considered, naturally. I also consider Priessnitz' compress as an agent producing hyperemia.

In conclusion I must mention Finsen's light treatment of lupus. Aside from other effects this treatment has the following result (78): "Immediately after such a treatment the skin appears red and swollen; this reaction gradually increases, reaches in about twenty minutes

the maximum, usually with the formation of a blister. If external impurities are kept away the reaction ends after eight to ten days with a superficial exfoliation. There yet remains an intense redness which totally disappears only after several months. This inflammatory process has undoubtedly a great importance for the success aside from the bactericidal effect."

We thus can see that even in the cure of lupus by light, hyperemic processes are also at play, just as is the case when lupus disappears under the influence of erysipelas. It is therefore clear that numerous agents are at our disposal for the production of hyperemia and it may appear one sided that I limit myself to only two kinds. On careful consideration we will find that this is necessary. For in these remedies we have the two extremes: on one hand the great acceleration of the blood-current by hot air, on the other hand any desired diminution by means of the stasis bandage and the cupping apparatus. We can thus not only study the pure effects of hyperemia but also nicely establish when the various kinds of hyperemia have a like or unlike effect. Besides I believe that there is not another agent which can produce both extreme forms as intensely and this, after the limits have been established, without damage to the body. All those remedies which act somewhat like the derivantia do so only indirectly by injuring the tissues, just as is the case in inflammation, and they do not permit of exact dosage as we can never say in advance how long and how intensely a mustard plaster, for instance, will affect a given individual. Both our agents, on the contrary, if properly applied do not injure the tissues and can be measured as regards dose just as an internal medicine.

CHAPTER XI

INFLUENCE OF HYPEREMIA ON THE LYMPH-CURRENT

The answer to the following question seems of great importance: How do the agents producing hyperemia affect the lymph-current? We will not here discuss the dispute in regard to the origin of the lymph, whether it is a transudate or a product of secretion of the endothelia of the capillaries, as it is of no value for our purpose.

The old view which considered the lymph a transudate of the blood-vessels, was based on the self-evident fact that the lymph-current of a bodily part is dependent on its blood pressure and blood volume. Accordingly any hyperemia, active as well as passive, must produce an acceleration of the lymph-current. This doctrine received its first blow through a contribution by Paschutin (79), which was perfected under Ludwig's supervision. He demonstrated that the most pronounced arterial hyperemia which he produced on the fore legs of dogs remained without any influence whatever on the celerity of the lymph-current. He produced hyperemia by cutting the plexus brachialis and verified the appearance of hyperemia by demonstrating an increase in the temperature of the extremity.

Paschutin did not even notice an increase of the lymph-current when, in addition to the cutting of the brachial plexus, he severed the cord of the neck and stimulated it, though the blood pressure increased four to nine times and accordingly in the paralyzed limb with its dilated vessels the greatest possible arterial hyperemia must necessarily have taken place. He could not even retard the usual sinking of the lymph-current, which always occurs in prolonged experiments. Among numerous experiments he could but twice produce a slight acceleration of the lymph-current, but in each instance could demonstrate that this was due to an evident error in the experiments.

Paschutin's results were confirmed by several others, principally by Emminghaus (80), who also labored under

Ludwig's supervision; also by Jankowsky (81), who worked with Cohnheim. He, too, found that arterial hyperemia, produced in a normal extremity by paralysis of the vaso-motors, does not only not accelerate the lymph-current but, on the contrary, frequently retards it. If, however, he produced an inflamed extremity or if he rendered the animals artificially hyperemic then the vaso-motor paralysis accelerated the lymph-current. On the other hand, other experimenters always found the lymph-current accelerated and increased in arterial hyperemia. Rogowicz (82), who worked under Heidenhayn, asserted that any arterial hyperemia, no matter how produced, as long as it is followed by an increase of temperature in the concerned part, increases the lymph secretion and accelerates the lymph-current. Paralysis of the vaso-motors, stimulation of the dilators and arterial hyperemia, produced by poisons, all had the same result. Rogowicz ascribes to the following experiment the main proof: He rendered half of the tongue hyperemic by repeatedly stimulating the lingual nerve and injected at that time into the saphenous vein a saturated solution of sodium indigo sulphate. The hyperemic side became quickly blue, while the other parts at first retained their normal color, being dyed later. When the other half of the tongue also became blue and if the one-sided hyperemia was prolonged, the hyperemic side decolorized much more rapidly than the other side. From this Rogowicz concludes that the lymph which carries the coloring matter to the tissues is more rapidly excreted on the hyperemic side and that in prolonged hyperemia an increased lymph-current again washes away more rapidly the coloring matter in the concerned side. He also found that the lymph of an arterially hyperemic limb, when the conditions in the above-described experiments existed, looked more blue than that of the corresponding other extremity.

Pekelharing and Mensonides (83) also saw a considerable increase of the lymph-current in arterial hyperemia of a hind leg which they had produced by cutting through the sciatic nerve.

Chabbas (84), who worked under Grünhagen, could demonstrate that "the secretion of the humor aqueus is a direct function of the blood pressure." He showed that

the lowering of the blood pressure by narcosis with chloral hydrate diminished, while increase of the pressure by nicotin or ligation of the aorta above the diaphragm increased the secretion of the humor aqueus.

These observations have been confirmed by others with still more exact experiments and in a more recent contribution Leber (85) has recognized their correctness. If the experiments concerning the dependence of the lymph secretion on blood pressure and fullness of the vessels are to be decisive, first of all the certain proof must be established that humor aqueus and lymph are one and the same. Many investigators, it seems to me, have a broad conception of the term lymph. Thus, Emminghaus (86) counts edema, hydrops, anasarca, hydrothorax, ascites as belonging to it and asserts: "Edema and increased lymph secretion are identical." If we furthermore consider the unnatural conditions under which these experimenters worked—animals poisoned with nicotin and curare, whose spinal cords and nerves were cut, whose aortas ligated, and artificial respiration induced—we will doubt the strength of proof produced by these experiments and understand the entirely different results. We must therefore draw the conclusion: We do not know whether and how the arterial hyperemia affects the lymph-current.

Just as different as these views are, just as pleasingly unanimous are those held in regard to the influence of stasis hyperemia on the lymph-current. All observers, without exception, found the excretion and the current of lymph greatly increased by it.

The first experiments on this subject were made by Tomsa (87). When he checked the venous blood-stream at the spermatic cord while the arterial flow remained unchanged, the current in the related lymph-vessels became considerably increased.

Emminghaus (88) made the same discovery on the legs of animals as did Gonitschewsky (89), a pupil of Cohnheim. He produced the stasis hyperemia with plaster of Paris pulp which he injected into the veins of limbs artificially rendered bloodless, permitting it to dry therein. As soon as this was reached he released the blood-current and a decided stasis hyperemia resulted. This

was followed by a decided dilatation of the lymph-vessels and increased lymph-current. The intercepted lymph was liquid and thin, contained many red and few white blood corpuscles and was but slightly coagulable.

Pugliese (89) made similar observations when he produced stasis hyperemia in the fore leg of an animal by compressing the subclavian vein. But he found in the majority of cases no change in the color and the solid constituents of the lymph. This difference from the finding of the previous observer is explained by the fact that the former with the plaster of Paris pulp produced an enormous, while Pugliese with the compression of the subclavian vein obtained but a moderate stasis.

At an earlier date Lassar (90) proved that also inflammation considerably increases the lymph-current. He therefore came to the conclusion that both stasis and inflammation considerably increase the lymph-current. Both kinds of lymph show vast differences: the lymph due to inflammation is a yellowish, tenacious, easily coagulating liquid containing many white but few red blood corpuscles, and on drying leaves a residue which exceeds considerably that of normal lymph and many times more than that of stasis lymph. Stasis lymph, on the other hand, is a thin liquid, slightly reddish, imperfectly coagulating and containing many red and white blood corpuscles. When Lassar added to the inflammation an arterial hyperemia by cutting the sciatic nerve, this had no influence on the lymph-current.

All these investigators produced the stasis hyperemia by ligating or compressing the larger vein trunks, by injection of plaster of Paris pulp or imperfect constriction of the concerned extremity as we do it in our stasis hyperemia. But even in the last instance they intercepted the lymph from a vessel below the constricting band. The outflow of lymph was therefore not prevented in any of their experiments. Matters are different with our stasis hyperemia produced with bandage or cupping apparatus. We constrict the lymph-vessels, too, and as these have still more delicate walls than the veins, we, in all probability, produce even a more perfect lymph than blood-stasis.

Those experiments, the correctness of which, considering the equal results, can not be doubted, can be taken in account by us only in so far as we must accept that after removal of the stasis bandage, that is to say, in the intervals, the lymph-current is increased.

I already mentioned that we have a kind of stasis formerly designated as "white stasis," which appeared to me to retain the lymph. At the same time the hyperemia falls in the background, but nevertheless the extremities swell and become edematous. When the hyperemia is absent the skin looks white. One sees this form of stasis very rarely. I have observed it in tuberculous joints and do not like it, as it proved entirely ineffective.

B. GENERAL EFFECTS OF HYPEREMIA

CHAPTER XII

ANALGESIC EFFECTS OF HYPEREMIA

There is hardly an effect of hyperemia which is more striking than that of the relief of pain. Both active and passive hyperemia have this property. We can observe almost regularly how a joint attacked by painful chronic rheumatism becomes less sensitive and occasionally insensible after a treatment for one hour in the hot-air apparatus. The influence of stasis hyperemia on the furious pains in grave forms of gonorrheal arthritis is much more pronounced. The pains grow less in half an hour to one hour after application of the rubber bandage. I will describe the astonishing and decided results as regards the relief of pain in these cases in the course of this work. But in all other painful diseases in which hyperemia can be employed with success, relief of pain is always its most prominent feature. The various forms of hyperemia remove neuralgias and headache and diminish to a considerable extent the sensitiveness of joints which have become painful from various causes.

Earlier, when my experiments with the treatment by hyperemia were applied to a limited number of diseases, I was inclined to look upon this peculiar relief of pain as mediate, in so far as the cause of the disease was influenced by the hyperemia and with its removal, also its symptoms, among which belongs the painfulness. I am still of the belief that this may play a role in the removal of the pain. We can conceive that the active hyperemia washes away poisonous substances which produce pain by injuring the nerve endings, while the passive hyper-

emia attenuates them. Something similar may be the case in injured joints, in which hyperemia relieves pain. However, the ability to lessen sensibility must be looked upon as a general property of hyperemia proper. This conclusion will be reached when we remember that the relief in some cases comes on so rapidly—in less than an hour—that there can be no question of a serious influence of the remedy on the cause of the disease.

Lately my assistant, Dr. Ritter (91), has experimentally produced the proof that indeed every form of hyperemia diminishes the sensibility of pain in the tissues. For a scientific explanation of this fact I refer to the contribution by this author.

Active and passive hyperemia alike relieve the pains met with in a series of diseases, e. g., in all chronic, painful, stiff joints, be these due to chronic rheumatism, arthritis deformans, injuries or other causes. In all acute painful infectious diseases, e. g., arthrites due to gonorrhea, acute rheumatism, tuberculosis, passive hyperemia excels also in its pain-relieving effect, while it seems to me neuralgias are better influenced by active hyperemia. At any rate, we must completely abandon the old view that hyperemia, e. g., the inflammatory hyperemia, as such, produces pain, for, on the contrary, these are due to the injury to the cells and nerve endings which is found in every inflammation, and the subsequent hyperemia with its changes far from producing or increasing pain, decidedly diminishes it. The well-known "thermic" diminution of pain is, in my opinion, produced purely by hyperemia, and it is a crude error to believe that the heat freed the painful parts from blood by revulsion or, as it was usually termed, by "decongestion."

My discovery of the analgesic effect of passive hyperemia stands in direct opposition to the medical views entertained heretofore, for it was considered self-evident, proven by daily experience, that blood-stasis produces pain. I know that my attempts to cure the pain in inflamed limbs with stasis hyperemia were received with wary shaking of the head. Nevertheless, I would not think of wasting time by producing proofs, for if there is anything in medicine easy to demonstrate it is this,

and every one who is seriously inclined to be convinced can do so any time. All I ask is that when these experiments are made, make them properly and do not apply the stasis bandage so firmly that grave disturbance in the nutrition of the tissues develops and the pressure on the nerves causes violent pain. I can only reply to those who have reported that the stasis hyperemia produces pain, that they do not know how to execute the technic.

The analgesic effect of hyperemia is not only useful in so far as this is agreeable to the patient but also because soon after its application it restores mobility to the stiffened joints. The stiffness of the joints in all inflammations is caused partially by gross anatomic disturbances and partially produced and maintained by contraction of the muscles, which again are due to painful irritation of the nerves in the joint. With the disappearance of the irritation the contractions, too, cease. Only in this way can it be explained why after the application of an agent producing hyperemia stiffened joints become mobile so rapidly. To be sure, soon after the discontinuance of the remedy pain and stiffness return and it would be only an apparent success if the hyperemia achieved nothing but the diminution of pain during or for some time after its employment. Fortunately, this remedy has also numerous properties, which favorably influence the cause of the disease and its anatomical sequences, so that the pain very soon diminishes or disappears not only by the hyperemia proper but on account of the improvement of the disease itself. Of this we will soon have more to say. Nevertheless, we must ascribe an important role to the purely analgesic effect of the hyperemia. It prevents the limbs from becoming fixed in faulty positions, to which reflex contraction of the muscles leads, enabling us to undertake passive motions at an early period and otherwise to avoid anatomic ankylosis

CHAPTER XIII

BACTERICIDAL EFFECT OF HYPEREMIA

If we observe cases of infectious diseases, such as we will soon describe, which not only rapidly improve and heal under treatment with stasis hyperemia but immediately after the application of the remedy experience a sudden change, we will hardly be left in doubt that we have to deal with a destruction or at least attenuation of the causative bacteria. The experimental proof that hyperemia has this property has lately been established by Nötzel (92). He succeeded in keeping alive fifty-one out of sixty-seven rabbits of whose certain bodily parts, while under the influence of a vigorous stasis hyperemia, were inoculated with otherwise fatal doses of anthrax bacilli and very virulent streptococci. Only sixteen animals died. Without exception these were animals in which the edema "from the very beginning had the character of a disturbance of nutrition." In those fatal cases that kind of stasis hyperemia has been used which I have designated as "cold stasis," to the inefficiency and harmfulness of which I have repeatedly called attention. That it was indeed the stasis hyperemia alone which saved the animals from death can be concluded from the fact that these same animals were inoculated a few weeks later with the same bacteria without the use of stasis hyperemia and that they all died, as did the animals used for purpose of control.

Of course, the fresh artificial infection is something entirely different from that of an infectious disease developed in a natural way, in which the bacteria have adapted themselves to the conditions of the body and to a certain extent also to its means of defense. Nevertheless, Nötzel's experiments are of great value, as they undoubtedly show that stasis hyperemia as such has bactericidal properties. Naturally it has been tried to bring this bactericidal effect in harmony with and to explain by the then prevailing theories of the protective powers of the single components of blood.

Thus Buchner (93) is of the view that in stasis hyperemia we have not to deal with a blood-stasis but with an

increased accumulation of leucocytes at the seat of infection which kill the bacteria by sending alexins into the serum. In contributions (94) of a later date, he states that the digestion and dissolution of the bacteria, like all other organic substances in the body, take place through enzymes contained in the blood and especially in its decomposed leucocytes.

Heller* thinks that the stasis hyperemia retains the products of metabolism of the bacteria and that these kill their producers. In the cure of tuberculosis we, therefore, have a sort of tuberculin effect.

Cornet (95) explains the curative effect of stasis hyperemia in a similar manner as does Heller. He also sees in the retention of the products of metabolism of the tubercle bacilli the essential but does not recognize the healing process as due to their annihilating effect on their producers, and believes that they stimulate the tissues to the formation of connective tissue and scars, which encapsulate the infectious focus making it harmless.

Richter (96) believes that "the successes of the method (stasis hyperemia) are due to the circulatory disturbance followed by margination and emigration of the leucocytes." He can see nothing else in stasis hyperemia save the production of the mildest form of inflammation, and places it alongside other methods of treatment which act similarly (tuberculin, cinnamonic acid, chloride of zinc, iodoform).

Nötzel shares Buchner's view that the curative effect of stasis hyperemia takes place through a concentration of the bactericidal power of the blood at the seat of infection, especially since he has learned by microscopic examination that there is a large quantity of leucocytes in the transudate. He therefore believes that its protective effect is superior to that of normal blood serum.

Hamburger (97) has explained the curative effect of stasis hyperemia in a different way: The stasis makes the blood richer in carbonic acid and this increases the bactericidal property of the serum, first, because the carbonic acid itself kills bacteria, second, because under

*Expressed during a discussion in the Kieler physiologischer Verein (Kiel).

its influence the red blood corpuscles swell, dehydrating the serum and increasing its concentration and, finally, because the serum gains in diffusible alkali. The latter occurs partially because with the greater concentration of the serum the percentage of alkali becomes greater, partially because under the influence of the carbonic acid alkali passes from the blood corpuscles into the serum liberating diffusible alkali through decomposition of the albuminates of the serum.

Numerous bacteriological examinations (for the literature see originals) prove the influence of the alkalis on the antibacterial effect of the blood. Thus, for example, according to v. Behring the susceptibility of rats to anthrax depends on the alkalescence of the blood. V. Fodor could increase the resistance to anthrax by the injection of alkali in the blood and diminish it by the injection of lactic acid. Furthermore, in immunized animals increased alkalescence of the blood is present.

In order to substantiate the correctness of his views, Hamburger cites a series of observations by physicians, such as the rarity of tuberculosis among lime-workers, who inhale, during a great portion of their lives, air rich in carbonic acid, and the frequency of this disease among proletarians, who nourish themselves principally with potatoes. The latter observation is to be explained by the fact that vegetable food diminishes the alkalescence of the blood while animal food increases it. Hamburger could furthermore demonstrate that the bactericidal property of blood is increased in venous stasis and on this he lays special stress—that the developed lymph-edema is a stronger bactericide than the corresponding blood-serum, which otherwise excels normal lymph. As the bacteria are usually situated in the lymph spaces this finding is especially important and explains the favorable effect of stasis hyperemia. The bactericidal property of exsudates is increased by carbonic acid in proportion to the increased amount of leucocytes contained in the liquid.

In a second contribution Hamburger (98) examined the influence of venous stasis on phagocytosis. He reaches the conclusion that its influence on chemotaxis is small and only large quantities of carbonic acid dimin-

ish the motility of the leucocytes to such an extent that they lose the property of taking up carbon particles.

Hamburger is careful enough to look upon the bactericidal properties of carbonic acid as one of the salutary influences of the stasis hyperemia and does not assert that it is the only effective remedy. Inasmuch as it is well known from older contributions, confirmed by the above-named investigators, that in a moderate stasis hyperemia—in a pronounced one the emigration of leucocytes ceases—leucocytes emigrate in large numbers to the diseased place, the favorable effect of this remedy could be conceived also in the sense of Metschnikoff's phagocytosis.

It is evident from what has been said that the stasis hyperemia, considered theoretically according to modern conceptions and theories, is a justifiable and logical remedy against diseases which are produced by bacteria, for it is not opposed to any of these theories but is, on the contrary, in accord with all of them.

I am far from underestimating the value of those bacteriological investigations, but can not refrain from pointing out that they all suffer from a certain one-sidedness. This is especially the case with Metschnikoff's theory of phagocytosis, which, according to him, is the effective and curative feature of the numerous phenomena produced by inflammation. Let us better take the standpoint, if we look upon inflammation as something salutary, that nature does nothing uselessly and that all the numerous changes which develop alongside and after each other have the purpose of suppressing or fighting infection. We will then admit that among the many changes the above-mentioned components of blood, recognized by exact experiments, have a wholesome effect, but in addition we will also have to point out that besides this a number of processes take place which, too, may be useful, but of which at present we have not exact knowledge, much less of their effects. The only thing which, in warm-blooded animals, is common to all inflammations, without exception, from the simplest to the gravest, and which takes rank over all other phenomena, is the change of circulation which always leads to hyperemia and which so far no one has satisfactorily explained. We will, there-

fore, have to recognize this process from which all other phenomena develop afterwards, as the most significant and most important. For it is not absent when parts free from vessels are irritated to inflammation, and it is the hyperemia of the surrounding vascular parts with which the body acts to the inflammatory irritation. It even happens that a quickly disappearing hyperemia remains as the only reactionary process to the injury of the inflammatory irritation and that further changes from this hyperemia do not even appear. Here we must conclude that the hyperemia in itself was sufficient to remove the injury.

For this reason it is but an imitation of a natural healing process when we increase the already existing hyperemia in certain bacterial affections, and institute it especially there where it is not sufficient. For it is theoretically conceivable that nature frequently does not accomplish enough in such cases. We can, for instance, assume that a man whose body does not react to a tuberculous infection by a sufficient hyperemia, from which the other inflammatory phenomena successively develop, is attacked by tuberculosis for this very reason or unable to heal it after it has taken hold. We can easily imagine that certain bacterial diseases are stubborn and chronic for the reason that their producers do not yield the necessary inflammatory irritation which again liberates the healing forces of the body and that we can effectively support nature by artificial aid in such cases. For I have repeatedly asserted that the forces of the body, though one must be blind not to recognize their purposiveness, are frequently imperfect.

(A disease to which the body does not react with the necessary inflammatory hyperemia and its subsequent phenomena, it seems to me, is chronic articular rheumatism apart from the acute, inflammatory exacerbations which occur in this affection. Men attacked by it frequently have a sensation of cold in the affected limbs. I could demonstrate in two cases which I examined a lower temperature of the skin over the affected extremities than is usual in other chronic inflammations. Further experiments in this direction would be opportune. And yet chronic articular rheumatism, as I will later dis-

cuss, is favorably influenced by all forms of hyperemia. Accordingly we have here a disease in which the natural forces are lacking and which we must replace artificially.)

As is known, the above-cited theories on the anti-bacterial properties of certain blood components and cells have been repeatedly opposed and have even to-day many enemies—more than the practitioner without a sufficient familiarity with the literature believes—so that none of them enjoys general recognition. Most of these are of no interest for our purposes and I can limit myself to one objection by Spronk (99), which he has made against the observations of Hamburger and Nötzel in regard to the bactericidal property of the stasis edema and apparently not unjustly: Just such bodily parts which are in an edematous condition are preferably attacked by bacterial diseases. This is so old a surgical experience that it is unnecessary to spend any more time on it. To this must be added that I myself had to report grave erysipelatoid inflammation and suppuration, which occurred in extremities subjected to stasis hyperemia. I soon, however, found out, as already mentioned in Chapter 7, that there existed an error in technic and that these undesirable accidents occur only when an excessive and prolonged disturbance is produced by the bandage. I have, therefore, repeatedly warned that for prolonged employment only hot stasis is effective, while cold stasis may have bad consequences as it may lead to serious circulatory disturbances. I can report that the hot stasis, instead of leading to erysipelatoid and other infectious diseases in the stased limbs, on the contrary, opposes these diseases most effectively and for many of them it is the best remedy.

We had to learn in such cases like in many methods of physical therapy—one need only think of the application of water for curative purposes—that the useful and harmful of a remedy frequently are close to each other and that one must know and measure his remedies in order to do good. The scientific confirmation for these facts is contained in the above-mentioned excellent contribution by Nötzel, who demonstrated that in order to kill bacteria, new blood and new transudate are always neces-

sary and that serious disturbances of circulation and chronic edema, instead of preventing, tend to favor infection. For this reason I do not employ prolonged stasis hyperemia in infectious diseases. How to proceed in the individual affections I will explain in the clinical part of this book.

I am well aware that my views on the favorable effect of stasis hyperemia on infectious diseases are in direct contradiction to the prevailing doctrines on their treatment. For in surgery it was considered a positive axiom that blood-stasis is highly injurious to all inflammatory processes and that the alpha and omega of treatment was contained in the removal of the stasis! For this reason, when a description of the stasis hyperemia as a means to produce new bone formation was given, it was stated that the remedy is "self evidently" to be entirely out of question in inflammation of the concerned extremities, even in chronic tuberculous inflammation. The correctness of this opinion seemed to be borne out from the observations by the internists of the so-called hypostatic pneumonia, which was looked upon as a consequence of the sinking of blood in the dependent parts of the lungs. To this came the fact that the so-called antiphlogistic regimen, which is designated by the three words "rest, high posture and ice for all inflammations," immediately improved grave and dangerous forms of inflammation of the extremities.

How can these peculiar contradictions be unified? First, it must be said in regard to hypostatic pneumonia that we have to deal with special conditions. It is produced by an exhaustion of the heart force, therefore in debilitated individuals whose natural capability of reaction has suffered, and, second, it does not appear to me as proven that it is the sinking of the blood which is the real cause and not other factors, such as deficient airing, and therefore deficient purification of the concerned parts of the lungs, while the hyperemia is perhaps only a secondary condition.

But there still remains the undeniably favorable effect of the antiphlogosis, of which I myself have been convinced many times, for I have been trained in one of the strictest antiphlogistic schools. It is plain that the

high posture must act favorably in all infectious diseases of the extremities, which are inclined to circulatory disturbances and venous stasis, so that gangrene threatens to occur or has already occurred. That an artificial increase of blood-stasis can but act injuriously in such cases needs no further discussion. Similarly the high posture must favorably effect all forms of chronic edema, the danger from which we have learned above, it removes the old edema and permits new and effective blood and edema to take its place.

