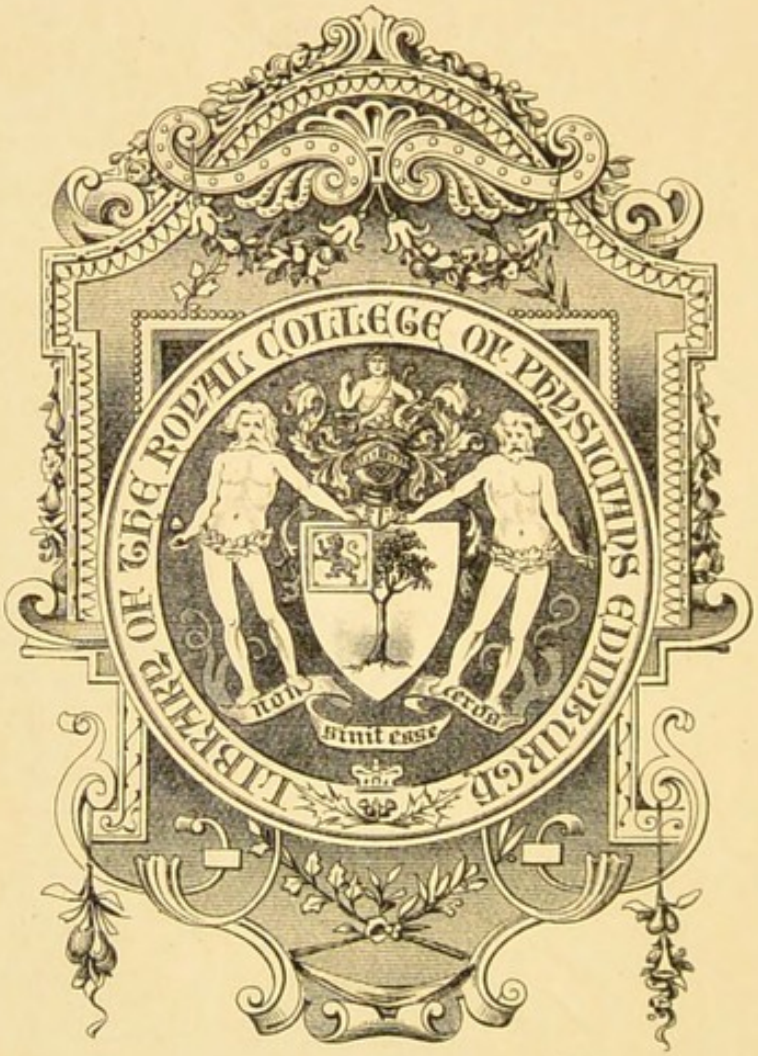
Hygiene of the lung in health and disease / by Leopold Von Schrötter ; translated by H.W. Armit.

