GIENE OF THE SICK-ROO

CANFIEL

THE

HYGIENE OF THE SICK-ROOM;

A BOOK FOR

NURSES AND OTHERS,

BEING A

BRIEF CONSIDERATION OF ASEPSIS, ANTISEPSIS, DISINFECTION, BACTERIOLOGY, IMMUNITY, HEATING AND VENTILATION, AND KINDRED SUBJECTS, FOR THE USE OF NURSES AND OTHER INTELLIGENT WOMEN.

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PREFACE.

This manual is the outcome of a series of lectures delivered before the University of Maryland Training School for Nurses. Its object is not to give a course in bacteriology, but to show in a clear way the connection between bacteria and disease, and how we may prevent the latter, by destroying as far as possible, the former. The subject, being a new department of medicine, is necessarily undergoing many changes. Things which are true to-day may be replaced to-morrow by stronger facts; therefore, while the author has tried as far as possible, to adhere to facts, and not indulge in fancies, it may be that he has made statements to which others might take exception, or to which they would not agree. At all events he has tried to state the truth, and if by chance he should have exaggerated the dangers of these bacteria, he hopes it will only serve to make the nurse more careful in her daily work.

W. B. C.

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INTRODUCTION.

It has long been conceded that skilled and trained labor of any kind accomplishes more good than ordinary unskilled labor. The physician has for years been trained and drilled in his work before starting on his life's career, while his most important assistant, the nurse, was, until very recently, a woman of more or less (generally less) intelligence, and with no other than picked-up knowledge. The trained nurse is now considered to be of so much importance in the sick-room that it is astonishing that the medical profession and the public were content to wait so long for her. So important is she, that it may be safely said that in many cases, particularly in typhoid fever and such wasting diseases, she really does as much, if not more, good than the physician. This, of course, is true only of the good nurse, the careful nurse, the *clean* nurse.

A nurse has power, too, to do much harm. Instead of preventing disease, as is her duty, she may carry it. She may be the means of unwittingly spreading contagion, when by a little precaution this could be avoided. To this end such a nurse should study the subject of preventive medicine, and know the reason why she does certain things. When Pope said, "A little learning is a dangerous thing," it is not clear what he exactly meant. In the present time such a statement would have to be modified. If this be taken in its literal sense, then many a physician, aye, many a man, carries a dangerous weapon in that "little learning."

While it may not be necessary for a nurse to take a practical course in bacteriology, yet she should have a good idea of the causes of contagion, the modes of infection, and understand some of the practical results of the laboratory. To this end this little book is offered to the nursing profession, with the hope that it may spread some clearer ideas on those invisible foes, the bacteria.

CHAPTER I.

BACTERIOLOGY.

It has often been asked what bacteria are and where they come from. These are questions which cannot be answered in a few words. That disease is never absent from a large community, or collection of people, is well known to all. Now the cause of the spread of disease was explained by attributing it to a *materies morbi,* but this expression was not explained.

But as we accumulate and compare experience, we believe more and more that all infectious diseases are caused by certain minute germs or microorganisms, of which the most important forms belong to the bacteria, and that each disease has its own particular organism, which always causes this disease in the person or animal susceptible to it, and never by any chance causes another disease. Now if these disease germs are not everywhere, they are so generally present that it is often a wonder that disease is not more prevalent than it actually is.

Knowing, as we do, the value of prevention, it is our duty as far as possible to try to keep these invisible foes from attacking the weaker members of humanity, and this the nurse has in her power to do as much as the physician, if not more so. To understand these micro-organisms is no small undertaking. Indeed, investigators in many parts of the world are devoting their whole life to the study and classification of these organisms, and yet they are far from comprehending the whole subject. Therefore it may seem almost futile to attempt to set forth in a clear manner just what these bacteria are and what bacteriology is.

These pathogenic or disease-producing germs may exist in the healthy body without necessarily giving rise to disease. In spite of the accumulation of new drugs and drug preparations, most thinking physicians admit that many diseases when once started cannot be shortened in their course by medication, even if some of the worst symptoms can be mitigated. Recognizing the fact that prevention is better than cure, the attempt has been made to cut short the spread of certain so-called preventable diseases by proper hygienic care. To do this is largely the province of the trained and skilled nurse, under the guidance of the physician. The same thing may be accomplished to a less degree by the intelligent mother, or by some other adult member of the family. To this end it should be impressed on every nurse, be she trained or not, that cleanliness is the essential to success in every case, whether in a surgical operation or in preventing the spread of certain diseases. She should also remember that hygienic cleanliness means much more than æsthetic cleanliness, the two being by no means identical. The scientific basis of preventive medicine must be the accurate knowledge of the causative agents of these diseases, and this is the study of bacteriology.

Bacteriology, as we now understand it, is the study of those minute organisms called bacteria, their appearance, shape, manner of growth and existence, and their effects on animals and human beings. This is in part what bacteriology means. The little organisms are called bacteria (little staves), bacilli (little rods), micrococci (little spheres). The rods and staves are of different lengths and thicknesses, and the spheres are like small billiard balls, and are sometimes spherical and sometimes oval; they may exist in pairs or chains. Although bacteriology has only been recognized as a part of medical science for about ten to fifteen years, still, the foundation of this subject was laid by botanists many years ago, and, indeed, some have thought it was only a more refined part of botany. It seems wonderful that such a science, and an important one, too, could have originated and could have created such revolutions in our ideas of the origin of disease as bacteriology has done. Strictly speaking, however, bacteriology had its beginning more than two hundred years ago, with certain observations made by a Dutchman (not a German, but a native of Holland) named Leeuwenhoek, who made the first discoveries in 1675. At this early date Leeuwenhoek, with the aid of a crude and imperfect microscope, endeavored to study these organisms, and tried to find out where they came from and what their connection was with certain epidemic diseases. Still later, Will, in 1752, endeavored to classify the then known bacteria, but his work amounted to little. In 1773–1786 Otto

Friedrich Müller gave some of these organisms names which we have not yet found it necessary to change. Thus we see that these few great minds, evidently far in advance of their time, and probably looked upon by their contemporaries as eccentrics, had done such good work that a part of it still stands, like the old Roman aqueducts, not to be improved upon at the present time.

One theory as to the existence of these bacteria was that of "spontaneous generation." All these investigators believed in the spontaneous growth of these substances, that they sprang into existence without parents, so to speak, just as we may see the growth or mould on the tops of the jelly glasses in the pantry ; it seems to have come from nothing. Now we believe, in this connection, that out of nothing, nothing can come, and that where bacteria are found, we may infer that they came from other bacteria before them. It was also thought that they sprang into existence from inorganic matter, and the question was, "Did they belong to the animal or vegetable kingdom?"—a problem which it has been difficult for many to solve. They lie so close to the borderland between animal and vegetable bodies, and possess so many characteristics of both, that proofs for either kingdom may be brought up, but they are generally classed with the vegetable. Their classification is very difficult; some are studied according to their shape, behavior under different circumstances—to be noted later—manner of growth on culture media, effects on animals, etc.

The two bacteriologists who are best known to the public at large, and who have probably done most for this department of medicine, are Pasteur and Koch. Pasteur's work was earlier and was on such subjects as the micro-organisms of fermentation, and this was applied practically to the making of yeast for purposes of fermentation. Then his work on the diseases affecting silk-worms, sheep, and chickens, and more recently his researches in hydrophobia, have not only been a valuable contribution to science, but have been of incalculable value in saving many lives and large sums of money. Koch, the German bacteriologist, is no less famous, if his work may not have yielded such practical results as Pasteur's. Koch's principal work is on the wound infection diseases, anthrax, tuberculosis, and Asiatic cholera.

In regard to these simple organisms themselves, it is very hard to give any conception of their size, but this may in a measure be done by comparison with objects whose size is already known. It will also be just as difficult to understand how it is possible to handle these little bodies, and to study them as we are able to do and learn their life history. Most of these organisms are rod-shaped, and an ingenious writer has said that fifteen hundred of the best known bacteria placed end to end would just reach across the head of a pin. This gives a much better idea of their size than if given in fractions of an inch or a millimeter. Their manner of growth varies; some grow out to great length and divide by constriction, others are formed from a central spot or spore within the rod. The rod opens and the seed or spore falls out and propagates its kind. In some forms they grow out to long chains before dividing.

The growth of these micro-organisms under ordinary circumstances is so rapid that a single germ may give rise to an incredible number in a short time; indeed, a writer has calculated that a single germ may give birth to sixteen and a half million germs in twenty-four hours; or, to make it more startling, a single bacillus the one one-thousandth of an inch in length, if allowed to increase without restriction, could in less than five days give rise to enough germs to fill as much space as is occupied by all the oceans on the earth's surface, supposing them to have an average depth of one mile. There need be no fear, however, for all these organisms are not harmful. On the contrary, many do good, as will be shown later; of those that are harmful many die, and on the principle of the survival of the fittest, not all bacteria that survive are pathogenic or disease-producing.

It is only necessary to look around us to notice of what benefit some of these micro-organisms are. Their presence, for instance, is one of the causes of fermentation, and they are cultivated for this purpose to be used in making beer, and they also give that peculiar odor and flavor to old cheese so dear to Epicureans. Another way in which these organisms do good is by splitting up the nitrogenous bodies and hastening decomposition. All refuse animal or vegetable matter thrown out or exposed to what we call decomposition disappears in time, and this disappearance is due to the activity of certain minute organisms which feed upon these substances and reduce them to their ultimate parts. Some organisms only live on living bodies, others on dead bodies, and some on both. They have many peculiarities; some cause that peculiar phosphorescence which we see on the water at times. Their manner of growth, too, is very peculiar; some are so hostile that they cannot live in each other's presence; others, again, are so affectionate that, like Damon and Pythias, they cannot live apart.

Thus we see that these bacteria make known their presence in various ways. To say that they are everywhere would be exaggerating the truth, but that they are very prevalent is without doubt. They are particularly prevalent in crowded communities, in cities, and in enclosed places where many people come together; this is especially true in hospitals. Such bodies have a tendency to settle to the ground, so that the air in a closed room is comparatively free from these impurities, but in a room in which there is motion and the air is disturbed by walking, the dust thus driven about by currents of air contains numbers of these organisms. It is only necessary to notice a sunbeam slanting across the room in which there is much dust to prove this statement. Again, such organisms are less abundant when the ground surface is moist, so that the germs adhere and have no tendency to fly about. If, then, disease is so prevalent in the form of these minute organisms in the air, it seems wonderful, indeed, that so many escape, but that there are good reasons why so many escape will be shown later.

The methods of study of these organisms are threefold—by the microscope, by cultivation, and by inoculation into animals. As seen under the microscope, these bacteria usually have no color, therefore we have to make use of certain artificial stains to make them visible, and even then we must use lenses which magnify from five hundred to fifteen hundred times. The staining fluids which we usually employ are the aniline colors, products of coal tar. They are fuchsine or red, violet, blue, and brown. The principle of staining depends upon the fact that most bacteria hold the stain much faster than other substances on the slide. For instance, in staining a preparation, the coloring fluid is poured on and every part is stained homogeneously; then, recognizing the fact experience has taught us, that bacteria have a greater affinity for these coloring fluids than for any other substances, the preparation is decolorized. This is usually done with some weak acid. Thus, suppose the preparation has been stained with fuchsine; it is dipped into a weak solution of muriatic acid, which washes out the color, and as the bacteria hold on to the color more closely than the other tissues, a point is reached which repeated experiments have shown to be right where the bacteria are stained and all else is unstained. By using these stains in this way, which it is hardly necessary to describe more fully, we are enabled to study the shape of these little bodies with exactness.

Naturally, the process of coloring deprives them of life, on account of the immersions into alcohol and acids; therefore if it be desired to study these organisms in motion (that is, those that have independent motion), it must be done in an uncolored condition, which is very difficult. As so many of these organisms have nearly the same shape and size and general appearance, we must resort to other additional means to differentiate and classify them. This we do by cultivating them in suitable media. The culture media most frequently used are made of bouillon, gelatine, and agar-agar. Constant study by professional bacteriologists has shown that some bacteria grow better on one medium and others better on another. In looking at the two solid media, gelatine and agar-agar, we notice first whether in its growth the organism cultivated liquefies the medium or not, or whether it grows as a filmy gauze on the surface of the medium, or whether it produces a growth of coloring substance on the surface. The way we separate one kind of organism from another, in a mixture containing several different kinds, is by the very ingenious plate method first suggested by Koch. If we have a handful of various kinds of seeds, such as grass, hay, rye, barley, etc., and are not able to separate them by looking at them, it is possible to resort to the method of strewing them on a piece of ground, and when they grow each particular kind may be separated from the others. Now in the same way bacteriologists separate a large number of bacteria in the same mixture. For instance, a little of a mixture containing several different kinds of bacteria is put into a test tube containing sterilized and liquefied agar-agar, which is then poured upon a glass plate which has been thoroughly sterilized. This is carefully covered to keep micro-organisms from falling on it, and it is put into the thermostat or brood-oven, that is, a small cupboard in which the temperature is automatically always kept at $98\frac{3}{5}$° F., body heat. The bacteria which are in the agar-agar are thus scattered over this entire surface, and after twenty-four hours in the thermostat, on looking at the plate, we see scattered here and there different kinds of growths or colonies, as they are called. By carefully studying these different colonies, and taking a little bit from each one and putting it on a cover glass and staining it in the manner above described, we are able much more exactly to distinguish the various kinds, and by putting the plate under a low power of the microscope we may study the shape of each colony and its manner of growth. In these two ways, by repeated study we are able to distinguish and classify a large number of the bacteria.

The third method, that of inoculation, is absolutely necessary in order to prove that a certain organism is the cause of a certain disease; for example, two different bacteria may have the same appearance microscopically, and the same peculiarities of growth on the media, and yet when inoculated under the skin of a susceptible animal produce entirely different results. Before we can be sure that a given organism is the cause of a given disease, we must be able to take it from the diseased animal or man, assure ourselves of its shape, size, appearance, and manner of growth, and reproduce the same disease from its inoculation into the same kind of animal. This has been done in comparatively few diseases. Those diseases in which we are certain of the specific organisms are tuberculosis, Asiatic cholera, typhoid fever, erysipelas, relapsing fever, glanders, leprosy, malaria, and a few others.

The bacteria of most diseases are generally rather easily destroyed by heat, by certain antiseptics, and some by prolonged drying and by freezing, but their spores possess great powers of endurance and are very resistant. For instance, while bacteria cannot grow in ice, their spores, and even they themselves, remain viable, and when brought into the proper conditions can cause the growth of fresh bacteria; thus we believe that infected water may freeze and form ice containing a large number of bacteria, whose power to do harm is held in abeyance; but let that ice once be brought into use, and it can spread such a disease as typhoid fever.

There are other forms of minute organisms capable of causing infectious diseases besides the bacteria. The parasite causing malaria, for instance, is not one of the bacteria, but belongs probably to the sporozoa, a low form of animal life. A form of dysentery is caused by an amœba. It is possible

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that many of the contagious diseases the specific causes of which have not yet been discovered are produced by parasitic organisms which are not bacteria. We are, however, most familiar with the life history and properties of the bacteria.

CHAPTER II.

INFECTION AND DISINFECTION.

In setting out on a new subject there necessarily arise certain expressions, some technical, others of more general use, whose exact definition is not very clear, and yet which the student should try to understand at the start. The question is often asked, "What is the difference between contagious and infectious?" This question is more easily asked than answered. In reality, the two words have not kept up with the onward march of medical science, and the difficulty of a distinction is only too apparent to those who will take the trouble to consult the best authorities. Contagious means infection by contact, whether mediate or immediate, while infectious means a condition produced by any poison from without. Infectious is a broader term and includes contagious. Whatever is contagious is infectious, but not all that is infectious is contagious. Infection has also been defined as the condition produced by the entrance and multiplication of pathogenic or disease-producing micro-organisms within the body.

When the material from a diseased person is inserted into the body of a healthy person and the disease is reproduced it is called inoculable. Some diseases are inoculable which are not infectious, and the reverse is true. The word communicable may be used to cover all these ways of conveying disease. When we say that a disease is infective, we mean that it infects or affects the whole body as distinguished from those diseases which affect a part of the body only. Most contagious diseases are infective, but when a disease such as ringworm can be inoculated into different parts of the body at once, this is an exception. In this way we test sometimes whether a disease has become general or is only local; for when infective, no local manifestations will appear on inoculation.

When a person is inoculated with a disease there is evidently a poison introduced into the system—a poison which grows and reproduces itself in the body almost indefinitely. This poison is living. This is very different from the poisoning caused by a mineral or inorganic substance, which may cause death but never increases in amount in the body. In all these diseases there is an attempt on the part of nature to get rid of the poison. This is done through the skin, the intestinal tract, etc.

The malarial diseases, Asiatic cholera and typhoid fever, represent the miasmatic-contagious diseases which are caused by a specific poison usually existing outside of the body and received into it from time to time. Such diseases are not supposed to be communicable from one individual to another. The eruptive diseases pass from one person to another and are more strictly contagious.

Thus the two words, contagious and infectious, are used rather loosely, and one can hardly be blamed for this when the advances in this branch of medicine are considered, while these two words have existed on, not keeping up with the times.

Diseases that occur in certain localities in sudden and violent outbreaks, affecting a large number in proportion to the population, are called epidemic; while those diseases which prevail in a given place are called endemic; and those which have a tendency to spread rapidly are called pandemic. These diseases do not appear as soon as the system is exposed to them, but take a certain time to develop. This is called the stage of incubation, and varies in different diseases. The following is a list of the principal diseases with their periods of incubation :—

Measles, ...	10 days
Scarlet fever, ...	4 to 7 "
Small-pox, ...	9 to 16 "
Varioloid, ...	9 to 16 "
Chicken-pox, ...	2 to 4 "
Typhoid fever, ...	7 to 21 "
Typhus fever, ...	2 to 21 "
Relapsing fever, ...	5 to 7 "
Malaria (intermittent fever), . . .	7 to 21 "
Erysipelas, ...	1 to 3 "
Diphtheria, ...	3 "
Mumps, ...	18 "

These periods of incubation may vary according to circumstances. They are especially variable when attempts have been made to prevent the disease by disinfection.

In attempting to check the spread of these infectious diseases, we have always the fact that they are caused by some *materies morbi* or morbid matter, and experience shows that certain substances are of great use in the sick-room and elsewhere in preventing the further spread of disease, and in destroying the disease poison as soon as it has left the body of the patient. The various substances used are called antiseptics, disinfectants, and deodorants. Unfortunately, these terms have been so much confused that not only the non-medical public, but even many of the medical profession, do not know the difference, or, if they do know, misapply these terms to the confusion of others. An antiseptic is that which retards, prevents, or arrests putrefaction, decay, or fermentation, or the bacteria which cause these; while a disinfectant is that which entirely destroys the poison and the germs which cause it. A deodorant is simply that which removes or deadens unpleasant smells. A substance may be malodorous and yet be harmless, and one may be free from odor and be teeming with dangerous germ life.

It might be unpleasant to some nurses if told that they must keep clean in their vocation. If told that cleanliness meant "freedom from dirt, filth, or any foul matter," as the dictionary defines it, it would sound very harsh indeed, for one's first idea of a modern hospital nurse is a woman above all things neat, tidy, and clean. It is not so much the presence of actual dirt visible to the naked eye that does harm, but that minute microscopical dust to which disease-producing germs are attached. Against such substances does the nurse have to guard, and to the presence and action of such minute bodies are due many of the diseases which are never absent from a large hospital or community.

The principal modes of infection are by the air, water, and food. The number of bacteria in the air varies greatly according to certain conditions. On high mountains and far out at sea the air is generally free from bacteria; the nearer we approach civilization the more abundant are the bacteria in the air. Indeed, many of the diseases are introduced into the system through the mouth and breathing apparatus, and the organisms of wound infection usually gain access to the body by the air. The latter are particularly abundant in the air of infected regions, such as in hospitals, etc. The organism of malaria, as is well known, can be carried by the air to great distances and cause the disease in regions where one would not expect to find it. This may be readily believed when we know that sand and dust may be lifted by the wind and carried incredible distances. Thus sand and dust from the great African desert have been found in sand showers in Berlin, and sand showers have also occurred on ships six hundred to eight hundred miles from land. Such showers have also been described in the western part of the United States. In enclosed places, and especially in hospitals, the air, rendered impure by the exhalations of the sick, may contain almost any kind of organism in addition to the unhealthy excretions from the body, which when dried may be carried about the room.

The soil or ground contains a large number of organisms which by gravitation find their way to the ground very easily. The bacilli of typhoid fever or Asiatic cholera—germs of the greatest interest to mankind—may be found in some soils, and the bacillus of tuberculosis is also at times found in the ground, while certain kinds of earths seem constantly to contain the organism of tetanus. These organisms, however, are usually only on the surface, and a few feet below the surface there are absolutely no germs to be found. While the soil may keep certain organisms viable for a longer or shorter time, it is, fortunately, not a good breeding place for them. This is particularly noted in cemeteries. Bodies of persons dying from the more common infectious diseases might be supposed to spread the disease, but this is not so, for the antagonism between the germs of decomposition and the germs of the infectious diseases causes a gradual destruction of both and a lessening of the spread of disease. Hence one rarely or never hears of authenticated accounts of the spread of disease from a cemetery. Of course, such varying conditions as moisture, porosity, quality of soil, etc., may vary the length of life of germs in the soil.

Dr. William H. Welch, in the *Medical News*, says in this connection that "the soil is not a good breeding-place for most of the infectious bacteria with which we are acquainted, but that it can retain for a long time with unimpaired vitality those which produce spores or which offer considerable resistance to injurious agencies, such as anthrax bacilli, tubercle bacilli, and the pyogenic cocci." In this connection the same author adds :—" Before leaving the subject of the ground as a source of infection, permit me to indicate briefly some conclusions which may be drawn from what has been said as to the principles which should guide us in preventing infection, directly or indirectly, from the ground.

" *First* in importance is to keep infectious substances as far as possible from the ground. This implies the early disinfection or destruction of such substances as typhoid and cholera excreta and tuberculous sputum.

" *Second.* The ground should be rendered as far as practicable unsuitable for the continued existence of infectious germs. This, at least for some diseases, is accomplished by a proper system of drainage, which, moreover, for other reasons, possesses hygienic importance.

" *Third.* Means should be provided to prevent waste products from getting into the ground around human habitations, or from gaining access to water used for drinking or domestic purposes. In cities this can be accomplished only by a properly constructed system of sewers. The system of storing waste products in cess-pools, whence they are to be occasionally removed, cannot be approved on hygienic grounds. There are conditions in which the disposal of waste products in deep wells used for this purpose, and whence these products can filter into the deep layers of the ground, may be permissible, but this can never be considered an ideal method of getting rid of excrementitious substances, and is wholly wrong in regions where wells are used for drinking water. But I am trespassing with these remarks upon a province which does not belong to me, but rather to practical sanitarians and engineers. I shall add that the advantage gained by preventing organic waste from soaking into the ground is not so much that the ground is thereby rendered better adapted to the existence of infectious micro-organisms, but is due rather to the fact that this waste is likely to contain infectious germs.

"*Finally*, in cities, good pavements, absence of unnecessary disturbance of the soil, cleanliness of the streets, and laying of dust by sprinkling, are not only conducive to comfort, but are sometimes hygienically important in preventing infection from the ground and dust."

Food is often the means of conveying germs into the body. Bacteria in the air may fall on the food in its natural condition, as on fruit and uncooked food, and be taken into the stomach. In the same way flies and other insects may step in contagious substances and deposit some of this on food. It is not impossible that such vegetables as lettuce may be a means of conveying disease poison to the body. Such vegetables as grow near the ground and are eaten uncooked are the most favorable conveyers of disease germs. It is very conceivable that a farmer, with the desire to raise as large and productive a crop of lettuce and other such vegetables as possible, will fertilize his field both before and during the crop with fæces containing, for example, typhoid bacilli. Fortunately, much of our food is eaten in a cooked condition, and the high temperature necessary for the cooking is always sufficient to destroy noxious germs and their spores.