As regards the ice-bag, I consider it, if applied for some time, a remedy which does not produce anemia but hyperemia, therefore the opposite to that expected of it. It is known that the intense cold obtained from the ice-bag produces at first a transient anemia, then a lasting hyperemia. One need only observe the skin which has been exposed to this remedy for several hours. The cold, as is proven by the well-known experiments of v. Esmarch, Schlikoff and others, penetrates deeply into the tissues and we can assume that hyperemia follows the stimulation by the cold also into the depth. The hyperemia is necessarily passive, because otherwise it would not be possible for the cold to penetrate so deeply, as the rapid blood-stream associated with active hyperemia would quickly equalize the difference in temperature. Finally we must remember the experience that frequently we obtain identical results with apparently or really opposite remedies. Thus some physicians treat the chest of a patient suffering from pneumonia with an ice-bag, while others apply a warm poultice and both see good results from each, particularly as regards the relief of pain. Theoretically, a really opposite, yet favorable result can be expected from both of our remedies somewhat in this manner: Of late it has been tried to treat bacterial diseases in two different ways: first, by killing the bacteria, as in antisepsis; second, by annihilation or combination of the injurious toxins, as in the anti-diphtheritic serum of v. Behring. Now let us imagine on one hand the stasis hyperemia as a bactericidal, on the other hand the antiphlogistic regimen as a remedy inhibiting the absorption and effect of the toxins, and we have reached in two entirely different ways one and the same

thing, namely, the favorable influence on the disease. That the effect of the toxins and especially their absorption are strongly influenced by the antiphlogistic remedies is evident from the previously cited contributions by Klapp.

From these statements it is clear that the contradictions treated above are not necessarily as sharp as they appear to be. However, we have here entered the domain of theory and in practical medicine experience plays the main role. And I believe to have gained enough of the latter to be able to assert that in reality these different remedies do not have so decidedly favorable an effect as one is led to believe. If we, for instance, treat an acutely or subacutely inflamed joint, which has no grave disturbances of circulation, antiphlogistically, the pain disappears rapidly, inflammation and fever diminish, but, as a rule, the treatment is long drawn out, resulting too often in ankylosis. If we, however, treat the same joint with stasis hyperemia, the pain disappears, as a rule, more rapidly, fever frequently diminishes immediately and what is more striking is the resulting increased mobility of the joint. Furthermore, the entire course of the disease is far shorter. I can not help but be under the impression that in such cases we have actually done harm with an antiphlogistic regimen. We have suppressed the phenomena disagreeable to the patient, but at the same time also the useful inflammatory reaction, thus prolonging the disease and, what is most important, causing the joint to become stiff. The result from the antiphlogistic regimen was therefore in reality a failure. On the other hand, antiphlogistic treatment is suitable and useful when nature overreaches the mark with the phenomena of inflammation, especially with hyperemia, as I have described.

Previous to my employment of stasis hyperemia for infectious diseases I made use of active hyperemia for the same purpose. The first experiments with hyperemia were made in the year 1891 for a pronounced infectious disease, tuberculosis, by hot air. I have described in my contribution of 1893 the complete failure of these experiments. With no exceptions I have been able to observe but changes for the worse. These observations have been

later confirmed by Thiem (100), who has had the same experience. Besides I found only two reports in the literature on the treatment of tuberculosis with hot air.

Clado (101), who, as I have already mentioned, has employed hot air for the treatment of tuberculous affections of the joints at about the same time I did, with a view of killing the tubercle bacilli in the manner of Tyndall's "fractional sterilization," reports that he has cured four out of six joints affected with tuberculosis, which he treated daily for one hour at a temperature of 110° C. Further details he does not furnish.

Wilson (102) has treated many cases of tuberculosis of the joints with hot air but has at the same time fixed the joints. He is of the view that the disease is favorably influenced by the treatment but can not positively assert this and does not know which of the two remedies has been effective.

The fact that one hears nowadays so little about the treatment of tuberculous joints with hot air, which has become so popular, seems to indicate that the results generally have been bad, for the remedy certainly has been used for all possible joint troubles, hence also for tuberculosis. I do not believe that my warning published in 1893 had a deterring effect; it seems that it either did not become known or was forgotten when Tallerman's apparatus drew the attention of wide circles to hot-air therapy. Similar failures were experienced by me with hot air when I commenced to treat by hyperemia acute inflammation of joints. To be sure, I only used it in four or five cases of acute gonorrheal or rheumatic arthritis but throughout with bad results. There either was no improvement or the affections became worse. At any rate, the effect of stasis hyperemia proved here considerably superior.

Wilson, too, has had no success in the treatment of acute articular affections. He expressly states that hot-air therapy has no favorable effect on acute and chronic gout, acute rheumatism and in the rheumatoid arthritides.

Numerous reports on the favorable influence of hot air on gonorrheal inflammation of joints can be found in literature. But it is not stated whether these really were acutely inflamed joints or only the sequences, especially

stiffened joints. In one contribution I do not know whether the author has really treated with hot air such acutely inflamed joints. Löwenhardt (103) states that he "has employed in all stages of gonorrheal arthritis hot air and has not seen an injurious effect from it." Immediately afterwards, however, he admits that "only when the temperature was high and in processes inclined to the formation of abscesses, I had no opportunity or did not feel justified in proceeding thermically." At any rate, even from this contribution we do not know whether Löwenhardt has obtained favorable results in acute or only subacute inflammation of the joints.

Recently Buchner, in the sense of the theory established by him, has expressed the view that the active hyperemia which he believes to have produced by means of an alcohol bandage, has a greater bactericidal effect than the passive form obtained by blood-stasis. I have demonstrated above that Buchner owes the proof that the hyperemia which the alcohol dressing produces also in the depth is really active and not one close to the inflammatory passive hyperemia. Everything seems to point that the latter is the case.

Finally Ullmann (104) has reported good results obtained from the treatment by hot air of infected wounds and bacterial ulcers. He attributes the good results to the bactericidal properties of the active hyperemia produced by hot air. It is noteworthy that the infectious affections treated by Ullmann were only superficial ulcers. These I have treated with hot air in the very beginning of my experiments and in my first contribution I reported an interesting case. Nevertheless, it seems very doubtful to me whether we have to deal with a bactericidal effect of the active hyperemia and I have repeatedly expressed these doubts. Here other influences are brought into play, namely, the bactericidal effect of the heat itself, which can not be doubted because of the superficiality of the ulcers, the acceleration of demarcation in gangrenous and necrotic processes and the vigorous formation of granulations.

If we should investigate the question how nature proceeds when it produces its inflammatory hyperemia, we would learn that in all inflammations it diminishes the

blood-stream after a transient acceleration and that this diminution remains throughout the stay of the inflammation. If we, therefore, look on the entire inflammatory process as something useful, we can not avoid taking in consideration the diminution of the blood-stream, and if we wish to support nature's healing we must not disturb it but, on the contrary, support it.

I have already mentioned that it is difficult to determine whether in the production of hyperemia we have to deal with an acceleration or a diminution of the blood-stream. This is especially so when we render inflamed parts hyperemic. For as observation with the microscope has shown, the inflammatory irritation, the effect of which is totally unknown to us, knows how to diminish an originally accelerated blood-stream and to keep it thus. All explanations which have been made for this peculiar phenomenon are entirely unsatisfactory and we have therefore to be content with the fact itself. But it is certain that agents which produce active hyperemia *per se*, in inflamed parts produce passive hyperemia, as the blood-stream in the vessels in the inflamed part becomes slower. The active hyperemia must not predominate, otherwise it will disturb the natural process of reaction. From this follows that we should employ an agent producing an intense active hyperemia, and such decidedly is hot air, while a moist warm poultice or a hot compress may increase the natural process of inflammation because they accelerate the blood-stream in a smaller degree and are therefore more suitable in inflammation. To this belongs my above-cited observation that a cupping glass which produces a bright red arterial hyperemia in a healthy portion of the skin causes a dark venous hyperemia when placed over a lupus, that is to say, chronically inflamed skin. To the extraordinary violent ebullitions, it seems to me, can be counted the hyperemia following the injection of Koch's tuberculin, and it is possible that part of the changes for the worse are due to it.

It is opportune to point on this occasion to the fact that after enormous exertions associated with functional active hyperemia, infectious diseases frequently appear in the overtaxed parts, e. g., tuberculosis and gonorrhea of the joints after excessive use of the extremities. I will

avoid drawing this conclusion, for those observations can be explained much simpler in the unusual strain and injury of the tissues, which is the consequence of each exertion. The best we can do is to maintain that the active functional hyperemia is not capable of warding off the development of those diseases.

After all reported experiences it seems to me logical from a purely theoretical standpoint, to first of all consider stasis hyperemia in the selection of the various forms of hyperemia for the treatment of inflammatory diseases. My practical results are in accord with this theoretic conception. That occasionally active hyperemia can be and has been successfully employed is beyond doubt, just as I am positive that the most intense forms of active hyperemia can be injurious under certain circumstances in acute inflammation and that stasis hyperemia is, to say the least, the superior one in chronic and subacute inflammation. It appears to me queer that more recent investigators, since for a long time no attention has been paid to my explanation of the described remedies as producing hyperemia, now take up the matter and apply hyperemia after certain fixed theories. One attacks the bacteria with serum, the other with leucocytes, the third with carbonic acid, etc., without considering that we have to deal with unproven theories. Though these theories are important and fruitful so that I would not spare them under any circumstances, yet they may become risky if practically applied in their onesidedness. We would be in danger of reaching a stage similar to that which prevailed in hydrotherapy, in which all possible unproven physiological experiments have been applied to practice and conclusions drawn from methods which have long ago ceased to be recognized by physiologists.

CHAPTER XIV

ABSORPTIVE EFFECT OF HYPEREMIA

For some time I have made use of active hyperemia produced by hot air for the purpose of absorption. I learned early that in chronic affections of the joints which I treated alternately with active and passive hyperemia, the former quickly removed the edema produced by the latter. Basing on this experience I employed active hyperemia in the treatment of elephantiasis and the edema following the healed fractures of the extremities. If an absorptive effect is desired, hot air must not be applied too long as otherwise it will produce edema. I have reported in my first contribution that limbs exposed to hot air of 100° C. for eight to ten hours daily became strongly edematous. We again see here the peculiarity of physical remedies, already mentioned, that yield variable results depending on the duration and intensity of their application, a feature which will yet demand our attention.

The absorptive effect of active hyperemia is in full accord with our modern scientific knowledge of the channels of absorption, for we know that almost the entire absorption of watery substances and bodies soluble in water takes place through the blood capillaries and not through the lymph channels, as was generally believed. This view is undisputed as far as the gastro-intestinal digestion is concerned, so that it is unnecessary to cite proof from the literature, a perusal of a modern text-book on physiology being sufficient for that. Absorption of water, salts, dissolved carbohydrates, peptones and some unchanged, soluble albuminous bodies takes place almost exclusively through the blood circulation. Small quantities of these substances have been found in the lymph channels only after the ingestion of large quantities. On the other hand, fat, whether taken up in a saponified condition or in the form of fine granules, is carried off almost exclusively by the lymphatics, but a very small portion apparently directly entering the blood.

Similar conditions prevail in regard to the absorption of materials from the tissues and cavities of the body. It has cost much time and difficulty until this conviction

was reached. And, indeed, it seems peculiar at the first glance that remedies, dissolved in water and injected into the very beginnings of the lymph-roots are not taken up and carried off by them but by the blood-vessels, which are separated by a wall. One would rather think that the open lymph spaces of the abdominal cavity, which v. Recklinghausen has demonstrated especially at the diaphragm, take up fluids instead of permitting them first to pass through the wall of the blood capillaries. Numerous experiments, however, have shown that this is indeed the case and that absorption occurs in a similar way as it does in the digestive tract. I will omit the fairly old experiments (105) from which the observers concluded that tissue absorption depends on the general and local blood volume and cite from the numerous contributions some of the more recent and important ones which offer decisive proof.

Orlow (106), a pupil of Heidenhain, observed that during the absorption of fluids and salts which he had injected into the abdominal cavity, neither increased in the lymph taken from the thoracic duct. Since they disappeared from the abdominal cavity during the observation they must have been taken up by the blood capillaries.

Starling, during the absorption of sodium indigo sulphate from the pleural and abdominal cavities, found the drug more in the urine than in the lymph.

Heidenhain (107), in a contribution in which he defends Orlow's results against attacks made by Cohnstein, says: "On the strength of Orlow's experiments and my own experience, I am convinced, now as before, that the most important channels of absorption of the peritoneal cavity are the blood capillaries, though the possibility exists—not disputed by Orlow—that the lymph channels of Recklinghausen carry a small quantity of fluid to the thoracic duct."

Hamburger (108) saw that after ligation of the thoracic duct absorption from the abdominal cavity took place just as rapidly as when the lymph-current was unobstructed. "From this follows by exclusion that the blood-vessels must be held responsible, if not totally, at least to a great extent." He tries to prove by the following experiment that the same condition prevails in regard

to tissue absorption: He clamped the aorta of an animal below the renal artery with forceps and injected a solution of potash of iodide in one of the hind legs, the vena cruralis of which he had exposed and provided with a small tube which permitted the outflow of blood from the foot end. He found potash of iodide in the venous blood of the leg. This must have been absorbed by the blood capillaries, for if the lymph-current had carried it into the blood it could not have reached the circulation any farther than the place of ligation of the aorta.

Asher (109) made a similar experiment. He ligated the abdominal aorta, exposed the arteria and vena cruralis, severed them and introduced canulæ. He injected a solution of sodium iodide into the tissues. He now caused an artificial blood-current to pass through the extremity excluded from the circulation, and found iodine in the blood coming from the vein. This could have been taken up by the capillaries only. Asher could demonstrate absorption of sodium iodide by the capillaries by several experiments made in a different way.

J. Munk (110) proved tissue absorption through the blood channels thus: He ligated the lymph-trunk of the neck and incised it above the place of ligation so that the entire lymph of the head was led outwards. Then he repeatedly injected poison under the scalp of the animals. He could note no important difference in regard to appearance and course of poisoning, irrespective whether lymph was let out or not. There should have been a difference if the lymph-roots had absorbed the poison. The poison (strychnin) could not be demonstrated in the lymph.

Though there could scarcely remain any doubt, after these experiments, that indeed the blood-vessels mediate almost the entire absorption of substances soluble in water from the tissues and cavities of the body, lately my assistant, Dr. Klapp (111), proved this conclusively. He had the happy idea of choosing sugar of milk for experimentation. Voit (112) has shown that every particle of sugar of milk hypodermically injected in any desired place is excreted by and can be found in the urine. Besides this substance can be easily demonstrated quantita-

tively with the polarization apparatus. We have, therefore, in sugar of milk a substance which permits exact quantitative determination of the extent of excretion on account of which experiments of absorption reached an hitherto unknown exactness.

Klapp ligated in dogs the ductus thoracicus and the ductus lymphaticus dexter and thus excluded all lymph channels which could further into the blood sugar of milk injected into the abdominal quantity. In spite of this, the sugar of milk appeared in the urine in the same time as was observed in the same animals a few days previous while their lymph channels were normal. Thus, the unassailable proof is established that substances soluble in water may be taken up by the circulation solely. Neither Klapp nor the above-mentioned experimenters deny that the lymph channels too may participate in the process of absorption, but inasmuch as their exclusion quantitatively does not retard absorption they evidently play but an unimportant role and do not possess the importance as regards the absorption of water, salts and substances soluble in water ascribed to them in the famous works of v. Recklinghausen (113) and Wegner (114). On the other hand, v. Recklinghausen has just as conclusively shown that small bodily elements (milk, emulsions, blood, cobalt, Indian ink) are taken up by the lymph channels of the diaphragm. These observations have been confirmed by several authorities. Thus Sulzer (115) found kernels of wheat which he had injected into the abdominal cavity, in the lymph channels on the chest side of the diaphragm and in the thoracic duct and believes that they get there without any medium, being but partially taken up by the leucocytes and carried off.

Similar results were reached by Muscatello (116). He found that the diaphragm is the only part of the serosa of the abdominal cavity intended for the absorption of granular substances. This absorption takes place with great rapidity. He believes that fine granular substances and some pliant bodies pass through the endothelial cells in a free condition, while rigid bodies are carried off, as a rule, by migratory cells.

We can, therefore, pronounce the following as an axiom, established by many scientific experiments: The

absorption of water and substances soluble in water in gastro-intestinal digestion and tissues and cavities of the body takes place essentially through the blood-vessels, the absorption of the smallest bodily elements, on the other hand, essentially through the lymph vessels.

For us practitioners the following question is of the greatest importance: Can we artificially influence this absorption, as I have already asserted, and can this influence, tested in practice, be demonstrated scientifically? Alas, as I have shown, we know so little about the influence of the lymph-current that the question whether we can aid in the absorption of bodily elements must be excluded from scientific discussion. We are for this reason limited to the question: How does the influence of the blood-current affect absorption?

We have some old scientific observations on this subject. During the era of venesection the influence of the general volume of blood on absorption was thoroughly discussed. As this is of no concern to us and since only the later contributions show a local influence on absorption, I will at once refer to these. When v. Esmarch's bloodlessness, on account of its great successes, stirred the minds of the surgeons the advantages and disadvantages offered by this process were zealously discussed. To that time belongs a publication by Wölfler (117), in which it is intended to show the lack of danger from strong antiseptics applied to wounds, the locality of which was kept bloodless. Though intended for a different purpose, this publication is of great interest to us because it plainly shows an influence of hyperemia on absorption. Wölfler produced a wound at the ankle-joint of dogs, dropped on it 3 grammes of a watery solution of potash ferro-cyanide and showed that the remedy could be demonstrated in the urine only after thirty minutes. If he made bloodless the extremity and applied to an equally large wound 12 grammes of the dye, as long as the bloodlessness was maintained no reaction appeared in the urine; ten minutes after removal of the bloodlessness reaction occurred in the urine. From this Wölfler concluded that the absorption of the dye into the circulation takes place more rapidly after removal

of the rubber producing bloodlessness than under ordinary conditions.

Wölfler tries to meet the objection that during the bloodlessness the dye may have spread below the rubber tubing in the extremity excluded from the circulation by diffusion and osmosis and for this reason enters the circulation more rapidly on releasing the constriction, by the following method: He applied the constricting rubber in the inguinal region and dropped the dye on the wound at the ankle-joint. After thirty-five minutes he applied a second piece of rubber tubing two fingers above the wound and removed the first. In spite of this no reaction occurred in the urine in the usual time. But after the second constriction was released the substance was found six minutes later in the urine. Wölfler concludes that below the constriction no imbibition with dye takes place in the extremity excluded from the circulation. Experiments with strychnin led to the same result.

As is well known, there occurs after artificial bloodlessness an enormous arterial (the so-called reaction) hyperemia. Thus we have an example that arterial hyperemia considerably accelerates the absorption of a substance soluble in water. The latter appeared in the urine in from six to ten minutes, though this lasts thirty minutes under ordinary conditions.

Klapp (118) justly offers some objections against the value of these experiments. He thinks that it is contrary to our experience on diffusion, osmosis and imbibition to accept that the applied liquid could not saturate the tissues in the vicinity of the wound without the blood-current and cites facts which prove that dissolved substances spread in the tissues even after interruption of the circulation. The fact that Wölfler after applying the second constrictor two fingers above the wound found no reaction in the urine does not yet prove that the immediate vicinity of the wound was not thoroughly saturated with the dye. Klapp further calls attention to the fact that all experiments in absorption with dyes and poisons are uncertain because they can be demonstrated only qualitatively by phenomena of poisoning and reactions but never quantitatively. It was this that led him to the above-mentioned introduction of sugar of milk for the purpose of ex-

perimenting on absorption, as this substance can be demonstrated quantitatively at any period of the experiment with great ease. This process is evidently so superior to all others that I will limit myself to a short reproduction of the theories made by Klapp in regard to the influence on absorption by agents producing hyperemia.

Klapp first of all demonstrated that active hyperemia produces a decided acceleration of absorption. He injected sugar of milk hypodermically into one of the hind legs of dogs and then placed the extremity for a period of twenty minutes to two hours in a hot-air apparatus. He found that among eighteen experiments in two instances insignificant scarcely noticeable differences became evident. In the rest absorption took place two to three times faster. From experiments which Klapp made on himself and on students he learned that hot air regularly produced an increase of absorption but in a less degree than that observed in dogs. Klapp showed in another contribution (119) that absorption in the abdominal cavity can be accelerated by hot air. Absorption was always present but not as considerably as when the remedy was injected in the leg and subjected to the same conditions. This is easily understood, for the hot air has an entirely different effect on a small limb than on the large belly.

It could be said against the value of these experiments on the effectiveness of the hyperemia, that they are unreliable, as the employment of heat produces numerous changes aside from the hyperemia. This objection seems justified because the influence of heat and cold on absorption has been demonstrated long ago. Thus Sassetzky (120) observed that certain drugs (pilocarpin, morphin, potash of iodide) were more quickly absorbed by the human body if he raised the temperature of the skin at the place of injection to 39° C. or if he heated the solutions; on reducing the same place to a temperature of 12° by freezing agents absorption was slower, the drugs appearing in the urine three or four minutes later than if the former method was employed.

v. Kossa (121), basing on the earlier experiments of Luchsinger and Claude Bernard, made the following experiments: He injected into the auricles of rabbits,

which he cooled with freezing agents of cold water (hydrant water at + 7° C. suffices), the strongest poisons, potassium cyanide, strychnin, picrotoxin. All these animals remained alive and well if the auricle was kept cool one to one and one-half hours, while the other animals either died or had to pass through the most intense forms of poisoning. He believes that during the effect of cold absorption takes place either not at all or at least so slowly that the drug is gradually excreted without producing phenomena of poisoning.

Klapp, too, could considerably retard the excretion of sugar of milk which he had injected into the tissues and into the abdominal cavity if he produced cooling by ice-water or with the ice-bag.

We know that warmth produces hyperemia and, according to my conception, arterial hyperemia, while cold produces anemia or, if applied for a long while, stasis hyperemia. These experiments, therefore, are in accord with our view that arterial hyperemia accelerates absorption, while anemia retards it. Several other interesting experiments of Klapp confirm this view. He found that wide opening of the abdominal cavity and short forward displacement of the intestines—up to fifteen minutes—accelerates absorption in the abdominal cavity, and that this is retarded after prolonged displacement. We know from numerous observations that a large abdominal incision and forward displacement of the intestines produces intense hyperemia in the latter. At first the hyperemia is an active one; later, in consequence of dehydration, cooling off and other injuries—passive. According to Hildebrandt (122), the active hyperemia lasts in rabbits about twenty minutes when it changes to the passive form. This fully agrees with Klapp's results and we again see that active hyperemia accelerates absorption although so major an experiment as is abdominal section and displacement of the viscera in itself necessarily produces an injury of the tissues of the abdominal cavity.

At first it seemed strange to me how Klapp's finding that elevated position of an extremity retards absorption, for we know from numerous experiments that edema disappears in such a condition. In healthy extremities

the retardation of absorption of sugar of milk by that method could be established without any doubt and we will not be amiss if we will ascribe this to the lessened volume of blood produced by the high posture. We, therefore, see that the scientific experiment confirms our view, gained from practical experience, that arterial hyperemia favors absorption.

On the other hand, considered from a purely theoretic standpoint, it seems reasonable to accept that a stasis bandage during its activity diminishes absorption. These thoughts have caused us to combine stasis hyperemia with massage, when used in non-infectious diseases for the removal of stiffened joints due to rheumatism and other causes, in the hope of producing absorption of morbid material which the hyperemia has softened and dissolved (see subsequent chapter).

Klapp has undertaken to solve the question by experiment. He, indeed, found that as long as the stasis bandage was applied absorption was considerably retarded and increased again on removal of the bandage. The increase of absorption after removal of the bandage was so considerable that the final result of the stasis hyperemia really meant acceleration. But it must be remembered that Klapp applied stasis hyperemia for only one hour after the injection of the sugar of milk and that the total excretion was completed in three hours. We, however, apply stasis hyperemia to diseased extremities for longer periods and we may accept that the final result is not an acceleration of absorption. For this reason we have added massage in such cases.

Another assistant of mine, Dr. Ritter, has earlier demonstrated the retarding effect of the stasis bandage on absorption. He injected tuberculin in tuberculous extremities, which were under the influence of an intense stasis hyperemia. He succeeded in the majority of cases in withholding for a considerable time the reaction of the tuberculin.

I have repeatedly called attention to the fact that water and substances soluble in water normally are almost entirely absorbed through the blood, but that this does not mean that the lymph-current could not do this; in fact, the latter seems to be the case, for instance, in

Volkmann's treatment of chronic articular effusion with powerful compression bandages. Volkmann himself describes that the bandages were so forcibly wound over the swollen joint that the part of the extremity below it became edematous and blue. The process is for this reason so painful that the patient does not sleep during the first night and frequently also during the second. Inasmuch as so firm a pressure renders anemic the entire region of the affected joint corresponding to the width of the bandage, it is probable that the effusion is forced into the lymph spaces of the joint and carried off by the lymph channels.

On the other hand, it seems that the lymph channels can be replaced by the blood channels in the absorption and removal of excreted lymph. For we surgeons often extensively destroy the large lymph trunks when cleaning out diseased axillary and inguinal glands, because we remove the region all glands and connective tissue, leaving only the larger blood-vessels and nerves. After such extensive operations we see comparatively seldom lymph-stasis, and we must assume that the excreted lymph is taken up by the blood-vessels until sufficient collateral lymph channels have formed. If this does not occur it seems that the blood-vessels can not always take care of the excreted lymph, for a number of cases are known in which, after such operations, lasting edema and elephantiasis developed.