HYGIENE OF THE LUNG

IN HEALTH AND DISEASE

PROFESSOR DR. LEOPOLD VON SCHRÖTTER



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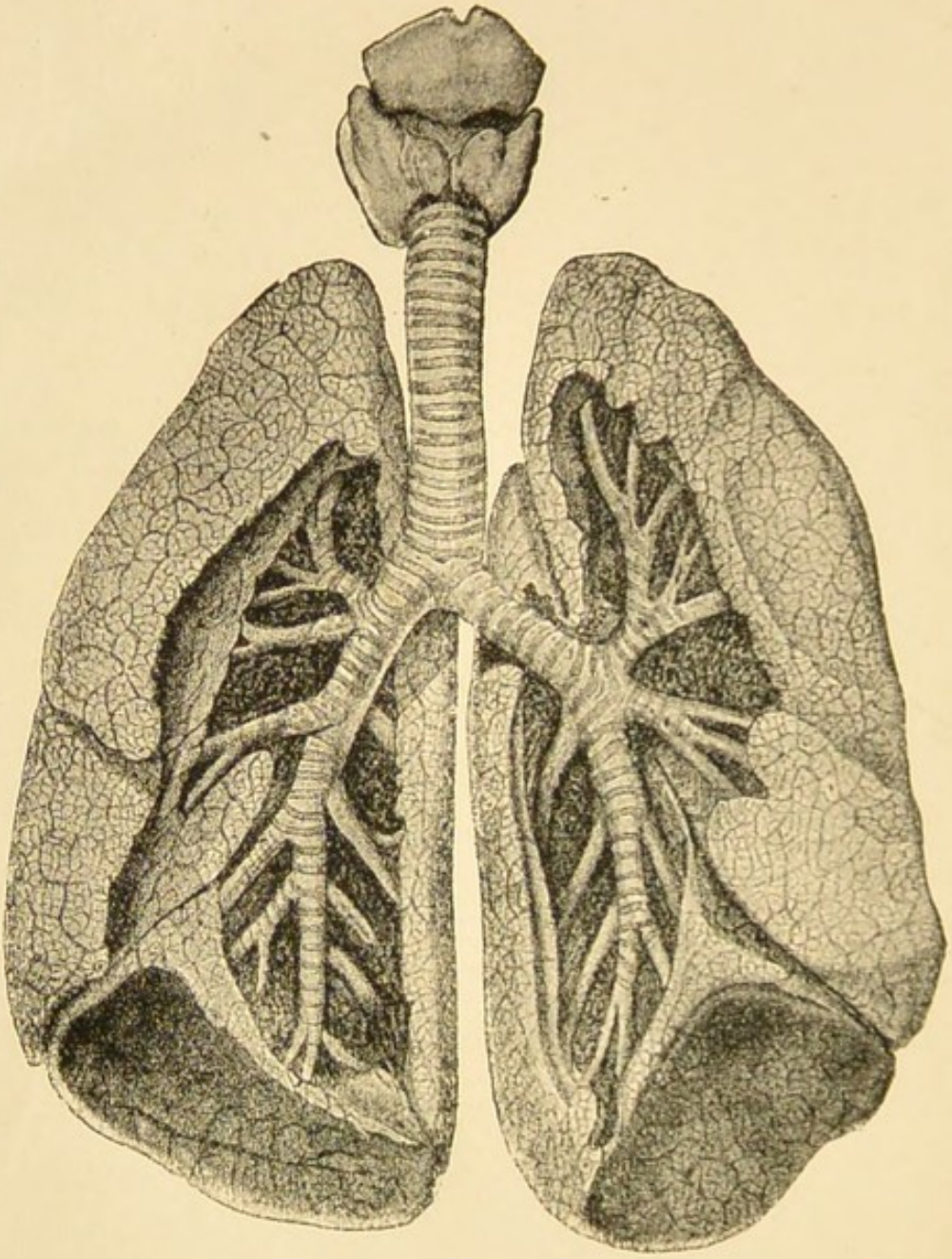

FIG. 1.—THE LUNGS, TOGETHER WITH THE TRACHEA AND THE BRANCHING OF THE BRONCHI.

HYGIENE OF THE LUNG

IN HEALTH AND DISEASE

BY

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WITH SIXTEEN ILLUSTRATIONS

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PREFACE TO THE ENGLISH EDITION

HYGIENE is essentially a social science. Its development depends partly on the results of observations and investigations by medical and other scientists, and partly on the application of principles suggested by these results. Legal and municipal administration alone would not be able to carry out the reforms in hygiene, as elaborated in these principles, without the aid of certain sections of the community. The task of the official servant is to see that none of the forbidden acts are committed in public places ; the task of the general medical practitioner is to see that the sins against hygiene are not committed in the privacy of the home. But this would not suffice to gain a great end. It is necessary that the people themselves should have a proper understanding of the general principles which actuate the hygienist to form regulations, and should possess some knowledge of the nature of the diseases and ills which hygiene is attempting to overcome.

This little book is intended to assist the lay person to carry out his part in the section of hygienic advance which deals with the respiratory system.

In these days of first-aid teaching it becomes a difficulty to determine the limits necessary for lay instruction ; for while too little knowledge will cause a failure,

too much will become merely useless ballast, and may even form a danger. Hofrat von Schrötter is to be congratulated on having gauged this limit to a nicety, and for having offered the reader just that material which is necessary for his purpose. The knowledge imparted in his pages is calculated to enable a lay person to become a useful member of the hygienic world; and when he has imbibed this knowledge, it becomes his duty to do his portion of the work of improving the condition of his fellow-men, and thus, indirectly, of preventing disease which attacks the respiratory organs, and especially that disease which has worked such ravage among men—tuberculosis.

The introduction of an English Edition will extend the usefulness of the book, and it is greatly to be hoped that it will obtain a wide circulation and elicit a deep interest in this branch of hygiene among Englishmen and Englishwomen.

While Hofrat von Schrötter has to a great extent adopted a chatty tone in the original, a more matter-of-fact and possibly dry tone has been chosen for the English version, because it was thought that the subject would appeal to all classes of the community without embellishments. The translator wishes to apologize for the shortcomings in the translation, and hopes that the English Edition will be fruitful in the great cause of hygiene.