Water may become a constant source of contamination, and particularly is it a conveyer of typhoid fever and Asiatic cholera, not only when it is taken into the body, but when it is used for the purpose of cleansing vessels in which food or milk is put and kept. Ice, another form of water, is by no means an uncommon cause of typhoid fever. Many of the filters in daily use for the purification of drinking water are of doubtful character. Milk is a very dangerous article of diet when not pure. In it many a disease germ may grow or remain alive and cause such diseases as tuberculosis, typhoid fever, etc. Of course, it is well known that the larger parasites, such as the tapeworm, get into the body through the food and drink. Many of the scrofulous affections in children are undoubtedly due to infection from milk derived from tuberculous cows.

It is hard to understand how some of the infectious diseases are hereditary. An inherited defect in the tissues causing defective vital resistance may be the cause of some diseases. This predisposition passes from parent to child. Also the essential cause of the disease may be transmitted from mother to fœtus. This has been shown in erysipelas.

Water shown by chemical tests to be pure may contain typhoid bacilli; on the other hand, the air of some of the apparently worst sewers has been found to be free from bacteria. For this reason it is never right to brand an article of food or drink as pure or impure until it has been tested both chemically and bacteriologically. To the nurse these facts may not be of so much practical use as of scientific interest, but the intelligent nurse cannot help being glad to know why she does so many things which otherwise would seem to her useless. These dangers from air, water, and food should always be considered by the healthy, and much more so by the sick, for it is well known that a diseased respiratory or digestive tract is much more susceptible to the attacks of disease in the form of these bacteria than when a condition of health exists. Indeed, the theory that fatigue invites disease by making the powers of resistance too weak can readily be accepted, but this will be considered in another chapter.

Disinfection consists in making harmless all infective material, that is, in destroying all disease-producing germs. It is, therefore, the fundamental idea in preventing infectious diseases. The ancients and those of more modern times used fire as a means of destroying objects infected by disease, and later on certain chemicals were used for the same purpose, but this was done in a hap-hazard way. It is only in the most recent times, since bacteriology has shown itself to be the scientific basis of all disinfection, that the work has been carried on in a thorough manner. The question as to what should be disinfected and what not, is answered by saying that everything containing disease germs or their spores should be disinfected, and this disinfection is not complete until all the bacteria and their spores have been destroyed.

The three methods of disinfecting most usually employed are, the physical, the chemical, and the mechanical.

Fire, used directly on such objects as will not be harmed by it, is the best disinfectant. Exposing objects to moist heat for a sufficient length of time will thoroughly destroy all bacteria and their spores. Thus tuberculous sputum is rendered harmless after being cooked for twenty minutes, and typhoid bacilli in fifteen minutes. All substances to be washed should first be boiled and occasionally stirred to insure a thorough disinfection in all parts. Dry heat was used for some time as a disinfectant, but it failed to give satisfaction. Many germs were destroyed by it, but the spores of these germs seemed to withstand the dry heat for a long time. It was seen that such objects as pillows, bed-covers, etc., could not be thoroughly disinfected in this way, as the dry heat could not penetrate into the centre, and this part was often many degrees lower than the outside. Far better and more effective is steam heat under pressure, which penetrates much more rapidly than dry heat, and disinfects much more thoroughly. Cold and ventilation have also been suggested as disinfectants. Cold will kill some bacteria, but in general has no effect on their spores. Ventilation, as is shown in another chapter, dilutes the number of germs in a given space, but does not destroy them.

Among the chemical disinfectants, corrosive sublimate (1 : 1000) has until very lately been looked on as a perfect disinfectant. Almost all books on the subject recommend it, and especially surgeons use it for the disinfection of the hands and whatever is not affected by its chemical properties. Recent experiments made at several laboratories, and especially at the Johns Hopkins Pathological Laboratory, have satisfactorily proved that corrosive sublimate is a less reliable disinfectant than has been generally supposed. This statement is made because its powers of disinfection have for so long been accepted without a question that harm has doubtless been done by an undue faith without sufficient proof. Pouring corrosive sublimate solution into spit cups was formerly considered as sure disinfection. Now it is known that a five per cent. carbolic acid solution is better, and boiling out the cups is the best thing of all. Carbolic acid is a good disinfectant, because it does not hurt the metal of the instruments. When no spores are present, a two to three per cent. solution of carbolic acid will disinfect, but a five per cent. solution is necessary to destroy spores.

An excellent disinfectant is the oxide of calcium, or quicklime. Pfuhl, in the "Zeitschrift für Hygiene," Vol. 6, gives the following directions for using quicklime in disinfecting fæces. Slake calcined lime in a wooden tub or vessel with water, using about 60 parts of water to 100 parts of calcined lime. This produces calcium hydrate in powder. Mix this powder in the proportion of about one part to four parts of water. This makes milk of lime, or lime-water. This is an excellent disinfectant, especially for fæces. It should be thoroughly mixed with typhoid fever fæces until they are strongly alkaline, then allowed to stand about four hours, and then they may be thrown out without danger. The important point to be remembered is that the disinfectant should be thoroughly mixed with the suspected fæces, and then allowed to stand before being disposed of. The nurse has a strong temptation to add the disinfectant and then throw out the fæces at once.

Creolin has met with some favor as a lubricant and disinfectant in making digital examinations of the vagina and uterus.

The trichloride of iodine, aseptol, chloride of zinc, the diluted mineral acids, and certain chemical gases have all more or less powers of germ destruction. In using sulphur, as is emphasized elsewhere, it should be remembered that it is only effective in the presence of moisture.

Mechanical disinfection can accomplish much good. Cleaning with brooms, brushes, wash-cloths, with the help of pumice stone and sand, removes mechanically many bacteria. Esmarch has advocated the rubbing off of the walls and floor of an infected room with dry bread crumbs, taking care afterward to burn the bread. It is astonishing how many bacteria can be removed by this simple method. Of course, all the implements used in cleaning should be sterilized or destroyed by burning. This method of cleaning should not take the place of the first-mentioned ways, but should precede them.

In using disinfection, it should be borne in mind that that method which is the most thorough, which disinfects the object most quickly, is the one to be preferred. Again, all things being equal, the simplest, cheapest, and most harmless method of disinfection should be employed. Lastly, disinfection should be carried out by those thoroughly skilled in the work. This is especially necessary because danger of spreading a disease is much greater when disinfection is badly carried out, rooms and objects being used which are by no means free from danger. Disinfection is practiced on the living, the dead, on products of secretion and excretion, on rooms, and on all objects which come near the patient and on all food which is suspected or likely to be dangerous. The diseases mentioned are the principal ones against which disinfection is practiced. That city Health Boards are not governed by the most recent knowledge is shown by the fact that the Health Board of Baltimore requires notification of such a disease as mumps, but does not require an inspection in case of typhoid fever.

In the report of the Committee on Disinfectants appointed by the American Public Health Association, conclusions were drawn as to the most useful agents for the destruction of spore-containing infectious material as follows:—

1. *Fire.* Complete destruction by burning.

2. *Steam under pressure.* 105° C. (221° F.) for ten minutes.

3. *Boiling in water* for half an hour.

4. *Chloride of lime.** A four per cent. solution.

5. *Mercuric chloride.* A solution of 1 : 500.

For the destruction of infectious material which owes its infecting power to the presence of micro-organisms not containing spores, the Committee recommends:—

1. *Fire.* Complete destruction by burning.

2. *Boiling in water* for ten minutes.

3. *Dry heat.* 110° C. (230° F.) for two hours.

4. *Chloride of lime.* A two per cent. solution.

5. *Solution of chlorinated soda.*† A ten per cent. solution.

6. *Mercuric chloride.* A solution of 1 : 2000.

7. *Carbolic acid.* A five per cent. solution.

8. *Sulphate of copper.* A five per cent. solution.

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* Should contain at least twenty-five per cent. of available chlorine.

† Should contain at least three per cent. of available chlorine.

9. *Chloride of zinc.* A ten per cent. solution.

10. *Sulphur dioxide.** Exposure for twelve hours to an atmosphere containing at least four volumes per cent. of this gas in presence of moisture.

The Committee would make the following recommendations with reference to the practical application of these agents for disinfecting purposes:—

FOR EXCRETA.

(*a*) In the sick-room:—

1. Chloride of lime in solution, four per cent.

In the absence of spores:—

2. Carbolic acid in solution, five per cent.

3. Sulphate of copper in solution, five per cent.

(*b*) In privy vaults:—

1. Mercuric chloride in solution, 1 : 500.†

2. Carbolic acid in solution, five per cent.

(*c*) For the disinfection and deodorization of the

* This will require the combustion of between three and four lbs. of sulphur for every 1000 cubic feet of air space.

† The addition of an equal quantity of potassium permanganate as a deodorant, and to give color to the solution, is to be recommended.

surface of masses of organic material in privy vaults, etc. :—

Chloride of lime in powder.

FOR CLOTHING, BEDDING, ETC.

(*a*) Soiled underclothing, bed-linen, etc. :—

1. Destruction by fire, if of little value.

2. Boiling for at least half an hour.

3. Immersion in a solution of mercuric chloride of the strength of 1 : 2000 for four hours.

4. Immersion in a two per cent. solution of carbolic acid for four hours.

(*b*) Outer garments of wool or silk, and similar articles, which would be injured by immersion in boiling water or in a disinfecting solution :—

1. Exposure in a suitable apparatus to a current of steam for ten minutes.

2. Exposure to dry heat at a temperature of 110° C. (230° F.) for two hours.

(*c*) Mattresses and blankets soiled by the discharges of the sick :—

1. Destruction by fire.

2. Exposure to super-heated steam, 105° C. (221° F.), for ten minutes.

(Mattresses to have the cover removed or freely opened.)

3. Immersion in boiling water for half an hour.

FURNITURE AND ARTICLES OF WOOD, LEATHER, AND PORCELAIN.

Washing, several times repeated, with :—
Solution of carbolic acid, two per cent.

FOR THE PERSON.

The hands and general surface of the body of attendants of the sick and of the convalescents should be washed with :—

1. Solution of chlorinated soda diluted with nine parts of water, 1 : 10
2. Carbolic acid, two per cent. solution.
3. Mercuric chloride, 1 : 1000.

FOR THE DEAD.

Envelop the body in a sheet thoroughly saturated with :—

1. Chloride of lime in solution, four per cent.
2. Mercuric chloride in solution, 1 : 500.
3. Carbolic acid in solution, five per cent.

FOR THE SICK-ROOM AND HOSPITAL WARDS.

(*a*) While occupied, wash all surfaces with :—

1. Mercuric chloride in solution, 1 : 1000.

2. Carbolic acid, in solution, two per cent.

(*b*) When vacated, fumigate with sulphur dioxide for twelve hours, burning at least three pounds of sulphur for every 1000 cubic feet of air-space in the room; then wash all surfaces with one of the above-mentioned disinfecting solutions, and afterward with soap and hot water; finally, throw open doors and windows and ventilate freely.

In reading over this formidable list of disinfectants the nurse may well be puzzled to know what to choose from so large a list. This list has not been published without objections. The efficiency of the mercuric chloride solutions has at times been questioned; the fumigation with sulphur in a closed room has also been viewed with skepticism by some. The use of too strong a solution of mercuric chloride hardens the hands to an unpleasant degree, and, as is now fully appreciated, destroys the cutting edge of surgical instruments. In general the two most commonly used disinfectants are the mercuric chloride solution, 1 : 1000, and the carbolic acid solution, five per cent.

The same American Public Health Association, through its Chairman of the Committee on Disinfectants, has prepared a report which is considered important enough to be reproduced here verbatim.

" DISINFECTION AND DISINFECTANTS.

"The object of disinfection is to prevent the extension of infectious diseases by destroying the specific infectious material which gives rise to them. This is accomplished by the use of disinfectants.

"There can be no partial disinfection of such material; either its infecting power is destroyed or it is not. In the latter case there is a failure to disinfect. Nor can there be any disinfection in the absence of infectious material.

"It has been proved for several kinds of infectious material that its specific infecting power is due to the presence of living micro-organisms, known in a general way as "disease germs;" and practical sanitation is now based upon the belief that the infecting agents in all kinds of infectious material are of this nature. Disinfection, therefore, consists essentially in the destruction of disease germs.

"Popularly, the term disinfection is used in a much broader sense. Any chemical agent which destroys or masks bad odors, or which arrests putrefactive decomposition, is spoken of as a disinfectant. And in the absence of any infectious disease it is common to speak of disinfecting a foul cesspool or a bad-smelling stable or privy-vault.

"This popular use of the term has led to much misapprehension, and the agents which have been found to destroy bad odors—deodorizers—or to arrest putrefactive decomposition—antiseptics—have been confidently recommended and extensively used for the destruction of disease germs in the excreta of patients with cholera, typhoid fever, etc.

"The injurious consequences which are likely to result from such misapprehension and misuse of the word disinfect will be appreciated when it is known that recent researches have demonstrated that many of the agents which have been found useful as deodorizers or as antiseptics are entirely without value for the destruction of disease germs.

"This is true, for example, as regards the sulphate of iron, or copperas, a salt which has been extensively used with the idea that it is a valuable disinfectant. As a matter of fact, sulphate of iron in saturated solution does not destroy the vitality of disease germs or the infecting power of material containing them. This salt is, nevertheless, a very valuable antiseptic, and its low price makes it one of the most available agents for the arrest of putrefactive decomposition.

"Antiseptic agents, however, exercise a restraining influence upon the development of disease germs, and their use during epidemics is to be recommended when masses of organic material in the vicinity of human habitations cannot be completely destroyed, or removed, or disinfected.

"While an antiseptic agent is not necessarily a disinfectant, all disinfectants are antiseptics; for putrefactive decomposition is due to the development of "germs" of the same class as that to which disease germs belong, and the agents which destroy the latter also destroy the bacteria of putrefaction when brought in contact with them in sufficient quantity, or restrain their development when present in smaller amounts. A large number of the proprietary "disinfectants," so-called, which are in the market are simply deodorizers or antiseptics, of greater or less value, and are entirely untrustworthy for disinfecting purposes.

"Antiseptics are to be used at all times when it is impracticable to remove filth from the vicinity of human habitations, but they are a poor substitute for cleanliness. During the prevalence of epidemic diseases, such as yellow fever, typhoid fever, and cholera, it is better to use in privy-vaults, cess-pools, etc., those antiseptics which are also disinfectants, *i. e.*, germicides; and when the contents of such receptacles are known to be infected, this becomes imperative.

"Still more important is the destruction at our seaport quarantine stations of infectious material which has its origin outside of the boundaries of the United States, and the destruction, within our boundaries, of infectious material given off from the persons of those attacked with any infectious disease, whether imported or of indigenous origin.

"In the sick-room we have disease germs at an advantage, for we know where to find them as well as how to kill them. Having this knowledge, not to apply it would be criminal negligence, for our efforts to restrict the extension of infectious diseases must depend largely upon the proper use of disinfectants in the sick-room.

"GENERAL DIRECTIONS.

"*Disinfection of Excreta, etc.* The infectious character of the dejections of patients suffering from cholera and from typhoid fever is well established; and this is true of mild cases and of the earliest stages of these diseases as well as of severe and fatal cases. It is probable that epidemic dysentery, tuberculosis, and perhaps diphtheria, yellow fever, scarlet fever, and typhus fever may also be transmitted by means of the alvine discharges of the sick. It is, therefore, of the first importance that these should be disinfected. In cholera, diphtheria, yellow fever, and scarlet fever all vomited material should also be looked upon as infectious. And in tuberculosis, diphtheria, scarlet fever, and infectious pneumonia the sputa of the sick should be disinfected or destroyed by fire. It seems advisable also to treat the urine of patients sick with an infectious disease with one of the disinfecting solutions below recommended.

"Chloride of lime or bleaching powder is perhaps entitled to the first place for disinfecting excreta, on account of the rapidity of its action. The following standard solution is recommended:—

"*Dissolve chloride of lime of the best quality* in pure water, in the proportion of six ounces to the gallon.*

"Use one quart of this solution for the disinfection of each discharge in cholera, typhoid fever, etc.† Mix well and leave in the vessel for at least one hour before throwing into privy-vault or water-

* Good chloride of lime should contain at least twenty-five per cent. of available chlorine. It may be purchased by the quantity at three and a half cents per pound. The cost of the standard solution recommended is therefore but little more than one cent a gallon. A clear solution may be obtained by filtration or by decantation, but the insoluble sediment does no harm, and this is an unnecessary refinement.

† For a very copious discharge, use a large quantity.

closet. The same directions apply for the disinfection of vomited matters. Infected sputum should be discharged directly into a cup half full of the solution. A five per cent. solution of carbolic acid may be used instead of the chloride of lime solution, the time of exposure to the action of the disinfectant being four hours.

"*Disinfection of the Person.* The surface of the body of a sick person, or of his attendants, when soiled with infectious discharges, should be at once cleansed with a suitable disinfecting agent. For this purpose solution of chlorinated soda (liquor sodæ chlorinatæ) diluted with nine parts of water, or the standard solution of chloride of lime diluted with three parts of water, may be used. A two per cent. solution of carbolic acid is also suitable for this purpose, and under proper medical supervision the use of a solution of corrosive sublimate—1 : 1000—is to be recommended.

"In diseases like small-pox and scarlet fever, in which the infectious agent is given off from the entire surface of the body, occasional ablutions with the above-mentioned solution of chlorinated soda are recommended.

"In all infectious diseases the body of the dead should be enveloped in a sheet saturated with the standard solution of chloride of lime, or with a five per cent. solution of carbolic acid, or a 1 : 500 solution of corrosive sublimate.

"*Disinfection of Clothing.* Boiling for half an hour will destroy the vitality of all known disease germs, and there is no better way of disinfecting clothing or bedding which can be washed than to put it through the ordinary operations of the laundry. No delay should occur, however, between the time of removing soiled clothing from the person or bed of the sick and its immersion in boiling water, or in one of the following solutions until this can be done :—

"*Corrosive sublimate*, one drachm to the gallon of water (about 1 : 1000), or,

"Carbolic acid, pure, one ounce to the gallon of water (1 : 128).

"The articles to be disinfected must be thoroughly soaked with the disinfecting solution and left in it for at least two hours, after which they may be wrung out and sent to the wash.

"N. B. Solutions of corrosive sublimate should not be placed in metal receptacles, for the salt is decomposed and the mercury precipitated by contact with copper, lead, or tin. A wooden tub or earthen crock is a suitable receptacle for such solutions.

"Clothing or bedding which cannot be washed should be disinfected by steam in a properly constructed disinfection chamber. In the absence of a suitable steam disinfecting apparatus, infected clothing and bedding should be burned.

"*Disinfection of the Sick-room.*—In the sick-room no disinfectant can take the place of free ventilation and cleanliness. It is an axiom in sanitary science that it is impracticable to disinfect an occupied apartment for the reason that disease germs are not destroyed by the presence in the atmosphere of any known disinfectant in respirable quantity. Bad odors may be neutralized, but this does not constitute disinfection in the sense in which the term is here used. These bad odors are, for the most part, an indication of want of cleanliness or of proper ventilation; and it is better to turn contaminated air out of the window or up the chimney than to attempt to purify it by the use of volatile chemical agents, such as carbolic acid, chlorine, etc., which are all more or less offensive to the sick, and are useless so far as disinfection—properly so called—is concerned.

"When an apartment which has been occupied by a person sick with an infectious disease has been vacated, it should be disinfected. The object of disinfection in the sick-room is mainly the destruction of infectious material attached to surfaces, or deposited as dust upon window ledges, in crevices, etc. If the room has been properly cleansed and ventilated while still occupied by the sick person, and especially if it was stripped of carpets and unnecessary furniture at the outset of his attack, the difficulties of disinfection will be greatly reduced. All surfaces should be thoroughly washed with the standard solution of chloride of lime diluted with three parts of water, or with 1 : 1000 solution of corrosive sublimate. The walls and ceiling, if plastered, should be subsequently treated with a lime-wash. Especial care must be taken to wash away all dust from window ledges and other places where it may have settled, and thoroughly to cleanse crevices and out-of-the-way places. After this application of the disinfecting solution, and an interval of twenty-four hours or longer for free ventilation, the floors and wood-work should be well scrubbed with soap and hot water, and this should be followed by a second more prolonged exposure to fresh air, admitted through open doors and windows.

"As an additional precaution, fumigation with sulphurous acid gas is to be recommended, especially for rooms which have been occupied by patients with small-pox, yellow fever, scarlet fever, diphtheria, and typhus fever. But fumigation with sulphurous acid gas alone, as commonly practiced, cannot be relied upon for the disinfection of the sick-room and its contents, including bedding, furniture, infected clothing, etc., as is popularly believed.

" When fumigation is practiced, it should precede the general washing with a disinfecting solution, heretofore recommended. To insure any results of value, it will be necessary to close the apartment to be disinfected as completely as possible by stopping all apertures through which the gas might escape, and to burn not less than three pounds of sulphur for each thousand cubic feet of air space in the room. To secure complete combustion of the sulphur, it should be placed, in powder or in small fragments, in a shallow iron pan, which should be set upon a couple of bricks in a tub partly filled with water, to guard against fire. The sulphur should be thoroughly moistened with alcohol before igniting it.

"*Disinfection of Privy-vaults, Cess-pools, etc.* When the excreta (not previously disinfected) of patients with cholera or typhoid fever have been thrown into a privy-vault, this is infected, and disinfection should be resorted to as soon as the fact is discovered, or whenever there is reasonable suspicion that such is the case. It will be advisable to take the same precautions with reference to privy-vaults into which the excreta of yellow fever patients have been thrown, although we do not definitely know that this is infectious material.

"For this purpose the standard solution of chloride of lime may be used in quantity proportioned to the amount of material to be disinfected, but where this is considerable it will scarcely be practicable to sterilize the whole mass. The liberal and repeated use of this solution, or of a five per cent. solution of carbolic acid, will, however, disinfect the surface of the mass, and is especially to be recommended during the epidemic prevalence of typhoid fever or of cholera.

"All exposed portions of the vault, and the wood-work above it, should be thoroughly washed down with the disinfecting solution. Instead of the disinfecting solutions recommended, chloride of lime in powder may be daily scattered over the contents of the privy-vault.

"*Disinfection of Ingesta.* It is well established that cholera and typhoid fever are very frequently, and perhaps usually, transmitted through the medium of infected water or articles of food, and especially milk. Fortunately, we have a simple means at hand for disinfecting such infected fluids. This consists in the application of heat. The boiling temperature maintained for half an hour kills all known disease germs. So far as the germs of cholera, yellow fever, and diphtheria are concerned, there is good reason to believe that a temperature considerably below the boiling point of water will destroy them. But in order to keep on the safe side, it is best not to trust to anything short of the boiling point (212° F.) when the object is to disinfect food or drink which is open to the suspicion of containing the germs of any infectious disease.

"During the prevalence of an epidemic of cholera it is well to boil all water for drinking purposes. After boiling, the water may be filtered, if necessary, to remove sediment and then cooled with *pure* ice, if desired."

CHAPTER III.

TUBERCULOSIS.

Tuberculosis is one of the most dreadful diseases that infest the human race, attacking so many, irrespective of color, sex, or age. It shows itself in various ways, and its power is so great that it causes more than one-seventh of all the deaths that occur. It is a condition which has only been clearly understood since the discovery of the bacillus tuberculosis in 1882 by Koch. From this discovery we know that the disease, whether affecting the joints, skin, or internal organs, such as the lungs and intestines, is identical, and always due to the presence of this specific organism. This disease is familiar to most persons in the form of pulmonary consumption, a disease which has been so universally fatal to mankind.