CHAPTER XV

SOLVENT EFFECT OF HYPEREMIA

In the diseases against which experience has shown the agents producing hyperemia to be useful, we have not always to deal with aqueous substances or such as are soluble in water, but generally with solid substances, such as blood-clots, granulations in joints and stiff joints. If we want to cause their absorption they first must be dissolved and there can be no doubt that the hyperemia is able to accomplish it. Under its influence we occasionally observe the disappearance of arthritic granulations and nodules in tendons in a comparatively short while. Among others, I had the opportunity of nicely observing it in a man whose diverse joints and tendon sheaths were in a hopeless condition due to an attack of gonorrheal rheumatism which he passed some time ago. He had been treated for a long time without any success with all sorts of mild remedies (massage, water, iodine application) and with energetic, torturing methods (medico-mechanic machines, brisement forcé with and without anesthesia), but never with agents producing intense hyperemia. On the extensor tendons of his fingers remained nodules perceptible to sight and touch, which enabled us to become thoroughly convinced in regard to the solvent effect of hyperemia. In order to study both kinds, I first applied on one side stasis hyperemia, then hot air on the other. During the application of each form I could observe how the nodules shrunk and disappeared. In a similar manner I saw some years ago how a nodule in a joint, perceptible to sight and touch, disappeared under the influence of the suction apparatus. The most striking effect of the hyperemia could be noticed in the first few applications; later the solution proceeded less rapidly.

As far as the fact of the solution of morbid, solid substances by hyperemia is concerned, there can be no doubt about it after these observations. I remind that since ages the so-called skin irritants and "derivative" agents, or, as we assert, also agents for the production of hyperemia, have been utilized for the purpose of

solution. For this reason they have fittingly also been called softening and dividing remedies. In the following I intend to discuss these facts more fully, not so much to confirm them as to depict the effective causes of the solution in accordance with our present knowledge.

It is undisputed that inflammation and especially suppurative inflammation has a tissue solvent and melting effect. This is attributed principally to the pus corpuscles. The above described uniform effects of pure hyperemia, however, plainly speak for it that the inflammatory hyperemia too plays a role. The following experience seems to confirm this: No one will think of attributing the dilatation of the urethral strictures with sounds to their mechanical effect only. It is generally admitted that the inflammation produced by the irritation of the scar softens the latter and makes it more yielding, and, following our views now prevailing, this is accomplished solely by the pus corpuscles. To oppose this, I point to the fact that scars (strictures) of the vagina, which if left unchanged would prove an obstacle to delivery, during pregnancy become so soft that they acquire an elasticity enabling birth to take place without difficulty. Here there can be no question of suppuration and only the intense hyperemia which prevails in all parts of the genital apparatus during pregnancy can have produced the solvent effect.

Even Billroth (123), in his treatise on inflammation, ascribes its solvent effect principally to the immigrated leucocytes. He says: "Every physician knows that the firm connective tissue, infiltrated by inflammation, may totally disappear and become dissolved in the process of suppuration; it is furthermore known that even cartilage and bone in inflammation may become changed into soluble substances and that tendons, nails and hairs only energetically resist this process of dissolution, the former being expelled as necrotic shreds during suppuration." He demonstrates on specimens of inflamed prepuces how the inflammatory edema and immigrated cells totally dissolve the connective tissue. He ascribes this effect to the cells for he says: "It seems to follow from the cited observations that one of the effects of living cells is their ability under certain conditions to transform the fibers

of connective tissue and also the fibrin fibers into a soft, semi-gelatinous consistence."

We saw from the above-cited unobjectionable observations that a solution of connective tissue is possible by hyperemia alone. We, therefore, can not help but state that the view that the suppurative process in inflammation only accomplishes the solution is one-sided and we must ascribe an important role to the hyperemia accompanying the inflammation during its course. I do not mean thereby to doubt the solvent and digestive effect of suppuration established by numerous observations. This effect has been ascribed for a long time to a digestive property of the pus corpuscles; these are said to excrete so-called digestive enzymes which accomplish the melting. It was principally Leber (124) who has aided this view to victory by his beautiful and convincing experiments. But numerous other experiments, which we can not cite here, have positively established the digestive and solvent effect of the leucocytes.

Recently Buchner (125) has ascribed to all cells of the body, in addition to constructive (assimilating), deconstructive (disassimilating) substances. The latter are said to be given by the cells as solvent digestive juices (enzymes) to the blood-serum, which assumes the same effect, while the constructive substances remain in the cells. According to Buchner, these digestive juices dissolve everything foreign that has entered the body, that is to say, not only organic foreign bodies, catgut threads, necrosed tissue, but also bacteria.

He holds to his view of the bactericidal property of the blood-serum, the effective components of which come from the leucocytes, but does not believe that this is a specific activity but that the effect of the blood-serum as regards the dissolution of everything foreign embraces also the bacteria, thus causing their destruction.

Buchner represents views which Landois (126) long ago has expressed, though not so extensively. This author first showed that every species has a blood of its own which it tries to keep clean from foreign components under any and all circumstances. For this reason any kind of foreign blood which is added to that of an animal or man is at once destroyed by the blood of

the receiver. Landois convincingly demonstrated that the blood-serum of every animal causes dissolution of the blood corpuscles from any different species. Recent bacteriologic research, which ignores these investigations, has fully confirmed these observations and more extensively utilized them in an entirely new direction.

The improvement of stiffened joints, which follows after the application of either active or passive hyperemia, must first of all be ascribed to the solvent properties of the blood. Certainly a good many other things must be taken into consideration. In all probability connective tissue adhesions become softer, more pliable and elastic in consequence of serous saturation and swelling. I have already repeatedly shown that a great portion in the removal of stiff joint is due to the relief of pain produced by the hyperemia. For otherwise it were not imaginable how a man could move his joint, afflicted with chronic rheumatism, after an hour's treatment in the hot-air apparatus, or a gonorrhoic his furiously painful, completely immovable inflamed joint, after an hour's application of stasis hyperemia.

Of late Sudeck (127) has tried to explain the favorable effect of stasis hyperemia on joints stiffened by trauma by an improvement in the nutrition of the bone, which he has demonstrated to be atrophic; (for details, see further). It is possible, though not proven, that this, too, plays a role, but we can not overlook the dissolving effect of the blood, which is proved by the disappearance of the tendon and articular nodules above described and directly observed by us.

We must never forget that the name hyperemia means a large series of chemical and physical processes, and the greater the experience which I am gaining in this direction the more do I turn from the one-sided views here represented by Sudeck and, as already mentioned, in a somewhat different direction also by bacteriologists. For that matter, I can not take friendly to the scheme, so prevalent in modern pathology, which ascribes the sole efficiency to only one of the many properties or substances of life processes. For if we carefully look upon the physiological processes in the body we notice that they have a multitude of purposes which point to one

final purpose. For this many examples can be cited; since we are here interested in the effect of hyperemia I will choose two forms of physiological hyperemia as examples, though more striking proofs can be found in other departments.

If we subject a part of the body to intensely hot air, it becomes vigorously hyperemic, and if the part was large, other parts of the body experience the same change. This hyperemia serves different purposes. It must give off the material for perspiration and cool the intense and rapidly flowing blood-current traversing the endangered part and finally reduce the temperature in the entire body as the blood is led towards the peripheral parts, there giving off the warmth which it has taken up. The hyperemia, therefore, fulfills at least three different missions, viz., it took up warmth at one place, gave it off at another and made possible the pronounced perspiration, but all these again served one ultimate end: to protect the body against local and general overheating. Intense hyperemia makes possible the excretion of water after consumption of a good quantity of food, the separation of variable digestive juices in the gastro-intestinal canal and finally resorption. And all these various processes again have but one general aim: the assimilation of food.

Nothing can prove better the entirely different effect of artificial hyperemia on diseases than this idea: One of the recognized effects of stasis hyperemia is the formation of new bone. For this reason it is used to knit fractures of bones which do not want to heal. This very hyperemia, nevertheless, does not permit the ends of joints suffering from large ulcers and caries to become ankylosed but, as numerous observations have convinced me, keeps the joint mobile which otherwise would certainly have become locked. Both active and passive hyperemia act equally in the dissolution of stiff joint. More details will be given in the concerned chapter in the special part.

Probably the solvent process of hyperemia changes the greater part of the diseased granulations and adhesions of stiffened joints into substances soluble in water, which is absorbed by the blood. But it can scarcely be doubted

that there still remain tissue particles which are carried off by the lymph channels. It is therefore desirable that our knowledge about the influence of hyperemia on the lymph-current become more thorough. As long as we know so little about these conditions, it is useless to establish assertions and assumptions that even in this direction our practical experience is supported and explained by scientific recognition.

CHAPTER XVI

NUTRITIVE EFFECT OF HYPEREMIA

In the discussion of the preceding chapters we were in the pleasing situation of treating matters of every-day experience. As for myself, I have not the least doubt that arterial and venous hyperemia relieve pain; that both are solvents; that arterial hyperemia absorbs, and that passive hyperemia cures infectious diseases, for I have seen this with my own eyes innumerable times. I could have described each of these facts with a few words, they requiring no further proof. Nevertheless, I brought lengthy discussions in order to explain those effects from the standpoint of our scientific views of to-day and to bring them in harmony with foreign observations. Fortunately it was possible to accomplish the latter; those facts, however, have been so positively established that, were the opposite the case, I still would have adhered to them to the fullest extent. I express myself decidedly, though my observations have received but little confirmation (if any) from others. For the properties of artificial hyperemia claimed by me in the preceding chapters are so striking that I would be a poor observer indeed had I been mistaken in them.

Conditions are entirely different in this chapter, which treats of the influence of nutrition by hyperemia. For although in the discussion of the effect of hyperemia, this question has been thoroughly and frequently considered in a manner directly opposite to my more recent observations, conditions are by no means clear. We will see that here the views are very contradictory.

The assertion that hyperemia as such has a nutritive effect is very old. First of all, this has been claimed for the so-called functional hypertrophy. It was believed that the increased function produces hyperemia and this in turn hypertrophy. I do not want to enter into this old quarrel. On the whole, it must be considered as decided that hyperemia is necessary for hypertrophy but that it is not the essential cause, but that the so-called functional irritation—a word for an as yet unknown conception—causes and enables the cells to take up sub-

stances from the excessive nutrition offered by the hyperemia, which they utilize for their increase or diminution. Inasmuch as we always have in view the practical aim to cure diseases with the hyperemias, we will limit ourselves to the question: Can we succeed in passively feeding through hyperemia weak, withered and undeveloped parts of the body to such an extent that they increase their utility (this being decisive) and circumference?

In my opinion two things must here be kept strictly separated, viz.:

1. Can we bring our completed bodily tissues in a state of hyper-nutrition through hyperemia; can we, as it were, artificially fatten them and can we by this means influence the physiologic growth?

2. Can we accelerate or incite the regeneration of tissue by hyperemia?

INFLUENCE OF HYPEREMIA ON THE NUTRITION OF COMPLETED PARTS OF THE BODY AND ON PHYSIOLOGIC GROWTH

Many of the older observations on the causes and existence of hypertrophic bodily parts can not be utilized because all possible things have been designated by the one term "giant-growth," of which we now know that they owe their origin to diverse etiologic factors. Thus, for instance, diseases which we now would classify as syringomyelia, acromegaly and the first degrees of diverse forms of muscular atrophy have been regarded as pure hypertrophy of bodily parts. We will, therefore, have to be careful in the selection of cases, accepting only those in which surely, or at least quite likely, hyperemia was the real cause of the hypertrophy of tissues and bodily parts. It has been asserted that muscular atrophy has been observed after venous hyperemia, especially as a consequence of venous thrombosis. Though these cases frequently have been confused with muscular affections of a different character, namely, with pseudo-hypertrophy of the muscles (lipomatous hypertrophy of muscles, juvenile progressive muscular atrophy and muscular affections of spinal origin) yet there are several evidently pure cases in which nothing else but a venous

thrombosis could be demonstrated as the cause of the muscular hypertrophy. The fact that the affection was limited to the domain of venous stasis proves that this was indeed the sole cause. The individual cases are so closely alike and of such decisive importance to our question that we will consider them in detail.

Paget (128) reports a case of hypertrophy of one arm after venous thrombosis The affected arm was almost one-third larger than the healthy one and this principally due to a greater development of the muscles rather than to a deep edema. The adjoining shoulder and the upper part of the pectoralis major muscle were strikingly large and wide. In connection with this case Paget mentions an observation made by Professor Laurie on himself: This gentleman became afflicted with venous thrombosis of one leg as a sequela to typhoid fever, which produced edema and thickening of the muscles for the rest of his life.

The following cases have been observed and described in detail. The age of the patients at the time of the attack of venous thrombosis was 19, 20, 22, 26, 26, 29 and 41 years; most of them were several years older when the hypertrophy was observed. Berger (129) reports three cases which concern the leg:

Case 1. The affection developed from venous thrombosis during typhoid fever. The left leg was very much thickened, the relief of the quadriceps glutei and triceps surae muscles were considerably arched forward. The foot was in the position of tip-foot. The skin of the affected limb was traversed by numerous dilated superficial veins; the surface temperature of both extremities was alike. The thickened musculature felt firm, hard and tense. Skin and bones were not noticeably thickened. There was no edema. Sensibility and reflex-irritability were greatly diminished throughout the entire leg. The patient easily tired in the affected limb, whose strength was greatly diminished. Muscular twitching frequently occurred after exercise. Electrical irritability was greatly diminished.

Berger took particles from symmetric places of the soleus muscle of each leg by means of Middeldorpf's harpoon for microscopic examination. There was a de-

cided difference on macroscopic inspection. The muscle of the affected limb was pale and anemic; that of the healthy one had the normal deep, red color. Microscopically a true hypertrophy of the diseased muscle was established, the fibers being more than double the normal size. Otherwise they were of normal character. There was no trace of interstitial fat or connective tissue granulation.

Case 2. Here, too, the disease was due to venous thrombosis in consequence of typhoid fever, and affected the left leg. The patient complained of pains, muscular twitchings and weakness in the diseased limb. This had a "truly Herculean musculature" which enlarged it considerably, while the skin could scarcely be designated as hypertrophic; the bone was normal. On the dorsal side of the foot only was edema, otherwise the enlargement was due to the muscular swelling. The limb was very weak, muscular force, electrical irritability and sensibility were greatly diminished.

Examination of particles of muscle removed in a manner described in the former case gave the same result as in Case 1.

Case 3. The disease was due to a gunshot wound of the thigh, which, according to the history of the case, probably was followed by venous thrombosis. There was enlargement of the left calf which was due to the muscles, as the skin and bones were not swollen. Nowhere was edema to be observed, the venous net of the calf was moderately dilated. The rest of the examination showed a condition equal to that in the two former cases. An anatomical examination of muscular particles was not made.

Lesage (130) tells of a man who suffered from a thrombosis of the left femoral vein during an attack of typhoid fever. Lesage saw the patient two years after this event and noted the following: The entire left leg was much larger than the right one. The hypertrophy was limited to the musculature and was largest in the calf. Edema and varicosities were absent. Bones and skin were not thickened. Electrical irritability, reflexes and sensibility were normal, the surface temperature of the affected limb was elevated.

At the end of the day some edema appeared at the foot and malleoli and a slight bluish discoloration of the skin. The muscular force of the diseased leg was stronger than that of the healthy one, the former, nevertheless, tiring much quicker when muscular spasms appeared in it. The muscles of the diseased limb were softer. Two years later Lesage found the same condition, the disease, therefore, remaining stationary.

The case reported by Eulenburg (131) concerns a man who also suffered from thrombosis of the left femoral vein in connection with a grave septic affection. A year before he had sustained a fracture of the vertebræ, which was followed by decided disturbances of innervation. Following the thrombosis was an immense hypertrophy and weakness of the muscles of the left leg. The examination of particles of muscle taken from symmetrical places of both legs showed muscular degeneration on both sides (the right leg was atrophic owing to the disturbance of innervation accompanying the fracture of the vertebræ), but on the left side "the degenerated fibers were much more numerous and thicker. They appeared swollen, though the dissection was alike. The fatty and waxy degeneration is pronounced; there are also less normal fibers. The interstitial fat infiltration shows characteristic series as found in pseudo-hypertrophy of muscles."

Goldscheider (132) presented a young man with hypertrophy of one leg due to thrombosis of the femoral vein accompanying a traumatic orchitis. This case was described in detail by Masskow (133). This case is of especial interest because its entire course was observed by Goldscheider. The patient was attacked by the thrombosis in 1894 and suffered in addition from violent twitching of the muscles. In 1897 the leg had the following appearance: The left saphenous vein and a vein on the left side of the abdominal skin were dilated, the calf shows some edema and cyanosis. The musculature of the left leg and especially of the calf is decidedly hypertrophic and feels harder than that of its neighbor. Its strength is weaker. The subcutaneous fat is moderately increased in the left calf. The left leg perspires more than the right and feels warmer but cools off

quicker and has less hair. The hypertrophic limb is weaker and tires easily. Sensibility is not disturbed. Electrical irritability of the muscles of the left calf is diminished. There exist muscular contractions, which occur about three or four times per second. On exertion of the affected limb cramp-like pains develop. An anatomical examination of the hypertrophic muscles was not made.

While in all these cases the increase in volume of the extremities was positively due to a venous thrombosis, this etiologic factor is in all probability also the cause in the two following cases, for which reason it may be permissible to add them to this group.

Auerbach (134), in an exhaustive contribution, reports the following case: A man, twenty-four years old, noticed on undressing that his right arm was larger than the left one; gradually weakness and rapid tiring appeared in the affected limb. The skin showed extensive venous nets and a bluish, marbled appearance. The right hand was cooler than the left. After a prolonged stay in the air it became dark blue.

Auerbach excised particles from the deltoid and biceps muscles of the affected and from the biceps of the healthy limb for the purpose of comparison by microscopic examination. He found that the case was one of true muscular hypertrophy. This was due to a decided expansion of the muscular cylinder. They were twice as wide as found in normal muscles but even those of the healthy arm were one-quarter wider. The muscular corpuscles were increased corresponding to the enlargement.

On operation the increased amount of blood, not only the externally visible one of the skin but also that of the muscle, was striking. The operation (performed in 1871) was followed by severe inflammation and suppuration in the affected limb. Auerbach demonstrated equal strength of both arms by the dynamometer; the strength of the right arm had, therefore, not increased in proportion to the muscular hypertrophy.

It is uncertain whether a venous thrombosis preceded the disease in Redlich's (135) case, though the history of the case speaks for it to such an extent that Red-

lich assumes this as positive. The patient, while suffering from acute fever, suddenly complained of violent pains in the left leg, which were followed by a considerable swelling. The limb remained enlarged, the patient continuing to experience abnormal sensations therein. The attending physician had diagnosed "lymphangitis." Six years later the patient was examined by Redlich, who found a considerable swelling of the left leg, especially of the calf. The enlargement was principally caused by the muscles but the skin, too, participated in it. The bones were normal. The growth of hair was less on the affected side. The skin was marbled but—except some varices on the left half of the scrotum—there was not noticeable any decided venous dilatation. This patient, too, complained of muscular weakness, paresthesia and pains, but these were not lacking also in the right leg. The patient suffered from other nervous phenomena, such as pupillary contraction, disturbances of speech, etc. Redlich considered these as incipient progressive paralysis.

A particle of muscle was excised from the calf of the hypertrophic leg for examination. During this procedure was found a thickened skin with a deep layer of subcutaneous fat. After division of the fascia there appeared a layer of fat, below which was the muscle. This looked pale but otherwise normal. Hemorrhage from the wound was insignificant. Redlich found generally normal muscular tissue on microscopic examination. The interstitial tissue was dense and, like the vessels, showed cellular infiltration. Much blood pigment was found in corpuscles.

It is possible yet highly improbable, that the case reported by Hitzig (136) belongs to our group. In a young man an injury to the right supraclavicular fossa was followed by venous stasis and muscular hypertrophy. As there also existed paralysis of the muscles of the chest it is very probable that this case was one of nervous trouble. Of importance is the fact, demonstrated by Hitzig, that the affected upper and fore arm was longer than the healthy one, a thing which was not noticed in any of the preceding cases.

These observations, the majority of which are unob-

jectionable, leave us in no doubt that as a consequence of a pronounced venous stasis, as it occurs after venous thrombosis, an enlargement of the limbs takes place which concerns exclusively or essentially the muscles. It would also seem that the proof has been established by the microscopic findings of the various investigators that we here have to deal with a true hypertrophy. This proof, however, is utterly shaken by contributions from Oppenheim and Siemerling (137), which show that the fibers of pieces of muscle taken from living men and animals always make the impression as if they were hypertrophic. This is so conclusive that Oppenheim and Siemerling always can tell with the microscope whether muscles have been taken from a living being or a corpse. Zuntz expressed the idea that living muscle strongly contracts when irritated by cutting or contusing instruments and reagents, so that the thickness of its fibers increases at the expense of length. Oppenheim and Siemerling substantiated the correctness of this explanation by experiments on animals. However, with the exception of an enlargement of the fibers, the above-mentioned observers have found no other positive sign of a true hypertrophy of muscles. Eulenburg found degenerated muscle fibers and states expressly that there existed a fatty infiltration in the muscle, which appeared in characteristic series as found in pseudo-hypertrophy of the muscles. Redlich found normal muscular tissue and, on the other hand, increase of interstitial tissue characteristic of pseudo-hypertrophy.

It must be added that in all cases (except in Lesage's case, in which the diseased muscle, however, tired more rapidly) the weakness of the enlarged muscles by no means can be accepted as a sign of true hypertrophy. Thus Auerbach and Redlich are of the opinion that this so-called "true muscular hypertrophy" represents the first stage of the lipomatous pseudo-hypertrophy.

The conclusion which we draw from these widely discussed diseased conditions is this: It is doubtless that increase in volume of affected limbs and especially of the muscles may follow a venous thrombosis. Whether this is a true hypertrophy or the first stage of a degeneration of the muscular tissue proper is unknown.

For our practical purposes, however, we can draw a positive conclusion, viz.: Under no condition is it permissible to artificially produce stases of such intensity as those which produce the so-called muscular hypertrophy. For we learn that in the majority of such cases the stasis at the same time produces nervous derangements and the result of the increase of the muscles was a decrease and not an increase of their usefulness.

It is possible that a true hypertrophy could be produced with a less intense stasis hyperemia while that intense hyperemia after a transient hypertrophy leads to degeneration. Against this is the fact that in many hundreds of cases which I have treated with degrees of stasis hyperemia permitted for therapeutic purposes, I have never seen a muscular hypertrophy. However, I have seen that limbs grown lean because of joint diseases rapidly regained their former condition, but no more so than could be explained with the improvement of the causative disease, for muscles and other tissues in many affections of the joints not only atrophy with great rapidity but also recuperate just as rapidly if the cause be removed.

Without doubt both active and passive hyperemia lead to rapid growth of the covering epithelial structures. Thus, it is known that in summer, when the skin is supplied with a greater quantity of blood than in winter, hair and nails grow faster. Besides there are numerous observations which prove that the same occurs in all chronic hyperemias. In addition decided exfoliation of the epidermis has been observed. To this class possibly belongs the so-called desquamative catarrh of stasis lung, in which the alveoli of the lung are filled with masses of shed epithelia.

Every physician knows that in the vicinity of chronic ulcers, accompanied by hyperemia, frequently increased growth of hair and epithelial thickening can be observed. Leber (138) could even artificially produce them by injecting phlogosin, a substance producing inflammation compounded by him.

From my own and Helferich's observations can be seen that increased growth of hair very often follows passive hyperemia; we frequently saw the appearance of in-

creased growth of hair after artificially applied stasis hyperemia.

That arterial hyperemia has the same effect can be seen, aside from the above-mentioned growth of hair in summer, by the hairy hands of surgeons, which, as a consequence of repeated washings, are in a continuous condition of hyperemia. It has been assumed that one or another of the chemicals employed is responsible for this; however, all washing agents act alike in this respect and therefore the hyperemia remains the sole cause.

A striking example for the increased growth of an epithelial structure under the influence of hyperemia is given by the frequently cited experiment of J. Hunter, reported by Paget (139): If the spur of a rooster be transplanted into the hyperemic tissue of its comb, the spur will develop to an enormous size.

It can therefore be considered as established that active and passive hyperemia produce increased growth of cover epithelium. On the other hand, I know of not a single case which could prove that secreting glandular epithelium is hypertrophied by hyperemia. On the contrary, we will soon show that chronic stasis in the liver produces even atrophy of the epithelial cells.

I have repeatedly observed that testicles, which can scarcely be counted among the secreting glands, greatly enlarged under the influence of stasis hyperemia, which I had employed against tuberculosis or for the dissolution of hard infiltrations following gonorrheal infection. This enlargement remained for some time after the cessation of the hyperemia. In one case of pronounced induration of the epididymis and fistula of one testicle following gonorrhea, I rendered hyperemic both testes by means of a rubber tube applied at the base of the scrotum. The patient complained that at first he was tortured from intense pollutions, which occurred several times during the night, while previously he rarely had a pollution during the night. This disappeared after a temporary cessation of the application and did not return on shorter application of the constrictor.

As I never have been in the position to anatomically examine testes enlarged by artificial stasis hyperemia it

must remain unanswered as to what causes the enlargement and which tissues are involved.

As is known, it has been held that chronic blood-stasis in the viscera due to heart disease, emphysema, etc., produces an increase of connective tissue in them, designated as cyanotic induration. I deem it useful to briefly review the changes which occur in the viscera in this chronic stasis, according to Ziegler's text-book on pathological anatomy:

The chronic engorged spleen is normally large or enlarged, rarely diminished. It is always indurated. The hardness is caused by the compactness of the red pulp. "The main change consists in an increase of connective tissue which concerns not only the trabecular system but also the walls of the blood-vessels and their vicinity. Occasionally a partial induration of the reticulum of the pulp cords can be demonstrated."

The liver in chronic stasis is, as a rule, somewhat diminished, its surface sometimes uneven and granulated. On microscopic examination the veins, especially the venulæ centrales including the near-by capillaries, are found to be dilated. In the more intense forms of stasis all capillaries of the lobules are dilated. "The liver cells between the dilated capillaries are always more or less atrophic and, as a rule, also studded with yellow and brown pigment granules, some with fat-drops. Degeneration has progressed farthest in the center and in the middle zones of the acini. If the circulatory disturbances and pronounced dilatation of the capillaries has lasted for some time, a part of the liver cells may have perished so that there remains between the wide capillaries only pigment granules. The periportal connective tissue of the liver is, as a rule, unchanged, yet it occurs that it becomes hypertrophic and infiltrated by cells so that a special kind of cirrhosis develops."