H. W. ARMIT.

Wembley, 1907.

PREFACE TO THE GERMAN EDITION

'Wo Sonn' und Licht nicht dringet ein,
Geht der Arzt oft aus und ein.'

THE object of this little book is to instruct the lay person on the functions of the respiratory organs and on the importance which a free exercise of these functions possesses for the human organism. All the harmful influences which are capable of producing diseases of the lungs will be dealt with, and the modes of life, which tend to prevent these diseases, will also be discussed. Equal attention will be claimed for the much-neglected dietary of respiration as is given to the dietary of digestion, which exercises the minds of so many.

The importance of this chapter on the teaching of hygiene is demonstrated by statistics. The number of cases of illness of the respiratory tract is incomparably greater than that of the diseases of any other organ. As is well known, the seat of predilection of tuberculosis—the greatest and most formidable enemy of mankind—is the respiratory track. In recent times a movement has been set on foot with the object of preventing this most destructive of all diseases, and measures to this end have been introduced on all sides. The happy results accruing from this are due partly to the regulations of the official sanitary authorities, and partly to the most praiseworthy endeavours of private

individuals and societies, which have been crowned with especial success in some countries.

Hygienic improvements cannot be materially furthered by the introduction of laws and punishments, but the instruction of the laity may attain this end. If this is carried out, not only will the advice of the doctor be adopted, but the law will be respected and willingly obeyed. In this way tangible results, which benefit the whole population, will be attained, albeit slowly. It is to be hoped that the following pages will assist in serving to this end. Many of the points can only be dealt with very briefly. However, while the reader is obtaining instruction, he will gain an insight into the difficulties with which the medical man has to contend, and into the amount of knowledge which he must possess in order to get a clear idea of the nature of the various diseases and of the possibility of their cure. He will realize how much more difficult the doctor's task is than that of the charlatan, who in the most impudent way recklessly risks the life of his fellow-creatures, through his want of knowledge of the important vital functions.

I can only hope that I have carried out my task of awakening the interest of the reader, and that by instructing him I may succeed in making him a useful assistant to his doctor. I have purposely avoided mentioning or explaining medicines or prescriptions for the various diseases; for this the patient must always seek the advice of his doctor—his family doctor.

SCHRÖTTER.

VIENNA.

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HYGIENE OF THE LUNG

PART I

STRUCTURE AND FUNCTIONAL ACTIVITY OF THE LUNGS

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It is not possible to speak of the lungs, and of the function of respiration which they carry out, without first casting a brief survey over the whole respiratory apparatus. The lungs, together with the circulatory organs, are only a part—albeit, one of the most important—of the arrangements for the maintenance of the metabolism and for the building up of the organism.

The air required for breathing should enter through the nostrils, and not through the mouth. Anyone can convince himself of this if he thinks of the unpleasantness which is caused by the blocking up of the nose, even if it be only for a short period—for example, for one night. The drying up of the oral and nasal cavities by the air passing through them produces a feeling which is so disagreeable that it can even prevent sleep. The mucous membrane of the nose always secretes sufficient watery fluid to charge the air, which is warmed in the nose and in the neighbouring cavities, with its proper amount of moisture. The warming of the air in this part of the respiratory apparatus is of considerable importance.

One must not undervalue the fact that the organ of

smell is situated in the nasal cavity, and that the nose thus becomes a sort of guard, which is supposed to control the condition of the air which passes through. Unfortunately, many people fail to heed the warning, and neglect to make use of the sense of smell more often than they neglect to make use of any of the other senses. One need only recall the atmosphere in badly ventilated rooms, in which many persons remain for hours, at times without being obliged to do so by their