After many years of work and investigation, proving each step clearly and carefully, Koch announced to the medical world the discovery of the tubercle bacillus. After numerous examinations of the expectoration and lung substance from tuberculous patients, both under the microscope and by cultivation, he succeeded in isolating a short, slender bacillus, which he thought was the specific germ of tuberculosis. Then he completed his chain of evidence by taking a pure cultivation of the bacilli and inoculating it into a susceptible animal, such as a guinea pig or monkey, and produced the same disease in these animals and found the same organism in them. After this discovery was once received by the medical world it began to be appreciated. To be sure, many skeptics asked, as always is the case with such discoveries, what was the use of this discovery if we could not kill the bacillus; and others said that whatever was strong enough to kill the bacillus was powerful enough to destroy the patient.

The advantage of the discovery of this bacillus from a diagnostic standpoint is invaluable. This may be very readily seen. A case of suspected pulmonary consumption presents itself; the patient is questioned, the history of the case learned, all the symptoms, the signs noted and a careful examination both by auscultation and percussion is made, and yet no positive results are reached; then a portion of the sputum, particularly that expectorated in the morning and free from food, is examined microscopically in the manner above described by aid of the aniline colors, and if the bacilli are present (and this method will generally decide), we may be sure of the cause of the disease and treat it early with the best possible chances for success.

Tuberculosis, therefore, being a disease caused by a specific bacillus, it is our duty to attempt to prevent the spread of this disease as far as it lies in our power; this we can in great measure do by trying to prevent the spread of the bacillus. "But how is this possible?" one may ask. A consumptive person who goes along the streets or in the cars may expectorate matter in which there are myriads of bacilli. As long as they are moist they are not dangerous, but let them become dry and be caught up by the wind and carried about, and they are then easily spread. Still, as said above, the bacillus may die on being exposed to drying, but the spores retain their vitality a long time and only await a proper soil to bud and germinate. This matter in the expectoration is then dried, caught up by currents of air and tossed about, or it attaches itself to minute particles of dust. Such dust is very easily inhaled by one exposed to it, and if such a one be susceptible, as we say, to tuberculosis, the bacilli or their spores find a lodging place in the lungs of this person and multiply and start the disease. It is undoubtedly true that consumption is very often spread in this way. It is possible that a hospital containing many consumptive patients may become a centre of infection.

As we cannot manage all those patients who go about and spread the disease, we must turn our attention to those under control. With these we must be particularly careful how the expectoration is disposed of. If the patient be able to expectorate in a suitable vessel, that vessel should always contain some antiseptic solution, as the bichloride of mercury, 1 : 1000, and when removed the vessel should not be washed out first, but should be put in a steam sterilizer or in the oven and be exposed to a high temperature for several hours. This certainly kills not only the germs of tuberculosis, but also their spores. Those patients who cannot raise their heads, as those in the last stages of consumption, are obliged to use handkerchiefs, towels, etc., to receive the expectoration. In these cases it is preferable to use small pieces of old linen which may be at once burned; but if material be used which it is not feasible to destroy by fire, it should be exposed to prolonged boiling or be put into a five per cent. carbolic acid solution for several hours. All clothing that comes in contact with consumptive patients should be boiled for at least one hour before being washed, and should never be used for other patients.

While the sweat and the breath of consumptive patients have never been known to contain the bacillus, and are therefore not contagious, still, the fact that the poison may be conveyed from the mouth to any other part of the body, should be sufficient to insure great care in disposing of whatever wearing apparel is used by them. In some hospitals small paper cuspidors mounted in tin frames are used, and the paper part when filled is removed and burned. This, being patented, is too expensive for a large hospital; still further, the tin frames are apt to become contaminated, and being in constant use are apt to scatter the dried sputum. While we may not believe that one patient in a hospital ward can catch consumption from another, still we should always think of the possible danger, and remember that where one patient or person is predisposed to this disease by some hereditary fault or taint, exposure to the disease may light up the first trouble.

The disease may find its way into the body through the circulation, through the lymphatics, or it may be taken into the stomach, or else by inhalation. The latter is the most probable way. The dried spores of the germ are carried about in the air with the dust, and gain access to the lungs of some unfortunate susceptible person and there "take root." Infection through the stomach is rare, as the hydrochloric acid contained in the gastric juice is generally strong enough to destroy the activity of the bacillus. Milk and meat, especially beef, may contain tubercle bacilli, the former, that is milk, often giving the disease to infants, but contagion through the stomach is, fortunately, as stated above, comparatively rare. Cases in which tuberculosis of the stomach and intestines is found are usually secondary to lung tuberculosis, and this is probably the cause of the disordered condition of the tuberculous patient in the late stages; the disease so affects the digestion that the gastric juice is not strong enough or abundant enough to cope with the larger amount of tubercular sputum which the weak patient is not able to expectorate and therefore swallows; but more of this will be considered later on.

In regard to the infection from tuberculous patients one thing may be stated here, and that is, as a matter of fact, the trained nurse, considering her occupation, is unusually exempt from consumption, while nurses in a religious order too often fall victims to this disease. This is explained by the fact that the trained nurse always, or nearly always, gets the proper amount of rest and exercise, especially in a well-regulated hospital, while the religious sister may be on duty from twelve to forty-eight hours at a time without rest, and she is in some orders never allowed to go out for exercise. In this way the strength is overtaxed and attacks of the bacillus tuberculosis are not warded off, because the system is not equal to the struggle. This shows, as will be noted later on, that not only exercise, but proper ventilation, is an important factor in preventing consumption.

So important has the necessity for prevention shown itself that many countries, and in the United States many of the cities, have enacted, and actually enforce with some pretensions to strictness, certain laws for the prevention of the spread of this disease. While New York City has no laws on the subject, the following rules to be observed for the prevention of the spread of consumption were approved by the Health Department of that city and ten thousand copies were ordered to be printed for public distribution:—

"Pulmonary consumption, or tuberculosis, is directly communicated from one person to another. The germ of the disease exists in the expectoration of persons affected with it. The following extract from the report of the pathologists of the Health Department explains the means by which the disease may be transmitted:—

"'Tuberculosis is commonly produced in the lungs (which are the organs most frequently affected) by breathing air in which living germs are suspended as dust. The material which is coughed up, sometimes in large quantities, by persons suffering from consumption contains these germs often in enormous numbers. This material when expectorated frequently lodges in places where it dries, as on the street, floors, carpets, handkerchiefs, etc. After drying in one way or another it is very apt to become pulverized and float in the air as dust.

"By observing the following rules the danger of catching the disease will be reduced to a minimum:—

"1. Do not permit persons suspected to have consumption to spit on the floor or on cloths unless the latter be immediately burned. The spittle of persons suspected to have consumption should be caught in earthen or glass dishes containing the following solution: Corrosive sublimate, 1 part; water, 1000 parts.

"2. Do not sleep in a room occupied by a person suspected of having consumption. The living rooms of a consumptive patient should have as little furniture as practicable. Hangings should be especially avoided. The use of carpets, rugs, etc., ought always to be avoided.

"3. Do not fail to wash thoroughly the eating

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utensils of a person suspected of having consumption as soon after eating as possible, using boiling water for the purpose.

"4. Do not mingle the unwashed clothing of consumptive patients with similar clothing of other persons.

"5. Do not fail to catch the bowel discharges of consumptive patients with diarrhœa in a vessel containing corrosive sublimate, 1 part; water, 1000 parts.

"6. Do not fail to consult the family physician regarding the social relations of persons suffering from suspected consumption.

"7. Do not permit mothers suspected of having consumption to nurse their offspring.

"8. Household pets (animals or birds) are quite susceptible to tuberculosis; therefore do not expose them to persons afflicted with consumption; also, do not keep, but destroy at once, all household pets suspected of having consumption, otherwise they may give it to human beings.

"9. Do not fail to clean thoroughly the floors, walls, and ceilings of the living- and sleeping-rooms of persons suffering from consumption at least once in two weeks."

Of course, it is right and proper to enforce such rules as strictly as possible, but while such rules may be enforced in well-managed hospitals, and in some private families where the scourge of this disease has shown them the necessity of care, in public gatherings and especially in large summer and winter hotels, in the United States, at least, no such rules are dreamed of, and in such places these very rules are violated singly and together, and in sleeping and eating, and also in the public rooms, the sick and the well come together and help to spread the disease. This is said to be true also of the American sleeping-cars.

CHAPTER IV.

TYPHOID FEVER.

Typhoid fever is a disease which is so much better understood by careful study of the patient that in many cases we may say that the intelligent, observing nurse knows more about the disease than the physician, for she sees the case throughout the whole day and night and notes each symptom, while the physician comes in only at long intervals, and usually sees the patient under the most favorable circumstances, for few patients fail to look brighter when their physician comes in.

Typhoid fever is a disease in which drug treatment seems to do little, and where intelligent nursing does much. The insidious way in which the disease begins and the gradual onset of all the symptoms made earlier observers suspect that it was caused by a slow poison, but it is only comparatively recently that the typhoid bacillus has been accepted as the actual cause of the disease. Eberth and Gaffky have done the best work in this direction.

The specific bacillus is a short, thick rod, which is found principally in the small intestines and spleen. The poison which these bacilli produce gives the disease that typical characteristic called "typhoid" or "stupid," for the patient while under the influence of the disease usually lies in a stupid condition. This poison is disseminated throughout the whole body, while the bacilli remain in the intestines and spleen. It is also the active presence of these bacilli in the lower end of the small intestine that causes in fatal cases those extensive ulcerations, erosions, and perforations of the intestines which so frequently end in peritonitis and death.

From the way in which many persons are attacked in the same family, district, and community, it has become pretty well settled that the *materies morbi* is taken in by the mouth with the food or drink; indeed, there is scarcely a doubt but that the poison comes from the drinking water in the majority of cases. This has been proved so often that some look to the drinking water in every case of typhoid fever. Other causes may be impure milk or food. It may be in the flesh of certain animals, or it may be scattered with the dust or come in contact with food, especially when taken raw. The theory that typhoid fever may be communicated by the ground has still some adherents, and it cannot be denied entirely.

The typhoid bacillus, when taken into the stomach, if it escape the gastric juice, sets up an inflammation of the intestines, and finding a lodging place there, causes a diarrhœa. It may be that there is a slight diarrhœa at the time the bacillus is taken into the body, and the altered condition of the intestinal secretions offers a good soil for it to grow in. Although we are quite well satisfied as to the bacillus, still, no one ever attempts to make a diagnosis of the case by looking for the bacillus. It is generally possible to make a diagnosis from the signs, symptoms, etc.; therefore the typhoid bacillus in this connection has no diagnostic importance. Unfortunately, the characters of the typhoid bacillus are so indefinite, and the difficulty of identifying it when obtained from external sources so great, that little advantage has hitherto been gained by attempting to discover it in water suspected of conveying typhoid fever.

Another very frequent source of the infection, and one rarely thought of, is impure ice. We know that water may contain typhoid bacilli, and we also know that this water may freeze and be used for consumption; we also know that many bacilli, particularly the typhoid bacillus, can retain its vitality below freezing point, although it cannot grow, hence ice, which was at one time supposed to reject all impurities on freezing, may be a most dangerous and unsuspected cause of typhoid fever. It may be noted in passing that some bacteria cannot grow in the presence of oxygen and some cannot live without it; to the latter class belongs the typhoid bacillus, and hence in that ice which contains streaks of light and air bubbles, just along the border of these air streaks the bacilli, if present, are particularly abundant.

While one case of typhoid fever is not usually contracted from another, still, we know that the same cause which produced the one may produce another, hence, when one or more cases occur in the same house or neighborhood it is our duty to look for the cause. All doubtful water, and, indeed, much water which appears innocent, should be first boiled and then filtered before using; the boiling destroys any life which may exist in the water, while the filtering makes it pure. Many persons drink artificial aerated drinking waters with the idea that they are free from disease germs; they are just as impure as some other waters, and while the carbonic acid gas may act destructively to some of the bacilli, still, there are enough left in the water to do harm.

When typhoid fever breaks out in a community, prompt measures to check the spread of the disease should be taken. This is rarely done until large numbers have been attacked. As the principal source of contagion is in the stools, they should be rendered as harmless as possible by the use of proper disinfectants and immediate removal from the sick-room. For this purpose various chemicals are used with great advantage, such as the chloride of lime, four per cent.; milk of lime in the form mentioned on page 43; carbolic acid, five per cent. The disinfectant should be thoroughly mixed with the stools and allowed to stand four hours. This careful disinfection is necessary to prevent the contamination of drinking water. We know that it is not an uncommon thing to notice in the country and in small scattered villages that the well or cistern containing the drinking water is at a lower level than the cess-pool, and if the soil be favorable, as it often is, the dangerous contamination may take place by the percolation of disease germs from the cess-pool to the drinking water, and even in cases where the cess-pool is at a lower level than the source of drinking-water supply, the soil around, becoming soaked with fæcal matter, may convey the poison, by capillary attraction against gravity, to the drinking water.

Many of our large cities and some small ones, too, are never free from typhoid fever, and at stated intervals suffer from severe epidemics of this disease. This is noticed particularly in cities which are situated on rivers, and which rely principally for their water supply upon these rivers. Now, many cities in taking their water supply from these rivers take with it a part of the sewage from the towns above them on the same river. It is said by some that rivers purify themselves after a flow of a few miles, but opinions differ widely on this point. Parkes, in his work on hygiene, says that purification takes place by the oxidation of the dangerous organic material, by deposition of the suspended material, carrying with it some of the organic impurities, or by the agency of organisms in the water, as fish, water plants, or the more minute algæ, some forms of which possibly feed upon or destroy the as yet unrecognized "somethings" which cause disease. This purification depends on the rapidity of the flow and several other conditions, and Parkes adds that while rivers at their source may be a safe means of supply, and that those that have once received sewage may, perhaps, be safe if they have flowed for some distance, the use of water from such streams is not advisable if any better supply can be obtained. Without going into this further, it can readily be seen how contaminated water and ice may spread this disease.

While typhoid fever is never absent from large cities, it is proportionately more common in the country and in villages, for the very reason that in the latter the water supply is not under control, as it is in the cities.

The best cure for this disease is not to let it occur, for of all preventable diseases, with the exception of small-pox, typhoid fever is one that could almost always be prevented. Some localities are without the proper water supply and others need good drainage; both of these combined should keep out typhoid fever entirely, while the lack of either one is no safeguard. Not many years ago in the city of Munich, in Germany, typhoid fever was so prevalent that strangers hardly dared to remain there for any length of time, while now this disease is so rare there that it is with great difficulty the medical schools can find a sufficient number of typhoid cases for clinical teaching. This shows what scientific sanitation can do.

One not uncommon source of infection is from water-closets in bad repair. A family locks up their city house for the summer months, and in all this time the water in the water-closet pans, evaporating, gives a clear opening from the cess-pools, wells, or sewers to the rooms of the house, and any backward currents of air may carry dried particles into the rooms. It is very easy to see that in this way disease germs may be blown into the rooms and lie in wait for these unfortunate house-owners on their return, one or more of whom may be attacked by some disease which they attribute to the malaria of the place, usually a summer resort, they have just left.

Besides the disinfectants above named, the dry chloride of lime, sprinkled into impure vessels, cesspools, etc., is amply sufficient to destroy all bacilli. All clothing from typhoid patients should be carefully boiled before washing. In this disease, as in pulmonary consumption, great care should be taken not to allow the clothing from the sick to remain in the ward or room after removal from the patient. It is a great temptation for the nurse to let them lie for a while near the bed and possibly shake them in the room. They should be carefully rolled up and not even shaken in the air, but immersed at once in boiling water for one or two hours, or in one of the disinfecting solutions given above, preferably carbolic acid five per cent.

CHAPTER V.

TYPHUS FEVER.

For a long time typhus and typhoid fever were not distinguished, but a careful study of these two diseases, made not so many years ago, showed not only many points of similarity but many points of difference. The term typhus tends to become confusing when we consider that the Germans use it when they mean what we call typhoid.

Typhus fever is not endemic in this country, and only occurs when cases are brought from other countries. It tends to spread where there are crowds of people in an unsanitary condition. It has received such names as ship fever, hospital fever, jail fever, camp fever, spotted fever, etc., etc. Its onset is very sudden and it is very contagious at short distances, but it is not believed that the clothes of the patient will carry the disease. Still, this is not decided. At any rate, those coming in contact with typhus patients are very likely to contract the disease. It is never absent from some countries and has only occurred as epidemic in parts of this country where it was brought in by ships from Ireland and other places.

The micro-organism causing the disease is not known. As the beginning of the disease is very sudden, as few escape it who come within the range of contagion, and as it is rapidly fatal in so many cases, the methods of precaution should be prompt. They are, immediate isolation of the patient and attendants, strict quarantine of the room and even of the house, and the burning up of the clothes and other articles used, if feasible. It has been advised to keep the patients in large and airy rooms. This is good advice in almost all diseases, but particularly in typhus, as the germ of the disease, although very virulent, is rendered less dangerous by dilution with fresh air, and because, as stated above, the area of contagion is very small. No especial directions are needed in this case which are not given in treating of typhoid fever.

CHAPTER VI.

ASIATIC CHOLERA.

Asiatic cholera is a disease so rarely met with in the United States, thanks to our cleanliness and good sanitation, that it need not be considered very extensively here. The disease has almost invariably been traced back to India, from which place it follows the course of trade, of travelers, of pilgrims, or of armies, moving either by sea or by land. The last epidemic of cholera in Europe cost that country 250,000 lives, which represents in money a loss of $8,000,000, besides the loss entailed by enforced idleness due to the paralysis of trade.

It is, like typhoid fever, a disease associated with unsanitary conditions, with filth and carelessness, and hence under properly existing circumstances an epidemic of Asiatic cholera should never occur. Like typhoid fever, also, the spread of cholera after its introduction into a locality is associated with contaminated water supply, filthy habits, and bad personal and domestic hygiene. It is conveyed by personal effects and their washing through the water and through certain kinds of food, but it does not seem to be transmissible through the air to any great distance. There is some evidence that the soil of a locality may become infected with the specific germ of cholera. There has been much time and study spent investigating the specific cause of Asiatic cholera, and the majority of those that pretend to know anything about the subject consider the so-called comma bacillus as discovered by Koch as the specific organism. This is a slightly curved bacillus (or spirillum) which grows out to long, spiral threads and divides, each piece resembling a comma.

The disease attacks principally those predisposed to it, and the lesion is found in the intestinal canal. As with typhoid fever, the disease germ resides in the dejecta, which are the source of infection. These, coming into contact with food, clothing, and especially drinking water, convey the disease further. This has been the history of the disease in the Eastern countries where it was most fatal. The people, understanding little or caring little for sanitary principles, emptied the house waste and water closet contents into the streams or on the ground near the streams or wells, or they washed contaminated clothing in streams which were used for drinking purposes. In this way the germ of cholera gains access to an individual and spreads the disease. These comma bacilli enter the intestinal canal and increase there with great rapidity, and when passed from the body they live and thrive in the presence of moisture. The bacilli do not invade the blood or organs of the patient. Of course, only those predisposed to the disease are attacked. Fright and fatigue, as in many diseases, are important factors in the causation of cholera. It attacks by preference those who suffer from diarrhœal diseases.

Epidemics of cholera occur so quickly, kill so suddenly, and create so much general consternation, that the principal treatment is to protect the well and do what is possible for the sick. "In time of peace prepare for war" is a motto which should be remembered in all such diseases. When a violent conflagration starts in a village not properly protected, the inhabitants are either hopeless and helpless, or they confine their efforts to protecting the unburnt district, letting the burning buildings be destroyed, until the fire has burned itself out. In the Eastern countries the same plan was followed with respect to cholera. The whole principle of treatment is to destroy the disease and limit its action. This method forms the basis of our international quarantine system, about which so much has been written. In spite of all these quarantine restrictions, however, the disease is apt to get through. The theory is to kill the comma bacillus and prevent its further growth. Quarantine by sea can be carried out rather effectually where political influences do not interfere, but quarantine by land by means of cordons is of little avail.

In the care of the sick, the dejecta and the vomited matter should be received into a vessel containing a carbolic acid solution (1 : 20), stirred up thoroughly, allowed to stand, and should then be emptied into a pit containing unslaked lime and covered by the same material. The vessels, clothing, etc., of the patient should be boiled in a carbolic acid solution (1 : 20) for an hour or more, while the body of the patient and hands of the attendants should be washed in a bichloride of mercury solution (1 : 1000). Healthy persons should be kept as far as possible away from the sick, all errors of diet should be guarded against by properly selected food and drink, and the strictest hygiene should be observed, and all excesses should be avoided. All water should be boiled and filtered before using, and the milk should be sterilized. Diarrhœa should receive immediate medical attention. In case of death from cholera, all the clothes should be burned, and it is just in such cases as this that cremation of the human body would be desirable. The rooms should be thoroughly disinfected for hours with fumes of sulphur or chlorine gas, and, if possible, everything that came in contact with the patient and could not be destroyed by burning should be exposed to prolonged dry heat, or to steam at 212° F., experiments having shown that while the comma bacillus may live, thrive, and multiply in moist places, it soon dies when dried.

It may happen that cholera will not appear again as an epidemic in America or in England, where cleanliness, the great protector against all diseases, is so universal as compared with other countries, but in case of sporadic or scattered cases intelligent supervision should be peremptory and immediate, and if the disease should spread military discipline is necessary.

CHAPTER VII.

SCARLET FEVER OR SCARLATINA.

In the early part of the sixteenth century the two diseases, measles and scarlet fever, could not be differentiated. Now there are few good nurses or experienced mothers who cannot distinguish typical cases of the two diseases after the eruption has appeared. What the specific micro-organism is that causes scarlet fever is not certain. Several investigators have described what they thought was the germ, but as yet that point is unsettled.

However, believing, as we do, that every infectious disease has a distinct cause in a minute organism, we accept the existence of an as yet undiscovered germ of scarlet fever, arguing from the history of the disease. Like many other organisms, it probably enters the system by the breath, but it may also enter with the food taken. It is certain that the poison of the disease infects the blood. This has been proved by inoculating with the blood of a patient and causing the disease. The breath of the patient, the saliva, the secretions of the pharynx, mucous membranes, the epidermis scales, the evacuations of the bladder and intestines all may contain the poison of the disease, and in case of running at the ear—a not uncommon accompaniment of scarlet fever—this running or pus may contain the disease poison.

Scarlet fever may be communicated by direct exposure to objects which are in the room during the illness, and to which the poison becomes attached, such as clothing, books, toys, etc. Trunks and packages containing infectious material may carry the poison to a distance. The clothing, books, and toys belonging to a child who has died of scarlet fever retain the poison indefinitely. This is particularly true when the mother, loath to part with the property of her dead child, puts them into a trunk or drawer, where they may lie undisturbed and harmless until, in after years, she takes them out and gives them away, or uses them on other of her children. This procedure is very often followed by scarlet fever wherever these objects go. In its tenacious attachment to objects and its portability to distant localities this poison surpasses in endurance and virulence that of any other eruptive disease, even of small-pox.

Milk, which contains everything in solution necessary for the nutrition of all persons, particularly of infants and young children, is especially dangerous on account of the risk of its carrying disease. Containing, as it does, so much nutriment, it forms an excellent medium for the life and growth of micro-organisms, and this seems to be true of the scarlet fever germ. Again and again have cases occurred which have been traced through the infected milk to the first case. The milk supply of the sick and the young cannot be too strictly watched.