The chronically engorged kidney is hard and firm, "the connective tissue between the urinary canaliculi is somewhat enlarged, the blood-vessels are wide and gaping, the walls of the capillaries and the adventitia of the veins thickened. Occasionally there occur inflammatory cellular infiltrations." Many of the epithelia of the canaliculæ become fatty.

In chronic stasis of the lung, the vessels of this organ, especially the capillaries, are much dilated, protruding into the alveoli. The lung becomes hard. "In some spaces the connective tissue is dense or in the process of inflammation or granulation, but this is due less to the stasis than to repeated hemorrhages found in such lungs."

As I found in the literature variable statements concerning the degree of granulation of connective tissue in engorged viscera, I asked my colleague, Professor Grawitz, to give me his experience on this point. This pathologist granted my request with great cordiality and supported his statements with instructive microscopic specimens, so that I became convinced as to the correctness of his descriptions.

According to Grawitz, thickening and granulation of connective tissue is most intense in the engorged spleen. However, he is in doubt whether this change is solely due to the chronic stasis or whether other causes, too, cooperate.

The engorged lung owes its density rather to the fulness of the capillaries (incision and pressure soften the lung), partially also to atelectases and filling of the alveoli with a primary exsudate and detached cells, than to granulation of the connective tissue. Even in the most intense forms of chronic stases the increase in connective tissue may be absent yet the "brown induration" of the lung is present.

If the stasis has persisted for some time in the liver, the capillaries of the lobules are greatly dilated, especially around the central vein. At the same time, destruction of liver cells takes place. This can be plainly recognized in fresh specimens, when affected by water, by the fact that the row of liver cells commences at a distance from the central vein. In the stased space one can observe only remnants of broken-down liver cells without infiltration of small cells. In grave, prolonged stasis destruction of the liver cells extends over the entire lobule and frequently reaches an enormous circumference. The final result of severe, chronic stasis of the liver, according to Grawitz, is atrophy of the liver cells and, as a rule, without development of connective tissue.

The congested kidney is dense to the feel but can be differentiated from chronic interstitial nephritis by the surface, which is smooth without formation of scars. Thickening of connective tissue may be present or absent, even in the most developed forms of chronic stases. If it is present, it is even and neither forms single foci nor produces infiltration of small cells; it is always without influence on the epithelial parts of the kidney.

Grawitz admits that chronic stasis of the viscera frequently produces increase of connective tissue but insists that this by no means happens regularly and that in many cases of pronounced chronic stasis it is entirely lacking.

It is known that lively connective tissue granulation follows after chronic inflammations; we know this especially from the chronic ulcer of the leg, where inflammation and intense blood-stasis go hand in hand.

We further know that chronic blood-stasis and more frequently lymph-stasis and repeated attacks of chronic inflammation may lead to thickening of the skin—the so-called elephantiasis.

No doubt exists in regard to the influence of passive hyperemia on the growth of the bones, both in length and thickness. Stanley (140) and Paget (141) made the first observations in this direction, and v. Bergman (142) collected the then known material in an article and added two new cases. These reports show that long bones become longer and thicker if inflammatory processes have taken place within. Similar observations increased rapidly and Helferich (143) demonstrated by a large number of cases that lengthening of bone frequently follows necrosis (as a rule, this is the cause of inflammation), occurring quickly after the disease has taken hold. Today this fact is well known to every physician and there is scarcely a surgeon who has not seen such cases in a large number. It is therefore unnecessary to enter into details.

Even the earliest observers attributed this hypertrophy to the hyperemia produced by the inflammation. v. Langenbeck (144) framed his observations in the following three sentences:

1. Diseases which cause irritation and hyperemia of bone tissue produce an increase in the length and thickness of the bone while the growth of bone lasts.

2. The increase in the length concerns first of all the affected bone, but can also be observed in a healthy bone of the same extremity.

3. The bone lengthened by this too rapid growth retains its dimensions throughout life. A decrease in length by resorption does not take place even though its cause, the disease of the bone, has ceased to exist for a long time.

Ollier (145) found that the length of the long bones in young growing animals could be increased by all sorts of irritation of the diaphysis, by tearing, excision and cauterization of the periosteum, by trephining of the medullary canal or by the introduction of foreign bodies, provided the irritation was maintained long enough.

In 1868 Schneider (146) reported a case, a young man seventeen years old, whose tibia and fibula became increased in length in connection with a chronic ulcer of the leg, and since then this phenomenon has been repeatedly observed in young individuals. That these ulcers led to thickening of bone and even to ossification of the ligamentum interosseum had been known for a long time. Schneider attributed this hypertrophy to an increase of blood produced by chronic inflammation in a young person.

These observations made it very probable that the venous hyperemia which accompanies all inflammations is the cause of the growth in length and width of the bones. A number of cases now prove this to be a positive fact, since a pure venous hyperemia was followed by the same result.

The following observation by Broca (147), so often cited in literature, belongs to this number: A man, seventeen years old, suffered for two years from a constant venous hyperemia of a leg, produced by an arteriovenous aneurysm below Poupart's ligament. The thigh was increased by 2 cm.; the leg by 1 cm. by the hyperemia.

Krause (148) describes a case of numerous sac-like aneurysms of the forearm and hand and pronounced vari-

cose dilatation of the veins of the dorsum of the hand and forearm, due to a bite from a dog in youth. These maintained for many years venous hyperemia of the extremities and led to ulcers of the fingers. Stromeyer amputated the extremity at the upper arm. Krause established that the forearm was longer by 1½ Parisian inches.

A similar case is described by Nicoladoni (149). In this case too a cirsoid aneurysm and decided formation of varices led to a prolonged venous hyperemia of the arm, which produced an increase in the length of the forearm. Israel (150) describes a leg lengthened 5 cm. by venous hyperemia due to a congenital angiectasis and Hitzig (151) describes an arm whose fore and upper arm each were several centimeters longer, due to a venous stasis of unknown origin.

Probably the so-called drumstick fingers, consisting of an enlargement of the bone, nail and end phalanx of the fingers, sometimes also of the toes, belong to this class. These are observed in grave affections of the heart, originating in childhood, emphysema, bronchiectasis and phthisis pulmonalis and in diseases producing chronic stasis. Bamberger described in these affections thickening of the bones of the legs and forearms. Fischer (152) believes that he is able to prove their development from hyperemia by the fact that in such cases he found an increase of 1° C. in the surface temperature of the palms as compared with other parts. It seems to me that this is no proof, for even normally the surface temperature is somewhat higher in the palm than elsewhere on the arm. However, it is probable that they owe their development to chronic stasis and not to the resorption of gangrenous substances from bronchiectases and cavernous spaces, as is held by Bamberger. Against the latter view speaks their occurrence with heart diseases and a case, described by Fischer, of a cachectic child suffering from craniotabes which was frequently attacked by asphyxia, which again led to stases and drumstick fingers.

There is, therefore, no doubt that a prolonged venous hyperemia produces hypertrophy of bones and of epithelial structures, principally hair. However, as the above-described cases of muscular hypertrophy are, to say the

least, uncertain, I know of not a single case of a bodily part or organ with active functions which has been rendered hypertrophic by venous hyperemia, the observations which have been made in stased viscera speak rather for the contrary.

After it has been recognized that under certain circumstances, superfluity of blood produces hypertrophy, this fact was made use of for practical purposes, with a view to stimulating the growth of parts of the body undeveloped in length and thickness by rendering them artificially hyperemic. Basing on a successful experiment on an animal, v. Langenbeck recommends in the above-cited contribution (in 1869) to hammer ivory pegs into the bones of shortened extremities of men (for instance, after resection of the knee-joint) and thus to produce an artificial inflammatory irritation, a proposition which later has been executed repeatedly in practice.

Ollier (153) recommended irritations of the periosteum in the middle of the diaphysis by repeated cauterization and other caustic agents in order to increase the length of bones. He succeeded in lengthening the shortened shin-bone of a young girl 1 cm. by the application of caustic paste.

Helferich (154) made the pure experiment of furthering the physiological growth of bone by means of artificial stasis hyperemia. He reported the following cases in which he observed the development of hypertrophy of diverse tissues by hyperemia:

1. A boy has been treated for years for congenital luxation with an apparatus which produced stasis hyperemia in the diseased leg. As a consequence, skin and muscles became thicker, while the bones increased in length.

2. A sixteen-year-old girl experienced an increase of 3 cm. in her leg from a chronic ulcer. Helferich succeeded in lengthening the healthy extremity 2 cm. by stasis hyperemia. This artificial hyperemia produced a true thickening of the skin.

3. Boy, ten years old, leg shortened 3½ cm. subsequent to a fracture of the femur and lengthened 1½ cm. by stasis hyperemia.

4. Girl, aged nine years, who had a slight paralysis of a leg. After the application of stasis hyperemia for

four months there was a slight lengthening of the tibia, thickening of the skin and increased growth of hair.

Helferich states that he has used artificial hyperemia also in five cases of infantile paralysis but he was not able to control the effect because of the shortness of the treatments.

Helferich's remark that after a prolonged application of stasis hyperemia he regularly observed thickening of the skin without edema, i. e., true hypertrophy of the skin, is indeed noteworthy.

His observations concerning the favorable influence of stasis hyperemia on the formation of callus will be discussed elsewhere; we will here discuss his attempts to improve the deficient formation of sequestra by means of stasis hyperemia. He succeeded in improving the formation of sequestra in cases of spontaneous fracture from total necrosis. Helferich successfully used a mild stasis hyperemia for the rapid production of an involucrum before solution of the sequestrum.

Schüller (155) repeated Helferich's experiments to treat atrophy and shortening of bone with artificial stasis hyperemia, he, however, added massage, inunctions and sea-baths, so that the results of his treatment are not pure. In addition, he instituted a dietetic treatment consisting of good nourishment and the introduction of calcium salts and limitation of the consumption of lactic acid from the food. He experienced good results in several cases of infantile spinal paralysis which had resulted in shortening and muscular atrophy. After several months of treatment he succeeded in not only evening the shortening of the bones but also in considerably improving the muscular atrophy.

In three cases Schüller, previous to the institution of this treatment, drove nickeled steel tacks in the bones. There were left *in situ* five to nine days and then removed. After two weeks stasis hyperemia, etc., was instituted.

The first of these cases has improved so strikingly that it merits brief quotation: A sixteen-year-old girl, who had been attacked by infantile spinal paralysis when two and one-half years old, still had as a sequela a shortening of 3 cm. of the right leg, a diminution of the right foot, decided atrophy of the calf, complete paralysis of the toes,

lividity and coldness of the skin of the foot. The described treatment, which was maintained for eight months, has produced a lengthening of the leg so as to be almost even with the healthy one, enlargement of the foot and "the calf, which before had almost entirely disappeared, has become full again." The toes now can be moved actively, that is to say, flexed and extended, while before they were never moved spontaneously. The foot, which was always blue and ice-cold and could make no other motion save that of limited dorsal flexion and which, when left alone, regularly tipped outwardly, now has normal color and warmth and can be moved actively in every direction.

It must be added that Schüller previously had performed arthrodosis of the foot and section of the plantar aponeurosis, and in addition to the hyperemic, gymnastic and dietetic methods has treated the case also orthopedically.

Of great importance also is Schüller's assertion that he has produced one-sided formation of bone tissue. In a case of pronounced genua valga due to rachitis, he drove nickeled steel nails on the outside of both femora about two fingers breadth above the epiphyseal line and removed them after five days. Two weeks later the described method—stasis hyperemia, massage and gymnastic—was instituted and the child sent to a sea resort. Four and one-half months later the worse deformity had entirely disappeared, the other considerably improved. Schüller attributes this difference to the right nail, which was driven in deeper than the left one. Both legs had greatly increased in length, which Schüller attributes to his treatment, therefore, to the lengthening of the thighs. Since we know that rachitic genua valga frequently disappear after the institution of a rational hygienic therapy only, which was also done here, this case loses much of its value as proof.

While the observations concerning the influence of passive hyperemia on hypertrophy are numerous, they are limited in regard to active hyperemia. I have already mentioned that the latter produces an increase in the growth of hair.

Bidder (156) removed from a young rabbit a piece from

one sympathicus 1.5 cm. long and thus produced arterial hyperemia of the concerned half of the head. The ear on that side became wider and longer than that on the healthy side. The same experiment with like success was performed by Stirling (157) on young, growing rabbits and dogs.

Penzo (158) made one of the ears of a growing rabbit lastingly hyperemic by subjecting it throughout the greatest part of the day to a temperature of + 37 to 38° C., the other at the same time anemic by employing a temperature of + 10 to 12° C. In five experiments he always obtained the same result: the hyperemic ear grew much faster. According to a photograph of the head of a rabbit thus treated the difference in size was considerable.

Here belongs also the above-cited experiment by I. Hunter, the unusual growth of a spur of a rooster transplanted into the hyperemic comb.

In opposition to this, Virchow (159) says that one can (probably in grown animals) maintain hyperemia of half the head for weeks and months by cutting the sympathicus without producing the least change in nutrition and Cohnheim (160) says the same even of young, growing animals.

Even atrophy has been observed after arterial hyperemia due to resection of nerves. Thus Schiff has seen atrophy of the laryngeal lobe in the turkey; Legros removed the uppermost ganglion of the sympathicus of a young rooster, which was followed by atrophy of the comb on the concerned side, and Brown Séquard and Vulpian (161), after cutting through the sympathicus of a guinea pig, observed atrophy of the brain on the related side.

These experiments therefore prove that artificial arterial hyperemia produced by section of vasomotoric nerves, though frequently producing hypertrophy, is not necessarily always followed by this result. I have already remarked that the following every-day experiences speak against the arterial hyperemia under natural conditions producing hypertrophic effects: People who expose during the largest part of the day their skin, especially that of the face, against high temperatures, thus rendering

it hyperemic, such as glass-blowers, foundrymen, stokers, bakers, by no means have a hypertrophic skin but, on the contrary, one characterized by delicacy and paleness when away from heat.

My own hands and forearms, since I have become a surgeon, on account of the repeated washings, are in a continuous state of hyperemia, which, to judge from the color, is an arterial hyperemia; the skin of these parts, however, has by no means become hypertrophic, if anything, rather atrophic.

Among hundreds of cases which I have treated with active hyperemia by means of hot air, I have not seen a single case in which this agent has produced an increase in the nutrition of the treated part which could not be explained by the improvement of the affection proper.

With the exception of the observations by Helferich and Schüller, I have found nowhere in the literature data on experiments to accelerate physiologic growth and to remove existing atrophies by pure stasis hyperemia. I am not aware that it has been tried to achieve the same purpose by active hyperemia. This is due to the fact that whatever observations on hypertrophy subsequent to hyperemia were accidentally made concerned almost exclusively the venous hyperemia. To this must be added that previous to my recommendation to utilize high degrees of heat as a harmless remedy to produce active hyperemia this was unknown. It is impossible to produce paralysis of vasomotoric nerves in man. For this reason I deem it important to here publish a few observations which I made when I first began to experiment with hyperemia.

I tried to improve the pronounced muscular atrophy and the paralysis by artificial hyperemia in three cases of spinal infantile paralysis of the lower extremities. There were no shortenings of the bones; whether the treatment produced an increase in their length I can not tell, as I have made no examinations in this respect. I therefore must limit my description to the effect exercised by the hyperemia on muscles and skin.

For the first two months I applied in the three cases prolonged stasis hyperemia. The constricting bandage was changed to a different place twice daily. I can

confirm Helferich's observations that the paralyzed extremities tolerated this method of treatment very well. I could not observe any result in a single case. I then applied two to three hours daily artificial arterial hyperemia by means of hot air, in one case two months, in the others one month each. This also was well tolerated*. To be sure, I was very careful and never permitted the heat to become excessive. Hyperemia nevertheless appeared in a sufficiently intense form. In one case I had a satisfactory success in so far that the previously cold and blue limb during the treatment became warmer, while the blue color faded. However, this success disappeared after the cessation of treatment. The arterial hyperemia did not have the least influence on the nutrition of the skin and muscles. In one case it even seemed to me as if the atrophic skin became thinner and more sensitive.

If we review the numerous cases and observations which have been cited to show that hyperemia, as such, produces hypertrophy, we are certain only that as a consequence of chronic hyperemia bones frequently experience an increase in length and thickness, cover epithelium granulates and connective tissue may increase, though this is not always the case.

As far as the muscles are concerned, it is extremely doubtful whether they become hypertrophic when influenced by chronic hyperemia. Even if we accept that the above-mentioned cases, anatomically considered, are true hypertrophies, physiologically they must be considered degenerations, as they led to muscular weakness. Thus, artificial hyperemia as a means to produce muscular hypertrophy in practice is out of the question, especially since it has been observed in such intense forms of prolonged stases as could scarcely be made use of without inflicting injury on the patient. In regard to other tissues, we know of no unobjectionable example which shows that it could passively be placed in a condition of hypertrophy by hyperemia; on the contrary, a

*I have demonstrated on a previous occasion (Virchow's Archiv, Vol. 153, p. 332) that the vessels of cold, blue, paralyzed limbs very well react to agents which produce active hyperemia, as the artificial bloodlessness normaliter produces in them a pronounced reactive hyperemia.

few observations speak for it that intense lasting hyperemia may even produce atrophy. For them, therefore, holds good Virchow's dictum that the cell can not be nourished passively but nourishes itself, thus refusing the nutrition offered in excess, unless they are influenced at the same time by stimuli, the nature of which is as yet unknown to us, which cause them to grow and multiply.

On the other hand, we must admit that as far as the cover epithelia and supporting tissue (bone, cartilage, connective tissue) are concerned there exists a possibility of passive nutrition by hyperemia, though occasionally this may not occur, as is shown by the above-mentioned observations.

I therefore believe that Roux (162) is correct in assuming that only the organs with passive* functions (supporting tissue and cover epithelium) but never such with active functions (muscles, nerves, secreting epithelia) are capable of increase by the mere increase of nutrition without other stimuli. Before I knew Roux' statement, I have differentiated these things in such a way that I said: Only the most modest tissues, which remain alive and exist even with the poorest nutrition, as is the case with the supporting substances and cover epithelium, can be passively nourished by hyperemia but not the higher organized tissues.

That this differentiation between the diverse tissues is justified is shown by the numerous observations of the substitution of highly developed tissue by connective tissue which occurs in the disturbances of nutrition. This is especially plain in the experiences made by numerous experimenters (163) in artificial circulatory disturbances in the kidney. If one ligates the renal artery, either alone or with the renal vein, the first consequence of this operation is an enormous accumulation of venous blood so that the kidney enlarges two to three times. The accumulation occurs because the empty vascular apparatus

*Organs functionating purely passively do not exist. Connective tissue contains the lymph-nodules and therefore participates in the preparation of blood and perhaps has some other "glandular" functions. Bone, whose function to sustain weight and muscle tension apparently is purely a passive one, contains the marrow which is also active in the preparation of blood. In spite of this the word "passive" here will scarcely be the cause of misunderstandings.

of the kidney, whose artery represents an "end artery" in Cohnheim's sense, is first of all filled with venous blood from the capillary anastomoses of the capsule. Later the hyperemia decreases and the kidney is even found to be anemic. After about eight days it regains its former size, then shrinks more and more and finally, if the supply of blood has been effectively interrupted, becomes a small mass of connective tissue, in which not infrequently occurs calcification. The microscopic examination of such kidneys shows that during the condition of venous blood stoppage the epithelium rapidly dies off. Even when the ligation lasts but a few hours it can not be saved. In its place there appears an extraordinarily rapid formation of connective tissue, which at first is rich in blood granulating into the kidney from various sides but finally it changes into a shrinking scar.

These experiences show us how careful we must be if we generalize observations, which show hypertrophy of individual tissues by hyperemia on all tissues.

Thus, I must stick to my already expressed view that I consider the attempts to make hypertrophic by artificial hyperemia formed and finished bodily parts as useless. I also hardly believe that one could succeed in so regularly influencing physiologic growth with this agent that one can speak of a method with which the desired purpose can be obtained with some certainty. However, I do not doubt that under certain circumstances artificial lengthening of growing bones can be produced by that agent. I must hold fast to this negative view in spite of the favorable observations made by Helferich and Schüller. Helferich's cases were few. He could increase the length of shortened growing bones in the four cases in which he used stasis hyperemia; in the five cases of paralyzed extremities treated in the same manner he did not produce muscular hypertrophy. As far as the thickening of the skin is concerned, which Helferich has regularly observed after application of stasis hyperemia, I am inclined to accept, for reasons to be stated below, that we had here to deal essentially with a chronic edema.

Schüller's results in producing not only lengthening of bones but also considerable hypertrophy of paralyzed muscles are indeed very striking. But, on one hand, his

experiments are not pure, for, in addition to hyperemia, he made use of several other therapeutic agents; on the other hand, the case where muscles which were completely paralyzed thirteen and one-half years became thicker and regained their function is in so striking a contrast to all our experience concerning the restoration of paralyzed muscles that it alone can scarcely be regarded as offering any proof.

That those observations are limited to but a few cases is for me decisive. I can only repeat that among the many hundreds of cases which I have treated with stasis hyperemia and among the many hundreds to which I applied active hyperemia, with the exception of increased growth of hair and isolated limited lengthening of bone, I have never seen a case of hypertrophy of tissues due to the hyperemia and which could not be explained in the simpler way as due to the improvement of the malady itself. I must admit that we have not sufficiently paid attention to the increase of growth of bones in length and that this perhaps occurred oftener than we have assumed. If, however, this had occurred regularly and to a great degree it could not have escaped us. And yet I have applied treatment with hyperemia in several cases for years.

After having written this for some time I made the following observation, which at first glance seems suited to shatter this my opinion:

A boy, aged eleven, whose father died of phthisis, became affected in March, 1902, with a caries sicca tuberculosa of the right shoulder-joint and entered, May 13, 1902, the surgical clinic.

He was a small, lean boy, with weak muscles. The entire region of the right shoulder was very lean. This concerned especially the deltoid muscle and those of the fossa supra-and infra-spinata, so that the acromion and the spine of the scapula protruded prominently. The joint was ankylosed, the scapula participating in each attempt at motion of the joint. The sulcus intertubercularis was sensitive on pressure, the right arm was 2½ cm. shorter than the left one. The Roentgen picture showed considerable destruction of the head of the humerus.

Stasis of the shoulder, as depicted in Figure 7, was applied from May 15th to 29th ten to twelve hours daily, then up to August 1st two hours daily (one hour in the morning and one hour in the afternoon). Improvement of mobility did not result. The Roentgen picture taken previous to his discharge seems to show a bony ankylosis of the joint. On the whole, the disease seems

to have improved, the general condition of the patient is better. On his discharge, August 2, 1902, the right shoulder, which previously was sunk in and atrophic, was at least as arched as the left one, if not more so. The right arm was exactly as long as the left one. On inspection the atrophy of the musculature seems to have disappeared, mensuration showed that the right upper arm was still ½ cm. thinner than the left one. The previously existing painfulness, especially that on pressure on the sulcus intertubercularis, had entirely disappeared.

This result surprised me very much. In the course of two and one-half months the shortening of 2½ cm. was remedied and the atrophic soft parts, though the shoulder-joint could not be used on account of the ankylosis, to all appearances became as large as those on the healthy side. That the lengthening took place indeed and is not due to an error in measuring, is evident from the two Roentgen pictures taken on admission and before discharge under the same conditions. While the former shows atrophy of the epiphysis as compared with the healthy arm, in the latter can be seen a bulky epiphysis which is broader than that of the healthy side. The same is the case with the neighboring part of the diaphysis. To be sure, measurement with the compass (the pictures are of the same size) shows that the diseased epiphysis is about 1 cm. lower than that of the healthy side but, at any rate, this is evened up by its greater broadness and increased growth of the diaphysis.

One should think that this is a pure case of passive nutrition of an atrophic joint by hyperemia, yet I do not believe that the case is to be thus regarded, for in addition to the disappearance of the other atrophies that of the muscles of the fossa supra- and infraspinata disappeared also, although they were external to the constricting rubber tubing and not at all affected by the hyperemia. Therefore, in this case also the disappearance of the atrophy occurred in connection with the improvement of the primary disease.

I have frequently tried to nourish the entire human being in a different manner. As is well known, the body is stimulated to increased formation of blood by withdrawal of blood; the successes of venesection in chlorosis are explained in this manner. I have tried to withdraw from the circulation large quantities of blood in anemic people by subjecting larger bodily parts to stasis hyperemia and thus to stimulate the rest of the body rendered bloodless towards formation of blood. To be sure, I never had pure cases but have employed the method only when it was indicated because of a different affection. Thus, if we had an affected ankle-joint in an anemic patient, the stasis bandage was applied high at the thigh without bandaging the healthy part of the leg. I am under the impression—we can only talk here of im-

pressions—that I have succeeded in several cases in improving and increasing the blood, and it may pay to keep an eye on this in the future.

INFLUENCE OF HYPEREMIA ON REGENERATION

We know from the experiments by Ambroise Paré, v. Dumereicher, Nicoladoni, Helferich and Thomas that retarded formation of callus can be considerably increased by institution of artificial venous hyperemia. It even seems that by means of hyperemia the deficient stimulus to formation of bony tissue in absent formation of callus can be fanned into life. At this time the influence of hyperemia on the healing of fractures is acknowledged.