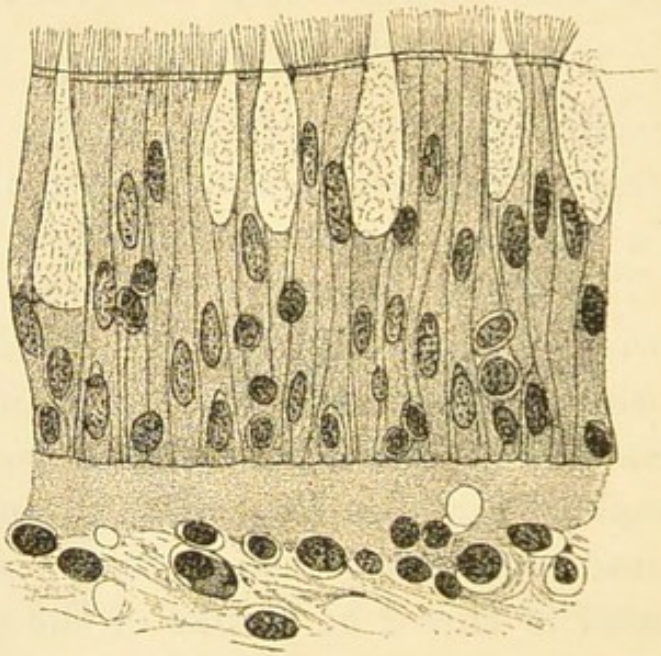


Fig. 2.—Ciliated Epithelium.

calling. They seem to enjoy an almost poisonous air, while they are very particular as far as their other senses—*e.g.*, that of taste—are concerned, and carefully avoid offending these.

The lower part of the fauces belongs both to the respiratory and also to the digestive tract. At the level of the larynx the division takes place into the respiratory tract, strictly speaking, and the gullet.

It is only necessary to mention with regard to the larynx that, besides the involuntary widening and nar-

rowing during quiet breathing, it can also be widened and narrowed voluntarily, and that it is lined with a mucous membrane which is extremely sensitive toward stimuli emanating from without.

The trachea represents a fibrous tube, in which a row of C-shaped cartilages is inserted at regular intervals. The object of this arrangement is to lend a certain degree of rigidity to the yielding structure, and

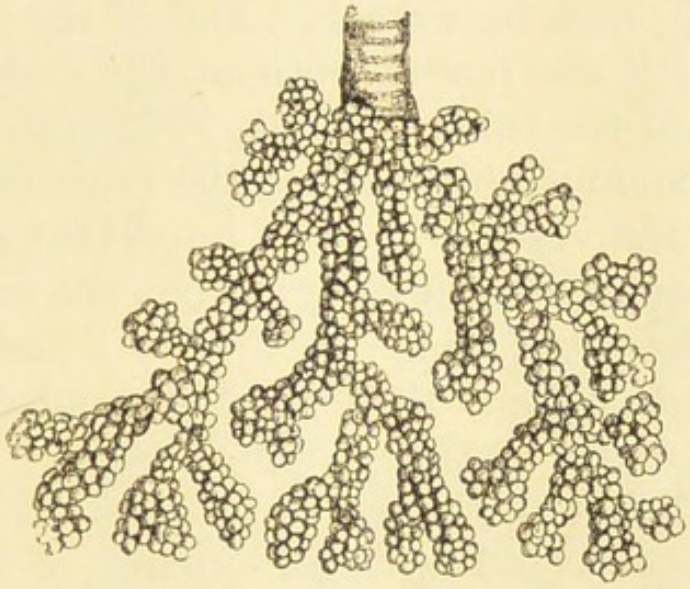


FIG. 3.—AIR VESICLES.

to ensure that the lumen remains of equal width (Fig. 1).

The mucous membrane, which lines the interior of this tube, possesses a large number of small glands, which under normal conditions secrete a tenacious mucus, in which dust-particles in the respired air are caught up. The inmost layer, looking toward the free surface, is formed of so-called ciliated epithelium —*i.e.*, cells which are provided with fine hair-like processes attached at the free surface. These processes are endowed with a continuous pendulous movement in the direction of the larynx, and the mucus sticking

on the surface is carried upwards by this movement (Fig. 2).

The branches of the windpipe—the bronchi—are similarly constructed, but after they have divided many times, like the branchings of a tree, they lose their cartilages when the diameter has diminished to about 1 millimetre ($\frac{1}{25}$ inch). The ultimate branchings form part of the lung itself. The substance of the lung consists of the terminal bronchioli of 0·2 millimetre, or $\frac{1}{125}$ inch in diameter, and of the pulmonary vesicles, which are placed both at the ends and also at the sides of the tubes (Fig. 3). While the windpipe and its branchings only possess the function of transmitting air, the vesicles form an important part of the respiratory apparatus in carrying out the exchange of gases. In size they range between 0·1 and 0·3 millimetre in diameter, and they number about 400,000,000 in men and about 320,000,000 in women. It may be mentioned that if all the vesicles were stretched out on one plane, one would have an expanse of from 40 to 50 square metres (about 43½ to 54½ square yards) during expiration, and if taken at the moment of inflation during a deep inspiration, it would cover from 100 to 120 square metres (about 109 to 130½ square yards).