The public schools, and, in fact, all schools where children, and especially children of the poorer classes, congregate, are very effective disseminators of the disease. In large cities the health boards are very particular about preventing children who live in houses where there is or has been scarlet fever from attending school. Laundresses have been known to spread the disease by mixing the clothes of infected people with other clothes. Physicians, hardened to exposure and too frequently thoughtless to true danger, are often very careless about how they pass from a scarlet fever case to a healthy child or a patient. Books in libraries and the public schools have been blamed, and justly, too, for spreading the disease.

In the presence of a person ill with scarlet fever the area of contagion is small, only a few feet; therefore, many who are exposed to the disease, and who are careful not to come in contact with the patient, bed, or objects, are not apt to contract it. Indeed, there are many persons who suffer no risk by coming close to scarlet fever patients, for they touch and handle the cases with perfect impunity. Still, such risks are not often necessary, and nurses, and even physicians, who are attending scarlet fever, diphtheria, and patients sick with other such contagious diseases should touch the patient only when absolutely imperative, and in bringing the face and mouth close to such patients, if such a thing should ever be called for, the mouth and nose should be covered and the breath held. Such precautions may seem foolish, but, considering the dangerous complications of these contagious diseases, too much care cannot be taken, and the physician or nurse who is negligent in these respects is guilty of criminal neglect.

We have undoubtedly a surgical and an obstetrical scarlet fever. That is, among the numerous germs which may find a suitable nest on a fresh surgical wound or an abrasion is the scarlet fever germ. Entering into an exposed wound, it may cause genuine fever, even in the adult. The lying-in-woman, too, is not safe from this source of danger; the abraded surfaces of the genital tract offer a good breeding place for the scarlatinal germ, and the disease may be the result. Most large cities have boards of health, whose duty, among other things, is to investigate every case of contagious and infectious disease with a view to preventing its further spread. However capable the health officers in these positions may be, it is well known that many of their sanitary inspectors are simply professional politicians with no idea of their duty.

Dr. J. Lewis Smith, in his work on "Diseases of Children," states that "The New York Board of Health enforces the following regulations to prevent the spread of scarlet fever as well as other acute infectious maladies :—

" *Care of Patients.*—The patient should be placed in a separate room, and no person except the physician, nurse, or mother allowed to enter the room or to touch the bedding or clothing used in the sick-room until they have been thoroughly disinfected.

" *Infected Articles.*—All clothing, bedding, or other articles not absolutely necessary for the use of the patient should be removed from the sick-room. Articles used about the patient, such as sheets, pillow-cases, blankets, or clothes, must not be removed from the sick-room until they have been disinfected by placing them in a tub with the following disinfecting fluid: eight ounces of sulphate of zinc, one ounce of carbolic acid, three gallons of water. They should be soaked in this fluid for at least an hour, and then placed in boiling water for washing.

"A piece of muslin one foot square should be dipped in the same solution and suspended in the sick-room constantly, and the same should be done in the hallway adjoining the sick-room.

"All vessels used for receiving the discharges of patients should have some of the same disinfecting fluid constantly therein, and immediately after being used by the patient should be emptied and cleansed with boiling water. Water-closets and privies should also be disinfected daily with the same fluid, or a solution of chloride of iron, one pound to a gallon of water, adding one or two ounces of carbolic acid.

"All straw beds should be burned.

"It is advised not to use handkerchiefs about the patient, but rather soft rags for cleansing the nostrils and mouth, which should be immediately thereafter burned.

"The ceilings and side-walls of a sick-room after removal of the patient should be thoroughly cleansed and lime-washed, and the wood-work and floor thoroughly scrubbed with soap and water."

If these rules were strictly followed the number of cases of scarlet fever would annually grow less. Of course, the duty of reporting a case of scarlet fever rests either with the physician or the householder. In many cases neither reports the case to the local health office, and probably in this way the disease is frequently spread. Again, rooms are so rarely properly disinfected after a case; they are simply given a superficial cleaning and, if in a boarding or lodging house, re-rented.

As soon as a case of scarlet fever is recognized it should be put in an upper room, so as to be beyond the other members of the household. Then all articles not strictly necessary for the patient, all hangings, curtains, rugs, etc., should be removed. Any papers or books which may have been used to amuse the patient should be promptly burned at the conclusion. The room should be ventilated, but should never be kept too cool. As the disease poison is principally in the skin, the whole surface of the body should be constantly kept anointed with vaseline rubbed up with a little carbolic acid. This not only cools off the body and is pleasant to the patient, but it prevents the scales of the skin from flying about and spreading the disease. A three to five per cent. solution of carbolic acid in water may be kept simmering on a stove or over a lamp. As the great danger in scarlet fever is the complications, and particularly the kidney complications, a case should never be hurried to recovery, but kept in the room and in bed a long time; hence the faithful nurse is under a great strain for weeks at a time. She should take daily exercise alone, avoiding other people, and keep up her strength, as too much fatigue might invite an attack of the disease in one who had not had it.

Desquamation, or the peeling of the skin and the disappearance of the eruption may take place anywhere between the first and the third week. It may begin even earlier, and the whole process is sometimes very slow. It is during this period that the skin should be kept well anointed, to prevent the dried scales of skin from flying about and spreading the poison.

By some unfortunate accident the laity, by that peculiar process that gets everything wrong, has learned to make a distinction between scarlet fever and scarlatina. It is just as well to state that the former term is English and the latter is Latin for the same condition. It is falsely understood that scarlatina is a light form of scarlet fever, a statement which probably had its foundation in some pseudo-philologist thinking that the two final syllables of the word "scarlatina" gave it a diminutive sense, and hence it meant a light attack of scarlet fever. Such an erroneous idea is unfortunate, and even dangerous, in that it tends to make one careless of the light cases, when in reality the light cases may have the worst complications if not kept in, and if allowed to go about may spread the disease, it being well known that light cases can cause the most severe ones, and vice versa. Hence it is always better to err on the right side, and if the case be doubtful and it looks like scarlet fever, it is better to treat it as such and use all precautions, than to be lax and spread the disease.

The time may come when an examination of the skin or of the secretions of the patient microscopically will tell us early in the course of the disease the exact truth whether it is scarlet fever or not.

CHAPTER VIII.

MEASLES.

Measles is a disease rarely absent from large cities, and is of itself generally without danger, but its complications, while not usually so severe as those of scarlet fever, are to be feared. As in most eruptive diseases, the eruption appears not only on the skin, but may affect the mucous surfaces of the body; hence the mucous membrane lining the mouth, the trachea, and the lung tubes may become sufficiently inflamed to give rise to sore throat, bronchitis, and even pneumonia. The mucous surfaces lining the inner side of the eyelids and also that covering the eye become inflamed. These are the most common complications of measles, but less severe ones may occur.

As the nurse is rarely called on to make a diagnosis, the exact appearance of the eruption need not be described. Mothers and others of intelligence are soon able to make out a case of measles from scarlet fever after the eruption has appeared, especially if they are typical cases. Occasionally, when the circulation of the blood in the patient is slow and there is some internal inflammation, due either to bronchitis or to pneumonia, the eruption presents a dark appearance, and we have a case of what is ordinarily known as "black measles." This may be explained as follows: The redness of the eruption is dependent, of course, on the blood flowing in each little point of eruption. Now, if the circulation is unimpeded the eruption retains its natural color, but if the circulation of the blood in the whole body be slow and the blood move sluggishly along in the small blood-vessels, lack of aëration or air supply, which makes red blood, causes the blood in those points to take on a dark hue, and when the blood moves so slowly that it coagulates it looks entirely black. This form of measles is usually fatal, not because the points of eruption are black, but because of impeded circulation and general weakened constitution Therefore, no case of measles should be made light of, and while children, those usually having the disease, may pass through the disease without medical attendance, still, the risk is great, and no case should go on without the attention of a physician.

For the very reason that measles is considered a disease without danger it is apt to spread, while a more dreaded disease, such as scarlet fever or diphtheria, whose dangers are appreciated, is kept in bounds. While the specific micro-organism of measles has never been isolated, it is considered to belong to the class called micrococci. It is highly contagious through the air and at a much greater distance than scarlet fever or diphtheria. It is communicated by the breath and by exhalations from the body. As so many diseases begin in the same way, measles is not usually recognized until the eruption has appeared. This is generally from ten to fourteen days after the patient has become infected. For this reason it is harder to trace this disease than other diseases which require a shorter time to make themselves known.

A case of measles should be isolated just as carefully as a case of scarlet fever. Children in the same house should be kept from the patient,

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and should also not be allowed to go to school. As the poison is undoubtedly in the skin, the whole surface of the body should be anointed with vaseline, which not only keeps the epithelial scales from flying about, but allays the itching, as in scarlet fever.

CHAPTER IX.

DIPHTHERIA.

Some diseases are dangerous because the nurse may carry them to others with whom she may come in contact; other diseases are particularly dangerous to the nurse herself, but the risk of carrying the contagion is small. Diphtheria is a disease which has both of these dangers. The nurse is always liable to catch it and she may easily carry it.

Diphtheria, like many other diseases, was originally unknown in America, the aborigines suffering only from those diseases induced by change in the climate incident to their wild life. Having once entered this country, diphtheria followed civilization, and it has occurred so often epidemically that bacteriologists, suspecting a specific cause, have been looking for the germ peculiar to it. This germ, or bacillus, has been pretty well recognized and described, but our practical results from this discovery are not great as yet.

The two men who have given the most time and attention to looking for this bacillus are Klebs and Loeffler, hence it is called the Klebs-Loeffler bacillus, or bacillus diphtheriæ. It is a small bacillus, possessing no independent power of motion; it forms no spores or seeds, but is itself very resistant, withstanding for a long time drying and other influences injurious to the less resistant forms. It lives and multiplies readily in milk.. The diphtheritic poison is a most peculiar poison to the cells of the human body, producing areas of cell death not only on the surface of mucous membranes, but also in the deeper parts, in various lymphatic glands at a distance from the local lesion, and in the spleen.

The discovery of the diphtheria bacillus is only one new fact in the germ history of disease. It is now pretty well settled that diphtheria begins as a local disease, attacking usually the mucous surfaces of the throat and nose, and by the formation of a membrane undermining the tissues in this region and poisoning the whole system. Like many other germs, the germ of diphtheria is in itself not so harmful, but it secretes from its minute body a violent poison which enters the system at the point of contact, which is usually in the throat or nose, and causes those extremely dangerous symptoms of poisoning and paralysis with which many a mother and nurse is so familiar. Unfortunately, it is probable that when once the disease has been recognized in a given case the specific poison has invaded the whole body, so that nothing can be done but try to sustain the patient and keep the disease from spreading to others. It is just here that modern medical chemistry has a large field for investigation, to study these dangerous poisons and furnish us with trustworthy and easily applicable antidotes which shall counteract the poison in the body without harming the patient.

Just now the only thing to be done is to keep up the system, treat the local parts attacked, and try to prevent the spread of the disease to others in the house or neighborhood. In this field the good nurse or intelligent mother has a great responsibility. Some cases are so mild that they are scarcely recognized, even by the physician, and it is just those mild cases that do the most harm, as the patient may go about and spread the disease without suspicion. Diphtheria is so contagious that a moment's exposure to the breath of a patient is sufficient to cause it in one susceptible, or to be in the infected room where the patient is under treatment, or even has been weeks or perhaps months previously, has in numberless cases caused the disease. In this case, of course, the breath cannot give the disease, but it can contain the bacilli attached to bits of secretion, etc. This is true, notwithstanding the fact that the area of contagion of this disease is small, like scarlet fever, as contrasted with whooping cough and measles. Damp, ill-ventilated, moist, and mouldy places help the germs to flourish, but are never of themselves sufficient to cause the disease.

The germ of diphtheria has no spores, but the germs themselves are very resistant and live in spite of much exposure. They withstand prolonged drying, and retain their vitality in rooms, clothing, etc., for months and longer. Thus a person with diphtheria becomes a centre of infection, endangering those near by and the whole locality. Another dangerous element is the fact that animals, particularly members of the feathered tribe, often have the disease; they both catch it from human beings and give it to them. Cats and cows have been known to have it, and with the latter the danger of contagion through milk is very great.

It is sad to say that milk, the most important article of nourishment that we possess, one so largely consumed by infants, children, and invalids, is a very good medium for the growth of many dangerous germs which either grow well or live a long time in it. In order to prevent the spread of the disease, preventive measures are of the greatest importance. There is one element of encouragement in all this danger, namely, that unless we come into very close contact with the patient the danger of catching the disease is not great in diphtheria and scarlet fever, two dangerous diseases, as it is in whooping cough and measles.

The bacillus of diphtheria when found is usually seen in the upper part of the false membranes and as bits of these are frequently coughed up in the course of the disease, herein lies the chief danger. This coughing is the more dangerous because the nurse, mother, or physician has so frequently the important duty of making applications to the throat, and in her zeal the nurse or mother is apt to receive some of the expectoration and poison in her face and throat from the patient, who spasmodically coughs when the throat is sprayed or mopped.

Dr. William H. Welch, of the Johns Hopkins Hospital, Baltimore, has made a careful study of diphtheria and the Klebs-Loeffler bacillus, and the following, taken from an article of his on account of its importance, is quoted here in full. He says :—

"From what has already been said, we are prepared to consider for a moment in what ways a person affected with diphtheria becomes a source of danger to those around him and to the locality. The diphtheritic bacilli are conveyed from the body in particles of diphtheritic exudation, saliva and other secretions discharged through the mouth and nose. (It is not necessary to consider here the comparatively exceptional localizations of the disease.) In this way the infectious substance may readily become attached to the person and clothing of the patient and of those around him, as well as to the bedding, furniture, floor and walls of the room, dishes, and other objects.

"Notwithstanding the statements current in nearly all the text-books, there is no evidence that the breath of the patient contains the diphtheritic germ, except as bits of false membrane or secretion may be mechanically expelled in the act of coughing, hawking, or sneezing. It has been proven experimentally that the expired air is incapable, during ordinary respiration, of detaching bacteria from the moist mucous surfaces over which it passes. The specific germs are not so readily conveyed by air currents from a diphtheritic patient to those near him as they are, for instance, from a patient with scarlet fever, in which the germs are in all probability thrown off from the surface of the body on light epidermal scales. Nor are the chances of infection of the sources of drinking-water with the diphtheritic bacillus so great as is the case with such diseases as cholera and typhoid fever, in which the stools contain in large number the specific bacteria, and are likely to be disposed of in such a way that under bad sanitary conditions these bacteria may find their way into wells and streams. While there are some accounts intended to show the conveyance of the diphtheritic virus through the drinking-water, we do not hear much of this as a source of infection, and it is not likely that it plays an important rôle, although it is probable that the diphtheritic bacillus may sometimes be discharged by the stools.

"Diphtheria is one of the infectious diseases the germs of which may be taken into the body by inspired air. Inasmuch as bacteria cannot, under ordinary conditions, occur as floating matter in the atmosphere until they have been completely dried down so that air currents can detach as dust the little particles to which they adhere, it is evident that only those infectious germs are likely to be conveyed by the air which are not destroyed by complete drying. As has already been mentioned, the diphtheritic bacillus withstands for months desiccation which is so injurious to the cholera vibrio and to many other species of bacteria. While, therefore, we must admit that air infection with the diphtheritic bacillus is a real and conspicuous danger, it is well to bear in mind that modern bacteriology has taught us the great lesson that the most frequent and important mode of infection is by contact with infected substances. When we consider the manifold ways in which the diphtheritic bacilli may be widely distributed, and when we consider the habit of young children —who are the most numerous victims of the disease—of handling everything and of putting everything into their mouths, we are led to appreciate that infection by contact must play the leading part in the transmission of diphtheria.

"A matter which, although not new, has attracted much attention in recent years may prove to be of such importance in the etiology of diphtheria that I will direct your attention to it for a few moments. Evidence has been brought forward intended to show that diphtheria may be communicated to human beings by domestic animals afflicted with this disease. The animals chiefly concerned are cattle, cats, and fowls. There have been reported in England during the last decade epidemics of diphtheria in which the evidence is strong that the diphtheritic germ was conveyed in milk. There are two theories as to these milk epidemics. One is that the diphtheritic virus got into the milk from persons affected with diphtheria, the other is that the cows yielding the milk were affected with diphtheria.

This second daring hypothesis Klein has attempted to support by experiment. He claims that by the inoculation of two cows subcutaneously on the shoulder with a broth culture of the bacillus diphtheriæ he has succeeded in producing genuine infection, with the appearance of vesicles and pustules on the udders and the elimination of the specific bacilli in the milk. These experiments should be received with great caution, as they are in opposition to all that we know concerning the exclusively local development of the bacilli at the point of inoculation. We possess no satisfactory evidence that cattle are ever affected with a natural disease identical etiologically with human diphtheria, although it is known that an affection sometimes called diphtheria may appear in calves.

"That cats may acquire diphtheria and may be a means of transmitting the disease to human beings is a widely spread belief. Medical literature contains many instances in which, on the one hand, cats appear to have contracted a disease by eating substances contaminated with the discharges from diphtheritic persons; and, on the other hand, children seem to have become infected with diphtheria by handling sick cats. Inasmuch as cats are among the animals most susceptible to inoculation with cultures of the Loeffler bacillus, acquiring a disease resembling human diphtheria, there is no *a priori* reason that they may not be the subjects of a natural disease etiologically identical with diphtheria.

"But the possibility of the experimental production of a disease in an animal is no proof of the natural occurrence of such a disease, and thus far there is not satisfactory evidence that diphtheria occurs as a natural disease in cats. What is necessary to settle the question is to make careful bacteriological studies in suspected cases of diphtheria in cats. The matter is of sufficient interest and importance to merit careful study.

"Pigeons also are susceptible to inoculation with the Loeffler bacillus, and it is well known that a membranous inflammation of the mouth, fauces, and trachea occurs as a destructive epidemic in chickens, turkeys, pigeons, and other birds. This so-called diphtheria of fowls has not, however, been found to be caused by the same micro-organism which causes human diphtheria, so that, notwithstanding some rather striking observations according to which human beings have appeared to contract diphtheria from fowls, there is no positive proof of the dissemination of genuine diphtheria in this way. It may be that human beings may become infected by the germs producing the so-called diphtheria in domestic animals, but if so there is no proof that the disease produced is etiologically identical with the disease caused by the Loeffler bacillus.

"Inasmuch as the diphtheritic bacilli are present only in the false membranes and other local products of the disease at the site of infection, and are distributed outside of the body primarily through these, it is apparent that the patient should be strictly isolated; that unnecessary fabrics and other objects, especially such as cannot be readily disinfected, should be first removed from the room where the patient is placed; that care should be taken to prevent, as far as possible, the soiling of the persons and clothing of the patient, of the attendants, and of the physician, as well as of other objects in the room, with the discharges of the patient; that opportunity should not be afforded for the desiccation of these discharges, which then may contaminate the air, and that efficient measures of disinfection of the room and of all objects which by any possibility can become infected should be employed.

"That the enforcement of measures indicated is capable of restraining the spread of the disease, even in crowded infants' asylums and hospitals, has already been demonstrated by actual experience. They require for their accomplishment education on the part of the community, of physicians, and of sanitary authorities in the principles of disinfection, and an intelligent appreciation of the dangers to be guarded against. I seize this occasion, as I have others, to urge the importance in cities of public disinfecting establishments constructed according to improved modern principles, and of a corps of men in the employment of boards of public health trained in proper methods of disinfection.

"The length of time that the patient should be quarantined, depends, evidently, upon the duration of the period in which active diphtheritic bacilli remain on the mucous surfaces attacked. As to this point we possess some definite information, which shows that the period varies within wide limits. In some cases the bacilli can no longer be found after the false membranes have completely disappeared; in many cases they vanish within three or four days after the local inflammation has subsided, but they have been found as much as fourteen days after the inflammation has gone, and when the mucous membrane appeared healthy. In a case reported by Loeffler, the bacilli were found three weeks after the return of the temperature to the normal, and were present for a month altogether in a state capable of carrying infection. It is evidently not possible to set a precise limit for the period of isolation of the patient. Loeffler suggests that the patient should not be permitted to mingle with others or to return to school for at least eight days after the disappearance of all local manifestations, and he reckons four weeks from the beginning of the disease as the period for keeping the children out of school. Where it is possible to do so, the length of this period can be controlled by bacteriological examinations of the mucous membrane of the throat.

"We have thus far considered the patient as the immediate source of infection. The evidence already mentioned in favor of the occasional dissemination of the diphtheritic virus through the milk suggests at once the importance of controlling, not only the condition of the milk as received for distribution, but also of inspecting the sources of milk supply. Evidently milk should not be sold from dairies attached to households where there are cases of diphtheria.

"It does not seem to me permissible to throw out altogether the possibility of the conveyance of diphtheria by domestic animals, especially by cats, which are likely to be fondled by children even more when the animals are sick than when they are well.

"In considering what can be done to render children less vulnerable to diphtheria, and to ward off an attack after exposure to the disease, the question arises, what conditions of the individual we may regard as predisposing causes. Clinical experience, as well as experiments upon animals, indicate that morbid states of the mucous membrane of the throat, such as ordinary catarrhal inflammations, swollen tonsils, sensitiveness to 'catching cold,' the existence of measles and scarlet fever, are predisposing factors. At all times, but especially during the epidemic prevalence of diphtheria, it is important to hold in check these morbid states as far as possible.

"The prophylactic value, in persons liable to exposure to diphtheria, of cleanliness of the teeth and mouth, and of the frequent use of weak antiseptic mouth-washes, nasal douches, and gargles is worthy of the attention of physicians. For this purpose Loeffler recommends aromatic waters, weak sublimate solutions (1 : 10,000 to 1 : 15,000), or, perhaps better, solutions of mercuric cyanide (1 : 8000 to 1 : 10,000); also, chloroform water, chlorine water (1 : 1100), thymol (1 : 500 parts of twenty per cent. alcohol). The use of some of these solutions evidently involves danger of poisoning in children unless special precautions are taken.

"The suggestion recently made by Dr. Jacobi, that, in addition to caring for those sick with diphtheria, places of refuge should be provided for the temporary stay of children sent from home to escape infection, seems practical and calculated to meet the circumstances of many families.

"The dominant rôle played by schools in the spread of diphtheria throughout a community renders especially urgent the introduction of a system of daily medical inspection of the schools.

"The importance of letting air and sunlight into dark, damp dwellings, and of attending in general to matters of domestic sanitation, is a lesson plainly to be drawn from the history of such places as nests of diphtheria."

One of the most important preventive measures after diphtheria is a thorough disinfection of the room occupied by the patient. Dr. J. Lewis Smith, of New York, thinking the method of disinfection by burning sulphur in a closed room for several hours was questionable or inadequate, experimented with it in a ward in the New York Infant Asylum in which there had been an epidemic of diphtheria. This ward was emptied, "the windows, doors, and crevices closed, and forty pounds of sulphur, or two pounds to the hundred cubic feet of air, were burnt until they were consumed." After several hours the doors were opened and dust from the floor, bedding, and furniture was stirred up and allowed to settle on culture media which had been prepared for the experiment. The result was that there were found on the culture media many forms of micro-organisms which had been in the room before the sulphur was burned.

As this mode of disinfection seemed far from perfect, Dr. Smith wrote to E. R. Squibb, of Brooklyn, and obtained the following reply:—

"Within the past ten years the efficacy of sulphur-fumigation against infectious material has been repeatedly denied and reaffirmed upon very good authority, and observations, apparently made with accuracy and care, have been reported from time to time to prove both sides of the question; so that all that can now be said is that burning sulphur is of doubtful efficacy, with the weight of the highest authorities in bacteriology against it. But to this it must be added that it is still largely used by very intelligent bodies in large institutions, boards of health, etc., where it would not be likely long to maintain an universal confidence.