I have made similar experiences in inflamed, especially in acutely and subacutely inflamed joints. Here inflammatory foci under stasis hyperemia change into stone-hard connective tissue scars. In tuberculous inflammations one can observe a hardening of the soft tuberculous granulation swelling and its change into scars, although naturally this takes place very slowly. Only in a few isolated cases, which we will describe, the stasis hyperemia produces a sort of acute inflammation and also changes the tuberculous granulation masses into tough, shrinking connective tissue with incredible rapidity. This kind of regeneration and rapid formation of completed connective tissue in principle is the same process but, in my opinion, more striking and more convincing than the healing of a pseudo-arthrosis. For we can see the entire process take place before our eyes in a few days, and by the sense of touch can follow the progress of cicatrization. This extraordinarily rapid cicatrization can be explained from the fact that in those inflammations is already present the first stage of connective tissue formation, infiltration of small cells and granulation.

The transformation of inflammatory foci in connective tissue scars possibly plays a great role in the cure of infectious diseases. I do not think it necessary that in all cases of healing of joint affected with an infectious disease the stasis hyperemia kills the bacteria, be that by serum in Buchner's sense, by phagocytes in Metchnikoff's sense, by carbonic acid in Hamburger's sense or by other as yet unknown bactericidal components of

the blood, but believe that a rapid cicatrization of inflammatory foci encapsulates the bacteria and makes them harmless. We know from experience that nature makes use of this method.

Naturally the influence of hyperemia on the formation of callus has been investigated experimentally. I will not discuss the numerous experiments by means of cutting through of mixed nerves where, in addition to the sensible and motoric paralysis on account of destruction of vasomotoric fibers, there is also produced an arterial hyperemia. I believe that these experiments have but a limited value for the decision of our question. For in addition to the hyperemia so large a number of unforeseen changes take place which influence healing that it is difficult to say whether the hyperemia as such exercises any influence on the healing of the bone-wound or not. This is noticeable in the results of these experiments (164); some investigators found that cutting of the nerve furthers the formation of callus, others that it retards the latter and again others assert that it has no influence whatever on the course of the healing. For the same reason I have not considered in the first section of this chapter Nasse's (165) much-discussed contribution on the influence of nerve-section on the nutrition of bone.

That these experiments can not be used for our question is evident. Samuel (166) has given us the experimental proof that here unnatural conditions are created for regeneration. He cut the plexus axillaris of the wings of doves and there appeared not only a pronounced hyperemia but also a formation of a large, steadily growing vascular net at the place of feather formation in the paralyzed wings, which lasted several months. The consequence, however, was not an increase but a diminution of the growth of newly forming feathers, which became more pronounced as the paralysis continued. If, on the other hand, Samuel ligated the axillary artery on an otherwise healthy wing there appeared for the time being a retardation of the growth of feathers, which again increased when the collateral circulation formed.

The only contribution which can be used for our purpose is that by A. Bum (167), who instituted stasis hyperemia in his animals in the same manner as we do

in our patients and who thus studied its influence on fractures. As rabbits are not convenient for experiments with stasis hyperemia, he used young dogs in whom he produced fractures of the diaphyses of both tibiæ. The extremities were placed in plaster of Paris casts around the foot and knee-joints in position of extension. Commencing with the following day, daily applications of stasis hyperemia lasting one and one-half hours were made to the thigh of one side. After rejecting all experiments which permit of a doubtful meaning, Bum comes to the conclusion that the callus formation on the side where stasis hyperemia had been maintained, had undoubtedly progressed farther. First of all, the periosteal callus was better formed in several cases, also the medullary callus. Whether or not the intermediary callus was furthered by the hyperemia could not be decided. The deposition of calcium salts in the callus seemed to be increased. On the other hand, Bum found that only when there was inclination toward good formation of callus was any noteworthy success experienced from hyperemia.

Except Bum I know of but one more experimenter—Samuel (168)—who has experimentally studied the effect of stasis hyperemia on regeneration, especially on that of feathers. But his experiments also can not be made use of, because he has applied high degrees of stasis, as we never dare use for therapeutic purposes. This has the opposite effect from that used in practice. He found that a constrictor applied to the forearm of doves produced a small yet plainly perceptible retardation of growth of the newly forming feathers. But he applied the constrictor so firmly that it frequently produced gangrene of the entire wing or at best suppurating vesicles and eschar of the skin, and permitted the constrictor to remain for a prolonged time. Thus he produced destruction of nutrition of the worst kind and it is to be wondered that by it the growth of feathers was not more retarded.

Long ago numerous experiments have been made to learn the influence of arterial hyperemia on the processes of regeneration. I will omit to discuss these experiments (169) in which by the cutting of mixed nerves in the extremities arterial hyperemia is produced, in addition to all possible grave changes of the tissues. Of

greater value are those experiments where by means of cutting or resection of the sympathicus of the neck arterial hyperemia of one half of the head is established. The majority of experimenters have worked with this method but have reached the most contradictory results.

Virchow (170) applied in dogs and rabbits, in whom he cut through the sympathicus on one side, inflammatory stimuli on equal places in both sides as equally intense in degree as possible, but could notice no difference in the course of the inflammations. From this and other observations he concluded "that the larger or lesser introduction of blood to a part is not as important for the nutrition of the individual elements as has often been accepted."

On the other hand, Snellen (171) found that cutting through the sympathicus accelerates the process of inflammation, the absorption of exsudates, the healing and cicatrization of wounds of the concerned half of the head.

O. Weber (172) confirms Snellen's experiments: "If the same injury be inflicted at the same time on the paralyzed and on the healthy ear, the reaction on the vasomotorically paralyzed part will be found more intense than in the healthy part. It does not matter whether the injury consisted in the introduction of a pea or glass bead in a cut wound, an incised wound, or the application of equal-sized pieces of caustic potash. Healing occurred more rapidly in the paralyzed part, as the formation of cells and vessels takes place more rapidly."

These investigations rested quietly until in 1881 Sinitzin (173) resurrected them by a contribution. From that year up to the most recent time a series of investigations have been published on this question without an understanding being reached. Sinitzin maintains that the hyperemia following the removal of the highest sympathicus ganglion gives the operated side greater power of resistance to foreign and neutral substances. Fine glass threads which he inserted at symmetrical places of both cornea produced the most violent inflammations of conjunctiva, cornea and iris, ulceration and threatening panophthalmia, but on the operated side there appeared either no reaction whatever or a very slight one. If

shortly before or after the removal of the highest sympathicus ganglion of the neck the trigeminus was cut in the cavity of the skull, the known disturbances of nutrition, neuroparalytic keratitis, ulcers of the conjunctiva and mucous membrane of the mouth, did not appear. The disturbances of nutrition, even though far progressed, can be cured or improved when the sympathicus ganglion is removed afterwards. This occurred even when no preventive measures were undertaken for the operated side; if, however, the carotis was ligated so that a hyperemia could not be produced, the phenomena of disturbed nutrition became established.

The correctness of Sinitzin's results has been keenly disputed. Eckhard (174) and Senftleben (175) retested the experiments, and both found that the removal of the uppermost sympathicus ganglion has no influence on the establishment and course of disturbances of nutrition following cutting of the trigeminus.

Danilewski (176) produced inflammation in the ear of a rabbit, and excised pieces from it. One to two days later he cut through the sympathicus and made the following observations: "The reactive hyperemia produced by croton oil equalizes more rapidly on that side in which, owing to cutting of the nerves, there was larger flux, the inflamed place being characterized during the first twenty-four hours by a specially intense color. If vesicles occur, with transparent or pus-like contents, the inflammation on the neurotomized side runs a more pronounced and violent course, the accumulation of blood is greater, the granulations are more developed and hyperemic. The course of the inflammatory process on the neurotomized side terminates twice as rapidly as that of the other. Healing on the operated side frequently takes place without loss of substance, occasionally even with hyperplastic granulation in the form of regeneration. On the opposite side the inflammation terminates, as a rule, with incomplete regeneration or more or less loss of substance. Suppuration on the neurotomized side is always more pronounced, the pus having the characteristics of the pus *bonum et laudabile;* on the unaffected side it is grayish, watery, semi-transparent, and flocculent. Necrosis following violent irritation takes

place exclusively on that side where the sympathicus is intact."

If Danilewski produced the inflammation only one to two days after the cutting of the sympathicus, a more intense reaction occurred on the operated side, the hyperemia was more pronounced, suppuration appeared more freely and granulation stronger. Blood effusions could be more easily produced on the operated side, but they were again more rapidly absorbed. Punched out wound healed twice as quickly on the operated side than on the opposite one, the regeneration of the tissues was more complete, while violent irritation led but little to necrosis.

While thus Danilewski confirmed the experiments of Snellen, O. Weber and Sinitzin, Samuel (177) reached entirely different results. "It is certain that arterial hyperemia, after the cutting of nerve trunks, or in the immediate neighborhood of inflammation foci, does not cause new growth. The same holds good for venous hyperemia."

In a later contribution Samuel (178) asserts that the observations made by the above-mentioned physicians, contradictory to his own views, prove nothing, because the experimenters have made use of the other apparently healthy ear of the animal for the purpose of comparison. This other ear, however, is not normal, for it becomes cool and anemic after the operation performed on the other side. Samuel believes that the operated side made use of the blood of the other, thus producing the anemia. Against this it can rightly be said that the view that local excess of blood mechanically withdraws blood from the neighborhood for some time can be considered as proven erroneous. As, however, Samuel, who is well known as a reliable observer, has demonstrated macroscopically perceptible pathologic processes, lasting sinking of temperature on the apparently healthy side, and as he also relies on a number of older observers who found the same conditions, there can be no doubt as to the fact itself. In all probability the anemia found on the apparently healthy side is due to reflectoric influences. Samuel made use of entirely healthy animals for purpose of comparison and found that the phenomena of inflam-

mation in sympathicus paralysis occurred more rapidly and more intensely, also that they lasted a good deal longer. To be sure, Samuel with this proof has not successfully opposed the results of the previous investigators, who have also removed the upper cervical ganglion of the sympathicus, for Sinitzin asserts that anemia and coolness on the non-operated side of an animal does not develop if the removal of the uppermost ganglion be added.

The most recent contribution in this domain by Liek (179) brings an absolute confirmation of the results of Snellen, O. Weber, Sinitzin and Danilewski. Liek showed by a series of comparative experiments that Samuel's above-mentioned objection to the interpretation of the healing after resection of the sympathicus is not to be considered. He found that superficial flat and deep-incised wounds of the ear of a rabbit heal much more rapidly when the sympathicus was cut through or the uppermost cervical ganglion was removed at the same time. The regeneration took place proportionately to the degree of hyperemia.

Liek's contribution offers, for this reason, the strongest proof of all because it is based on a large number of experiments and in spite of this the results were not contradictory, and because any objections which could be raised against the merits of the experiments have been duly considered and rejected.

Penzo (180) demonstrated in a new manner the favorable influence of hyperemia on regeneration. He constructed an ingenious apparatus in which he could keep warm either one ear or limb at a temperature of about 38° C., while the other could be cooled to a temperature of 10 ° C. The animals were removed from the apparatus for only a few hours daily. It was found that the hyperemia produced by the warmth considerably accelerated regeneration in open and subcutaneous wounds, while the anemia produced by the cold retarded it. Penzo also experimented with these agents to determine their influence on fracture of the ulna in rabbits. Here the difference was extraordinarily pronounced. While on the cold side after seven to eight days not even the beginning of regeneration could be noticed, the fracture on

the warmed side was already firmly united by callus, which, on microscopic examination, proved fully formed.

Thus we see that the predominant view of the experimenters is that artificial active hyperemia considerably accelerates regeneration. If we consider that the contributions which base on a large number of experiments, very plainly show the same result, we must recognize this as fact and can say: While the favorable influence of hyperemia on physiologic growth of the organs and nutrition of tissue is proved only in regard to supporting tissue and cover epithelium (surface epithelium) and even this not for all cases, for other tissue however, being at least very doubtful, it can not be doubted that regeneration is promoted by active and passive hyperemia.

I can not leave these observations without asserting that in regeneration this influence by hyperemia is proven just as for completed tissues, so for tissues with passive functions, surface epithelium and supporting tissue, for the scars consist of these. The fact that nerves and vessels form in the scars does not speak against it, for without them new growth can not be imagined. We know that nerves and vessels are not excessively present in scars and that their function leaves much to be desired.

The effect on regeneration by agents producing hyperemia has been utilized for a long time. Thus, heat in the form of moist compresses, poultices, etc., has been used to stimulate weak granulation. For the same purpose we have numerous chemical irritants, e. g., turpentine ointment, camphor wine, and nitrate of silver.

Guyot's (181) incubators are reminded by Penzo's experiments. This physician placed wounded limbs in an apparatus, the air of which was heated to 36°. The temperature must not exceed 40°, nor fall below 20° C.

We can count here also the treatment of frost-bite by hyperemia proposed by Ritter (182). Ritter found most effective the active hyperemia produced by hot air. One could conclude from this that the vascular paralysis and venous stasis which were accepted as conditions produced by the freezing, were removed. This view is rejected by Ritter's observations, which show that good

results are also obtained with artificial stasis hyperemia. For this reason Ritter thinks that the hyperemia effects a regeneration of the cells damaged or destroyed by the freezing. He does not, as is customary, look upon the freezing hyperemia as something obnoxious which should be combated but, on the contrary, as a useful and natural reaction of the body to the injury which, in the majority of instances, should be supported. That really both forms of hyperemia have a favorable effect on the healing of frost-bite, I have become convinced by Ritter's case.

I, myself, in the beginning of my experiments with hyperemia, have repeatedly treated ulcers which have not healed by other remedies, with hot air, and I believe that the successes of Ullmann (Chapter XIII.), with infectious ulcers, were due more to this effect of the active hyperemia than to its bactericidal influence, as Ullmann believes.

In conclusion we must discuss the question, which form of hyperemia best supports the building up and regeneration of the tissues? I believe the majority of physicians will answer without much thinking, "the active arterial hyperemia." In numberless contributions one can read that "an improvement of the circulation" and removal of blood-stoppage naturally have a favorable influence on the nutrition. The observation that the functional hyperemia accompanying the activity of the organs is active, seems to support this view. In reality this view is not at all proven and if we here permit our school-mistress, Nature, to talk, and accept her institutions as rational we will come to a diametrically opposed opinion. It has been frequently emphasized that nowhere in born man can there be seen a more pronounced regeneration than in inflammation, nay, that this inflammatory regeneration, as shown by Weigert, overreaches the mark, producing in a short time in place of the injured tissue an excess of new one, so that one is justified in speaking of an inflammatory hypertrophy. Inflammatory hyperemia, however, is not active but passive. And if we turn to the most moderate regeneration which we know of, the development of the fertilized ovum to an embryo and that of the latter to a

ripe fetus, we well observe, as has been shown by Bonnet's (183) investigations, the most magnificent stasis hyperemia that we can see anywhere in the human body. The blood current in the wide blood-spaces of the placenta is slowed to such an extent that intense edema and extensive hemorrhages develop in the tissues of the placenta. According to Bonnet, the embryo draws most of its food from the slowly moving blood, especially from the edema and from the transuded decomposing blood. Also the rest of the food is created by the stased blood through dissolution of tissue components from the mother.

As regards the function of the tissues we have to deal with entirely different processes. Work is done principally by oxidation of the tissues and for this a quick blood-stream is necessary, which must always supply new blood rich in oxygen. For undisturbed work it is furthermore necessary that the combustible products which act intoxicating and paralyzing on the active organ, be continually washed away and this, too, is best accomplished by a powerful rapidly flowing blood-stream.

I therefore believe we are justified in establishing the following as an axiom: Functional hyperemia is active; that which serves to build up tissues in all probability passive. From this must not be concluded that the cell, which intends to enlarge or increase in consequence of an unknown stimulus, can not take the necessary food from a rapidly flowing blood-current. Much seems to speak for it that function, accompanied by active hyperemia, leads to enlargement of the active parts and that a few of the above-cited observations and experiments show that also active hyperemia favorably influences regeneration. But, first of all, the building of the tissues that leads to functional hypertrophy proceeds so slowly that it can not in the least be measured with the great rapidity of inflammatory and embryonal regeneration, and again we even do not know whether in those cases the eating cell really takes its food from an accelerated juice-stream. For the inflammatory hyperemia, too, is originally active, and the inflammatory irritation changes the originally rapid into slower blood-current. It is not at all improb-

able that the unknown growth stimulus possesses the same property.

The functional hypertrophy shows a great analogy with the inflammatory one. Here, as there, an injury precedes the increase and enlargement of the tissue cells, which causes the hypertrophy. Thus Weigert (184), the discoverer of inflammatory tissue hypertrophy, has expressed the view that the exercise hypertrophy is an indirect consequence of function, because it is the latter which leads to injury of cells and this to hypertrophy.

The circumstance that the work of the tissues leads to active hyperemia, does by no means indicate that the latter is essential for the following formation of new tissue. In all probability this, too, will take its food from a slowed blood-current, for we now know that even the decomposition of our own body tissues produces inflammatory phenomena. One thinks of the subcutaneous blood-effusions, which produce hyperemia and intense edema, and of fever and albuminuria, which has been observed during its resorption just as after vigorous physical exertion which led to a pronounced decomposition of body tissues. Hypertrophy, however, does not develop during labor but in the intervals of rest afterwards and the sensation of fatigue prevents us from continuing labor after great physical exertion. It seems to me very probable that considering the relationship of both processes, the functional and inflammatory hypertrophy are both associated with a passive hyperemia.

These ideas are presented especially to those physicians who have no objection to an artificial active hyperemia, but—as has been done by several of my immediate colleagues—have opposed my efforts to cure diverse diseases with artificial passive hyperemia, an an excrescense of a mad phantasy, but who also know of no other reason than that passive hyperemia "self-evidently" represents a grave disturbance of nutrition.

C. SPECIAL PART

TREATMENT OF DIVERSE DISEASES WITH HYPEREMIA

CHAPTER XVII

INTRODUCTORY

In the following chapters, which are to treat on the therapy of diverse diseases with artificially produced hyperemia, I do not intend to cite and discuss all treated cases. This alone would fill a large volume, since the number of cases exceeds by far the figure 1,000, and besides, I could not do it for the reason that a large part of these cases are not now accessible.

I am here especially concerned in the discussion of the technic for those diseases which have been successfully treated with hyperemia. I will cite histories of cases only where my assertions have not been substantiated by suitable examples heretofore.

I also deem it superfluous to report a series of cases which we have experimentally treated with hyperemia but where our experience is so meager or so deficient that positive conclusions can not be reached.

A few general remarks are in order. Any remedy, be it chemical or physical, acts differently in proportion to the dose in which it is administered. A medicinal remedy useful in a small dose may become injurious, even fatal, as the size of the dose is increased. H. Schulz (185) has shown that there exists in this respect a regularity like a law. He proceeded from the biologic axiom established by Arndt for normal conditions, that is based on a generalization of Pflüger's "twitch law," as follows: "Small stimuli fan the activity of life, medium large ones further it, strong ones impede it, and the strongest ones destroy it." Schulz emphasizes that this law holds good also for the effect of medicines and poisons, and that it

does not lose its validity when applied to pathologic conditions. For the latter case it must be borne in mind that for diseased organs the stimuli may be strong when they can scarcely be considered as such for healthy organs.

This difference in effect on the body evidently holds good also for the physical remedies, perhaps to a greater degree than for the medicinal remedies having not very strong an effect. One need only think of cold water, where success depends entirely on the intensity and length of application, the least error being sufficient to change the healing effect into one apt to produce sickness.

If we consider the two methods* principally treated in this book, the active hyperemia by hot air and the passive by stasis with a bandage or suction apparatus, we come to the same conclusion. I have mentioned that the former, applied daily one or at most two hours, is one of the most important absorbing agents, and have shown this effect principally in the absorption of edemata. On the other hand, I have shown in my first and larger contribution in 1893 that hot air of 100° C. applied to a portion of the body for seven to ten hours produces intense forms of edema.

Stasis hyperemia in a medium degree is one of the best pain-relieving agents in diverse affections; if an excessive degree be applied, it, on the contrary, produces violent pain and the most disagreeable sensations. The same method in a medium degree again favorably affects a number of acute and chronic local infectious diseases; if, however, it be applied too intensely it injuries in the same diseases, or even produces them. If we wish to use our agents against disease we must always remember this, and by experience must ascertain in what degree and of what duration they may and can be applied in each individual disease. We also must consider that just as do medicinal substances, our agents produce variable reactions in different individuals; that what is to one a weak stimulus may be a strong one to another.

*Artificial hyperemia stands between a chemical and physical agent; though we produce it in a simple physical manner and resorption, for instance, is a physical process, the main effects, however, we must consider as chemical in character.

CHAPTER XVIII

TREATMENT OF TUBERCULOSIS

I begin with the treatment of joint tuberculosis because it was the first disease against which I applied hyperemia. In my opinion, passive hyperemia only need be considered as a therapeutic agent for it. I consider intense active hyperemia here as very injurious, as already repeatedly discussed; as a general rule, I have seen turns for the worse after its application.

I hit upon the idea of applying hyperemia against tuberculosis by the following observations made by older physicians: Farre and Travers, in 1815, and Louis, in 1826, called attention to the frequent appearance of pulmonary stenosis in phthisis, explaining it by the pronounced anemia of the lungs which this form of heart disease produces. The observations of those physicians have been confirmed without exception, so that Frerichs (186) could pronounce the dictum: "Pulmonary tuberculosis, be the relation of this disease to tuberculosis as it may, is the usual end in diseases of the pulmonary artery." On the other hand, Rokitansky (187) maintains that diseases of the heart accompanied by fullness of blood in the lungs offer immunity against tuberculosis. Here follow his own words: "A relation of hypertrophy of the heart to tuberculous disease is the result of numerous observations. In a number of one hundred and forty-three cases (simple, eccentric, as well as concentric hypertrophy), I find that in fifteen cases there is a now extinct tuberculosis of the lungs. In all other cases—persons of variable age, sex, occupation, etc.—there never was a tubercle, from which can be concluded that both diseased conditions can not exist at the same time in one and the same individual, and especially that in the presence of the named disease of the heart no tuberculosis, especially pulmonary tuberculosis, can develop."

The same immunity against tuberculosis Rokitansky ascribed to people with distortions of the spine, in whom, as is well known, pronounced stases develop in the circulation of the lungs. Here, too, I will let Rokitansky speak: "At first we were surprised by the absence of

any trace of suspected phthisis pulmonalis in the corpses of persons with distorted spines; after these observations have increased to a considerable number the noteworthy find in each individual case because of its constancy, the rule follows that in distortions of the spine tuberculosis, and especially pulmonary tuberculosis, does not occur."

Rokitansky gives for this statistic numbers. He found among fifty of his post-mortems of concerned cases no more than three in which tuberculosis was present at the same time, cases in which insignificant distortions and deformities of the thorax only were present.

Rokitansky's observations have been repeatedly confirmed but have also been much attacked. I will not cite from the rich literature the contributions by the followers and opponents of Rokitansky's doctrine. I only remark that the large majority of physicians who have expressed themselves on this do not allow Rokitansky's assertions to stand in so sweeping a way as he has expressed them, but nevertheless acknowledge the correctness of the principle and admit a relative immunity of stased lungs against tuberculosis. Those of the readers who are interested in this question I refer to a portion of the literature found in the bibliographic references (188-200 inc.). I can well omit to discuss those observations, for they were for me only the inspiration to treat a single disease with hyperemia. The experience I gained at it compelled me to apply this treatment to numerous diseases, turning the whole question into a different domain.

My first contribution on the treatment of tuberculosis with hyperemia I published in the year 1892 (201). I described it in detail in larger contributions which appeared in 1893 (202) and 1894 (203). My last publication on the subject appeared in 1895 (204). Since then I have published no further details on the treatment of tuberculosis because we were continuously occupied with experiments to discover the right technic of stasis hyperemia for this disease; for with no other affection at all suitable to treatment with hyperemia did we experience so much difficulty in working out the technic as with tuberculosis. Of special importance here is the fact that an incorrect application of stasis hyperemia may become very injurious. It is therefore important,

if this remedy is to be generally used by the general practitioner, to give plain and exact rules for the application of the process and to so arrange them that even the inexperienced can do no harm . I believe that we have now so perfected and simplified the technic after many years of experimentation that harm from this agent can be avoided. I deem it advisable to briefly describe the process of the development of the technic.

In the beginning I made daily applications of stasis hyperemia of one or several hours' duration, but soon changed to a prolonged application. (The process has already been described in Chapter VII.) The bandage was worn day and night, but twice daily the bandage was changed to different places to avoid pressure. Usually it was removed only once a week. I then permitted the affected parts, which were in a condition of swelling and edema, to regain their size in order to demonstrate and watch any change in the diseased limb. The results of the treatment were variable, splendid successes alternating with failures, or such cases where stasis hyperemia alone proved inefficient necessitating other conservative or operative measures. In all cases the improvement following the first application of the remedy was striking; pain disappeared, existing contractions were loosened, even the mobility of diseased joints improved considerably. Tuberculous patients who previously could make no use whatever of their diseased limbs were frequently able after a few days to undertake some light work. But I had to report to the Surgical Congress, which met in 1894, some disagreeable and dangerous accidents produced by the stasis hyperemia in the tuberculous limbs. The most frequent complication was the occurrence of cold abscesses, which evidently were furthered to a great degree by the stasis hyperemia. Seldom the abscesses appeared without symptoms, in the majority of the cases the course was highly characteristic: After an immediate improvement in the tuberculous joint the patient suddenly complained of pains which appeared in a definite place, sensitiveness against pressure in that place being great. On removal of the bandage after the edema and swelling had subsided, the incipient abscess could be recognized by the evident

fluctuation. The latter, at any rate, appeared when the stasis hyperemia was continued. Occasionally the abscesses under the hyperemia grew more rapidly and became more numerous than we have ever seen them before, so that no doubt existed that they were produced by the stasis hyperemia.