The structure of this respiratory surface is as follows : Each little vesicle is lined with a layer of cells (epithelial cells) within, is covered on the outer side with elastic fibres, and between these two layers a close network of bloodvessels (capillaries) intertwines itself (Fig. 4). Were these last-named spread out and placed side by side, they would cover a surface of several thousand square yards. The lung substance derives a high degree of elasticity from its elastic fibres, so that

when the organ has been inflated it can contract to one-third of its volume.

It is necessary to consider how the air is carried to the lung through the conducting tube (nose, fauces, windpipe, and its branches), and how the proper exchange of air is brought about. The process is that

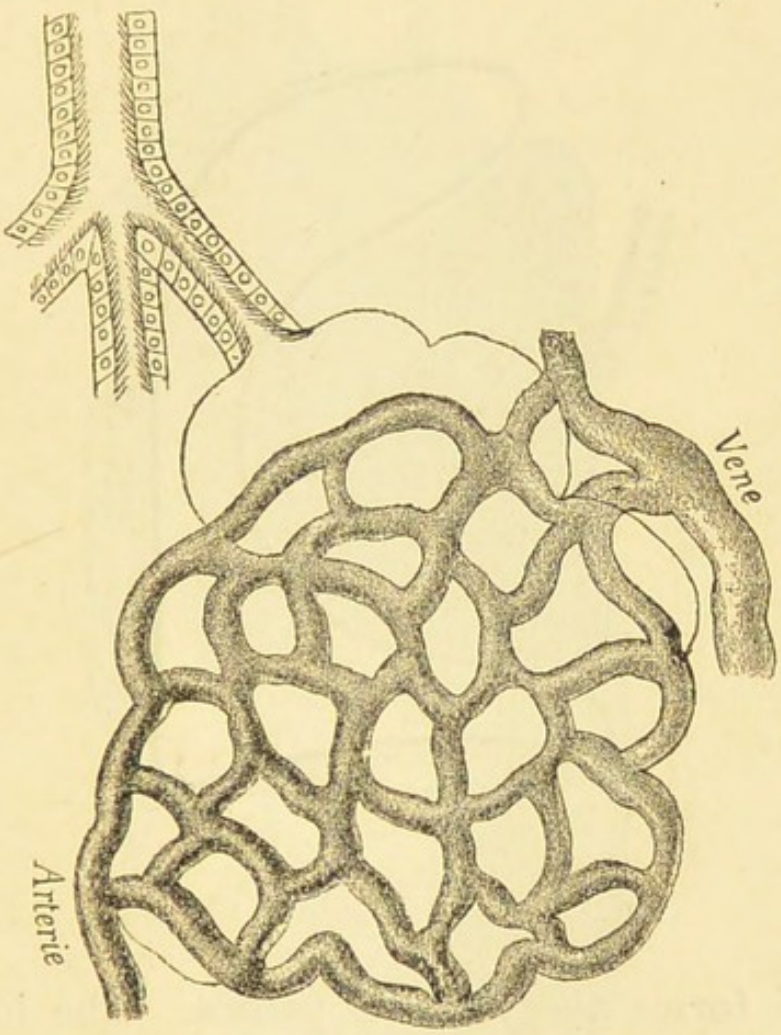


Fig. 4.—The Bloodvessels of a Pulmonary Alveolus.

of inspiration, which means the expansion of the lungs, and expiration, which means the contraction of the lungs. A perfectly free mobility is necessary for the change in size of the organ, which completes sixteen to twenty breaths in the minute during quiet respiration. This mobility is provided for by means

of a very peculiar adaptation of the lung in the cavity of the chest (thorax). Each half of the chest, as it were, contains two membranous bladders, inside each of which one lung is so inserted that it is covered by the corresponding wall of the bladder, to which it is firmly attached—the pulmonary pleura—while the outer wall of the bladder is attached to the chest wall,