"How often the fumes are applied dry and how often moist no one can tell from the current record; and how many of the failures of the dry gas would be successes in the presence of moisture there is no means of knowing.

"Formerly, when sulphur was burned in closed chambers as a disinfectant, the surfaces were all wetted, and the pot of burning sulphur was set in water or wet sand, that the heat might evaporate off a constant supply of watery vapor.

"These conditions are now frequently, if not generally, neglected; and where this is the case, failure, on principle, should be the rule.

"Nearly all, if not all, chemical disinfectants are in a state of tension, ready to change on coming in contact with the matter to which they are applicable; and these changes are either by oxidation or deoxidation, and the moment of greatest power or activity is the moment of change, when they, by reacting on infectious matter, pass from a state of tension to a state of rest under new relations. The agency through which these changes almost universally become operative is the vapor of water.

"When sulphur is burned in a close chamber the dioxide is formed by condensing the molecules of oxygen from the air upon each molecule of the sulphur, and a heavy gas is the result, which tends to settle at the bottom of the chamber and to run out through the lower cracks. Any moisture present is at once seized by this rather inactive anhydride, first forming sulphurous acid, and then, by oxidation from the air, sulphuric acid. The dry gas, or anhydride, not only seizes with avidity all watery vapor in the air, but also the water held in the surfaces of all bodies with which it comes in contact, and in the presence of this moisture only is it ready for further oxidation. Then it is by this oxidation that it deoxidizes the matters with which it is in moist contact, filling the surfaces of these matters first with sulphurous acid, then, by the change, with sulphuric acid; and it is during these changes that its power is exerted.

"If there be no moisture supplied to the burning sulphur, that which was present in the air and on the surfaces of the chamber is soon used up, and the dry gas remains indefinitely in a comparatively inactive, ineffective condition. The dry, passive anhydride would necessarily destroy all organisms which breathed in any degree, because breathing surfaces are moist. But in embyronic life protected by shell, as in seed, if the shell be dry the gas would be impotent. Many bacteriologists have admitted that burning sulphur would kill bacteria, but not germs."

This is quoted in full because it is important to impress the fact that sulphur to be effective should be burned in the presence of enough moisture.

Dr. J. Lewis Smith uses the following:—

℞	Carbolic acid,	one ounce
	Oil of eucalyptus,	one ounce
	Spirits of turpentine,	eight ounces.

Mix this thoroughly and add two tablespoonfuls to the quart of water in a pan with broad surfaces, and maintain in a constant state of ebullition or simmering in the room occupied by the patient.

Other methods have been proposed, but all with the same object.

CHAPTER X.

SMALL-POX.

Small-pox is a disease which prompt vaccination has so far limited in this country that epidemics occur at longer intervals each time. It is the one disease which can, with certainty, be prevented. That vaccination, properly performed, protects for a varying period against attacks of small-pox no person understanding medicine will deny. It is a disease which, when once occurring, should be treated by the strictest isolation.

Even if the theory of vaccination has never been satisfactorily explained, its practical results are so clear that it should be performed on all persons indiscriminately; if the disease be recognized or suspected early enough, even on the patient himself. This should be compulsory by law, as it is in some places. The protective power of vaccination shows itself in a few days if it appears at all, while the disease itself, when once contracted, takes a longer time to develop.

Hence, vaccination, even after the disease has set in, mitigates the attack and shortens the disease. In almost all well-regulated cities which have a health officer there is a corps of vaccine physicians, whose duty it is to vaccinate the unvaccinated as often as they may think proper, to inspect all vaccination marks, and to give certificates to all school-children before the opening of each session. Theoretically, this would effectually stamp out small-pox if this method were carried out so strictly. Practically, such strict supervision only obtains after small-pox has broken out or after a scare of the disease.

Cases that do occur are usually brought in by emigrant ships—which, indeed, are at the bottom of much of the poverty, misery, and disease in the United States.

Dr. J. Lewis Smith says:—"Small-pox is so very contagious that there is danger that the physician and attendant may communicate it through their persons or clothing. The virus adheres tenaciously to objects, and may be conveyed by them long distances."

All unnecessary objects should be removed from the room and disinfectants should be thoroughly used. While small-pox has some very undesirable complications, they are by no means so dangerous as those following scarlet fever. As an offset to this, the disease itself is much more to be dreaded; it is so severe and its mortality is so great. As in measles, there is a black variety of small-pox, and there are other varieties which are very fatal. Aside from the dangers of great mortality, the nurse should never forget the terrible disfigurements that may and often do follow an attack of small-pox. She should follow the physician's directions with military precision and particularly use faithfully any means to prevent the "pitting," which is, after all, the worst result of small-pox.

The scientific name for small-pox is variola. If the patient have been vaccinated at some period in his life, the disease, which is rendered milder in consequence, is called varioloid; that is, resembling variola. It is much like variola or small-pox, and is chiefly dangerous because it causes genuine small-pox in one not vaccinated and predisposed. In fact, each disease can communicate the other.

CHAPTER XI.

YELLOW FEVER.

Yellow fever is another of the preventable filth diseases. It has been considered by some as a miasmatic-contagious disease, but a more careful study seems to have separated it from the malarious diseases. The specific organism of this malady has not yet been found, although much work on the subject has been done. There is some reason to believe that it is caused by a germ whose habitat is in the intestines. The disease is found principally in the tropical regions and rarely where the temperature is below 70° F. Its period of incubation is from one to fourteen days, and its onset is often very sudden and its mortality very high.

Overcrowding and the presence of filth, such as the accumulation of excreta around dwellings, are the most usual predisposing causes. It is particularly prevalent on shipboard and in seaports, and is very apt to break out on an infected ship as soon as it lands. As soon as the temperature gets below

70° F. the disease begins to disappear, and usually the first frost puts a stop to the disease. One attack generally, but not always, protects against future attacks of the disease. The negro race is almost exempt from the disease. Occupation, filthy surroundings, fatigue, dissipation, any excesses, and, it is said, fear, all invite the disease. It is epidemic in warm countries and may be carried by the air, but the intervention of a high wall or a stream has been known to cut off its march.

Persons who live among the sick and are used to the climate are not so apt to contract the disease as the fresh arrivals who are not acclimated. The prophylactic treatment is very important. The strictest quarantine should be enforced, although its power of preventing the disease has been called in question. The occasional outbreaks occurring in the southern parts of the United States have in every case been due to the collection of filth and dirt. Careful quarantine, pure drinking water, good sewerage and ventilation, and supporting treatment will do much toward removing the disease.

CHAPTER XII.

EPIDEMIC INFLUENZA.

Epidemic influenza, or more commonly called the grip, from the French "grippe," is a disease which has become painfully familiar to a large part of the civilized world. It has aroused such universal interest and consternation that a few words about it may not be out of place in this work. It assumes so many forms and appears in so many disguises that an exact description of the disease is not easy. It appears so suddenly and seems to attack so quickly that the Germans call it "Blitzkatarrh," or lightning catarrh, because it seems to strike like lightning.

The most prominent symptoms are high fever, marked prostration, generally dry cough, and severe pains in the back, limbs, and head, especially across the forehead. The disease usually lasts a short time, and if there are no complications recovery is not slow, but, unfortunately, the convalescence is the worst part, the patient often continuing to be under the influence of the poison for weeks, months, and even longer. The most dangerous complication is pneumonia, which seems to follow this trouble in weakened individuals with remarkable frequency.

Epidemic influenza has been familiar to physicians for fifty years or more, but the more recent epidemics, occurring in the past few years, have given not only physicians, but also laymen, a very undesirable experience with this disease. It usually begins in Russia and sweeps across the continent and ocean in a few weeks, often in opposition to winds. As the more recent attacks have occurred since our greater familiarity with bacteriology, it was natural that the first announcement of the reappearance of this disease should have set bacteriologists and would-be bacteriologists to look for the specific organism, and many were the reported discoveries which were published in the daily press, which at the present day seems to be the disseminator of our knowledge of medicine.

Many discoveries of the specific organism of this disease have been announced, but it is doubtful if any of them are of value. Unsanitary surroundings and damp weather with heavy fogs favor the spread of the influenza. It is probably a miasmatic disease, like malaria. Little can be done by the nurse to prevent the spread of the disease. It has been said to be contagious, and with this idea some physicians have isolated with alleged good results their cases. Any attempt to destroy the as yet undiscovered germ of this disease is probably of no use, and hence no especial precautions are needed; that is, considering the disease with our present knowledge.

CHAPTER XIII.

PNEUMONIA.

Although pneumonia can hardly be classed among the preventable diseases, still, it probably belongs to those diseases whose cause is a micro-organism. It can hardly be said to be contagious, but where a number of cases occur in the same place and about the same time it is very likely that the cause is the same. It was at one time looked upon as a simple inflammation of the lung substance, but recent bacteriological studies have detected the presence of certain organisms which are usually absent where there is no pneumonia.

The organism most generally agreed upon as standing in causal relation to the ordinary acute pneumonia is described as a diplococcus, that is, it is two round cocci apparently joined together. This organism has been found in the sputum of those sick with pneumonia, and its almost constant presence in this disease is very strong evidence that it is the specific organism of pneumonia. Unfortunately, we are not able to reproduce the disease in animals in a manner to make the chain of evidence complete. When the sputum from a pneumonic patient is inoculated under the skin of a rabbit, the animal sickens and dies in a few days, and the blood is found to contain an almost pure culture of these diplococci, but the same experiments with dogs and some other animals have not been so successful.

Epidemics of pneumonia have occurred and been reported from time to time in which the disease, according to the history given, seems to have been transmitted by contagion, but this cannot be absolutely proved. There is one significant fact connected with this disease which would seem to point to the presence of a specific organism, and that is that sailors far out at sea and exposed to the severest weather rarely have pneumonia, while rheumatism is not an uncommon disease with them, which might look as if the pneumonia organism did not thrive at sea—a place where notably few germs live and thrive—and that a pneumonia was something more than an ordinary inflammation of the lungs.

Precautions are rarely taken to prevent the spread of this disease, and this is very natural, too, for experiment has shown that this very diplococcus of pneumonia is very often found in the sputum of apparently healthy persons. Still, the sputum of pneumonic patients might just as well be disposed of in a careful manner as to be thrown out like harmless matter. The sputum cup should always contain a one-to-one-thousand bichloride solution, and the cup should be cleaned frequently, especially if the sputum has a dark or reddish-brown color, due, in part, to the presence of blood. No especial attempts at isolation are necessary. It might be added that the sputum of pneumonic patients contains this diplococcus long after the disease has disappeared and the patient is entirely well.

CHAPTER XIV.

WHOOPING COUGH. PERTUSSIS.

Whooping cough is a communicable disease depending on a specific poison and prevailing epidemically or sporadically. It is highly contagious. The poison seems to have certain periods of activity and can exist outside of the body. When introduced through the respiratory canal, it produces those well-known symptoms so familiar to mothers, nurses, and many others. The principal and distinctive sign is the whoop, which is evidently of a nervous origin. The period of incubation is about two weeks, and the poison is carried from one child to another, principally through the dried sputa.

Several investigators have described micro-organisms, but none of them are distinctive, and the true germ of pertussis is still to be discovered. Children with pertussis should be isolated, their expectoration well disinfected, and their clothes, which are very ready carriers of the disease, should be well boiled before washing. The disease, like many others, is dangerous on account of its complications, hence the child should be under the care of the physician.

CHAPTER XV.

MALARIA.

The word "malaria" literally means "bad air." In its present sense it comprises intermittent, remittent, and continued fever. Whatever causes malaria is very elusive, and in spite of much work by able investigators there seems to be doubt in the minds of some if the organism of malaria has ever been discovered.

Like most diseases, malaria was studied by its effects and by certain peculiarities of the disease. It is a disease peculiar to low lands, to marshy districts where there is much water in a comparative state of quiescence, particularly near fresh water, or fresh and salt water mixed. The disease does not flourish below an average of 58° F. for the twenty-four hours, and will not prevail as an epidemic unless the average temperature ranges as high as 65° F. for the twenty-four hours. It seems to prevail particularly where there has been much digging up of the soil. Workmen who dig up our city streets on the slightest provocation meet their just punishment in this disease. The hospital and dispensary records show an increased number of such cases when there is much digging up of the streets.

From its name it may be seen that it was studied first in Italy, and that is because it occurs in its worst forms in parts of Italy. Whatever is the cause of the disease, it can be carried by rivers to places not subject to it; it can be carried by heavy winds up mountains where it is never supposed to occur. In this way an outbreak in the Catskill Mountains one summer was accounted for. It has been carried for a short distance to sea, causing an outbreak on vessels near land. The earliest work on the causation of this disease was done on the Pontine Marshes in the neighborhood of Rome. Persons not acclimated who remain exposed to the air of the Pontine Marshes usually acquire malaria, and even those at a distance from the Marshes when the wind blows without obstruction are apt to catch this disease.

The Italian investigator who first described what he thought was the malarial organism was Dr. Tommasi Crudeli, of Rome. He had observed for years large numbers of cases in and about Rome, particularly among the strangers; he also noticed the extreme prevalence of this disease when the wind blew from over the Marshes to Rome. Still further, he noticed that when trees grew between the Marshes and a certain locality that the disease did not penetrate and infect that locality, that is, the trees seemed to act the part of a filter and free the air from this unknown cause of disease.

Tommasi Crudeli exposed glass plates to the air of malarious districts and then examined the cultures thus obtained microscopically. Noticing an organism always present, he described this as the malaria organism, but work done since has shown that Crudeli simply described some ordinary ingredient of the air. In 1882 Laveran, a Frenchman, while serving in Algiers had opportunity to see large numbers of cases of malaria, and he made use of this opportunity by studying them. His work was done under great disadvantages and with many hindrances, for he had very imperfect instruments and crude lenses; still, with no further help he carefully studied the blood of the sick, and his observations recorded at that time were so well made that further work has done little but confirm his efforts.

Laveran found in the blood an organism or germ which he called a protozoön or plasmodium. It assumes different shapes at different times and at different stages of the disease, is found either free or in the blood corpuscles, and is particularly abundant during a paroxysm. His theory was that this little organism, much like a parasite, attacked the red blood corpuscles, deprived them of their red color, which is their life, and prevented them from doing their work. The use of quinine causes these organisms to disappear. This organism is now accepted as the cause of malaria, and its diagnostic value has been proved to the satisfaction of clinicians, but the life history of the organism has not yet been completely studied, as it does not grow on the ordinary culture media.

The disease is of such universal occurrence that many of its peculiarities are well known to all, lay and medical alike. It is not at all contagious, and no special means of disinfection are necessary. The weak and sickly are more liable to catch it, but few escape if sufficiently exposed. Strangers visiting Italy often fall an easy prey to the disease, because they are careless and render themselves liable to it. This they do by spending the whole day in sight-seeing without stopping for the proper amount of food and rest, and this drain on even the strongest system, kept up for days and possibly weeks at a time, invites an attack of any disease which may be near at hand. This in that country is usually a severe form of malaria or perhaps typhoid fever. The night air is to be dreaded, not because it contains any more dangerous ingredient than the day air, but because it helps to cool down and weaken an already overtaxed system and bring on this disease. There are no particular means of prevention that a nurse need especially take.

CHAPTER XVI.

THE BACTERIA OF SURGICAL DISEASES.

In spite of the numerous changes and improvements in the methods used in antiseptic surgery, all writers agree in giving to Sir Joseph Lister the credit of having first used modern antiseptic methods in an intelligent way. However much we may have changed the methods of protecting wounds, the principle which was founded by Lister remains the same. It is on this common ground of surgical antisepsis and asepsis that the surgeon and the bacteriologist meet.

Even before the days of Lister, operators had noticed that some wounds healed at once without suppuration or inflammation, while others suppurated and healed very slowly or not at all. Suppuration and wound infection were at first supposed to be caused by atmospheric air, and hence wounds were treated by occlusion, that is, they were sealed up hermetically This, of course, kept out the air, but as it did not improve the condition of the wound, it began to dawn on the minds of the surgeons that perhaps the cause of infection was not the air itself, but something in the air. Then the question was asked, "Where was this infecting material, and how did it get into the wound?" It might be on the patient, on the instruments, on the operator, or in the air, and from any of these places it may get into the wound and infect it.

In order to remove the infecting material from these various places, we employ antisepsis to destroy it, and endeavor to get a condition of asepsis. By antisepsis we mean a means employed to destroy the activity and even the life of the infecting organism. If we succeed in this, then a condition of asepsis, or entire absence of infection, is obtained. As prevention is the aim of modern medicine, we endeavor to prevent the contamination of wounds rather than attempt to clean them after contamination has occurred.

Now, not only are the expressions, asepsis, antisespis, not clear to many nurses, but even physicians have a very hazy idea as to what these words mean. All tissues of the dead body will become putrid under certain circumstances, such as moisture, warmth, and the presence of bacteria. Absence of any of these factors will prevent decomposition. The thrifty house-wife first boils her fruit or preserves and then seals them in air-tight vessels while hot, thus destroying all bacteria and preventing the ingress of new growths. Perfect sterilization lasts only so long as the object or place is properly protected, contact or exposure, even for the shortest possible time, causing contamination. As already related in a previous chapter, fire is the most perfect sterilizer, and exposure to heat for a sufficient length of time will effectually and certainly destroy any known micro-organism. A facetious writer, in speaking of our "invisible foes," the bacteria, and the extreme difficulty or even impossibility of completely sterilizing the human body, said that when Shadrach, Meshach, and Abednego emerged from the seven-times-heated fiery furnace, into which they had been cast by the order of Nebuchadnezzar, they were thoroughly sterilized.

Before performing an operation, the surgeon first destroys any germs that may be present by the use of antisepsis, and this done, he prevents the ingress of further bacteria by strict asepsis. Thus the rule in surgical operations is, antisepsis up to the time of operation, and then asepsis. An exposed wound, whether accidental or made in the course of an operation, offers every inducement for bacteria to grow; the blood, the tissues exposed, the dust, containing germs and falling on the wound, all cause disease. They cause disease by being carried through the circulation to other parts of the body, or else the ptomaïnes, that is, the poisons which the bacteria secrete, are distributed over the body through the circulation. Not only will these ptomaïnes get into the small lymphatic channels and be absorbed and cause septic fever, but the bacteria themselves are taken up by the vessels and are carried to different parts of the body, producing what are called metastases, or secondary deposits of the disease. This is familiar in the boils which so often appear in numbers in weakened individuals. There are so many dangers from this that it seems almost hopeless to try to avoid the "ubiquitous bacillus." In the first place, the dust in operating rooms is a source of danger, and, notwithstanding the fact that modern operating rooms are carefully built, dust is always present, especially in adjoining rooms and in the outer air, and this dust brings with it bacteria.

The ideal operating room has smooth, kalsomined walls with rounding corners, smooth washboards gently curved to meet the floor, hard wood floor, highly polished, with as few and as small cracks as possible, no hangings, no rugs, no matting, glass and metal instrument table, plain operating table, preferably of metal, instruments easy to clean and with few cracks or angles for bacteria to lodge in. Notwithstanding these elaborate precautions and the methods of antisepsis just explained, bacteria and dust containing bacteria do get in.

The calculation of the number of bacteria in cities by an ingenious Frenchman is interesting if not startling:—

"The number of bacteria on the top of a high mountain is one to the cubic meter. In the Parc de Montsouris, in the south of Paris, he found 480 bacteria to the cubic meter of air, whilst in the Rue de Rivoli the proportion was 3480. In a new room in the Rue Censier he found 4500 to the cubic meter—more, that is to say, than in the centre of Paris in the open air. In a room in the Rue Monge, he counted 36,000, in the Hôtel Dieu 40,000, and in the Pitié, an older hospital, 319,000 bacteria to the cubic meter. At the Observatory Montsouris, 650,000 bacteria were found in a gram (15 grains) of dust; in the room in the Rue Monge the amount was 2,100,000. In the hospitals the proportion was so high that counting the number of bacteria in a whole gram of dust was found impossible.

"*The dust is the great conveyer of micro-organisms.* At 2 A.M., when a city is most quiet, the fewest germs are to be found in the air; at 8 A.M. the industry of domestic servants and dustmen has already made the air to teem with bacteria. At 7 P.M. it is once more high, for many houses are being 'tidied up' besides, sundry kitchen operations are unhygienic. Thus the 'small hours' unfavorable in many respects to patients hovering between life and death, are the least septic of the twenty-four. The day proportions indicate that household duties cause more septic diffusion than is excited by traffic and industry. Thus the value of residence at the seaside and on mountain peaks is scientifically demonstrated."

While these statistics may be well worth noting, it would hardly repay any one to live on a mountain peak to avoid the bacteria. The presence of bacteria in the air and in other places, however, does show the necessity of proper precaution in performing surgical operations, and it also shows that bacteriology, or the study of these bacteria, has opened a new era for surgery. The knowledge gained from this new branch of medicine has opened new fields of usefulness for the surgeon, so that many diseases formerly treated by drugs are now treated with success by surgery.

In the prefatory chapter to his well-written work, "Aseptic and Antiseptic Surgery," Dr. Gerster says:—"To a large number of medical men the aseptic and antiseptic methods present an incongruous chaos of seemingly contradictory and often incomprehensible detail, arbitrary and varying, according to the predilections or whims of this or that teacher. Yet the principle involved is based on the correct observation of a common biological process, namely, that of the decomposition of organic substances. The well-known methods employed since the earliest dawn of civilization for the preservation of organic, especially animal, substances are based upon the empirical yet correct appreciation of the causes of putrefaction, and the practical adaptation of these methods to the healing of operative or accidental wounds contains the whole essence of the new surgery. Evils that former generations of surgeons deplored, but could not effectually combat, such as septicæmia, pyæmia, hospital gangrene, and erysipelas, have been much abated as a direct consequence of a clear understanding of their essential nature and causation.

"*Prevention* has become the watchword of modern practice, and it can be said that, by the successful employment of the preventive methods of the present day, surgery has become a *conservative* branch of the healing art. The elimination of the accidental disturbances of repair caused by wound infection has depressed the percentage of mortality following amputation of the extremities from an average of thirty-five per cent. to about fifteen per cent. The dread of undertaking and submitting to a surgical operation has greatly diminished, and timely—that is, early—surgical interference has become more and more frequent, to the great advantage of both patient and physician.

"The fear of suppuration, with its dreadful consequences, does not stay now the hand of the surgeon, as of old, when an operation was always considered a forlorn hope and a last resort. The principle underlying antiseptic surgery has ceased to be the subject of serious controversy. The methods of wound treatment are, to a certain extent, still undergoing changes, hence should not be accepted as final. Yet it is undeniable that, as the clearness of the simple *principle* of asepticism applied to wound treatment has advanced, so the frequent changes and bewildering vacillations characteristic of the experimental stage of the new discipline have naturally given way to steadier methods. At present, changes are not so frequent as formerly, yet progress, especially the conquest of new fields for the legitimate practice of active surgery, is not at a standstill."

This is quoted at such length to impress the importance of cleanliness in surgical operations. Indeed, it has been stated that more deaths have been caused on the battlefield by bacteria than by the sword.

The bacteria of surgical diseases are principally the organisms of suppuration, pyæmia, septicæmia, and erysipelas. The most common cause of suppuration or pus formation is a micrococcus called from the golden yellow color of the mould it forms in cultures, staphylococcus pyogenes aureus, or the golden grape coccus. These micrococci are arranged together in bunches like grapes and are found in almost all forms of acute suppuration. Another micrococcus of suppuration is the staphylococcus pyogenes albus, or white grape coccus. Under the microscope it is exactly like the last variety, but in cultures it is white and not yellow. Another form is called the streptococcus pyogenes, or pus-generating chain coccus, because it grows in cultures to long chains. These three, then, are the principal causes of suppuration.