I have assumed that this *per se* is no bad sign. I saw in the appearance of the abscesses an effort on the part of nature to melt in and to expel dead, useless and diseased tissue. I even gave rules how to treat these cold abscesses and recommended aspiration and subsequent filling with iodoform glycerin. I believed that both remedies, stasis hyperemia and iodoform, happily supported each other in so far as the former led partially to cicatrization, partially to cold abscesses of such foci as could not be reached by the iodoform. As regards the change into cold abscesses we could combat them more successfully than any other phenomenon of tuberculosis with iodoform. But I have later concluded that the production of large cold abscesses by stasis hyperemia in the majority of cases doubtlessly means a turn for the worse of the disease, for they appear so frequently and grow so rapidly that one can not master them.

The other ill experience we made was the development of large granulating masses which, as a rule, appeared in open ulcers and fistulæ of open joint tuberculosis, but sometimes also in subcutaneous covered ones, finally breaking these through. Occasionally I saw after a continuance of the remedy the desired shrinking and cicatrization of the excessive granulation; often, however, it progressed unhindered and compelled us to stop the treatment and to replace it by bloody operations. The worst, however, was that in open joint tuberculosis, evidently under the influence of the remedy, developed the most violent acute inflammations, of which we know that they become associated with chronic edemata. I then had to report hot abscesses, lymphangitis, adenitis, erysipelas, and erysipeloid affections of the skin, even a case of suppuration of the ankle-joint with a lethal end from sepsis. However, these bad complications were observed only in grave forms of tuberculosis. I saw them

only in connection with large, tuberculous ulcers, and especially in large joint cavities which were filled with pus and which communicated with the outside by means of a fistula.

As a rule, errors in the technic of bandaging or too careless use of the limbs, which was permitted by us as much as the pain permitted it, could be demonstrated. But on objectively considering the cases we could not get away from the conviction that the applied remedy was blameless. I, therefore, then advised to dress aseptically cases of open joint tuberculosis which were to be treated with stasis hyperemia, and to permit the use of the limbs either not at all or to a very limited extent. I furthermore reported that even in cases running a favorable course stasis hyperemia alone did not lead to our goal. Frequently we had to make use of conservative methods, extension bandages, plaster of paris casts, iodoform injections, etc., or even to resort to more or less important operations.

Now it seems reasonable to assume that if the same remedy once is followed by the most brilliant success, while another time it leads to a grave failure, it was correctly applied in the first case and falsely in the second. This conclusion, I, too, have drawn from my experience. It struck me as significant that the stasis hyperemia was followed by the best results in tuberculosis of the shoulder joint, where it can be applied only with comparative difficulty, and in a few cases of tuberculosis of the testes. In both the locality, as I have already said, does not permit a prolonged application of the hyperemia. At most the latter can be used twelve hours daily because the place of constriction can not be changed, thus, if applied for too prolonged a time, producing disagreeable phenomena of pressure.

I have furthermore observed that after prolonged application of the stasis hyperemia edema becomes prominent and the hyperemia becomes less apparent. Thus, a chronic edema had formed, which was positively harmful for the production of prolonged hyperemia. I, therefore, proceeded in this way: I applied prolonged stasis hyperemia only for a few days, then ordering intermissions, which were lengthened in proportion to the im-

provement of the cases until finally the method was applied only one hour daily.

I also established that that form of stasis hyperemia which so influenced the circulation that intense lividity and diminution of the temperature of the skin were produced in the corresponding part and especially that stasis which led to pain and real inconvenience are noxious. I, therefore, prescribed:

1. Stasis must never produce pain, otherwise it is either improperly applied or the case is not suited for this agent and must be treated in a different manner.

2. The stasis must not be cold, it must not reduce the temperature of the skin to such an extent that it feels colder than the skin of the other extremity. It is favorable for the course of the tuberculosis when the stasis, on the contrary, can so be applied that the temperature of the skin becomes elevated and the locality exposed to the remedy makes the impression of an acute inflammation.

After the establishment of these rules, the dangerous complications, the grave acute inflammations, disappeared. But while the first rule can be easily followed, for we need only tell the patient to either advise us or himself loosen the bandage as soon as he feels the least pain or paresthesia in the limb, the second rule is executed only with great difficulty. While it is easy to produce hot stasis in acutely or subacutely inflamed limbs, this proves a quick task in chronic tuberculosis, and what is more difficult yet is to maintain the stasis after it has once been produced, Thus, the cases of joint tuberculosis treated with stasis hyperemia required great care and though the results improved the formation of cold abscesses did not fail to appear.

We then reduced more and more the duration of the daily applied stasis. We were especially influenced in this by Nötzel's above-mentioned contribution in which it was proven experimentally that the chronic edema which develops after prolonged stasis is just as harmful to the course of infectious diseases as is the acute stasis useful. In shortening the time of application of the remedy, I followed somewhat this plan: In the first few days hot stasis is instituted seven to twelve hours daily.

until the painfulness of the joints is considerably diminished. Then the time is reduced one half and gradually reduced still more until after a few weeks or months the stasis hyperemia is applied but one hour daily. As an example for this method of treatment, I cite the following two cases:

1. A child, seven years old, from a tubercular family, commenced to suffer in June, 1899, from pain in the right wrist-joint, which gradually increased until in the winter of the same year the joint became swollen and stiff. Passive motions and massage undertaken by a physician aggravated the trouble.

March 20, 1900, I found the right wrist-joint evenly swollen, having a circumference 1½ cm. larger than the left joint. Flexion and extension were practically suspended, supination somewhat limited. The fingers were fairly movable. The right forearm was atrophied. The joint was sensitive to pressure in two places. Fluoroscopy showed confluent carpal bones so that their outlines could not be recognized.

From March 20th to October 1st I applied stasis seven to twelve hours daily with repeated intermissions of eight days. While the bandage was removed the limb was kept in an elevated position several hours.

Hyperemia was continued from two to three hours daily from October, 1900, to March, 1901. Then the treatment was discontinued. The joint improved rapidly, especially as far as mobility and pain were concerned. However, in October, 1900, swelling was present about as much as before and examination with the Roentgen rays showed yet a confluence of the carpal bones, though a brightening of the picture could be noticed.

March 8, 1902, I examined the child for the last time. I found full mobility of the right wrist-joint and full function without any limitation. Measurement showed that the circumference of both joints was alike. The child used the right arm again more than the left one, for which reason the previously established atrophy of the right forearm had not only disappeared, but even had a circumference at the thickest place exceeding by ½ cm. that of the left arm. The child used its hand throughout the entire treatment in the beginning as much as the pains permitted.

A Roentgen picture taken March 18, 1902, shows absolutely normal bones.

2. A child, four years old, of a tubercular family, was attacked by tuberculosis of the left wrist-joint in the winter of 1899. Several cold abscesses developed, which were incised by a physician.

I saw the child July 12, 1901, and noted the following condition: The left wrist-joint is fusiformly swollen, on the back of the hand is an ulcer about as large as a dime and several fistulæ leading to rough bones. The hand hangs in flexed contraction and subluxated; motions are considerably limited.

Stasis hyperemia was applied from eight to twelve hours daily from July 12, 1901, to April 1, 1902, with numerous intermissions

of one to several days' duration; from April 1 to August 23, 1902, stasis hyperemia was applied one hour daily. The disease improved slowly, but a successive progress could be noticed.

August 23, 1902, treatment was discontinued because it appeared that healing was complete. I made the following find: Hand is slightly subluxated, wrist-joint is not swollen any more. Fistulæ and ulcers have firmly cicatrized. The wrist-joint, in spite of the subluxation, fully permits all motions. The child uses its left hand just as well as the right one. It has also used it during the treatment as well as it could. The Roentgen picture taken July 12, 1901, shows weak and blurred outlines of the carpal bones; that taken January 7, 1902, shows plainer outlines. All other bones of the hand and forearm were very much atrophied. The Roentgen picture taken August 23, 1902, shows sharp outlines of bones, but such considerable destruction in the carpal and metacarpal bones that one must wonder at the good function.

With this method of treatment edema was found only at first. Its disappearance was caused by high posture of the limb during the intermissions.

Since applying the remedy in this form I have scarcely seen cold abscesses; at least, they did not appear any oftener than usually observed in tuberculous patients; the results were quite satisfactory. However, even this method of application is too complicated for general practical use and we now almost exclusively make use of a method established by Tilmann in the Greifswald Surgical Polyclinic and with which he obtained excellent results in the out-door treatment of tuberculous joints. He applies stasis only one hour daily in a manner described in Chapter VII (see Fig. 6). For this time it is permissible to allow the hyperemia to strongly affect the limb, but the bandage must not be applied tight enough to cause pain or paresthesia in the treated extremity. I also do not consider the appearance of the above-described vermilion spots useful. However, the hyperemia must be intense. Demonstrable edema does not occur in the short period of one hour but a decided swelling of the treated part of the limb. The parts situated peripherically from the affected place are not bandaged, and thus the method is still more simplified when compared with the previous one. It is also not necessary that the stasis bandage be applied closely above the affected joint but can safely be put, for instance, in tuberculosis of the wrist or ankle-joint, around the upper arm

or thigh whenever there seems to exist a reason that this is desirable.

With this form of application of stasis hyperemia I believe the reproach, which could be made previously, that it is difficult and in the hands of the inexperienced dangerous, is conclusively unjustified. I recommend it, therefore, for use by the general practitioner, especially since this short application is followed by as good results as those of longer application. To prove this I cite the following case:

A laborer, twenty-three years old, suffered for four years from a tuberculous inflammation of the right foot. Three weeks prior to admission he was confined to bed, because the right foot caused severe pain whenever he tried to press on it. Pain also occurred spontaneously, so that the patient frequently could not sleep at night.

On admission, April 1, 1902, the right ankle-joint was irregularly swollen. Its circumference exceeded that of the other joint by 9 cm. Motions were very painful and possible only to a slight extent. The patient could walk lamely and with pain by the aid of two canes. The joint was everywhere sensitive to pressure.

The region of Chopart's joint is swollen, the talo-navicular joint very sensitive even to the least pressure. In front of the external malleolus is found a soft, fluctuating swelling.

The Roentgen picture shows enormous destruction of the talus, great destruction on the ankle-joint surface, periosteal granulations in the calcaneus, and pronounced atrophy of all bones of the foot and leg.

April 8, 1902, stasis hyperemia was applied one hour and this treatment repeated daily, which rapidly relieved the pain and increased the mobility of the affected foot. The soft swelling in front of the external malleolus developed into a cold abscess, which was incised on April 22nd under Schleich's infiltration anesthesia. About a teaspoonful of pus was evacuated. Stasis hyperemia was continued.

June 10th at the opening of the fistula the point of a sequestrum was noticed; this was extracted. It had the size of half a white bean and was strongly carious. June 11th and 17th small sequestra were expelled.

August 5th the affected joints everywhere became tough and hard. Bright red strong granulations sprang from the fistula in front of the malleolus, but little pus being excreted from it. There was no pain on pressure or motion. As other sequestra were suspected, the fistula was divided to the extent of 3 cm. under Schleich's infiltration anesthesia and a sequestrum as big as a pea and four smaller ones were removed with a sharp spoon. The wound was covered with aseptic gauze. The first dressing remained *in situ* eight days. August 14th another small sequestrum was expelled from the fistula. August 22nd the fistula was firmly closed. The patient is able to walk without cane or pain; mobility of the ankle-joint is

present a moderate degree. The circumference has diminished 5 cm.

As long as the fistulæ remained open the patient was ordered confined to bed, but had to walk daily about fifty paces as soon as the pain had disappeared.

I apply but rarely in addition to this form of stasis hyperemia other conservative measures. I have almost entirely abandoned the combination of stasis hyperemia with iodoform treatment. Even the cold abscesses are not treated any more by aspiration and subsequent filling with iodoform-glycerin. If they have existed previously they are opened by a small incision and the pus evacuated. One to three days afterward stasis hyperemia is instituted. If abscesses develop during the application of this remedy it is stopped for a few days; they are also incised. The fistulæ thus created heal slowly while stasis is continued. Occasionally the small wound heals rapidly under the influence of the hyperemia by means of a blood coagulum. If pus reaccumulates the latter must be removed.

Large cold abscesses I occasionally incise, curette, fill them with iodoform-glycerin after the method of Billroth and close the wound by suture. Stasis hyperemia for the joint tuberculosis is instituted only after the wounds have healed.

Of late I make no difference between open and closed tuberculosis and treat one the same as the other. If we have to deal with fistulous or ulcerated joints the dressing is removed during the hourly application of the stasis and the limb placed on cotton, which catches the excreted serum, pus and occasionally blood which appear during the stasis. The affected limb hangs or lies free, or is loosely covered with cotton.

Fistulæ frequently close under stasis hyperemia. If they remain open though the diseased joint has improved, the fault is usually due to hidden sequestra. In two cases I observed how the sequestra were expelled from the fistula under this treatment; in other cases they must be removed. The above-cited cases offer the best example for this.

In tuberculous ulcers the beginning of improvement is first noticed on the fresher color of the granulation.

Special proof that healing is making progress is had when the margins of the skin of the tuberculous ulcers, which almost always are undermined, heal firmly to the base and epithelisation commences at the margins. Immobilizing dressings are used in a few isolated cases and, in fact, are not necessary because any pain in the majority of cases is quickly relieved by the stasis hyperemia or at least so much improved that immobilization becomes unnecessary. I even instituted careful passive and active motions as soon and as much as the pain permits this.

I also do not hastily resort to extension. Contractions for which it is indicated, as a rule, are seen to improve after a few weeks, especially if the limb is daily subjected to careful active and passive motions. If the intense forms of contractions are not dissolved by the stasis hyperemia any kind of an extension dressing for the purpose of straightening of the limb can be utilized, which, however, should be removed when the contraction has been overcome. The extension, therefore, is solely an orthopedic remedy.

Special mention is merited by the flexion contraction of the knee-joint, which frequently occurs in spite of healing or improvement of the tuberculosis of the joint. It is noteworthy that it is not infrequently the apparently mild form of cases which show this phenomenon, while grave cases become perfectly mobile. In these contractions immobolizing bandages or apparatus which effect the position of extension should be employed.

As soon as the pain has disappeared I have no scruples in permitting the limited use of the tuberculous extremities during treatment. I permit people with affected shoulder, elbow and wrist-joints to use the arm for smaller work required in daily life. People with diseased knee-joints, provided that they have so far improved that walking is possible without producing discomfort and that there are not present large tuberculous ulcers or excreting fistulæ, are permitted to walk. I am more careful in affections of the ankle-joint because the weight of the body is apt to produce flat feet. Here the patient is enabled to walk while out of bed by carrying a plaster of paris cast, made from two halves so that they can be

easily removed. As soon as the patient goes to bed, the bandage is removed so that motions of the diseased joint can be executed. In cases in which the foot inclines to tip-foot position or is still very painful, it must be protected against the bed-cover by a hoop. Naturally the use of the limb is permitted only to that extent that no, or at least very slight, inconvenience arises therefrom, and that this does not increase by it.

This treatment has the advantage that it leads to functionally useful joints, for it is a poor result of a tedious, conservative treatment of a tuberculous joint if it terminates into a stiffness of the diseased joint. For this reason I have from the very beginning of my experiments as much as possible declined to immobilize the tuberculous joints, and thus, as far as usefulness of the joints is concerned, have obtained a number of brilliant and lasting results of which I will cite here a few examples:

1. An eight-year-old boy two years previous to his admission in the surgical clinic at Kiel became affected with tuberculosis of the knee-joint, which had been treated with sea baths and leather splints with but temporary success. On admission was found a tumor albus of the left knee-joint and subluxation of the leg posteriorly and slight contraction in flexion. Pain was slight but the patient was unable to walk. I first treated the diseased knee with iodoform injections without any success and from November 29, 1891, to January 25, 1892, also without success.

From May 14 to June 27, 1892, prolonged stasis hyperemia was applied. Then this agent was applied during the night only and finally only one hour daily. After this the affection improved. Now after ten years the young man, who has chosen a business career, informs me that both knees are equally mobile, large and strong, and that he can stand and walk all day long, laming with the left leg a little only after extended marching tours.

2. I treated, in 1892, in Kiel, a seventeen-year-old tailor apprentice, who for two years had suffered from tuberculosis of the right wrist-joint. I found a fusiform swelling of the right wrist-joint. Rotation and extension were entirely suspended, flexion possible only in a small degree. On each attempt at motion great pain was produced. The hand was useless.

Stasis hyperemia was applied continually from June 15 to August 25, 1892, then up to October 24th nights only. I can not now establish how long after that he used the remedy by the hour.

The father of the patient now advises me that the right hand remained somewhat smaller and the right arm somewhat thinner than the left, the disease itself, however, has so healed that his son, who has abandoned tailoring and has become a stable-man,

can do the hardest work with the cured hand without injury; the hand is usable to the fullest extent.

3. An eleven-year-old girl was afflicted with tuberculosis of the elbow-joint. The right elbow-joint was fusiformly swollen, and was fixed in a right angle. Motions were almost suspended. The joint was sensitive to pressure. Stasis hyperemia (prolonged) was applied from March 15 to April 26, 1892, and nightly from this date to June 26, 1892. In the last two months the joint was carefully massaged, and passively moved during the day. June 26th the child was discharged. The stasis hyperemia was continued at home during the night and later one hour daily.

The girl is now grown. Her joint is movable to the greatest extent, and can be used for work. Only after severe exertion even now appears a sensation of lameness in the right arm, which soon disappears after a short application of stasis hyperemia.

The above-described method of treatment, in my opinion, is not only the best but it also has the great advantage of being the simplest and cheapest, especially since this treatment can be carried out at home, in the office or the dispensary, as has been shown by Tilmann, at least as far as the upper extremities and the incipient and milder forms of the lower extremities are concerned. The physician can make an appointment with his patients at his office, apply the stasis hyperemia, and have them remain in his waiting-room while he personally convinces himself about the correct position of the bandage.* As the conservative treatment of tuberculosis is so tedious that it can hardly be carried out to the end in the hospital, I am in the habit of permitting the patients themselves to apply the bandage to the lower extremities, and thus daily convince myself that they have executed it correctly. In such cases out-door treatment is possible very soon. A second person must apply the bandage to the arm. The patient himself states whether it is too loose or too tight. Skill is not necessary for this.

There are no dangers connected with stasis hyperemia applied only one hour daily; it leads neither to cold abscesses nor to excessive granulations nor to acute inflammations. If abscesses develop they are incised.

Frequently the objective changes in the joint do not keep pace with the improvement of function and the

*This is especially important in the beginning and with patients of limited intelligence. One frequently makes the observation that an apparently well-placed and properly fitting bandage after one-quarter of an hour is either too loose or too firm.

decrease of pain. Especially the swelling is occasionally present in its entire circumference, while the limbs are already used without inconvenience, differentiating from the original swelling only by a greater hardness. Return to the normal form of the joint, as a rule, takes place gradually.

I also have seen cases of tuberculosis which improved with incredible rapidity under stasis hyperemia so that they soon entirely lost the character of a tuberculous affection. These cases are so striking that I always seriously considered whether I could count them as tuberculous and assumed that we may have to deal with a diagnostic error in so far as an osteomyelitic, gonorrheal or otherwise affected joint for once took a chronic course and erroneously being accepted as tuberculosis. Nevertheless, I have seen four to five of such cases in which not the least doubt as to the correctness of the diagnosis could exist.

All these forms of tuberculosis which rapidly change their character under stasis hyperemia without exception characterize themselves by the appearance of an intense reaction beneath the stasis bandage, frequently even at slight constriction. The diseased joint becomes bright red in color and hot to the feel. Occasionally blisters or acute eczemata appear, so that one who would see the limb but not the bandage could assume it to suffer from an intense, acute inflammation. After a few weeks all remedies can be dispensed with, the tuberculosis heals itself with formation of stone-hard connective tissue in the diseased joint. It is to be regretted that these cases are extremely rare.

We yet have to draw the limits within which the stasis hyperemia is indicated for tuberculous joints. It is abandoned and replaced by other conservative measures when it does not produce an improvement of the affection. It is, furthermore, not to be recommended, as, in fact, all conservative remedies, in such cases where the position of the limb is so faulty and must remain faulty that even at best the result of conservative treatment is worse than that of resection, to which procedure we have to resort after the improvement of the disease.

In very large tuberculous abscesses and especially in

hydrops tuberculosis, treatment with iodoform is superior to stasis hyperemia, and is therefore always instituted by us. On the other hand, in both cases after the disappearance of the pus or watery effusion stasis hyperemia is frequently very useful as after treatment.

I must also devote a few words to the so-called amputation cases in tuberculosis of joints. That in fully developed cases of pulmonary consumption and in incipient amyloid a gravely affected tuberculous joint is to be amputated is so self-evident that there is no need wasting words on it. Even otherwise cases may occur where one would be guilty of omission if in consideration of the general condition amputation were not performed. These aside, I never know in the beginning any case of amputation but treat them all at first conservatively as an experiment. For I have seen the gravest cases heal under conservative methods, especially under stasis hyperemia. The case of the twenty-three-year-old laborer described in the beginning of this chapter is such a case. A well-known and experienced colleague whom I showed the patient in the beginning of the treatment expressed the opinion that it was a "primary amputation case," where one had best not tarry with conservative treatment nor with resection. Now the man is using his legs. On the other hand, we have incipient forms of tuberculosis apparently having the best change which, in spite of immediately instituted, rational, conservative treatment, proceed unimpeded and finally have to be subjected to the surgeon's knife.

Finally, I should mention the observations which others have made with stasis hyperemia produced with the rubber bandage. But the literature on the subject, though my first contribution on this method was made eleven years ago, is so meager that it is not worth while to examine it. Results were good and bad, the latter, as I know from oral inquiries, more than the meager literature seems to indicate. In the majority of places the method has been decried as dangerous, uncertain, or ineffective. However, this does not discourage me. I know very well that it is not only dishonest but also stupid to attempt to hold a post recognized as doomed. But I do not yield here one step, on the contrary, make

one in a forward direction and assert that the largest part of the failures is to be ascribed to faulty technic, from which reproach I can not even free myself. And while formerly I claimed for stasis hyperemia that it was a good method of treatment of tuberculosis of joints, which claims a prominent place alongside the other methods, I now declare it the best conservative agent at our command, which with the least dangers simply and cheaply achieves results, especially as far as function of the diseased joints is concerned, with which none of the others can be measured even approximately. It must be added that at the same time it is the most agreeable of them all because it takes away the pain from the patient without causing him any new ones, leaving him most perfectly the use of his limb.

With this I do not mean to say that the mutilating operations have been done away with; for even this remedy frequently leaves us in the lurch, it is by no means infallible, especially as it is a pronounced individual remedy, for the main question always is centered in the kind of blood the patient places at our disposal against the disease. But I hope that with the progressive experience in this domain, with the better development of technic for each individual case, results will be still more favorable and operations pushed to the background.

More recently we have again commenced to treat open and closed tuberculosis of joints with the suction apparatus, having made but a few experiments years ago. This was mostly used twenty minutes, rarely one half hour or longer daily.

If a tuberculous joint is placed into the apparatus and the air within thinned, enormous hyperemia and swelling of the affected part occur. Occasionally this is not so pronounced in the first few days, but after the apparatus has been used two to four times it appears in an intense form with great regularity. From the fistulæ and ulcers bloody colored serum and pus flow out, while granulating masses protrude as if they were sucked out from the depth. In the beginning hemorrhages frequently take place from fistulæ and ulcers, but after repeated use of the apparatus the granulations become more capable of resistance and do not bleed any more. Daily use of the

apparatus produces edema, which may reach the highest degrees and become chronic, this even though the apparatus be used only every other day.

The effects of the apparatus on the course of tuberculosis, if used daily, were variable. In some cases it produced rapid and striking improvement, in others just as rapidly aggravation, on the whole similar in character to that experienced with excessive stasis hyperemia, viz.: Cold abscesses, breaking through and changing into ulcers, granulating masses and development of rodent ulcer with undermined, thin margin of the skin, etc., with the only difference that the entire process occurred more rapidly correspondingly to the greater and more energetic effectiveness of the apparatus. On the other hand, we had the best results with this agent. I will cite examples for both:

A woman, fifty-one years old, during an attack of vertigo in February, 1901, fell to the floor; a few days later pain appeared in the knee-joint, which became considerably worse and at last so intense that the patient could limp only while walking with great pain, which latter awakened her even from sleep. Admitted February 15, 1902.

The left knee-joint is fusiformly swollen and is 2¼ cm. larger in circumference than the right; it is fixed in flexion contraction, can not be extended, and can actively be bent to less than a right angle. On flexing the joint, pseudo-fluctuating swellings appear laterally and below the patella.

Suction apparatus was used twenty minutes daily, from February 20th to April 8th. A decided hyperemia appeared only after the third application and thereafter regularly. Edema did not form.

March 14th the patient had lost her pain, walked without laming, free from pain, felt perfectly healthy, and could even run. April 9th she was discharged, with the following result: The knee can be fully extended and actively bent to an angle of 70 degrees. The circumference of the left knee at its largest point measures 1 cm. more than that of the right. The patient can use her knees all day long without any inconvenience.

The next case is an example of a cure of very grave and far progressed tuberculosis of the joint by hyperemia with the suction apparatus:

A boy, aged thirteen, became affected, in August, 1900, with tuberculosis of the left elbow-joint. He was admitted to the surgical clinic (Greifswald) June 12, 1901. There was a fusiform swelling of the left elbow-joint, which had led to cold abscesses. The Roentgen picture showed an apparent sequestrum in the

olecranon. The joint was fixed at an angle of 105 degrees. Motions were impossible actively and but slight passively.

As we had here to deal with tuberculosis with abscesses, these were incised, curetted and sutured, after the method of Billroth, after being filled with iodoform-glycerin; the suspected sequestrum in the olecranon was not found. Healing took place almost by first intention and the patient was sent back to his family physician for treatment July 12, 1901.