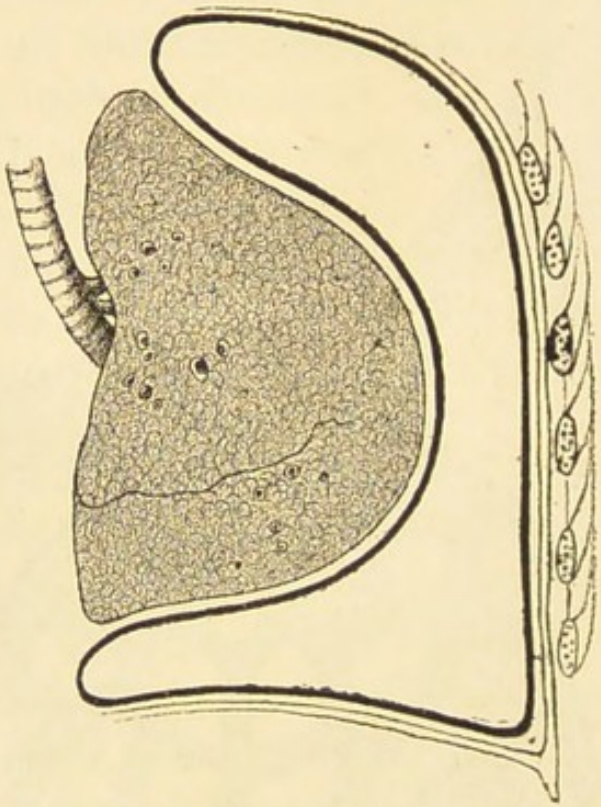


Fig. 5.—The Pleural Cavity.

and thus forms the parietal pleura. The lower part covers the diaphragm (Fig. 5).

Since the lung is perfectly adapted to the chest wall, no space exists normally between the pulmonary and the parietal pleura. Only in certain diseased conditions can such a space be formed, when fluid, a growth, or even air may be interposed between the layers. These layers being covered by a smooth layer of cells, and being always kept moist, make it possible for the

lung to move easily in the thorax. The expansion of the thorax and the inflation of the lungs during inspiration takes place by means of the action of muscles. During quiet respiration it is chiefly the diaphragm which acts. It is not a series of rapid contractions

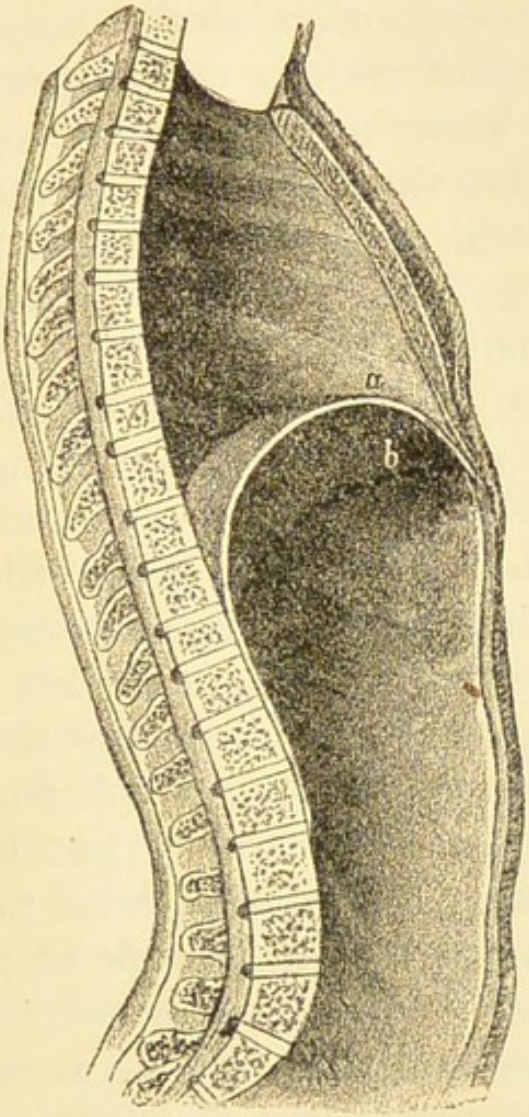


Fig. 6.—The Diaphragm.

like the work of the ordinary muscles, but is slower and more prolonged. The diaphragm (Fig. 6) represents a muscular plane, stretched between the cavities of the chest and abdomen, and protruding dome-shaped into the cavity of the chest. The arch is flattened

when the muscle contracts, which takes place during inspiration. The capacity of the chest is enlarged from above downwards, and since a vacuum cannot exist in it, the lung must follow and expand to the extent of the downward movement of the diaphragm, and air must enter into it through the air-passages. Thus the first expansion of the lung is downwards. But another set of muscles can also enlarge the cavity of the chest. These muscles are attached to the ribs, and act by lifting them during inspiration from behind forwards (sagittal diameter) and also laterally (transverse diameter). The lung, following these movements, expands horizontally as the air is sucked in.