All forms of suppuration owe their origin to infection from without. This infection in the form of these organisms may enter the body by lesions of the skin, mucous membrane of the digestive, respiratory, or genito-urinary tract. Wounds that bleed freely do not usually suppurate, because the flowing blood washes away the organisms, and large wounds demand medical attention and thus often avoid suppuration, but the small, jagged wound that does not bleed, the wound inflicted by a blunt and unclean instrument, is apt to suppurate. In the mouth, wounds may cause suppuration, although the saliva is apt to prevent this. As long as the skin is intact no infection or suppuration will take place, but let the skin be excoriated or rubbed, or let the hand be constantly bruised by the use of a tool, as in working or in rowing, and the lacerated skin may take up pus organisms, and the constant working of the hands and fingers will cause the germs to spread by the lymphatics to other parts of the body.

A very common way of carrying infection from one part of the body to the other is by scratching, the organisms, being carried under the nails, are inoculated into the skin by the edges of the nails.

The relation of the diseases of suppuration to septicæmia and pyæmia is a very close one. Literally, septicæmia is defined as an infective disease caused by the absorption of septic or poisonous products, while pyæmia is septicæmia with the formation of secondary abscesses. That is, they are both probably caused by the pus organism, but in septicæmia the disease is not carried all over the body, while in pyæmia the pus organism is carried by the circulation to other parts of the body, causing the formation of secondary abscesses, called also metastatic abscesses.

The whole idea of antiseptic surgery is to thoroughly clean the part of the patient to be operated on, clean the operators' hands, instruments, and everything else used. The rules laid down by Gerster in his "Surgery" are that the hands and forearms, *especially the finger-nails*, of the surgeon and his assistants should be well scrubbed in hot water with soap and brush for five minutes; likewise the region of the body of the patient to be operated on, after carefully shaving off the hair. After this follows an immersion of the hands in corrosive sublimate lotion for one minute. All rings, bangles, and bracelets should be removed from surgeons and nurses. Instead of the corrosive sublimate solution, green soap may be used. The instruments should be subjected to a careful and minute cleansing with soap and brush, especial care being taken to remove dry particles of blood, pus, etc., from the grooves and behind the clasps of the more composite instruments, which ought to be taken apart each time for cleansing. They should be immersed for ten minutes in a three per cent. solution of carbolic acid before use. As few instruments as possible should be used, and they, simple, smooth, and well-polished. During the operation the wound should be freely and frequently irrigated with the proper kind of a disinfecting fluid; the hands of the surgeon and his assistants should be also washed at not too long intervals in a disinfecting fluid (corrosive sublimate, 1 : 1000); the instruments should be kept immersed in a three per cent. solution of carbolic acid (which is least injurious to them).

If the surgeons or nurses touch a not disinfected object the hands must be disinfected anew. Sponges should be beaten free from calcareous particles, then immersed for fifteen minutes in dilute muriatic acid to dissolve the remnant of lime, washed in cold water, then thoroughly kneaded by hand with green soap in hot water for five minutes, rinsed, and then immersed in a five per cent. solution of carbolic acid, in which they remain until required for use. Sponges used in an antiseptic operation can be used again. Careful washing out with green soap and hot water of all the remnants of fibrin and blood, then immersion in a five per cent. solution of carbolic acid, is sufficient. It is not good to use too many sponges at an operation. When saturated with blood at an operation, they should be washed free from it in *hot water*, then thrown into a basin filled with a carbolic acid solution, and hence handed to the surgeon. Carbolic acid is preferable for the preservation of sponges until used because it does not become decomposed and inert, as, for instance, corrosive sublimate.

Ordinarily, the two disinfecting solutions above mentioned will usually be found sufficient, and they have the further advantage of being easily procurable. Boiled water as a solvent for these substances is to be preferred. A convenient and ready way of mixing the carbolic acid solution, is to add one tablespoonful or four teaspoonfuls of pure carbolic acid to a quart bottle of hot water. This will make a solution of the strength of about three per cent., reckoning 650 grams to the ordinary wine-bottle. The corrosive sublimate solution may be easily made by using the compressed tablets of corrosive sublimate and ammonium chloride, as put up by Sharp and Dohme, of Baltimore, and other reliable manufacturing chemists. Each tablet is composed of 7.3 grains of corrosive sublimate and 7.7 grains of ammonium chloride, which, when dissolved in one pint of water, will give a solution of 1 : 1000. Sufficient green coloring matter of neutral and innocuous properties is added to render them distinctive and prevent mistakes. The ammonium chloride is added to facilitate solution and prevent decomposition of the corrosive sublimate when dissolved in ordinary spring or well water.

Dr. John B. Roberts, of Philadelphia, has formulated the following, to be observed in operations at his clinic at the Woman's Medical College Hospital of that city:—

"After wounds or operations, high temperature usually, and suppuration always, are due to blood poisoning, which is caused by infection with vegetable parasites called bacteria.

"These parasites ordinarily gain access to the wound from the skin of the patient, the finger-nails or hands of the operator or his assistants, the ligatures, sutures, or dressings.

"Suppuration and high temperature should not occur after operation wounds if no suppuration has existed previously.

"Bacteria exist almost everywhere as invisible particles in the dust; hence everything that touches or comes into even momentary contact with the wound must be germ-free—technically called 'sterile'.

"A sterilized condition of the operator, the assistant, the wound, instruments, etc., is obtained by removing all bacteria by means of absolute surgical cleanliness (asepsis), and by the use of those chemical agents which destroy the bacteria not removed by cleanliness itself (antisepsis).

"Surgical cleanliness differs from the housewife's idea of cleanliness in that its details seem frivolous, because it aims at the removal of microscopical particles. Stains such as housewives abhor, if germ-free, are not objected to in surgery.

"The hands and arms, and especially the finger-nails, of the surgeon, assistants, and nurses should be well scrubbed with hot water and soap by means of a nail-brush immediately before the operation. The patient's body about the site of the proposed operation should be similarly scrubbed with a brush and cleanly shaved. Subsequently the hands of the operator, assistants, and nurses and the field of operation should be immersed in, or thoroughly washed with, corrosive sublimate solution (1 : 1000 or 1 : 2000). Finger-rings, bracelets, bangles, and cuffs worn by the surgeon, assistants, or nurses must be removed before the cleansing is begun, and the clothing covered by a clean white apron, large enough to extend from neck to ankles and provided with sleeves.

"The instruments should be similarly scrubbed with hot water and soap, and all particles of blood and pus from any previous operation removed from the joints. After this they should be immersed for at least fifteen minutes in a solution of beta-naphthol (1 : 2500), which must be sufficiently deep to cover every portion of the instruments. After cleansing the instruments with soap and water, baking in a temperature a little above the boiling-point of water is the best sterilizer. During the operation the sterilized instruments should be kept in a beta-naphthol solution and returned to it when the operator is not using them.

"The antiseptic solutions mentioned here are too irritating for use in operations within the abdomen and pelvis. Water made sterile by boiling is usually the best agent for irrigating these cavities and for use on instruments and sponges. (The instruments and sponges must be well sterilized.)

"Sponges should be kept in a beta-naphthol or a corrosive sublimate solution during the operation. After the blood from the wound has been sponged away, they should be put in another basin containing the antiseptic solution and cleansed anew before being used again. The antiseptic sutures and ligatures should be similarly soaked in beta-naphthol solution during the progress of the operation.

"No one should touch the wound but the operator and his first assistant. No one should touch the sponges but the operator, his first assistant, and the nurse having charge of them. No one should touch the already-prepared ligatures or instruments except the surgeon and his first and second assistants.

"None but those assigned to the work are expected to handle instruments, sponges, dressings, etc., during the operation.

"When any one taking part in the operation touches an object not sterilized, such as a table, a tray, or the ether towel, he should not be allowed to touch the instruments, the dressings, or the ligatures, until his hands have been again sterilized. It is important that the hands of the surgeon, his assistants, and nurses should not touch any part of their own bodies, nor of the patient's body, except at the sterilized seat of the operation, because infection may be carried to the wound. Rubbing the head or beard or wiping the nose requires immediate disinfection of the hands to be practiced.

"The trailing ends of ligatures and sutures should never be allowed to touch the surgeon's clothing or to drag upon the operating table, because such contact may occasionally, though not always, pick up bacteria, which may cause suppuration in the wound.

"Instruments which fall upon the floor should not be again used until thoroughly disinfected.

"The clothing of the patient in the vicinity of the part to be operated upon, and the blankets and sheets used there to keep him warm, should be covered with dry sublimate towels. All dressings should be kept safe from infection by being stored in glass jars or wrapped in dry sublimate towels."

Experiments recently performed at the Johns Hopkins Hospital on the disinfection of the skin, and especially the hands, have yielded some new and very interesting results. It was at one time supposed that the bringing of powerful disinfectants in contact with the skin was sufficient to thoroughly disinfect it. It is now known that the presence of natural oil and fat on the skin is sufficient to prevent the action of these substances. Dr. Wm. H. Welch has found and described an organism which he calls the white staphylococcus, or staphylococcus albus epidermis, because it is found not only on the skin, but in the deeper layers of the skin which escape the ordinary methods of skin disinfection. What the exact significance of this organism is is not easy to say, but it has been found in certain morbid conditions where its presence was very suspicious.

This organism was found and studied by passing thoroughly sterilized threads through the previously sterilized skin and then putting these threads in culture tubes, as already explained, when a growth of this white staphylococcus would soon appear. This organism on the hands could cause infection when the hands had apparently been thoroughly disinfected by the ordinary methods. This is supposed to be the cause of the stitch abscess and the suppuration that so frequently occurs around drainage tubes.

For this reason some advanced surgeons have abandoned the use of skin stitches and drainage tubes, a thing which may be considered by some as doubtful progress.

Dr. Welch says, in an address read at the

Second Congress of American Physicians and Surgeons, in Washington: "The demonstration of micro-organisms in layers of the epidermis deeper than can be disinfected by present methods suggests that more attention than seems now to be customary should be paid to the skin of the patient as a source of traumatic infections. It also admonishes us to receive with caution the statements recently made concerning the elimination in suppurative diseases of staphylococci by the sweat.

"The conditions for the efficient action of chemical disinfectants have been found to be far more complicated and less easily controlled than was formerly supposed, and the substitution, wherever applicable, of the simple and certain methods of disinfection by heat, such as have been long employed in bacteriological laboratories, is to be commended. Chemical disinfectants still have their place for many purposes in the operating-room, but their place is not in fresh, healthy wounds.

"Thorough scrubbing of the skin with soap and warm water by a sterilized brush removes many bacteria, but not all, and it cannot be regarded as a satisfactory means of cutaneous disinfection.

"The fallacy in previous work on disinfection of the skin with corrosive sublimate has been that in testing its efficiency the sublimate was not first precipitated by sulphide of ammonium. If this precaution be first observed, it will be found that corrosive sublimate accomplishes much less than is generally supposed. Our revision of the work relating to cutaneous disinfection with sublimate has led to some curious and interesting observations, and to results which at first seemed paradoxical.

"By examining the hands of surgeons who are in the habit of washing them daily in solutions of corrosive sublimate, it was found that the mercury becomes so intimately incorporated with the epidermis that its presence there can be demonstrated by means of sulphide of ammonium at least six weeks after any contact with mercurial solutions has taken place. Micrococci in the epidermis which have not been killed by washing in sublimate solutions, but which have been brought into such relation to the sublimate that even after prolonged washing of the skin with alcohol and water they will not grow on culture media until the skin is washed with sulphide of ammonium, may also remain a long time in the epidermis.

"Hence, it may happen that prolonged scrubbing of the hands of such persons simply with soap and warm water may remove so many superficial bacteria that the cultures from the scrapings of the epidermis may show very few, occasionally even no, colonies: whereas, when this is followed by washing in sublimate and then in sulphide of ammonium, a much larger number of colonies appear in the cultures. The apparently paradoxical result, which is obtained only from the hands of those who have previously washed them in sublimate solution, has no reference to the application of the sublimate immediately after the soap and water, but it is to be explained by the liberation, by means of sulphide of ammonium, of the bacteria held in check by the mercury used, it may be, several days before the experiment. The same result is, of course, obtained if the sulphide of ammonium be applied immediately after the scrubbing with soap and water.

"These observations upon the persistence of mercury in the epidermis and its long-continued inhibition of the growth of bacteria, make it necessary in all work upon disinfection of the hands to first precipitate the mercury with sulphide of ammonium whenever the experiments are to be made upon hands which have been washed in sublimate solutions, even if it has occurred a long time previously. Exactly what relation the mercury in the epidermis holds to the bacteria which it does not destroy, but whose growth in our nutrient media it prevents, we cannot say. We may, perhaps, think of these bacteria as enveloped in an albuminous combination of mercury. One thing is certain—that, when the sublimate has been as thoroughly washed off from the skin as possible with water, or has been applied days before, the nutrient gelatine or agar is not rendered unfit for the growth of bacteria by the mere presence of the small quantity of mercury carried into it with scrapings from the epidermis, for the bacteria which have reached the epidermis after the application of the sublimate—

and these are often identical with those inhibited by the mercury—develop as usual. It is only those bacteria which were originally brought into contact with the sublimate in some such manner as that suggested, which will not grow until after the application of sulphide of ammonium, and it is not—as has been usually supposed in other observations of a similar kind in disinfectant experiments with sublimate—the alteration of the nutrient medium by the presence of a trace of sublimate which inhibits the growth of the colonies.

"As to the practical efficiency of disinfection of the skin with solutions of corrosive sublimate, it is to be said that this agent, when properly applied, kills most of the bacteria upon the surface of the skin. The washing of the skin with alcohol immediately before the use of the sublimate increases its efficiency to a marked degree. If the mercury after the employment of this method be precipitated by washing the hands in sulphide of ammonium, it will be found that the results are much less favorable than would appear by cultures made from the skin and under the nails, without the use of sulphide of ammonium.

"It is especially the scrapings under the nails and around the matrix of the nails which yield positive results when ammonium sulphide is used, but often negative ones without this precaution.

"It may be urged that it is not necessary actually to kill the bacteria upon the skin; it is sufficient if they are rendered incapable of growth, and as most of those which are not killed by the sublimate do not grow upon our ordinary nutrient media, it is reasonable to infer that they will not grow in wounds. This line of argument certainly deserves consideration; nevertheless, there is no positive proof that these bacteria will not grow in wounds under some conditions, and surely one will feel safer with a method of disinfection which actually kills the bacteria.

"The best results have been obtained in disinfection of the skin by the following method:—

"1. The nails are kept short and clean.

"2. The hands are washed thoroughly for several minutes with soap and water, the water being as warm as can be comfortably borne and being frequently changed. A brush, sterilized by steam, is used. The excess of soap is washed off with water.

"3. The hands are immersed for one or two minutes in a warm, saturated solution of permanganate of potash and are rubbed over thoroughly with a sterilized swab.

"4. They are then placed in a warm, saturated solution of oxalic acid, where they remain until complete decolorization of the permanganate occurs.

"5. They are then washed off with sterilized salt solution or water.

"6. They are immersed for two minutes in sublimate solution, 1 : 500.

"The bacteriological examination of skin thus treated yields almost uniformly negative results, the material for the cultures being taken from underneath and around the nails."

CHAPTER XVII.

THE BACTERIA OF THE MOUTH.

The bacteria of the mouth are very numerous, including not only those which are always present, or rarely absent, but also the accidental ones. Among the former are found a great number, some, always present, whose action is not understood, some which evidently play an important part in the splitting up of the food substances taken and assisting digestion and assimilation, and still others whose action under certain cirstances is very harmful.

As the mouth is one of the chief avenues of approach through which bacteria gain access to the body, it is not surprising that certain organisms of well-known diseases have been found in the mouth even when the individual did not have the disease caused by this particular organism. Thus typhoid fever, Asiatic cholera, pneumonia, phthisis, and several other diseases find their way to the body through the mouth.

The decay of the teeth is supposed to be caused by micro-organisms which attack them. They probably become especially active when the chemical composition of the saliva is so altered that its inhibitory power is lost or permits acid fermentations. The theory is that either the micro-organisms find their way into the teeth and the acid of the abnormal fermentation enters and does the harm, or else the acid makes a way for the organisms to enter. In adults occasionally, and in children especially, the mouth is apt at times to undergo inflammation; that is, the mucous membrane lining the mouth cavity becomes inflamed. This inflammation may assume different forms, and one form is called parasitic, because it is caused by a minute parasite. This disease is called the thrush.

Thrush is a disease characterized "by inflammation of the mucous surfaces, the peculiar feature of which is the presence of points or patches of a curd-like appearance on the inflamed surface." It occurs in children of all ages from a few weeks up, and may even be found, though very rarely, in adults. The most common primary causes are improper feeding, indigestion, inflammation of the intestinal tract, general weakness, and such causes. It is a common disease in foundling hospitals, in crowded tenement houses, among the poor, and especially where the infant is bottle-fed. It is a parasitic disease and communicable by contact.

One frequent cause among foundlings is the use of a common nursing-bottle not properly cleansed, so that the disease is passed from infant to infant. An ordinary inflammation of the mouth, called a stomatitis, may become a thrush by the presence of the thrush organism. This is present in the form of little white points visible to the naked eye, each point consisting of a tangled mass of the thrush organism, or fungus, as it is called. The thrush fungus is different from the other organisms described in that it is a mould belonging to the vegetable parasites. It is seen under the microscope as a tangled mass of delicate branching filaments which grow very rapidly and penetrate into the layers of the mucous surfaces. It may be implanted upon an inflamed mucous surface from the air, but the most common method of transplanting it is by the nursing-bottle. This same fungus in milk causes fermentation, and undoubtedly by this means gives the disease to children.

In children thrush soon yields to treatment if the cause is removed; that is, in children under six months, but in children over that age it often proves very obstinate. As victims of thrush generally have a disordered digestion, the latter needs the physician's care first, especially as this indigestion so alters the composition of the saliva that the fungus flourishes and returns even when removed. The proper local treatment is to thoroughly cleanse the mouth with clean, warm water and a soft linen rag, and then apply on a rag ordinary borax dissolved in glycerin and water in the proportion of about a half teaspoonful of powdered borax to three ounces of water and one or two teaspoonfuls of glycerin. Of course, extended treatment should be left to the physician, as many complications of the disease might occur which might be beyond the nurse's knowledge.

If it is not practicable for each child in a hospital to have its own nursing-bottle separate from all others, then after each use, the whole bottle, and especially the tip, should be thoroughly sterlized by boiling in water, and if the milk is suspicious it should also be subjected to thorough sterilization. In most diseases, and in all febrile diseases, the mouth needs the constant attention of the nurse.

Every one has felt the extreme discomfort of awakening to find the mouth open, the tongue dry, and the lips parched. This in health is of little importance, but the sick suffer particularly from this unpleasant accompaniment of almost all diseases, namely, that of a dry and often unclean mouth. The nurse who knows how gently and skillfully to cleanse the mouth and give the lips their moist feeling, is of more use in the sick-room than all the sympathizing friends combined. The tongue, which has always been regarded as indicative of various changes in the alimentary canal, should not escape the careful study of the nurse.

Normally, the tongue is of a dull red color, and at times in health it assumes a furry, whitish look, but ordinarily it is red. Exceptionally, some persons have a tongue always coated, but when we see a tongue covered in whole or in part with a white, grayish, or even dark fur, it is proper to look for the cause. The popular idea is that constipation will cause the tongue to become furred, and this opinion is correct as far as it goes. A tongue also becomes coated when the individual is confined to a liquid diet or when he is starved. Patients convalescing and on a milk diet have almost always a very white tongue. This white fur to the tongue is composed partly of minute organisms like the thrush fungus in form, and it is partly epithelium, which grows very quickly on the tongue. Ordinarily, in health the constant use of the tongue in mastication rubs off this epithelial layer as fast as it is formed, and the organisms do not have a chance to grow to a great extent, but in diseases where the patient diets, or where the diet is liquid, the epithelium is not rubbed off and is allowed to grow and be colored white or dark, according to the color of the food or medicine taken. In some diseases the tongue assumes a red color and is very dry. As this hardly belongs to the subject, it need not be considered further, but it may be said that the altered condition of the intestinal tract and the juices secreted by it is not without effect on the secretion of the saliva and the tongue.

These various conditions of the mouth and the tongue need attention on the part of the nurse much more frequently than other conditions apparently more important. The excess of fur on the tongue causes a very unpleasant and familiar odor to be generated in the mouth of the unfortunate patient, and the nurse should make it her duty to cleanse the mouth and free it from the excess of matter many times during the day and night, and especially after eating. For this purpose a soft, clean rag and warm water may be used as a preliminary.

The tongue should be scraped by a piece of whalebone or an ordinary tongue-scraper and the mouth be washed out occasionally with a mixture of tincture of myrrh, a teaspoonful to a half tumblerful of water. To this may be added a half teaspoonful of the chlorate of potash, if desirable. Borax also may be used as in thrush. If the patient is able to expectorate, the mouth may be rinsed out with a solution of the bichloride of mercury (1 : 2000), if great caution be used that none is swallowed, and the mouth then be washed out with water.

The care of the mouth is one of the most important of the nurse's duties and one most appreciated by the sick patient, and an intelligent attention to this point not only makes the patient feel better and more comfortable, but may entice a very sick person to eat who otherwise would not care to do it.

CHAPTER XVIII.

OPHTHALMIA NEONATORUM.

Ophthalmia neonatorum is a purulent inflammation in the new-born, of the conjunctiva or mucous membrane lining the eyeball and the inner parts of the lid. Its synonyms are purulent ophthalmia, gonorrhœal ophthalmia, blennorrhœa of the conjunctiva, and purulent conjunctivitis. It is due to an organism called the gonococcus or micrococcus of gonorrhœa, and is usually transmitted to the eyes of the new-born child by the diseased condition of the genital tract of the mother. The organism is the specific germ of gonorrhœa and generally appears in pairs or fours, which are slightly flattened at the point of contact. It may be very beautifully stained in gonorrhœal pus with a weak, watery solution of methylene blue when the organisms are seen in or on the pus cells.

This disease generally begins on or before the third day after birth, and is particularly prevalent among the children of the poor, unclean, and those crowded together. The eyelids are red and swollen and painful to light, and the pus or matter may be seen oozing under the closed lids. What makes this form of ophthalmia, or "babies' sore eyes," so important is the fact that it is one of the most fruitful causes of blindness.

Thirty per cent. of all inmates of blind asylums in Great Britain have lost their sight from this cause alone, and 71 per cent. of all who lose their sight in the first year of life, and 23 per cent. of all those up to the twentieth year who are blind, owe this blindness to ophthalmia neonatorum. From 1870 to 1880 the population of the United States increased 30 per cent., while blindness in the United States in this time increased 140 per cent. The only proper treatment of this condition is never to let it occur, and while this may not be possible, still, the number of cases can be materially decreased by careful preventive measures. After the disease has once broken out it comes within the province of the physician and should be actively treated, but the prophylactic or preventive means should be familiar to the nurse, for too often, by the carelessness of the nurse, midwife, or even physician, the eyes of the new-born are not looked at until too late. The self-confident physician is not unfrequently the cause of blindness.

The best and universally adopted method of decreasing blindness is that advocated by Credé. He tried different means, and finally settled on a two per cent. solution of the nitrate of silver, one drop of which should be dropped into each eye of every child born. The consequence was that in the institutions of which he had charge the number of these cases of ophthalmia neonatorum decreased rapidly, and his method has been recommended to all those who deliver women, whether in public institutions or in private families. While it is not advisable for mothers, nurses, or midwives to use Credé's method when a physician can be found, yet in a case of emergency, when the mother of the new-born child is known to be infected with gonorrhœa, the child's eyes should not be neglected.