The boy was readmitted February 21, 1902, with a severe tuberculosis of the elbow-joint. The joint was irregularly swollen and surrounded by a chain of large ulcers, which were covered with spongy, gray granulations, whose skin margins were undermined and from which fistulæ led into the depth. The largest of these ulcers was as big as a dime. Ulcers and fistulæ suppurated considerably. The probe met rough bone. The skin was so extensively undermined that the probe pushed into a fistula reappeared at the opening of another 7 cm. distant. The elbow was very sensitive to pressure, the left upper arm was decidedly atrophic.

The patient was treated with the suction apparatus twenty minutes daily since February 25th. The region of the joint became dark blue; bloody serum, pus, blood and spongy granulation masses were drawn from the fistulæ. For hours after the application of the apparatus the region of the affected joint was hot to the feel. After fourteen days the excretion from fistulæ and ulcers greatly diminished, the granulations began to look dark red, the undermined skin began to heal to its basis. Fourteen days later it could be noticed that the previously soft swelling became hard. May 1st it was established that the fistulæ scarcely secreted, the skin had healed everywhere and that the ulcers were covered with a crust which was left undisturbed. In May an intermission of two weeks was ordered, after which treatment with the suction apparatus was resumed and now administered every other day. The patient was discharged August 1, 1902, with the following result: All ulcers and fistulæ have healed and are covered with skin; the joint looks smooth and has lost the form of a spindle; it feels hard all around. Mobility has not increased. The patient previous to his discharge has been taught the use of the stasis bandage, which he is instructed to use one hour daily for one or more months, when he is to present himself at the clinic.

The Roentgen picture offered some interesting points. The one taken at admission of the patient showed the ends of the joint confluent and undeterminable. The bones were very atrophic. With progressive improvement the bones became plainer, and on discharge the bones became sharply defined and showed a darker shadow in the region where the disease had its seat than that of the healthy, distant parts. To judge from the picture there exists a bony ankylosis of the articular ends; in the soft parts cordlike dark shadows, which probably represent tough connective tissue strands, which have developed from the granulations and which cause the joint to appear so hard to the palpating finger.

In contradistinction to these successes, which I could

multiply considerably, we have observed the contrary in tuberculosis of the joints under the influence of the suction apparatus. The two worst cases I let follow:

1. A cabinet-maker, fifty-three years old, states that he took sick February 23, 1901, subsequent to a sprain of the right wrist-joint. This became painful and swollen. The symptoms became aggravated, for which reason patient was admitted November 22, 1901.

He suffered from extensive, double-sided pulmonary tuberculosis. The right wrist-joint had a larger circumference of 3½ cm. than that of the left. It was almost entirely stiff, in fact, so much that the finger-tips at the attempt to make a fist remained 7½ cm. disant from the palm. Rotation, too, was considerably limited.

The affected limb was treated one-half hour twice daily with the suction apparatus since November 24th. Decided hyperemia appeared and after a few applications also chronic edema. January 23, 1902, I found, after an improvement in the mobility of the finger and wrist-joints, a cold abscess on the ulnar side of the hand, which was aspirated without injection of iodoform. Treatment with the suction apparatus was suspended for a few days and then resumed. Since February 14th the apparatus is used only twenty minutes every other day. February 20th the abscess perforated spontaneously, and as there appeared to exist pus retention, it was incised. A mixed infection occurred with high fever, so that April 23d resection of the wrist-joint had to be performed, and owing to progressive suppuration, the arm was amputated May 27th.

2. A boy, three years old, strongly scrophulous, suffered from open grave tuberculosis of the right wrist-joint. He received daily treatments of twenty minutes' duration with hyperemia by the suction apparatus. First treatment was given March 25, 1902. March 26th developed an acute inflammation of the affected joint with reddening of the skin up to the upper arm, which compelled us to suspend the treatment. The inflammation disappeared after a few days but meanwhile the tuberculosis of the wrist-joint made considerable progress. The trouble was aggravated by the appearance of several new ulcers with strong granulations and undermined margins. Since June 25th stasis hyperemia by bandage was instituted which produced a slow but decided improvement.

Thus in the treatment with the suction apparatus we have had alongside of successes the same failures we have seen before in prolonged and intense stasis by bandage and have drawn the conclusion that we have used the suction apparatus too long and too forcibly. After these preliminary experiments we have reduced its application, so that it does not produce chronic edema. For this reason I never use it daily but, depending on the reaction it produces, for twenty minutes every second to

fourth day. We take care that it is not used again until all edema has disappeared. Since this is observed we have not seen those failures but our experience with this method is so limited that we can not pass an opinion on its merits as a therapeutic agent for tuberculosis of the joints. I recommend that for the present the general practitioner use hyperemia produced by the application of the bandage, and advise against the use of the suction apparatus until further experience concerning the caution with which it has to be applied and its effect can be acquired.

TREATMENT OF OTHER FORMS OF TUBERCULOSIS

Besides tuberculosis of the joints, it was that of the testes which I have treated most frequently by means of stasis hyperemia, which is applied in the following manner:

If both testes are diseased they are firmly drawn downwards and a soft piece of rubber tubing padded with cotton is placed around the basis of the scrotum and so firmly drawn that it produces stasis hyperemia; the ends of the rubber are closed with a pair of forceps. If only one testis is diseased, it is drawn downwards, while the healthy one is pushed upwards. The rubber constrictor is applied in the same manner. The testes are placed in a spacious suspensory. The constrictor, since the place of constriction can not be changed, is permitted to remain one hour only.

One easily succeeds in this manner in producing an intense stasis hyperemia in the testicles. I have made good use of it in ulcerating and fistulous cases, and have observed how large ulcers have healed. The agent proved less successful in the tuberculous indurations of the epididymis as they are found in the beginning of the disease.

In spite of good results, I have almost entirely discarded the stasis hyperemia in tuberculosis of the testes, for one gets but rarely a case for treatment where the tuberculosis is limited to the epididymis or to it and the testes. As a rule, the vas deferens or even deeper parts have already been attacked, which are beyond reach of the influence of our agent.

I have also used stasis hyperemia in tuberculosis of bones, tendon sheaths, glands, skin and subcutaneous cellular tissue and also lupus of the skin. Concerning the tuberculosis of tendon sheaths my experience is very limited. I have seen considerable improvement follow the use of stasis hyperemia, but never a complete cure, and gladly give up this treatment because extirpation of the affected tendon sheaths leads to the purpose more rapidly and shows good functional results. In pure tuberculosis of the bone, as a rule, I remove by operation the focus if it can be foreseen that the function of the corresponding limbs will not be damaged by the operation. As regards glandular tuberculosis the cubital gland is really the only one suited. The treatment is without practical importance and I will, therefore, omit it.

I have seen no results or only transient improvement from the treatment of lupus with pure bandage stasis. On the other hand, I have repeatedly produced cures of ulcerated lupus of the face with stasis hyperemia produced by cupping glasses. But this treatment, too, is of no practical value, as extensive facial lupus can not be treated in this manner, while small lupous foci are best excised and the wound margins sutured. Besides, Finsen's photo-therapy excels this process.

Jacoby (205) has made the attempt to cure pulmonary tuberculosis by hyperemia. He followed my idea which led me to the treatment of surgical tuberculosis, and in principle he worked with the same agents with which I treated tuberculosis in the beginning. He places the lung apices low and affects the chest by a bath in hot water. Though I have repeatedly asserted that the active hyperemia by heat is unfit for the treatment of tuberculosis, I do not wish to say that here the hot water could not favorably influence the disease. For, as I have already pointed out, hot water belongs to the agents that produce a less intense hyperemia. To this must be added that the deeply situated tubercular foci on account of the peculiar "inflammatory irritation" are capable of retarding a blood-current flowing fairly rapidly.

I know of a simpler remedy to make the lungs hyperemic for a definite period, viz., inhalation of thinned air. This could be easily fulfilled with apparatus, but it no

doubt would be simpler to compress the nostrils with the fingers and to advise the patient to deeply inhale through the nose and to exhale through the mouth so that he becomes asphyxiated enough to bear it. As far as I know this has not yet been tried, while consumptives, basing on different presuppositions, were permitted to exhale in thinned air, a process which now has undoubtedly been dropped.

CHAPTER XIX

TREATMENT OF ACUTE AND SUBACUTE ARTHRITIS.

Among the acutely inflamed joints for which treatment with stasis hyperemia is applicable, I mention in the first place the arthritis of gonorrhoics. I have treated with this remedy various forms of this inflammation and have seen the best results in such cases, for which heretofore we lacked a remedy and which are so grave that they lead to ankylosis or at least to the severest stiffness, and which Koenig named "phlegmonous." As is known, aside from the joint proper also the structures near it, especially the tendons, are involved. These cases are characterized by intense pain.

I know of no other remedy which has as prompt an effect in any disease as the hot stasis, which can be very easily produced in such cases. An hour after the application of the remedy the pain is greatly diminished, and in cases in which the least touch, especially an attempt to move the stiff fingers, is accompanied by maddening pain, any motion being simply an impossibility, to the greatest surprise of the patients, careful passive motions can be undertaken and, what is more important still, without any injury for the patient. The patient soon learns the advantage and agreeableness of the remedy and asks for the stasis bandage when it is kept off for some time. It has proved itself the best hypnotic when worn during the night, and has given longed-for rest to sufferers who have been unable to find any sleep in spite of powerful narcotics.

At first I had good results in such cases with the permanent application of stasis hyperemia save a two-hour interval per day. Of late I have prolonged the intervals and have reduced the stasis hyperemia to one half hour, but have become convinced that this is not sufficient. In the graver cases the bandage has to be worn at least from ten to twelve hours daily and, as a rule, even longer. On account of the rest I order the bandage worn over night, although it can not be watched very carefully. The bandage should be applied an hour

before retiring in order to be convinced that it does its duty. In the gravest forms even a daily treatment of from ten to twelve hours is not sufficient. In such cases I order the bandage worn throughout the day with the exception of a two-hour interval. The stasis must be vigorous, but in these cases particularly the axiomatic law holds good that this remedy must diminish, not increase the pain. One must not be content until vigorous stasis and diminution of pain have been achieved. Fortunately in acute inflammation this is easy. A bandage applied relatively loose produces very intense and hot stasis and relieves the pain instantaneously. I at once commence with careful passive and, as soon as possible, active motions, which, as already mentioned, is possible with our remedy. Splints are used only in the intervals when the bandage is not applied or during the night when the pain is still intense. In the intervals the limb is elevated in order to diminish the old edema and to permit a new one to take its place.

Stasis hyperemia has never failed me in the grave forms of gonorrheal arthritis and the successes as regards rapidity of cure and the function of the extremities are brilliant as compared with anything that I have ever seen before. In Kiel these cases were not infrequent and my teacher, von Esmarch, used to treat them with plaster of paris cast. Though the latter was removed as soon as the affection permitted this, ankylosis, or at least severe stiffness, was the rule.

I have also employed stasis hyperemia in mild forms of gonorrheal arthritis but not with the same regular successes as in those grave forms, which fortunately are excellently suitable for treatment with stasis hyperemia. In order to illustrate the effects of this remedy, I will cite one case which has been treated successfully and one where success was not obtained:

A man, twenty years old, was attacked three months prior to admission by a gonorrhea. Five weeks ago he suddenly began to suffer with pain in the right wrist which robbed him of his sleep. A physician who was called pronounced it a case of acute articular rheumatism, enveloped the joint in cotton, treated it with the ice-bag and finally applied iodine until the skin became

inflamed and cracked. When all this proved useless, the extremity was bandaged to a splint which the patient has worn for the last four weeks. This all without any result.

The patient was admitted July 9, 1902. The region of the right wrist was very much swollen; the circumference of the wrists was, on the right one 25½ and on the left one 18¾cm. The back of the hand was edematous, which could be followed up to the region of the elbow-joint. The palm was filled in. Redness of the skin was absent. The fingers were fixed in extension; the hand in pronation. The region of the wrist and of the extensor tendons was extremely sensitive to touch, the least attempt to move the wrist or the fingers caused the patient to cry out aloud. He asserted to have slept for the last weeks through the day not at all and during the night very little, because the pain in the wrist, in spite of its being fixed to a splint, was unbearable. He was in a poor general state. The joint between carpal and metacarpal bones was extremely sensitive to touch. The Roentgen picture shows each metacarpal bone surrounded by a broad bright margin. It looks as if each of them were surrounded by a layer of cotton and therein placed alongside each other. The upper ends of the second to fifth metacarpal bones show the most decided changes. Their articular ends are attacked by caries and show periosteal granulations. But neither they nor the bones of the fingers show the atrophic changes usually accompanying inflammation of the joints. The soft parts of the arm are atrophic, while those of the forearm can not be made out on account of the edema. The patient still had a discharge from the urethra containing gonococci. He had no fever.

The affected limb was fastened to a splint and, first of all, elevated until the next morning in order to diminish the edema and to enable a more detailed examination. In this, however, we did not succeed, the circumference yielding on the morning of July 10th the same result. At 8:45 the same morning the stasis bandage was applied to the arm. After an hour the patient had no more pain. To the greatest surprise of the patient, slight passive movements were possible without pain in the

wrist-joint and the fingers. At 9:45 the bandage was removed and reapplied from 10:45 to 2 p. m. In the evening he wore it again from 7:30 to 10:30, and during this time the patient had the first deep, uninterrupted sleep for a long while. Soon after the removal of the bandage the pain came back so that the patient could not sleep.

In the morning of July 11th the joint again became painful and sensitive to touch. The bandage was worn from 8:45 to 1 p. m.; after it was worn for twenty minutes the pain disappeared but reappeared an hour after the removal of the bandage. Stasis hyperemia was again maintained from 7 p. m. to 8 p. m.; it produced a strong redness, swelling and heat in the affected limb. The patient had slept from 9:30 to 4 uninterruptedly. There was no pain on pressure, passive motions of the wrist and fingers were possible to a great extent.

July 12th the patient wore the stasis bandage from 11:45 until 9:30 of the following morning. In the meantime it was fastened on a different place. He slept throughout the entire night.

The bandage was again applied without interruption from 5 p. m. July 13th to 11:30 a. m. July 14th. Since then pain in the wrist did not appear even in the intervals during which no hyperemia was maintained, and pressure elicited some pain only in the joint between metacarpus and carpus. The patient commenced to actively move wrist and fingers. Supination was still rather painful, which now was undertaken in a great measure. After the bandage was off for eight hours, the circumference of the affected joint was again measured, showing 23.5 cm.; therefore, there was a gain in spite of the hyperemia of but 2 cm. The diminution of the swelling was also recognizable by the wrinkled condition of the skin. The improvement of the disease progressed steadily while the time of the hyperemia was gradually shortened. July 22d we commenced slight massage, which was stopped on the 28th because it left some pain.

August 1st the patient was referred for treatment in the dispensary with the following status: The circumference of the right wrist is 19¾ cm. (decrease since July 10th, 5¾cm.), and is 1 cm. larger than the healthy

wrist. The swelling, which is still present, feels firm and hard. Pains can be elicited only by strong pressure on the joint between carpus and metacarpus. Active flexion of the hand is almost entirely free, rotation entirely free; extension, on the other hand, is still very limited. The fingers can be bent up to 2 cm. from the palm and thoroughly extended. In the polyclinic (dispensary) a daily application of stasis hyperemia for one hour was given up to August 5th and then massage was added, while the hyperemia was applied only half an hour daily. A few days later the patient withdrew from further treatment and observation; at that time he was entirely free from pain and could bend the fingers into a fist.

This case shows that the short hyperemia which we described as the most useful for tuberculosis is not sufficient for the grave gonorrheal inflammation of joints. Though the bandage removed the pain while it was on, it reappeared soon after the removal of the bandage; a decided success was only obtained when we employed prolonged stasis hyperemia.

In a second similar case, though not quite as grave as the former, we had the same experience in a still more decided manner. In this case we achieved success only when we applied the stasis hyperemia, as we were used in the beginning, for twenty-two hours daily; especially was sleep only obtained when we permitted the patient to wear the bandage throughout the night.

The following case of a mild form of gonorrheal arthritis shows a lack of success with the treatment by stasis hyperemia.

A man, aged twenty-two, contracted three weeks ago a gonorrheal urethritis. A week later he experienced pain in the left foot, which, after the application of warm compresses and inunction with tincture of arnica, disappeared to such an extent that he could walk with the aid of a cane. As the pain got worse on walking and appeared also in the left knee and a lymphangitis was added, the patient entered the clinic August 29, 1901. The dorsum of the left foot was swollen, Chopart's and Lisfranc's joints were very sensitive to pressure. Extension of the foot was unimpeded, flexion limited, pro- and

supination almost suspended. The left knee joint was contracted in flexion and was very painful; objective changes, however, could not be noticed. Lymphangitic stripes could be observed from the foot to the lower third of the thigh. The patient had a discharge from the urethra containing gonococci and slight fever.

Up to November 2d Priessnitz's compresses were applied, which produced no improvement whatever. From November 2d to November 5th stasis hyperemia was employed throughout the day with intervals of several hours, also without any success, save that the affection of the knee disappeared entirely, and the lymphangitis almost entirely. The stasis hyperemia in this case, however, remained without any influence whatever on the pain in the ankle, for which reason no success was expected from it. It was stopped after a use of three days.*

Applications of tincture of iodine and hot air proved useless, the latter even aggravating the pain during the night; a plaster of paris cast was applied December 1st, which removed the pain in a few days.

Though this case does not represent a grave form of gonorrheal arthritis, the stasis hyperemia remained without any influence on the pain of the affected ankle. We can see that this remedy, which has so miraculous an effect in this disease, remains useless in exceptional cases. I suppose that this is due to the blood which the patient places at our disposal. However, the few failures can not decrease the merits of the remedy for gonorrheal affections of the joints, as it helps even in the gravest forms, when all our remedies frequently leave us in the lurch, at least in regard to the re-establishment of good function. Indeed, I hardly know a remedy which makes such an impression on the physician and patient as does the stasis hyperemia in the gravest cases of gonorrheal arthritis. When everything else has failed its beneficent effect can be noticed even within half an hour. I can understand why stasis hyperemia has been dropped as a remedy in tuberculosis, because the technic has its peculiarities and because previous to the introduction of

*This was too soon. Recently I observed a grave case of gonorrheal arthritis of the knee in which success came only after weeks, but then completely.

the short-time stasis, this agent has been improperly applied, thus producing aggravation of the trouble, but I do not understand why it is not employed in gonorrheal joints. For, though I have recommended the remedy for it in 1894, and later have repeatedly called attention to it, I know of no contribution on it from any other source. From this one can conclude that in a time when the desire to publish experiences is prevalent, the stasis hyperemia has not been employed against gonorrheal arthritis to any great extent. And this when the success obtained is so prominent and the technic so simple. One simply goes according to the sensation by the patient, instructing him that he must have no trouble with the bandage and that, on the contrary, the trouble must be diminished; and with a comparatively loose application one can obtain without difficulty the desired hot stasis.

I must remark that I have never treated hydrops of the joints of gonorrhoics with stasis hyperemia, and that I have caused to disappear with this remedy the dry forms of this articular inflammation within a few days. I have been similarly successful with stasis hyperemia in other acute inflammations of the joints. In acute articular rheumatism, of which, to be sure, I have treated only ten cases, the patients unanimously remarked that the pain quickly disappeared after the application of the stasis bandage. The joints which have been subjected to stasis hyperemia showed regularly a more rapid retrogression of the other disease phenomena than those which have not been so treated. However, the number of the cases is so small and acute rheumatism is so contrary a disease that the joints which look serious to-day may almost appear cured the next day, so that positively final conclusions can not be drawn.* The treatment is the same as in gonorrhea of the joints.

I have observed the best results in all kinds of acutely and especially subacutely diseased joints after treatment with stasis hyperemia. Thus, I have cured with it two cases of grave puerperal inflammation of the knee-joint

*Stasis hyperemia has been successfully made use of since the above was written in several hospitals for acute articular rheumatism.

which had existed for weeks, with very satisfactory results in regard to function. This means a good deal, because, as a rule, these cases lead to stiff joints. Of late I have treated the following case of traumatic arthritis, which seems worthy of mention:

An owner of a farming estate, aged twenty-six, sustained an injury to the right knee-joint by a fall from a bicycle, which resulted in suppuration, though the fever and inflammation were not very pronounced. He was admitted in the surgical clinic June 24th. We found above the patella a wound about 3 cm. long situated across the limb. In the joint was considerable effusion. On pressure serous pus escaped from the wound. The patient had pain in the knee but could limp. He had no fever.

June 26th stasis hyperemia was instituted and employed two hours daily; it immediately caused the pain in the knee to disappear. June 30th no more pus was evacuated from the wound, and the patient was discharged July 8th with a normally functionating knee without effusion, after use of stasis hyperemia for only twelve days. The wound was entirely closed save a superficial stripe of granulation.

The following case also seems worthy of mention:

I treated in 1893 a child which was acutely attacked by a high fever. After some time appeared an inflammation of the knee, which was soon followed by a turbid, coagulating effusion. The lower end of the femur was thickened and painful. The high fever disappeared, but a moderate temperature and the inflammation in the knee remained and the latter did not improve though the joint was treated antiphlogistically and was aspirated and washed out. The joint very soon became stiff and sensitive. I instituted stasis hyperemia, which appeared in its most intense form. With one stroke the disease improved; in a few days fever, effusion and inflammation disappeared and the joint became mobile. Probably we had here to deal with a case of mild acute osteo-myelitis of the lower end of the femur, which involved the neighboring joint. I do not employ stasis hyperemia in larger abscesses of the joints, but have employed it successfully in such cases as after treatment, when by means

of aspiration and irrigation with antiseptic liquids suppuration has been checked, pain and stiffness of the joints remaining.

The duration of hyperemia in non-gonorrheal inflammation of the joints depends on each individual case. In one case the application of the bandage for one to two hours is sufficient, again in most cases it has to be applied for from eighteen to twenty-three hours daily. In these cases, too, it should not be employed permanently and in the intervals the limb is to be postured high in order to remove the old edema as much as possible. I act in these cases essentially in accordance with the objective condition of the patients; if he states that after a short period of stasis the pain disappears and the restricted motion improves, I limit the application of the bandage to one to two hours daily. If the patient states that soon after the removal of the bandage the pain reappears, I employ the remedy longer. Many patients ask that the bandage be reapplied because it produces subjectively improvement. The suction apparatus can not be employed in acute and subacute inflammation of the joints on account of the intense effect.

I consider stasis hyperemia the best form of hyperemia which can be employed in the affections under discussion. The active hyperemia, as produced by hot air, in these affections, as well as in tuberculosis, I consider useless and refer the reader in this respect to what I have said in Chapter XIII. I had an opportunity, a short while ago, to be convinced of the superiority of passive hyperemia over the active form in a case of phlegmonous gonorrheal joint.

A girl, nineteen years old, ten weeks previous to admission, was suddenly attacked with violent pains in the left wrist and was treated for it in a different hospital for several weeks with hot air. The joint became gradually stiffer and the sensitiveness did not diminish. She was received at the surgical clinic September 28, 1900. The left wrist was but little swollen, and measured 1 cm. more than the other. The skin was red, the joint on the dorsal side of the hand very sensitive to pressure; it was in slight flexion and pronation and each attempt at flexion elicited violent pain. Stasis hyperemia was used from

September 28th to October 28th throughout each day and this removed the pain in a few days so that soon passive motions and later active motions could be executed. When discharged the joint could be flexed and extended to 50° and actively rotated without pain. The affected limb became usable.

CHAPTER XX

TREATMENT OF OTHER FORMS OF ACUTE INFLAMMATION

A remedy which gives good results in acute inflammation of the joints is naturally applicable to such of the soft parts. I have employed it in several cases, so, for instance, for an endemic outbreak of facial erysipelas, which we had in the poorly constructed hospital in Greifswald. In thirteen cases I used the stasis bandage, which was so tightly drawn around the neck that, while producing no trouble, it created a vigorous hot stasis of the face with intense redness and swelling of the skin. In only one case did the erysipelas extend to the bandage; in the rest the disease remained remarkably limited. The average duration of the disease was four to nine days.

In the cases so treated the improvement of the general condition, the rapid fall of temperature and the rich desquamation which appeared early were striking. Inasmuch as erysipelas is an uncertain malady, it is quite possible that accidentally I met very mild cases and for this reason the suppression of phlegmon, which we have succeeded in accomplishing with this remedy several times, is of more value. I cite here the most brilliant of these cases, though I have published it once before.

A butcher, aged forty-three, November 2nd sustained a wound 2 mm. wide across the small finger of the left hand. He worked with it up to November 5th without paying attention to the wound. It finally became inflamed and the patient called three times on a physician, who incised it each time. November 11th he came to the hospital because the condition got suddenly worse following the last incision. On the flexor side of the small finger in the region of the second part was found a cross wound in which a tendon was exposed. The entire region of the flexor tendons of the small fingers was extremely painful on touch up to the wrist. If we pressed over the sheath of the flexor tendon from the wrist-joint towards the wound, a discolored, watery liquid appeared at the wound. The ulnar part of the skin of the region of the wrist and 3 cm. upwards was very red and

sensitive to pressure. The joint between the first and second part of the little finger was open. We discovered an extensive lymphangitis of the forearm and swelling of the cubital gland. General condition was bad; pain severe. Immediately while in the dispensary before even being admitted to the hospital at 11 a. m. of the same morning (November 11th) a stasis bandage was applied to the arm, while the patient had a temperature of 39° C. taken in the axilla. It cost quite an effort to produce the right kind of hot stasis without also producing pain. When this was attained the pain soon disappeared. The painful and stiff little finger could now be bent by the patient. The stasis was continued to 4 p. m., then removed. As this all was done previous to admission, no exact record of his temperature was obtained.