Our organism is endowed with an excellent arrangement in that, after the inspiration has been carried out by means of active muscular contractions, the expiration is brought about, as a rule, without any such help, so that a saving of energy is attained thereby. As soon as the diaphragm has left off contracting, it is pushed upwards again, chiefly through the elasticity of the expanded lung, which tries to regain its balance, and also in part by the elasticity of the abdominal organs, which have been pressed together to a certain extent by the descent of the diaphragm, and the air is driven out of the lung. The cavity of the chest further diminishes by the sinking of the ribs, which were raised during the inspiration. This is brought about by their own weight, after the traction exercised on them has ceased. Under certain conditions, the abdominal muscles can exercise an additional action by pressing strongly on the chest, and thus energetically driving out the air.

That we do not, as a rule, need the whole activity of one organ must be regarded as a further very im-

portant arrangement. A reserve of activity is always present for increased needs. This applies also to the lungs. During quiet respiration not all the parts of the lung are equally expanded. It is chiefly the apices of the lungs, reaching up into the regions of the neck, which undergo less extensive change in volume, and the same applies to the centrally placed parts as compared with the parts more peripherally situated. We shall see, however, that this may be a disadvantage, for those parts which are less active have a greater chance of becoming diseased. For quiet respiration, therefore, the activity of the diaphragm alone suffices to set a sufficiently large portion of the lung into action; but when the requirements are increased for forced inspiration, when air has to be pumped into those portions which are not usually inflated, an increased contraction of the diaphragm may still suffice. But as a rule, the assistance of other muscles and groups of muscles (the elevators of the ribs and those of the shoulders) becomes necessary. The cavity of the chest as a whole then becomes enlarged in all its diameters, and the atmospheric air is sucked into all parts, even into the most distantly situated air-vesicles. One can convince oneself of these processes not only by measurements of the increased capacity of the chest, and by listening to that peculiar noise which the air, penetrating into the lung vesicles, produces, but also by experiments on animals and by certain morbid phenomena—*e.g.*, the friction of the roughened layers of the pulmonary and parietal pleura.

The movements of the diaphragm are less extensive in women than in men under normal conditions.

It can be seen from the description of the mechanism that the movements of the lungs during inspiration

are passive—the lungs expand by muscular activity. The expiration follows as the result of the elastic retraction of the lungs. However, the will has an influence on both movements. We can set the muscles during inspiration into more rapid and more energetic action, we can call more auxiliary muscles into action, and even during quiet expiration press on the thorax by means of muscular action beyond the limit of the elasticity of the lung, and in this way bring about an increased expression of air.

The majority of people attach the greatest importance to the ingestion of food, and even spend a large proportion of their mental activity on the various details in connection with their meals, while, as a rule, the process of respiration, with all that belongs to it, is regarded as being less worthy of attention, as being of subordinate importance. But if one compares the 10,000 litres of air which a person breathes daily with the small volume of solid and liquid food used up by a moderate eater ; if one considers that the quality of the air is really much more important than that of the diet ; and, lastly, if one considers that a person can fast for days, but dies in a few minutes if the respiration is stopped, one realizes the error of this view, and the vital importance of the respiratory process.

During quiet respiration about 500 c.c. (about 30 cubic inches) of air are inspired and expired at every breath. This is usually called the tidal air. One must not imagine the respiratory process and the exchange of air connected with it as consisting of the inhalation of a certain quantity of air into the lung, and of the expiration of the same quantity of air of slightly changed composition. After a quiet expiration a not inconsiderable quantity of air (about 1,500 c.c.) remains

in the lungs, which is termed residual air. Only about one-sixth of the freshly inhaled air is subjected to the respiratory change, while five-sixths remain behind. This is especially well shown in an experiment with an irrespirable gas, such as hydrogen. If one allows one quiet inspiration of this gas, and then examines continuously the expired air, one will find that from six to ten expirations are required to get rid of all the hydrogen.

We are, however, capable of taking in a far greater quantity of air, with the help of the auxiliary muscles. This is called the complemental air, and may amount to 1,600 c.c. In the same way we are able by forced expiration to expel a considerable quantity of air over and above the ordinarily expired air. This is called the reserve air, and may amount to about 1,600 c.c. The sum of the tidal, complemental, and reserve air constitutes what we call the vital capacity of the lung —*i.e.*, the amount of air which can be taken in by the deepest inspiration and expelled by the most forcible expiration. The average quantity is about 3,500 c.c., and varies according to the sex, age, weight, and height of the individual. The increase of volume of the expired air as compared with the inspired air is explained by the higher temperature of the former. The vital capacity of the lung is gauged by expiring after a deep inspiration into a well-balanced bell-jar inverted over water. The volume of air in the jar is then measured. Hutchinson and others have invented apparatus for this purpose, and a very efficient one, the diagram of which is shown in Fig. 7, has been devised by Professor Clar of Vienna.