The Medical and Chirurgical State Faculty of Maryland, appreciating the importance and great dangers of this disease, appointed a committee, which had the following notice printed in large, clear type on a card 10 by 14 inches. This card has been distributed widely and is placed conspicuously in every public place where it may catch the eyes of those interested:—

WATCH A BABY'S EYES CAREFULLY FOR A WEEK AFTER BIRTH.

If they look Red, or Run Matter, take it at once to a Doctor.

THE CHILD MAY BECOME BLIND IF NOT TREATED PROPERLY.

The same Committee also sent the following circular letter to every midwife in Baltimore:—

To the Midwives of Baltimore:

The undersigned practicing physicians of Baltimore were appointed by the Medical and Chirurgical Faculty of Maryland to take measures tending to diminish the blindness in our city and State. About *one-third of the blind* in our Blind Asylums have lost their sight through a disease which is common among the newly-born. This *fearful disease*, which causes so much suffering and unhappiness, *can often be prevented by proper care. It can nearly always be cured and sight saved if treatment is begun early and kept up.* The disease shows itself by redness and such swelling of the eyelids that the baby cannot open its eyes; the eyes discharge yellow matter. The disease usually begins during the first few days of life. This disease will often cause incurable blindness in forty-eight hours unless properly treated.

We ask you to impress upon the mothers you attend the *great danger of delaying treatment.* Do not let them waste valuable time in using breast-milk, chamomile tea, quince water, and other home remedies, for *a day lost may rob the infant of its sight.* Insist upon sending the child, as soon as the disease begins, to a physician, or, if the parents are unable to procure one, to a dispensary.

You can do much toward *preventing* the disease by thoroughly cleansing the child's eyes immediately after it is born. Wash the eyes carefully with fresh, warm water and a piece of perfectly clean, soft linen. Do not use water or linen which has been used on other parts of the body, but wash the eyes first of all. You will assist greatly in the important work of diminishing blindness—

1. By washing the eyes of the newly-born as described above, in order to prevent the disease from attacking them.

2. By instructing the mothers whom you attend concerning the *importance of watching the eyes closely during the first and second week.*

3. By calling attention to the *dangers of the disease,* and the *great urgency of prompt medical treatment.*

The following was sent to each physician in Baltimore:—

DEAR DOCTOR:

As you will see from the enclosed circular letter, we are making an effort to impress upon the midwives in our city the dangers of Ophthalmia Neonatorum. Our Health Department has sent a copy of the enclosed to each midwife in Baltimore. In this work we ask your co-operation.

CHAPTER XIX.

VENTILATION AND HEATING.

Ventilation is one of the most important and least appreciated factors in the prevention and cure of disease. By ventilation we not only replace the impure air by fresh and pure air, but by admitting this fresh air we dilute the number of disease germs which may happen to be present in any given space.

It is strange that so many in all occupations understand to a small extent the theory of ventilation, but practically ignore it absolutely. It is not uncommon to see a body of physicians in scientific session in a room the atmosphere of which is almost unbearable. Many public halls, even in this enlightened age, are built in a manner æsthetically beautiful, but with no thought to ventilation. Any one who has felt the oppressive effect of heavy air will readily understand why a collection of people in one of these halls or churches, listening to a lecture or sermon, is often so sleepy that the most eloquent words fail to impress them.

The atmosphere is not a fixed chemical compound, but a mixture containing principally nitrogen, oxygen, carbonic acid gas, and other things, as follows:—

COMPOSITION OF ATMOSPHERIC AIR.

Oxygen,	209.6 per 1000 volumes
Nitrogen,	790.0 " "
Carbonic acid (carbon dioxide),	0.4 " "
Watery vapor,	Varies with the temperature.
Ammonia,	A trace.
Organic matter (in vapor or suspended, organized, dead or living),	Variable.
Ozone,	Variable.
Salts of sodium,	Variable.
Other mineral substances,	Variable.

The atmosphere has been described as a gaseous envelope encircling the earth; an ocean of air, at the bottom of which we live. Under ordinary circumstances we are not conscious of living in this atmosphere, but when we consider that the air extends upward anywhere from 50 to 200 miles above sea level, it is evident that we, at the bottom of this air ocean, must be subject to great atmospheric pressure. It is true that the pressure of the atmosphere on the body is about 15 pounds to the square inch of surface, or the whole body supports a weight of several tons, but as this pressure is equal in all directions it is not noticeable. It is only when we remove the pressure on one side, as in the experiment of exhausting the air from beneath the hand by an air pump, that we appreciate this great pressure.

As water normally seeks its level at the lowest point, we take the pressure or weight of the atmosphere at sea level as a standard, and reckon from this point. Torricelli discovered the fact that the pressure of the atmosphere could be measured by taking a glass tube sealed at one end, filling it with mercury, and inverting it by placing the open end covered with the thumb in a vessel of mercury. This was the first barometer. The column of mercury stood at about 30 inches at sea level. The density or weight of the air differs at different levels; it being elastic and having weight, it is more compressed below and lighter above. That is, the higher we ascend, the thinner or rarer becomes the atmosphere, and the column of mercury in a Torricellian barometer stands lower and lower the higher we ascend, until the level is reached beyond which man and other animals cannot live.

Knowing, then, what air is and how essential it is that we should breathe pure air, it is unfortunate that dwellers in cities and in crowded communities are compelled to spend most of their lives in impure air. Impurity of air is directly and indirectly one of the most usual causes of death. The air may be composed of its proper ingredients, none lacking and none in excess, and yet it may contain impurities in the shape of vapors, gases, or solid particles. Some of these can be detected by the taste or smell, and hence cannot do harm without a warning; others may be smelled or tasted at first only, but later the nerves lose their delicacy and the impurity is not noticed.

Fortunately, the atmosphere is not an immovable mass. Noxious gases are diffused, become diluted, and are carried away by currents of air; solid particles, in time, fall to the ground by their own weight, or are washed down by rains, or plant life absorbs the impure gases. In enclosed places the facts are far different. In rooms not perfectly ventilated and inhabited by healthy persons we find scaly epithelium from the mouth, fibers of cotton, wool, and linen, portions of food, bits of human hair, of wood, of coal, etc. Green wall paper often gives off little particles of arsenical dust, and the moisture of the paste on green wall paper, especially in damp weather, may cause the diffusion of arseniuretted hydrogen in the room. This has been brought up as a cause of poisoning, and there may be some truth in this supposition.

In rooms occupied by sick people, particularly in a sickness where there is much perspiration, in addition to the air being vitiated by respiration, it is contaminated by the abundant exhalations from the body of the patient. The peculiar and unpleasant odor from these exhalations is at times noticed in the best hospitals, and physicians have claimed that the odor of certain diseases, as, for example, typhoid fever, is pathognomonic.

Looking at the composition of the air, it is seen that the nitrogen is a constant ingredient, while the amount of oxygen is variable, and increasing the amount of carbonic acid gas means less oxygen, as the carbonic acid gas is formed from the oxygen. Animals give out carbonic acid gas and plants exhale oxygen. In considering the impurities in the air, it is well to remember that it is not the presence alone of an excess of carbonic acid gas that constitutes bad air, but also a decrease in the amount of oxygen, together, in many cases, with the products of respiration and perspiration. Indeed, there seems to be great doubt in many minds as to what bad air is. It is well to impress the fact that warm air is not necessarily impure, nor is cold air always pure, as many persons seem to think.

The fact that the excess of carbonic acid gas in the atmosphere does not constitute impure air is partly shown by the fact that workers in certain trades, as in brick fields, cement works, and soda water factories, who constantly live in an atmosphere of carbonic acid gas, do not suffer at all. The feeling of closeness in an unventilated room is due more to the want of oxygen than to the excess of carbonic acid gas; but it is due also, as just stated, to the impurities in the exhalations of those present. The carbonic acid gas is equally diffused through the air of a room; it is very easily got rid of by opening windows, etc., while neither organic matter nor watery vapor diffuse rapidly or equally through a room.

The impurity of air is often caused by imperfect sewerage and drainage systems. Of course, one would hardly expect to find pure air in the best cleaned and ventilated sewers, still, the air of the Berlin sewers has been said at times to be entirely free from bacteria. The bad air of sewers is caused by the mixture of excreta, house-water, debris from streets, factories, etc., all of which, being mixed together, undergoes decomposition and generates such impure gases as sulphuretted hydrogen, etc. Constant flushing of sewers will tend to carry these gases off, but at times, when the atmosphere is heavy and when there are backward currents of air, these foul gases and any bacteria which may happen to be present, adhering to pieces of dust and dirt, are drawn back into houses, dwellings, etc.

The ideal sewer trap in dwelling houses and other buildings is an S-shaped pipe, which is always partly filled with water to prevent the impure air from backing up into the houses, but this does not always keep out the gas. This is particularly true of a house which has been unoccupied for some time during the warm season. The heat causes the water in the S-shaped pipe to evaporate, and the impure sewer gas has free access to the rooms and soon diffuses through the whole house. The result is that when the family returns and the house is taken again there is probably an outbreak of some disease, such as typhoid fever. The actual cause is rarely thought of and the summer resort is usually blamed for the illness.

The air of all towns and cities, especially where there is much manufacturing done, is particularly impure, not only because of the respiration, combustion, etc., but because of the noxious gases generated by these factories. As plant life is largely instrumental in absorbing impure gases, it shows the necessity of having a certain number of parks and squares scattered throughout the city, as well as the importance of cultivating trees on the streets. There are many occupations which are particularly dangerous on account of the impure air which they cause. For example, miners, potters, china scourers, grinders, button makers, cutlers, cotton, wool, and silk spinners all work at trades which furnish impurities to the air. These impurities in the form of dust are inhaled by the respective workers, and cause various lung disorders of a chronic and often fatal nature. There are other trades in which certain fumes are the chief danger, as in makers of matches, painters, plumbers, white lead workers, workers in arsenic and mercury, gilders, etc.

Probably the best known example of an unventilated room, the one most familiar to us, is a room in which the air has been rendered impure by respiration. Such air usually contains organic matter in suspension, such as epithelium, hair, probably some bacteria, never free but always attached to dust and small particles, excess of watery vapor, and carbonic dioxide. This produces in persons heaviness, headache, weakness, and it may be nausea. The poisonous element in such air was supposed to be the excess of CO_2, but from experiments on animals it has been shown that it is not so much the excess of CO_2 in the air that causes these ill effects, but absence of the proper amount of oxygen, and more particularly the excess of organic matter held in suspension.

The large number of deaths in the Black Hole of Calcutta was caused by the combination of all these agencies, and the few survivors of this horrible ordeal felt the bad effects of this impure air for a long time. George Kennan's graphic description of the badly ventilated prisons of Siberia shows to what tortures the Russian prisoners are subjected, and much of their suffering is undoubtedly due to the forced breathing in this vitiated air.

When the air in a room which was at first free from impurities becomes gradually worse, the occupants do not notice it so markedly as would a person coming into this room from the outer air. The latter is at once struck with the unventilated odor and finds it unbearable. It is usually in certain trades, as tailors, shoemakers, sewing women, and all others leading a sedentary life, that the effects of the slow poisoning are noticed. Those engaged in these trades just mentioned, as well as others, come to their morning work in a room fairly well aired at first. There they sit, gradually becoming affected by the air growing hourly heavier. They feel tired and sleepy;

they yawn frequently, showing that the lungs are seeking for more oxygen to take to the starving blood. Usually such persons lead this sedentary life and remain in this close room and constrained position for hours at a time. Such persons, too, are generally underfed and, it may be, are intemperate. All these factors together have a permanent effect on the system, and the most common result is pulmonary disease, usually consumption. This consumption is, of course, not *caused* by the vitiated air and surroundings, but the individual is put into a favorable condition to take the disease if exposed to it, and the extreme prevalence of the germ of consumption rarely allows them to escape. One reason why such persons take consumption so easily, is because their power of respiration and lung expansion from this constrained position is very limited, and let the germ of consumption by means of contaminated dust once get access to the lungs by being breathed in, there is not enough respiratory force present to get rid of it, as there might be in a strong and healthy chest.

Air in a room may be too rapidly relieved of its oxygen by the burning of gas jets. While candles and oil lamps use up comparatively little oxygen, it is a well-known fact that gas lights exhaust the supply of oxygen very quickly, using in an hour about as much as six persons in the same time, and they give the air in such a room a dry, uncomfortable feeling without necessarily making it as impure as respiration does. The connection between bad air and diarrhœal diseases is particularly noticeable in children. Of course, we believe that all such diseases are caused, directly or indirectly, by some specific germ, but the impure and heated air may be the instigator. Thus, so much has been said about the normal constituents of pure air and the accidental ingredients of the atmosphere, because it is now well recognized that the air, with its varying changes in composition, density, temperature, humidity, rate of motion, and other conditions, influences for good or evil the health of the individual. The individual uses the oxygen and gives out carbonic dioxide, which is at once taken up by the plants, which use the carbon dioxide and liberate the oxygen, to be again used by animals.

Thus this interesting interchange of gases goes on and the balance of gases in the atmosphere is kept up. Through the diffusion of gases and currents of air the atmosphere is of about the same consistency everywhere. The heavy carbon dioxide has a tendency to sink, and the lighter oxygen to rise, but by diffusion these two gases intermingle.

Now, having considered the composition of the air, it would be well to look at our means of supplying pure air to closed habitations, particularly to large buildings, as hospitals, halls, etc. Of course, in the open air there are always currents of air and breezes caused by the difference of pressure and temperature of different parts of the atmosphere. In this way breezes and winds are caused which purify the air by blowing away and diluting noxious gases and impurities in the air. The air in every inhabited room should be pure enough not to cause an odor which may be perceived by one coming from the outer air into the room. The sense of smell is the most convenient standard. One way to look for an excess of carbonic acid gas in a room is to expose a vessel containing ordinary lime water to the air of the room, when the carbonic acid gas will cause a cloudiness in the lime water to appear. The idea of ventilation is to supply fresh for impure air, to flush out the emanations from the skin, breath, etc., and dilute any impurities, whether germs or otherwise, in the air.

Dr. Wm. H. Welch in a recent article says:— "By means of free ventilation, disease-producing micro-organisms which may be present in the air of rooms are carried away and distributed so far apart that the chance of infection from this source is removed or reduced to a minimum. It is a well-established clinical observation that the distance through which the specific microbes of such diseases as small-pox or scarlatina are likely to be carried from the patient by the air, in such concentration as to cause infection, is small, usually not more than a few feet, but increases by crowding of patients and absence of free ventilation. The well-known experiences in the prophylaxis and treatment of typhus fever are a forcible illustration of the value of free ventilation.

"It is, of course, not to be understood that by ventilation we accomplish the disinfection of a house or apartment. Ventilation is only an adjunct of such disinfection, which, as already mentioned, is of first importance."

This change of air should take place so gradually that it is not perceptible. That is, there should be a constant stream of warmed pure air passing through the room so slowly that it is not perceptible. The principles of ventilation depend on the fact that air when heated tends to expand, and by expanding escapes through the cracks of the buildings and through the porous walls. This expansion causes a partial vacuum, which is quickly filled by the cool, fresh air drawn from without, so that one of the best ways of furnishing fresh air to a room is to make a hot fire in it, when the warmed air will expand and draw in the cool air from the outside through the porous walls and cracks in the doors and windows. Another simple method of ventilation is to have an open fire, which causes a steady current of air to pass through the room and, by the heat of the fire, up the chimney. The carbon dioxide being heavy, it would be supposed that it would sink to the floor, but in reality this is not so; for the diffusion and the varied currents of air cause it to be scattered through the room, and, in fact, the heated air is apt to rise to the ceiling and carry the carbon dioxide with it.

The more difficult problem of ventilating a hospital has not yet been satisfactorily solved. The simplest method is to have a shaft below near the floor, through which cold air can enter, and a shaft above near the ceiling, through which warm and impure air can escape. In order to do this without creating a strong draught, the shaft above should not be immediately over the shaft below. When the ventilating current is feeble and not strong enough to remove the used air, a lighted gas jet in the upper ventilator will heat the shaft, and the expansion thus caused will remove the air more quickly.

The two methods of ventilation are the natural and artificial. In natural ventilation we have three forces at work, namely, diffusion, winds, and the difference of weight of masses of air of unequal temperature. Diffusion takes place in every room that is not air-tight. It occurs through brick and stone, especially when they are dry, and for this reason a newly built house with fresh, damp walls is unhealthy, because diffusion cannot take place through these walls. Of course, this diffusion is not sufficient for perfect ventilation, but it helps. The wind can only be used in part to ventilate rooms. It blows the stagnant stale air out, and by causing a partial vacuum draws in purer air behind it. By blowing over the tops of chimneys and shafts the wind draws by suction the bad air from a room or building and purer air is drawn in through the cracks caused by imperfect carpenter work. Ventilation by aspiration is used principally on board ship and in large halls. The ventilation by unequal weights of air is illustrated in the heated room, as explained above. The heated air expands so that a portion of it escapes. To compensate for this, purer air is drawn in through the walls, cracks, etc., and this in turn is heated, and so on in this way the air is kept changing.

In artificial ventilation the used air is either drawn out of a building (method of extraction), or the fresh, purer air is forced in (method of propulsion). These methods are used in mines, mills, factories, and large halls. The ways of testing these methods are very complicated. They are principally by determining the amount of space, the number of people, and how much air each one requires, as well also as examining the air by the senses, by chemical and microscopical means.

The system of ventilation used in one of the most carefully built hospitals in this country, and it may be in the world, is supposed to be as near perfect as possible. Whether all the theories of ventilation as used in the Johns Hopkins Hospital in Baltimore have come up practically to the expectations and plans of those who began and finished this great work, it is not easy to find out. The following quotation from the description of the Johns Hopkins Hospital will give a fair idea of the methods of ventilation used in that institution.

"The extent of external temperatures in Baltimore have a range from 102° F. in summer to six degrees below zero F. in winter, these extremes occurring about once in ten years. To provide for these extremes requires buildings and apparatus which would be satisfactory in either Calcutta or St. Petersburg.

"Let us first consider the arrangements for ventilation in cold weather. In the wards and rooms occupied by the sick, the sizes of flues and registers and the amount of heating surface have been arranged for a supply of one cubic foot of fresh air per second for each person in the ward, with the possibility of doubling the supply for a short time in flushing out the ward, as will be presently explained. In the pay wards, where each patient has a separate room, making it more difficult to secure thorough distribution, the supply of air is to be one and a half cubic feet per second per head. In the isolating ward, designed for cases giving rise to offensive odors or in which a large amount of organic matter is thrown off, or in which, for other reasons, a large amount of air is desirable, the air supply is fixed at two cubic feet per second per head. Finally, three rooms in the isolating ward are arranged with perforated floors for an air supply of four cubic feet per second per head, with capacity for doubling this if desired. For all the wards the air is warmed in cold weather before it is admitted to the room, forming the so-called method of heating by indirect radiation or by air convection.

"All registers and flues for fresh air are of such sizes as to permit the passage of the requisite amount of air with a velocity not exceeding one and a half feet per second under ordinary circumstances. Air currents of this velocity having a temperature of from 70° to 75° F., are barely perceptible by the hand, and create little or no discomfort. The fresh air registers are, as a rule, placed in the piers in the outer walls at a height of nine inches from the floor, one register being allowed to each pair of beds. Besides these there are registers beneath the windows in the wards, which are only used in very cold weather, to check the down draughts produced by the chilling of the air through the glass of the window. The chief register, being that in the pier between each pair of beds, is so arranged that the nurse, by turning an iron arm upon its face, can reduce the temperature of the incoming air nearly to that of the external air, or can increase it to the maximum which the heating coil affords, but without changing the quantity of the air admitted.

"Ordinarily, as is well known, when a room heated by indirect radiation becomes too warm, the only way to shut off the heat supply is to close the register and thus shut off the air supply also, but in these wards the temperature can be regulated at the different registers, in different parts of the room, to suit the needs of different patients, without interfering with the air supply."

The heating of private houses and public buildings is a matter deserving of more notice than it often receives. In so many cases, especially among the poorer classes, the proper temperature is maintained by keeping the rooms closed, and, as in some stables, depending on the animal heat. Of course, while this may keep up the proper temperature when the weather is not too cold, it does so at the expense of the air. Experience has shown that the proper temperature for rooms is from 65° to 70° F., and in many cases higher. The strong, the young, and the well do not usually need a high temperature, but children, the feeble, and, indeed, all at the extremes of life need a higher temperature.

The principal methods of heating are by open fireplace, by stoves, by furnace and hot-air pipes, by hot water, and by steam. In America we are supposed to like overheated rooms. This may be a bad habit or it may be due to our climate.

Mr. Frederick N. Owen in the American Appendix to Parkes' "Hygiene" says:—"Those accustomed to a daily heat of 70° to 100° F. in summer, may perhaps become less capable of resisting cold in winter. It is also a fact that most parts of our country possess a drier atmosphere than that of England and Western Europe, and that moisture acts as a protective against the loss of bodily heat; hence an American room in winter, with a dry, hot air (70° F.), may appear to its occupants no warmer than an English room with a moister air at 65° F., or even at a lower point."

A few points may be learned from the apparatus at the Johns Hopkins Hospital. All the wards and much of the hospital are heated by a system of circulation, through iron pipes, of hot water of comparatively low temperature and pressure. In many of the rooms there are, in addition to this, open fireplaces. A few rooms are heated by steam. From the boilers the heated water passes into the great outflow main and from this into the smaller mains and from these to the pipes in the heating coils. The heat being supplied to the rooms, the cooled water is returned to the boiler to be heated and used again.

"This circuit is practically a closed one, none of the water being drawn off or used at any point, so that there is very little loss. The force which produces this circulation is a small one, being the difference in weight of a column of heated water from that of a similar column of water of from 8° to 15° F. lower temperature, each column being about 29 feet high, which is the difference between the level of the water in the boilers and that of the top of the heating coils. By means of valves on all the mains, and on the supply and the discharge pipe to each coil, the rapidity of the circulation can be controlled for each building and for each coil, thus giving a corresponding control over the temperature of the coils themselves, since this is dependent on the amount of water of a given temperature which passes through the coil in a given time.

"The entire system of hot water heating at the Johns Hopkins Hospital contains about 175,000 gallons of water, and practical trial has shown that it produces an equable, agreeable temperature in all the buildings to which it is applied, in all conditions of cold weather, and with the fullest ventilation desired. To prevent loss and waste of heat in the pipe tunnel and in the basements of the several buildings, the pipes are covered with felt enveloped in asbestos paper, and the whole is enclosed with stout canvas thoroughly painted. The effect of this protection is marked and satisfactory —very little heat is lost, as is shown by the temperatures in the pipe tunnel, and a great saving of fuel is thus effected. The heating coil most distant from the boiler is 763 feet away.

"The great advantage of this system of heating for rooms constantly occupied by the sick in the climate of Baltimore are: its uniformity of action, the comparatively low temperature of the heating surface over which the air is passed, the ease with which different temperatures may be secured in different rooms, or even for different beds in the same room, and, above all, that it insures the delivery of a large supply of air heated to the temperature required for comfort without the risk of overheating or of sudden changes."

The heating of certain rooms not in constant use, and in which it was desirable to have the means of raising the temperature in them more rapidly than could be done by the circulation of hot water, is effected by low pressure steam heat.

CHAPTER XX.

IMMUNITY AND PROTECTION FROM DISEASE.

And now, having considered some of the principal causes of disease, and having shown how universally scattered about disease germs are, it naturally suggests to ask why we do not all have every disease and what protects us when we escape.

We know that it is possible to have bacteria in some form in the water which we drink and use, in our food, on things we touch, in the air we breathe; indeed, there seems to be no place within our reach where it is not possible for bacteria to be found at some time. If disease, then, is present in so many forms and so universally, it seems wonderful that so many escape.