After removal of the stasis bandage pain reappeared quickly. At 6:45 p. m. patient had a chill. The bandage was then reapplied. Again it cost a great effort and difficulty to obtain the right hot stasis without pain. After this was attained the pain disappeared rapidly, the temperature sank at 8:30 p. m. to 38° C. and at 10 p. m. to 38.7° C. At 10 in the evening the bandage was removed for a short while, then reapplied and worn until 4 a. m. When the stasis edema became somewhat lessened it could be seen that the swelling and redness at the wrist had disappeared, as did the lymphangitis; only the region of the flexor tendon of the small finger was still sensitive.

November 12th the stasis bandage was worn from 9 to 1, from 5 to 8:30 and from 10:30 p. m. to 10 a. m. of November 13th. After this the disease was essentially removed, the swelling had diminished, only some sensitiveness remained in the above-named place. With large intervals the stasis hyperemia was continued to November 15th. The temperature did not rise November 12th over 38.6° C.; November 14th not over 37.7° C., and was normal since November 15th. Small superficial tendon shreds were expelled from the wound, which healed quickly. The suppurating joint remained somewhat stiff and had crepitation on motion but, on the whole, the disease was removed without any disturbance of the function of the hand.

This is a very important case in so far as it represents

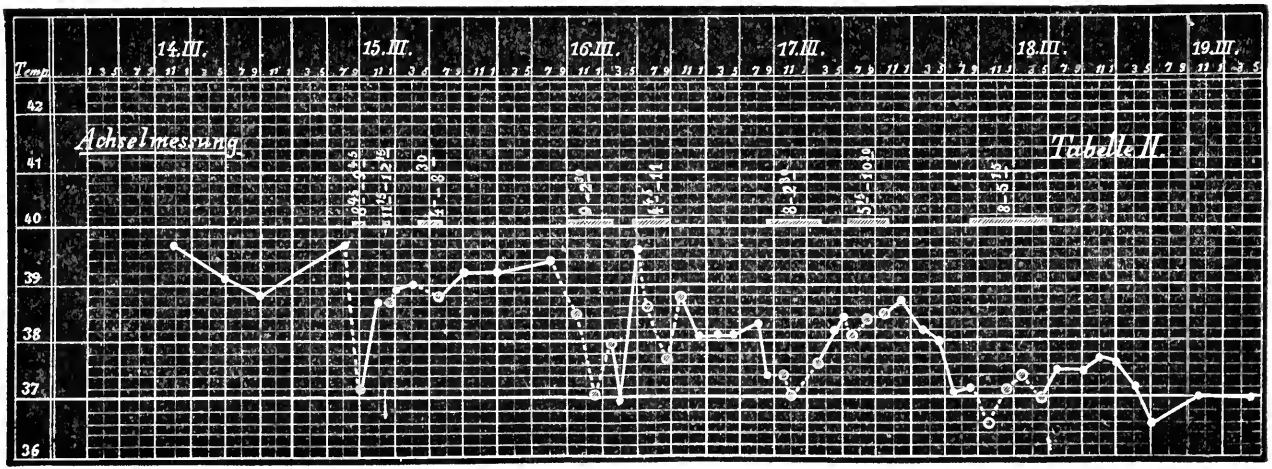

Temp.
14.III.
15.III.
16.III.
17.III.
18.III.
19.III.
42
41
40
39
38
37
36
Achselmessung.
Tabelle II.

Fig. 10.

one of the dreaded cases of phlegmon of the sheath of the flexor tendon of the fifth finger, which under the most favorable circumstances terminate in a mutilation and grave functional disturbance of the hand. To be sure, we had here a favorable case, as the tendon sheath was probably only infected at the incision undertaken for the evacuation of the pus, shortly before the patient's admission.

The following case of acute inflammation which has been treated with stasis hyperemia and which, too, has been published by me before, is instructive in a somewhat different direction:

A smith apprentice, aged eighteen, became acutely affected March 10, 1901, with pain, swelling and redness of the right knee-joint without an external injury. He had to go to bed and passed a sleepless night. He was treated with compresses of alumen acetate.

He entered the clinic March 14th. The entire region of the knee-joint was red and inflamed. The redness extended almost to the middle of the leg. The knee-joint itself was not involved nor the bursa praepatellaris. There was an intense lymphangitis on the thigh, but the greatest pain was at the inner side of the knee-joint. This was in slight flexion and an attempt to extend it produced pain. The swelling was so intense that the circumference of the affected limb at the swollen place exceeded that of the healthy extremity by over 5 cm. An abscess could not be demonstrated. The general condition of the patient was very much disturbed; he was delirious during the first night and jumped out of bed, so that he had to be watched. The next morning the use of stasis hyperemia was begun. The desired hot form was achieved. The accompanying curve (see Fig. 10) illustrates the time during which this remedy was employed and its influence on the temperature. The dotted line represents the time during which the remedy was employed. On the whole the course of the disease was as follows: Immediately after the institution of stasis the pain diminished. In the following night the patient was still restless, in the subsequent one he slept quietly. The pain (even on pressure) and the general condition of malaise had fairly disappeared since March

16th. Since March 19th temperature was normal. In spite of this an abscess formed on the outer side of the leg below the knee-joint, which was opened March 25th. It contained chocolate-colored pus, from which a pure culture of streptococci was obtained. Two rabbits which were inoculated with it at the ear became erysipelatous with lymphangitis and lymphadenitis. In both the disease took a moderate course and the animals escaped with their lives.

Therefore in this case the stasis hyperemia did by no means kill the bacterial factors, but it seems that their virulency was weakened. I especially call attention to the influence of the stasis hyperemia on the temperature, which can be appreciated from the figure without any trouble. But I emphatically warn that it is not advisable for any physician to apply stasis hyperemia in such cases, unless he has acquired a familiarity with the remedy in other affections, and that the remedy is suitable in such cases only when seen early. I am convinced that the greatest mischief can be produced with the remedy in progressed cases of phlegmon of the soft parts. The circulatory disturbance in such cases is so pronounced that gangrene of the attacked parts is threatening, in which cases the removal of the blood-stasis is indicated and not an increase of the latter.

Therefore, even he who sees many of such cases would but rarely find a suitable one for this remedy. More detailed rules I can not lay down, because my experience in such cases is limited, it being more in the form of experiments. In several cases which appeared to me as suitable for stasis treatment I have refrained from using the remedy when improvement did not occur immediately after the application of the bandage.

CHAPTER XXI

TREATMENT OF CHRONIC STIFF JOINTS

The successes achieved with the treatment by hyperemia, both active and passive, in all forms of chronic stiff joints, be they caused by articular rheumatism, arthritis deformans, injuries or acute, especially gonorrheal inflammation, are decided and convincing. Active hyperemia has been employed by means of hot air. Its effects merit recognition in chronic rheumatism and arthritis deformans, especially striking are here, like in all diseases which are favorably influenced by hyperemia, the immediate relief of pain and increase of mobility. After a somewhat prolonged application one can observe reduction of swelling, decrease of existing crepitations and disappearance of abnormal nodular swellings. The same results, as I have repeatedly pointed out, can be obtained with stasis hyperemia, but one meets occasionally with greater difficulties in getting an intense stasis hyperemia than is the case in tuberculosis.

Finally, treatment with the suction apparatus must be considered here. These, too, as was to be expected, we have employed with good results in arthritis deformans and chronic rheumatism. I have found the suction apparatus especially useful in several cases of gonitis crepitans, in which hot air had proved ineffective.

It is superfluous to cite examples of the favorable effect of hyperemia in these diseases for they have been so often described and confirmed that they require no proofs. I will not omit to mention that I have frequently met cases, especially of chronic rheumatism, for which I have employed all these remedies (hot air, stasis hyperemia, suction apparatus) one after another without lasting success. Almost without exception they at first produced subjective improvement, reduction of pain and increase of mobility. Finally a standstill was reached and no further improvement coming on, the patient not infrequently withdraws from the treatment. As a rule, however, the improvement can be noticed early and plainly. Among all the cases which I have been able to follow I have observed but one real cure and this was a

case in my private practice. The cure was obtained principally from the use of stasis hyperemia; at the same time slight massage was employed but only to the extent of rubbing away the edema which had developed.

Better and more complete cures than in chronic rheumatism and arthritis deformans I have obtained in several cases of grave gonorrheal stiff joints, which followed acute inflammation. Among these are two cases which, in spite of protracted medico-mechanic therapy, forcible motion of the stiffened joints, massage and compresses, had not improved and were in hopeless condition. The two gentlemen concerned were agreeably surprised at the change in the therapy, as in place of the former painful treatment a pain-relieving one with better results took place.

In most cases where many points were affected I have combined both methods, active and passive hyperemia. This is to be recommended because the treatment of all bodily joints with one of the remedies, especially hot air, alone is difficult of execution. One can also soon learn from the patients which of the two agrees with them more. I have usually found that at first they prefer hot air, later on, however, the stasis hyperemia. Very often in these cases it is hard to tell whether really one or the other remedy has produced the greater improvement; for, as I have already remarked, one can frequently observe that with the treatment by hyperemia of individual joints the others improve at the same time.

The treatment with hyperemia is furthermore very successful in stiff joints due to trauma, and for these cases, too, it can be said that both active and stasis hyperemia are equally efficient. After I had obtained good results in traumatic stiff joints with the suction apparatus, my former assistant, staff-surgeon Dr. Blecher (206), demonstrated that the ordinary stasis hyperemia by means of a bandage produces good results.

Of late Sudeck has confirmed the observations made by Blecher. Sudeck is of the view that stiff joints after inflammation and injury are due to bone atrophy demonstrated by him as associated with them and that the stasis hyperemia acts by an increase of new bone growth. This view is very one-sided, for while it is true that in

those diseases the bones become atrophic, it is not they alone which suffer, for the soft parts, too, become atrophic. I have mentioned it repeatedly that the atrophy of the soft parts improves under treatment by hyperemia. It is therefore arbitrary to place the atrophy of the bones in the foreground, with the improvement of which the stiffness becomes better. For I have observed stiff joints of grave form in which the Roentgen rays showed hypertrophy and not atrophy, improve under treatment by hyperemia, also such which evidently concerned only the soft parts, as in tendon and skin scars, caused by panaris. Furthermore, I have observed, as already mentioned, that nodular thickening of the tendons due to gonorrheal inflammation disappears under treatment with hyperemia. I therefore, now as before, lay great stress on the solving effect of hyperemia, which, as already mentioned, we have been able to observe repeatedly. That in addition other factors are active I have never doubted.

I have often asserted my belief that serous infiltration and swelling of shrunk soft parts play a great role and, above all, the relief of pain associated with hyperemia. Otherwise it could not be understood how stiff joints, after having been rendered hyperemic for one hour, become more mobile. That alongside of this the purely passive nutrition of the bone can play a role I do not doubt. But of all things which are considered this is the least proven. That atrophies rapidly disappear after the removal of the cause of the disease is no more astonishing than that they develop with an incredible rapidity. But we know the reason neither for one nor the other.

In traumatic stiff joints I have of late made use of the suction apparatus and consider it for these affections the most prominent remedy. While the suction apparatus must be used with the greatest caution in infectious affections of the joints, in traumatic stiff joints it can be used boldly. The affected joint is exposed in the apparatus to a vigorous hyperemia one to two times daily. We have never seen any damage result from it in these affections. As a proof I will describe several cases:

1. A laborer, aged thirty-five, sustained January 1, 1902, a luxation of the left elbow-joint. This was corrected by me by the bloodless method twenty-two days

after the accident, and immediately afterwards the daily treatment with hot air and massage was begun. February 15, 1902, the following status was found: The elbow-joint can be flexed to an agle of 87° and extended to 125°. Supination and pronation can be executed to a very limited extent.

February 15th treatment with the suction apparatus was commenced, lasting every day twenty minutes. Immediately afterwards considerable subjective improvement set in; the patient stated that the joint was more supple. March 5th the forearm could be extended to an angle of 135° and flexed to an angle of 70° and extended to 145°. Rotation was entirely free and the joint well movable and functionating. Very striking was the rapid diminution of the swelling under the treatment with the suction apparatus. For an old luxation this seems to me an excellent result.

2. A fifteen-year-old boy was attacked in December, 1901, by a panaris of the dorsum of the right hand, which was split outwardly. Over the third metacarpus was a scar adherent to the bone. The bone felt thickened and so appeared in the Roentgen picture. All fingers of the hand, except the small one, the last two joints of which could be moved, were stiff, which was due to an immobilizing dressing worn continuously. This stiffness was especially pronounced in the phalango-metacarpal joints. These joints could not be moved with the greatest force. The hand was treated in the suction apparatus half an hour twice daily from February 13th to March 14th, 1902. All fingers, except the middle one, became entirely mobile and could be bent into a fist. The middle finger did not keep pace and the Roentgen picture shows that there exists a bony obstacle in its phalango-metacarpal joint.

It seems to me that this case, too, can be considered an excellent success. At least, I used to try in vain to restore the mobility in just such fingers which became stiff in the phalango-metacarpal joint by inflammation and prolonged bandaging. Even forcible motions under anesthesia do not suffice; if the latter, however, are carried to excess it may come to full luxations.

As already mentioned, both forms of hyperemia loosen

stiff joints, but, as in passive hyperemia by a bandage, while this is on, absorption is retarded, I have kneaded away the edema in chronic articular rheumatism, which has been treated with stasis hyperemia for some time, once or twice daily, and Blecher recommends the addition of massage for traumatically stiffened joints which have been treated with stasis hyperemia by a bandage.

I will now briefly recapitulate the technic of the treatment of stiff joints with hyperemia: 1. Hot air is to be applied one hour daily according to rules laid down in the general part. 2. The suction apparatus is used one to two times daily for from twenty to thirty minutes. 3. Stasis hyperemia with the bandage is employed from eight to twenty-two hours daily. In the interval the limb is to be postured high and the developed edema massaged away once or twice daily. All that is needed is a kneading away of the edema; scientific massage is not essential.

In all treatments with hyperemia which must be continued for months and years, as is sometimes necessary in joints afflicted with chronic rheumatism and arthritis demormans, it is advisable to occasionally desist from treatment for a week, a month, or even longer.

I consider the treatment of stiff joints with hyperemia as extremely important, for, with due respect to the results achieved by mechano-therapy, as practiced in special mechano-therapeutic institutes to which such cases nowadays apply for treatment, I have never been able to free myself from the conviction that we have here a case of fashion overdone. Very frequently we see cases which have become worse instead of better by mechano-therapy, for the strongly irritating treatment produces inflammatory processes in the chronic stiff joints. Besides, the treatment is by no means pleasant to the patient and, what must also be considered as of no small importance, the treatment can be had at certain institutes only. Therefore, I believe that a method which is at the disposal of every physician and which yields at least the same results has a great value. From a large experience I have come to the conviction that if two institutions would be opened, in one of which mechano-therapy only were practiced, while in the other treat-

ment with hyperemia exclusively were used for equally grave cases of stiff joints, the latter would soon get the upper hand. I am not so one-sided as to assert that mechano-therapy is without value or that it could not usefully be combined with the treatment by hyperemia.

An important feature of the latter is that the patients themselves soon become familiar with it and are able to continue it at home, for frequently these diseases are so chronic that a complete course of treatment in the hospital is impossible. [The author adds that for this reason his hot-air boxes are the most important because they are durable and cheap and therefore within reach of even poor patients. A very good Betz apparatus can now be obtained for a few dollars. Should, however, the patient be so poor that he can not get an apparatus himself, an arrangement for a loan of one from his physician has proven a good way of controlling a case by the attending physician.—*Ed.*]

CHAPTER XXII

HYPEREMIA AS AN ABSORPTIVE AGENT

I have demonstrated that active hyperemia is one of the most powerful agents for the promotion of absorption. For this reason I have used it extensively for the absorption of edema and especially as after-treatment of bone fractures, in which, as is known, edema usually develops on rising, after the fracture has healed. But in all other forms of local edema, as long as acute inflammation did not develop with them, I have successfully employed active hyperemia. I have also derived great benefit from its use in fully developed forms of elephantiasis. The following case may serve to illustrate its effect:

A woman, aged twenty-eight, noticed eighteen years ago that a swelling appeared on the external malleolus of the left foot, which gradually became enlarged and spread after several deliveries. She was admitted July 3, 1900, with an enormous elephantiasis of the entire left extremity and incipient elephantiasis of the right leg. The left extremity was treated daily for one hour from July 4th to the 28th with a hot-air apparatus which took in the entire limb. The following measurements will give you an idea how thick the limb was and how effective the hot-air treatment proved.

The circumference of the limb was:

	July 3d.	July 28th.	Decrease.
Below inguinal bend.....	67.5 cm.	56.0 cm.	11.5 cm.
Middle of thigh.....	67.0 cm.	60.0 cm.	7.0 cm.
Above patella.....	67.5 cm.	51.0 cm.	15.5 cm.
Below patella.....	53.0 cm.	42.0 cm.	11.0 cm.
Middle of leg.....	49.5 cm.	42.0 cm.	7.0 cm.
Malleoli	34.0 cm.	29.5 cm.	4.5 cm.
Lisfranc's joint.....	28.5 cm.	25.5 cm.	3.0 cm.

During the treatment the woman lost 9½ pounds. The limb, as compared with its appearance before treatment, could hardly be recognized. The patient was given a hot-air apparatus for use at home. Whether she has used it and with what success is not known.

The active hyperemia by hot air has further been employed for the absorption of effusions of the joints.

My assistant, Dr. Klapp (207), and Dr. Schaffer (208) have reported the observations made in the local clinic. We have so far treated about sixty cases with hot air and with very satisfactory results. To be sure, one does not always succeed in causing the effusion of joints to disappear or in preventing its return, nevertheless, I consider the remedy one of the best, if not the best, we have. The great advantage of the treatment is in this, that the affected joint is not fixed and that the patient is permitted to make motions with it. Indeed, we have been successful in the ambulatory treatment of several cases of chronic hydrops genu. The avoidance of immobilization seems to possess a great advantage, for one frequently sees the return of effusion which had disappeared in fixed joints, when the patient rises and moves about. True, even this remedy fails occasionally, of which I was convinced but recently. A young gentleman had a chronic hydrops which quickly disappeared after application of hot air and rest in bed, but reappeared on rising.

Bloody effusions, just as watery ones, can be successfully treated with active hyperemia. The injured has subjectively a pleasant sensation from the remedy. We see here, like in all other cases in which treatment by hyperemia is effective, that the rapid disappearance of the pain and symptoms is always the most prominent and first sign.

We have also treated with hot air a series of cases of blood effusion into the soft parts. The very nature of the affection does not permit us to say whether this method has been of great use or not. Taken all in all, I am decidedly under the impression that it is about as effective as massage.

Wherever we wish to unfold vigorous absorption the active hyperemia which is produced by hot air stands in the foreground; it is to be employed daily for one hour, or at most two hours. In the latter case the affected limb is to be exposed to the remedy morning and and evening an hour at a time. Passive hyperemia by means of a stasis bandage need scarcely be considered here, though we have used it frequently with good results in combination with massage for effusion of blood.

But here we have to deal more with a dissolving than an absorbing effect and the latter is accomplished essentially by massage. On the other hand, I have great confidence in the suction apparatus for such cases, especially when it is so employed that the affected part is rendered hyperemic by a few movements with the piston, air being permitted to enter immediately afterwards, and this procedure is often repeated. We have used the apparatus for this purpose several times, but our experience is so limited that I can pass no opinion on its efficacy. The arrangement of Junod's boot with which attenuated and condensed air can be applied alternately, seems worthy of a trial in such cases. This seems especially indicated in joint effusion where we first render hyperemic the diseased part and then exercise a powerful pressure over it. We could combine the absorbing effect of hyperemia with the tried Volkmann compression, for it is doubtful whether there exists an agent for compression which has a stronger and at the same time less harmful effect than evenly compressed air.

CHAPTER XXIII

TREATMENT OF NEURALGIAS AND OTHER PAINS BY HYPEREMIA

In several places in this book I have plainly shown that of all effects exercised by hyperemia the pain-relieving one is the most striking. It has also proved itself very effective in various painful affections without demonstrable anatomical changes, especially in neuralgias. For the latter active hyperemia is evidently the far better remedy. I have used it, as did many other physicians, with good results in numerous cases of lumbago and sciatica and a few cases of trigeminus neuralgia. It is self-evident that in lumbago the pelvic and lumbar

Fig. 11,

regions are to be treated, but even in sciatica I find it more useful to treat the affected region with the special attachment for the hot-air apparatus than the subjection of the entire limb up to the hip to hot air.

Trigeminus neuralgia was treated by us in a very simple manner. We permitted the hot air, as it came from the chimney, to flow against the diseased face, or we fastened a wooden attachment to the chimney and held one end, shaped like a funnel, 10 cm. from the skin.

[A similar arrangement could be utilized with the

Betz apparatus by inserting a tin pipe into the top opening intended for ventilation. Hopkins hot-air apparatus (see Fig. 11) will prove more convenient and the current of hot air can be thrown directly on the skin.—*Ed.*]

I have treated only a few cases of trigeminus neuralgia (altogether eight) with hot air, among which six were of a grave form which had previously been treated in vain with all possible remedies. Of these eight cases, five have been cured by this agent and three have not been cured. In two of the latter I had to perform resection of the nerves. I have also employed against trigeminus neuralgia stasis hyperemia, which I produced by the application of a rubber bandage around the neck, but had no result with it. In two cases in which the stasis hyperemia failed, I succeeded with active hyperemia produced by hot air.

On the other hand, I have successfully employed stasis hyperemia against all sorts of headache, especially anemic headaches, and the successes which we have achieved have been confirmed in other quarters. It also has a favorable effect on headaches from other causes, even in that produced by meningitis; for these we have employed it several times successfully to the extent that the patients complained less. In two cases of chorea, the remedy acted favorably; in one it produced an astonishing result. I have also tried stasis hyperemia on the head for epilepsy but could not observe a marked success.

The technic of stasis of the head is very simple. Apply a rubber bandage or, better still, an elastic bandage one side of which has hooks, the several eyes successively arranged in rows, so firmly around the neck that a perceptible hyperemia occurs in the skin of the face. Here, as elsewhere, the rule must be observed that the hyperemia must never aggravate but, on the contrary, diminish the symptoms. As soon as the patient begins to complain, either the bandage is too firmly applied or the case is not suitable for this treatment. I have given a detailed description of this method in an earlier contribution (209). I suspect that the better effect of the active form of hyperemia in neuralgias is due principally to increased absorption.

CHAPTER XXIV

USE OF HOT AIR IN DISEASES OF THE BLOOD-VESSELS

An old quarrel turns around the question whether the dilatation of the vessels which occurs after artificial bloodlessness, heat and similar effects is to be interpreted as a paralysis or irritation of the vessel nerves respectively vessels. As regards the reaction hyperemia of artificial bloodlessness, about which the former was the prevailing undisputed view, I believe that I have convincingly proved (210) that there can be no question of a paralysis. By analogy I conclude that the same is the case after heat effects, as long as we have no burns. If this dilatation by heat is an active process we have in it a remedy to exert a powerful stimulus on the vessels not unlike the effect by intense cold. This happens in a large number of hydrotherapeutic measures. But I believe that the effect of intense hot air in this branch is more effective than any other form of heat. I have frequently observed that in the circulatory disturbances of old fractures the edema and the lividity of the skin disappear much faster after it than any other remedy. The same holds good for a peculiar and disagreeable vascular disease, which is prevalent in Pomerania, leading to leg ulcers and eczema and counted among the varicose affections. The large veins in these cases are but little dilated but on standing there immediately appears a pronounced lividity and venous stasis in the skin of the leg, which again produce all the known phenomena preceding grave varices. Probably we have to deal with an affection of the small veins and perhaps also of the capillaries. [The method of treatment for varicose veins consisting in the strapping of the affected area by means of adhesive plaster strips has produced favorable results which undoubtedly are solely due to hyperemia. In one instance the patient, a woman of about fifty, could not tolerate the treatment because the straps irritated her skin. I suggested hot air and after ten treatments a small varicose ulcer which bothered her considerably had entirely disappeared and the general

tone of the vein was improved. In four other cases the results were promising in the beginning, but the patients did not continue the treatment long enough, preferring to wear elastic stockings.—*Ed.*]

Even in these stubborn cases hot air has repeatedly rendered us excellent service. Perhaps the addition of a cold douche, applied to the bright red limb immediately after its removal from the hot-air apparatus, has a still better effect. As is well known from hydrotherapy it is the rapid change between cold and warm which stimulates the vessels. At any rate, it seems to me that hot air is one of the most important agents with which to exercise diseased and inactive vessels (a sort of gymnastics of the vessels). Nor do we need to limit ourselves to the consideration of the arteries and veins. I believe I have demonstrated in my contribution on the development of collateral circulation that in the hyperemia produced by the dilatation of the vessels the capillaries play a prominently active role. In this case the hot air is to be employed one hour daily.

At the first glance one could assume that the favorable effect of hot air on frost-bite, which Ritter has established, is due to the exercise and strengthening of the apparently paralyzed vessels; but this view falls flat, for Ritter proved that the stasis hyperemia, too, is effective in such cases. Ritter's view that we have here to deal with a stimulation of the regeneration of the injured cells is probably correct.

CONCLUSION.

I hope that I have succeeded in sketching the outlines of a doctrine of the effect and application of hyperemia on as scientific a basis as that of any other of our therapeutic methods with the advantage of being simple and logical. It seems to me that I have presented views and observations sufficiently ripe, for I have practiced these methods for more than eleven years and as I have so far treated with hyperemia over a thousand cases, most of my assertions are based on unusually rich observation. I have intentionally avoided reporting experiments in other directions than those described, which have not led to definite results. It is for this reason that many diseases, besides those described, for which I have employed hyperemia, have been mentioned either superficially or not at all.

[In a private letter to the editor the author regrets that he has been unable to incorporate in his book the favorable results obtained with hyperemia in cases of teno-vaginitis and promises to publish them in another edition which, however, will not appear for some time.—*Ed.*]

But I am convinced that a remedy which nature uses so extensively for the removal of all possible injuries permits of a still wider application.

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