There are several theories as to immunity and protection from disease, and while many of them come near the probable truth, none of them are entirely satisfactory; still, even at the risk of indulging in theories in a book supposed to be practical, the principal explanations of these conditions must be given to complete the subject.

Dr. A. C. Abbott, of Philadelphia, in a recent article in the *Philadelphia Medical News*, in reviewing the principal experimental work that has been contributed to the subjects of immunity and infection in the past few years, says: "Until the year 1888 there existed four different doctrines by which the condition of acquired immunity against infection could be accounted for. The first of these theories suggests that the immunity commonly seen to exist in animals that had passed through an attack of infection against a subsequent outbreak of the same malady, and likewise the immunity that had been produced artificially, exists by virtue of some bacterial product that has been retained in the tissues of those animals, and that by its presence prevents the development of the same organisms when they subsequently gain access to the body. This is the so-called 'retention hypothesis.'

"On the other hand, Pasteur and certain of his pupils believed that the resistance frequently afforded to the tissues by an attack of infection, following upon vaccination against infection, was due rather to an abstraction *from* the tissues, by the organisms that were concerned in the primary attack, of a something that is necessary to the growth of the organism should it gain entrance to the body at a subsequent time. This view is known as the 'exhaustion hypothesis.'

"In 1884, Metschnikoff published the first of a series of observations upon the relation that is seen to exist between certain of the cells of the lower animals and insoluble particles that may be present in the tissues of these animals."

This theory, which is both fascinating and plausible, is set forth in the following article published in the *Philadelphia Medical News* some time ago by the author:—

"When a physician attempts to cure disease he simply removes, as far as possible, the cause, clears the way to recovery, and lets Nature do the rest. In many cases Nature does her work well, although not always getting due credit for warding off disease and protecting us from harm; in other cases she succumbs to her stronger foe—Disease. Those of us who live in crowded communities are surrounded by an invisible enemy, and with every breath we are liable to draw in disease in some form—and yet so many escape. We open our windows and let in what we call 'fresh air,' and as the sunbeam slants across the room, what myriads of dusty atoms meet our eyes! If in a quiet room we inhale at every breath this dust, what would we not breathe in the streets of dusty cities, in mines, and in mills?

"In the sanitary management of our cities, the danger of flying dust, with its many impurities, is rarely considered, and the dust of city streets, that should be properly sprinkled and carted away, is simply stirred up by the indolent sweepers and much of it is probably taken away in the clothes and breathing apparatus of the unfortunate passers-by. Such dust, when inhaled, does harm both from the impurities it may contain, and, when present in appreciable quantity, from its mechanical action and irritation.

"That germs float in the air, even in the most secluded spot, the careless housewife knows to her sorrow when she leaves her jelly-glasses uncovered for a short time and finds the surface covered with a beautiful mould. Bacteriology has told us that the germs of some contagious diseases are found in the air and may be inhaled and produce disease. Thus diphtheria, glanders, measles, whooping-cough, hay-fever, pneumonia, and consumption are all undoubtedly in part due to the inhalation of dust containing the germs of these diseases. If, then, the germs of disease are in so many forms floating in the air, it is strange indeed that so many escape, especially when we consider the crowded public and private rooms, cars, and other places where the sick and well meet together and breathe the same air.

"Fortunately for us, Nature has erected a series of barriers against such an enemy as inspired dust, and in exposing us to this danger, has given us certain means of protection that repels attacks not unusually severe.

"In persons who breathe as they should, all inspired air passes first through the nostrils, and is thus not only warmed to the proper temperature for the throat and lungs, but the moist walls serve

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as a sieve by which the air thus inhaled is as far as possible relieved of dusty impurities. This shows at once the importance of breathing with closed mouth, especially in passing from a heated to a cooler atmosphere, and of always thus breathing in an atmosphere of visible dust. The moist walls of the lining membrane of the nasal cavities fill the inspired air with moisture, thus making it more agreeable to the throat and lungs.

"The nasal passage in almost every animal deviates from a straight channel, and this is according to the needs of the animal. In man, who is upright and far from the ground, the passage is only slightly curved and may almost be considered rudimentary in its development. In birds, which fly far above the earth, the nasal passage is almost straight. In all quadrupeds, and especially in those that graze or seek their food on the ground, and those exposed to sudden changes of temperature, as in amphibious animals, the nasal passages are exceedingly tortuous and in a high state of development, and their extreme moisture, due to the active secretion of their lining mucous membranes, serves, as far as possible, to catch and stop the entrance of dust into the throat and lungs. This is familiar to us in the cold nose of the dog, cow, etc., and in the constant sneezing of the horse.

"Those who breathe abnormally, with open mouth, are much more liable than others to diseases of the throat and lungs. In spite of the outward defense we have in the nose, dust and foreign substances do occasionally get into the throat and trachea, but the latter is so very sensitive to the slightest irritation that the presence of such foreign substances excites a cough, and they are quickly expelled. The minute anatomical structure of the lining membrane of the trachea is, as we know, much like the waving surface of a wheat-field. The whole surface of the trachea and larger lung-tubes is covered with ciliated epithelium the waving motion of which is from the lungs upward to the throat, and very minute particles of dust and foreign substances that find their way into this region are thus gradually removed. This membrane is also active during sleep, as many throat sufferers and others may have noticed from the fact of their 'morning cough' on rising.

"In spite of these defenses which Nature has raised against her enemies, disease germs and foreign substances find their way into the trachea and even to the ultimate ends of the finest lung-tubules. In this way disease germs, and especially the tubercle bacilli, get into the lungs, and in those predisposed to this disease this organism easily thrives. From recent investigations in microscopical anatomy we now know that Nature does not give up even after these foreign substances and disease germs find a place in the body.

"In the organism, and more particularly in the blood, there has long been known a cell or corpuscle called the white blood-corpuscle, or leucocyte, and in suppuration the same cell is recognized as the pus cell. That this cell seems almost ubiquitous in the body, and that it assumes different rôles under different circumstances, has also been the subject of repeated investigation. The most recent function now assigned to this cell is that of a "carrier cell," scavenger cell, or phagocyte, because its function has been learned to be that of devouring or carrying off germs and foreign substances. This was noticed in those who worked in dusty atmospheres. The dust was inhaled in such quantities that it got into the lungs, and, as it could not all be coughed up, it worked its way into the lung substance, where, by irritation, it attracted these carrier cells or scavengers, and, as far as possible, these promptly attacked the particles and carried them either to the nearest lymphatic gland, where they would be quiet and harmless, or the dust-containing cells found their way into the lungs and were coughed up. This has been repeatedly noticed in the case of coal miners, in whose expectoration large numbers of these cells were found, and in those cells bits of coal dust could be easily recognized. In some cases in which the piece of dust was too large for one cell to devour, two or more would join together and close around it.

"These cells have certain movements, called amœboid, from their resemblance to the movements of the amœba, one of the lowest forms of life, and found on the surface of fresh-water ponds. These amœboid movements consist in a change of shape on the part of the cell by which it thrusts out a part on one side and draws in another part, and by thus changing its shape it surrounds the substance and assimilates it. These movements, however, are so slow that they cannot be seen, much like the moving of the minute hand of a clock or watch; a change is noticed on making intermittent observations, but the actual movement cannot be seen. That these cells endeavor to do their work as well as possible is shown by the fact that years after miners have ceased to work in coal mines it has been noticed that the expectoration remained dark, and a microscopical examination showed these cells to be full of coal and pigment, thus proving that the carrier cells were still trying, as far as possible, to remove the foreign substances. This has been experimentally demonstrated by introducing finely divided organic substances, such as powdered cinnabar, into the tissues and lungs of the animal, and after a short time microscopically examining the tissues and glands of the animal, when these carrier cells are found loaded down with this red pigment. This is especially true of the cells in the glands.

"In all these cases the rôle of the foreign substance is undoubtedly passive, while the cell is active.

Further study of these cells showed that they act antagonistically to pathogenic bacteria—that between these cells and the bacteria there is a struggle for existence or supremacy, and on the result of the struggle depends a condition of illness or health. These observations were first made on a disease produced by a fungus in a fresh-water crustacean, the daphnia, a 'water flea.' The fungus swallowed by the crustacean produces spores that pierce the intestinal wall, enter into the tissues, and are at once surrounded by these phagocytes. Here a struggle takes place that results in a victory for the cells, the latter closing around these fungus spores, devouring them and finally destroying them by a process of 'intra-cellular digestion.' In this case the action is very simple, but in the case of other animals and man it is not so simple.

"A careful study of these bacteria, both biological and chemical, has fully proved that they exert their deleterious action not so much by their actual presence, as by a poison or ptomaïne that they secrete from their minute bodies, and that each specific bacterium or bacillus has its own peculiar body-product which, in the case of pathogenic or disease-producing germs, is a poison. This then complicates the struggle between the bacteria and the body-cells. There is then an actual life-and-death struggle between cells and bacteria. Inoculation of a frog with the bacillus anthracis showed this struggle very beautifully. A study of the cells of this frog revealed them with bacilli and parts of bacilli within the cell-wall in process of digestion or disintegration.

"Thus there is good reason to believe that in the presence of a contagious or infectious disease, the germs, floating about or in some way gaining access to the individual near by, find their way into the body, and there a struggle takes place between them and these cells, that are attacked by the invaders. Now begins a struggle for supremacy. The cells close around the attacking hosts and endeavor to destroy them and carry them off, or at least to prevent the further ingress of the bacteria. If the cells are victorious, they devour the germs, carry them away, and thus the individual escapes the disease. But if the germs increase too rapidly, and, by the secretion of the poison or ptomaïne from their bodies, cause the death of the cells, then sickness results. In this case the accumulation of these carrier cells that are killed by the germs results in suppuration, for the cells of pus are but the white blood corpuscles, leucocytes, or phagocytes, when dead. As heat increases the motion of these carrier cells and also their protective activity, the rise of temperature that precedes and accompanies suppuration has been looked upon as an attempt on the part of Nature to assist the activity of the cells and to destroy the invading bacteria.

"Immunity from second attacks of certain diseases, as well as the protective influence of certain inoculations and vaccinations, has never been clearly understood, although various explanations have of late been offered. In all probability, although this is but a theory sustained by analogy, after recovery from the contagious disease, usually occurring but once, the bacteria are supposed to secrete some morbid virus that hinders their own life, just as animals produce carbonic acid gas, which is poisonous to them, or the yeast-fermentation produces alcohol, which stops the growth of this fungus.

"In the same way, after these attacks, the cells of the body are supposed to contain some substance that resists the second attack of those organisms. The strength and duration of this immunity differs in individuals. Of course, the ability of these cells to struggle with bacteria is lessened in weakened individuals, and hence, for example, it is very probable that the lowered vitality caused by being chilled below the recuperating point invites an attack of pneumonia or some other disease, not from the mere chilling, but from the weakening of the strength of the cells. In hereditary diseases predisposition plays an important rôle.

"We thus see that before nature succumbs or yields to what has been very wisely called an 'attack' of a disease, she uses various means of defense—and, fortunately for us, often comes off victorious."

This explanation of Metschnikoff, embodied in the article just quoted, was at first received without question, but when it was further studied objections began to be brought against it, and some of these had great weight.

A fourth explanation of immunity is advanced by Buchner, who suggests that "in the primary infection from which the animal may have recovered there has been produced a 'reactive change' in the integral cells of the body that enables them to protect themselves against subsequent inroads of the same organism."

All these four theories have some ingredients of plausibility, and it is probable that they all, combined or singly, at different times are true in explaining immunity. In general, the extremes of life, the weak and the sickly, and any one very much fatigued and frightened, become an easy prey to disease, while the well and healthy in the same condition would escape. The protection acquired in vaccinations, as in small-pox, in hydrophobia, and as Koch intended his tuberculin to act, is supposed to be according to the retention theory.

It is of interest to add that some recent work on pneumonia has shown that in the beginning of the disease and up to the time of the crisis there is circulating in the blood of the patient a certain poison, which has been called pneumotoxine, and which is very likely produced by the pneumococcus or bacillus of pneumonia. After the crisis this pneumotoxine disappears, and a new substance which was not there before is now found in the blood.

Experiments on animals and also on patients would seem to indicate that this new substance which appears in the blood after the crisis, in reality causes the crisis, and is the result of the struggle of the cells to overcome the poison produced by the pneumonia bacillus. The consolidation of the lung substance and the immense amount of fibrinous matter which is found in the air spaces of the lungs in a certain stage of pneumonia is supposed to be an attempt on the part of Nature to erect a barrier against this invading host and the poison produced by it, from getting on to the lungs and then into the whole body. If we have not cleared up this subject fully and satisfactorily it shows that we are on the right track, and in a few years, if not sooner, we may expect to have practical results from these apparently useless experiments.

If we can find out what this substance is that is found in the blood of pneumonia patients after the crisis, and can produce it artificially and introduce it into the system of pneumonia patients early in the course of the disease and cut it short, we shall be reaping very valuable and practical results from the laboratory.

CHAPTER XXI.

FOOD.

The subject of diet has not entered sufficiently into the education of the physicians of the United States, and the important question of dietetics is too often left to be learned by experience in the course of practice; consequently, it will be noticed in America that the physician gives directions as to the drugs and medicines, but his orders as to what the patient shall take for nourishment and refreshment are very vague and often unsatisfactory. Now, if there is one thing important above all other things in the treatment of most diseases, and especially in lingering and wasting diseases, it is what the patient should have and what should be withheld. The very fact that the nurse is given general directions in so many cases is sufficient reason why she should know something about the food she gives.

Too much or too little food, bad food, food improperly cooked, may all pave the way to disease, even when the body is in a state of health. How much more important is it, then, in sickness to give specific directions about the food to be taken, and to carry these directions out with intelligence? Of course, it should be remembered that personal taste should always be consulted in giving food to an invalid, and that distasteful food forced on a patient too often disagrees, all physiological reasons to the contrary. The very fact that a patient expresses a desire for a certain thing will help to digest it.

From improper food may come inflammation and congestion of the digestive tract, which may favor the growth and increase of dangerous bacilli in the intestines. In this way typhoid fever, Asiatic cholera, diarrhœa, dysentery, and even tuberculosis may find an entrance into the system. The careful selection of food well chosen may correct this disordered state of affairs and cure the disease with little need of drugs.

Milk, especially human milk, is the most perfect food known, containing, as it does, all the necessary ingredients for nourishment; hence, it is used in infancy in health, and in adult life in many diseases. In large cities the milk is too often adulterated and poor. The most usual adulteration is made by adding water and then stirring in meal. Several instruments have been invented to test the purity of milk, but they are not so reliable and easy to handle that the average householder can use them with satisfaction. Thin, diluted milk has a pale blue color and a poor taste, and such milk is more fluid than it should be. The Germans use the "Nagelprobe," which is carried out by dropping a little milk on the thumb nail, and seeing if the milk will remain suspended from it when the nail is held down. Good milk is consistent enough to stay on the nail, while thin milk will run off.

As the sick usually digest slowly, milk should be given in small quantities and at short intervals. Many persons think that the mere putting of food into the stomach is sufficient. The nurse should know that it is the digestion and assimilation of food that strengthens and helps the patient. Too much poured into a weak stomach is either vomited or passes out, causing a diarrhœa. It is often necessary to add an alkali to milk to correct that acidity which it is so hard for some stomachs to endure. The most common addition is lime water. This may be added in the proportion of one part to three or four of milk. As mastication is not needed to swallow milk, the tongue in a milk diet soon becomes very white, not only on account of the collection of epithelium scales, but because the milk whitens the tongue. The globules which rise to the surface of milk on standing form the cream, and when this is skimmed off the residue is called skim-milk. This is sometimes used when the system is so weakened that it cannot digest the fatty globules of the cream.

When milk is given for a long time it palls on the patient, and then it ceases to do good. For this reason it should be given intermittently, when there is a prospect of its being used for a long time, for when it cannot be borne it is exceedingly difficult to find a good and suitable substitute for it. As has been mentioned in another place, milk is not only a good food, but it is a good medium in which disease germs can live and grow. For this reason, milk for the sick and the young should be used only from the most reliable sources, and when there is doubt the milk should be sterilized. By sterilization is meant the exposing of milk in a covered vessel to steam for twenty to thirty minutes, until all germs in it are destroyed. When there is any doubt as to the purity of the milk, condensed milk has been suggested as a substitute, but sterilized milk is to be preferred, and sterilizers are so simple and cheap that they may be owned by every family in which there are children or invalids using much milk, or a sterilizer may be improvised.

Koumyss, which is fermented milk, usually mare's milk, has been used with great success in cases of dyspepsia. It is very grateful to the stomach and can be taken in large quantities, and it increases the weight very rapidly. In weakened conditions of the stomach it will often be necessary for the nurse to predigest the milk. This may be done by adding some form of pepsin. Fairchild's peptonizing tubes are especially good, but give the milk a very unpleasant flavor.

The efficacy of beef tea has been frequently called in question of late. In this connection it should be remembered that not all that is poured into the stomach of an invalid will give strength. The beef tea, like all other foods, to do good must be digested and assimilated. It is not uncommon to notice the beef tea floating on top of the stools of an invalid, and this is especially true when a diarrhœa has been set up by the frequent feeding with beef tea. Many of the beef extracts on the market are of no use, and the apparent good results are more imaginary or a matter of tradition than actual. Many of these so-called foods are given warm, and the heat of the food alone acts as a stimulant and brightens up the patient for the time. Hot water would often have the same effect. Chicken, rice, and other soups are bland and pleasant and may give some strength. All these soups and broths are better made at home by the nurse than bought outside. The good nurse should understand the practical side of cooking.

There is nothing that takes the place of water as a quencher of thirst. Milk, which normally contains 87 per cent. of water and most usually more, is very near water as a quencher of thirst.

Young infants often cry because they are thirsty and would readily take water instead of the milk if the former were offered to them. Most nurses never think that infants may become thirsty. The sick often crave for water, and this craving is particularly marked when the disease is one that causes much water to be lost from the body. Thus in all diarrhœal diseases, in all fevers, and in all cases in which the fluids are withdrawn from the body in excess, the thirst is very great. At one time it was considered very bad practice to give water in these conditions, but now it is conceded by all modern practitioners of medicine that this loss of fluid from the body should be made up. The water in every case should be given with great caution. In fevers the excessive thirst should be quenched with slightly acidulated drinks or with water given with a teaspoon. Cracked ice is very grateful and by melting in the mouth quenches the thirst of a fever patient better than water. In diarrhœal diseases in which there is no fever, water should be given very sparingly, but enough to make up for the waste. As all foods contain water in some proportion, the patient takes water with almost everything. Persons in health often pride themselves on the small amount of water they take. This in part is a matter of taste, but it is undoubtedly better to take water through the day and even at meals.

However dear to the heart of the patient or the nurse, or even the doctor, the subject of prohibition may be, it should never be forgotten that alcohol and its derivatives are often very important in the sick-room, provided they are used with that precaution necessary in the case of all dangerous drugs. It may be stated at the outset that whisky, wines, etc., are not tonics, but stimulants, and when used it is because their effects are desired immediately. They should always be used with extreme caution in the young of both sexes where there may be danger of forming a dangerous habit. On the principle that stolen fruits are the sweetest, many persons, especially young men who have heard of the horrors of drink, take the first opportunity to test the danger of drinking and learn to like a liquid which they would not have been tempted to use if it had not been prohibited.

The nurse and the parents should never forget that the best stimulants are the strongest, and on the principle of not sending a boy to do a man's work, they should administer whisky or brandy where sudden stimulation is needed. A very common combination is whisky and milk. In typhoid fever and such wasting diseases, a half glass of milk to which two tablespoonfuls of whisky have been added should be given every hour if they are assimilated. The whisky does the stimulating and the milk nourishes. The various wines are good in convalescence, and champagne is highly recommended when an irritable stomach rejects all other things. Ale and beer are too heavy for a weak stomach, but in sleeplessness a glass of beer at bedtime will often bring the required rest. Brandy is more astringent than whisky, and hence the former should be preferred in diarrhœal diseases.

Tea and coffee are very useful stimulants and universally used, but they are the causes of many conditions of dyspepsia and have undoubtedly done much harm. A cup of black coffee after a hearty dinner undoubtedly acts as an aid to digestion, but the too constant use of coffee and tea reacts very dangerously on the nerves. The effects of tea are especially noticeable on women of the poorer classes, who tipple tea the whole day long because they cannot get enough to eat. The contact of the astringent tea with the mucous membrane of the empty stomach soon causes a condition of tanning, so that the secretion of the gastric juice is interfered with and the lining of the stomach is tanned and hard, and dyspepsia is the result. Coffee is not quite as dangerous as tea, but the continued use of coffee brings on a condition of "nervousness" which it is very hard to get rid of. In this connection it might be well to say that the staying properties of coffee are much greater than those of alcoholics. Thus of two men doing the same kind of hard work or indulging in a walk of a long distance for a wager, the one who takes coffee outlasts by far the one who looks to whisky or brandy for strength.

The amount of nourishment in chocolate is very great. Travelers who walk long distances or who go sight-seeing and become fatigued find a piece of hard chocolate of great use as a food.

Invalids cannot always stand cocoa or chocolate they are too weak, for the large amount of fat in this substance makes it too rich for them. When deprived of some of its fat it is a very useful substitute for tea or coffee.

When there is no special aversion to them, eggs form a very important article of diet in the sick-room. White of egg beaten up to a delicate froth, put into a glass into which a tablespoonful or two of whisky is poured, and slightly sweetened makes a very pleasant and refreshing tonic and stimulant for the sick when the powers are flagging. A soft-boiled egg agrees with many persons, and an egg boiled hard and crushed with the back of a spoon is generally very soon taken up by the system.

Meats should not be given until convalescence is well under way. The best meats are beef and fowl. Chicken broiled or boiled until the flesh drops off the bones is very digestible. Beef is also digestible and nourishing. A small piece of steak cut thick and broiled quickly over a hot fire, and then delicately seasoned, makes a very attractive dish for one able to sit up. Of the other meats mutton is better than veal, and pork should never be used. In fact, all fat meats and all meats fried are as poison to the stomach of an invalid, and often to a well person.

Stale bread and toast are better borne by a weak stomach than fresh bread and hot breads of any kind. Of the various vegetables, the starchy ones are the most objectionable, and many of the fresh ones are too indigestible for a weak stomach. Raw oysters are more easily borne than any other food, provided the individual has no especial dislike to them. Fish is just as well excluded from the diet list of an invalid. The various jellies are very pleasant to the stomach, but they are of doubtful use and are more valued by the laity than by the profession.

The friends of the sick are in the habit of sending all manner of things that the invalid cannot possibly eat, and it is the duty of the nurse, in the absence of the physician, to say positively what shall be allowed and what prohibited. Fruits should be admitted into the sick-room with the greatest caution. While the juice of an orange is very refreshing and generally free from danger, the pulp is hard even for a healthy person to bear. Bananas are also extremely indigestible, and a strict quarantine should be kept against them.

Of course, these outlines of diet are not sufficient to guide the nurse, but she should add to them by a practical course in the kitchen; for a good nurse should be a good cook and be able to do anything that will help the recovery of her patient. Much good food is spoiled by bad cooking or by a bad fire, and the only way to understand all these difficulties is to have practical experience in the kitchen. The few hints given here may help the nurse in the right direction, and she can fill up the gaps by study in physiology, cooking, and other branches.

In such diseased conditions as diabetes, dyspepsia, diarrhœa, dysentery, constipation, and other diseases a special diet is needed. This the nurse cannot learn from such a book as this. She must follow the exact directions of the physician, and note that while the general plan of each one of these conditions is alike, each case will need special study, and no fast rules of diet for it can be laid down.

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