The relationship between the air which has been drawn into the alveoli of the lung and the blood which

is circulating in the capillaries of the lung must now be considered. For practical purposes, we can regard the air as consisting of 79 volumes per cent. of nitrogen and 21 volumes per cent. of oxygen.

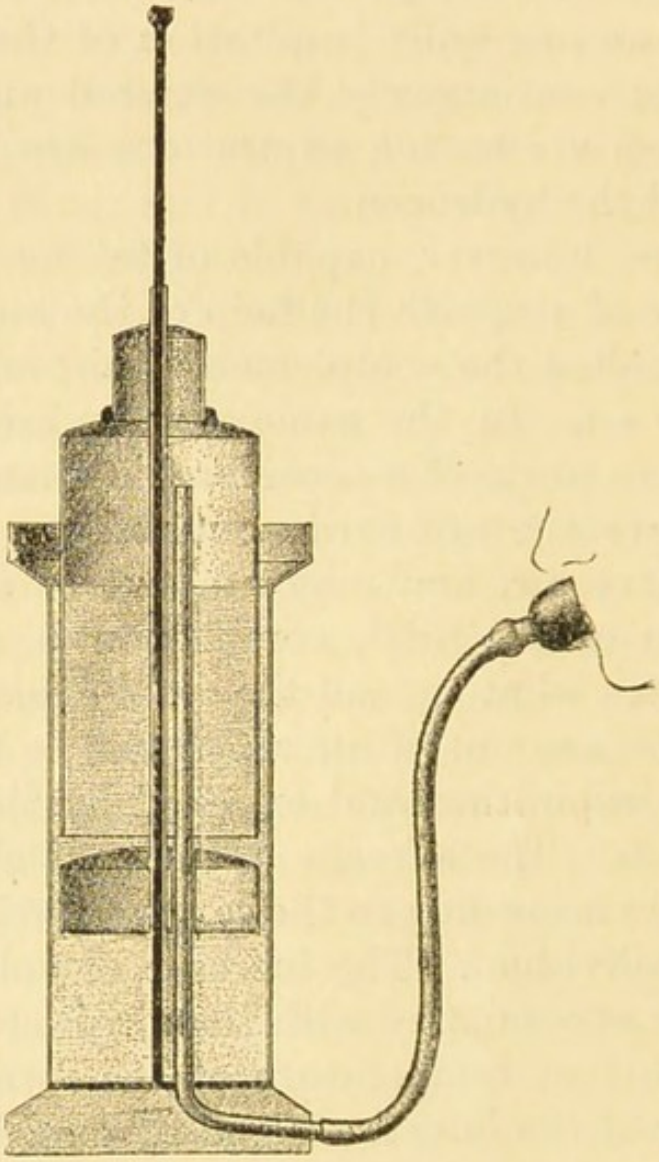


FIG. 7.—SPIROMETER.

Nitrogen has only a mechanical significance in respiration, and is absorbed by the blood according to physical laws. Oxygen, on the other hand, is subjected to a chemical combination. How much oxygen the blood takes up depends on its tension in the air contained in the alveoli. Quite a small percentage of

the oxygen is taken up by the plasma, while by far the greater proportion is attracted to the blood-corpuscles, and is combined with the colouring-matter of these cells—the hæmoglobin. The blood takes up the oxygen so greedily that up to 98 per cent. is claimed. While the blood takes up oxygen, it gives off carbonic acid, which is present to a small degree in the blood-corpuscles, and to a large extent in the plasma. The carbonic acid is diffused in the air of the vesicles of the lungs until the tension is equalized, and is then excreted in the expired air.

The taking up of oxygen in inspiration is, therefore, the most important factor of all the vital processes and for the building up of the organism. In expiration the most important factor is the getting rid of the carbonic acid, which is produced in the oxidation processes in the tissues. When the blood has been saturated in the above-described fashion with oxygen, —*i.e.*, arterialized—it flows toward the left side of the heart, and thence to the organs, where the oxygen is given up to the tissue elements, the cells. The blood becomes increasingly poor in oxygen in response to the vital processes, the so-called internal respiration, and in consequence richer in carbonic acid—*i.e.*, venous. It flows back to the right side of the heart, and thence again back to the lungs, where it is recharged with oxygen. In order to give an idea of the velocity of this process, it may be mentioned that each blood cell passes through the pulmonary capillaries twice in each minute.

One can easily demonstrate the excretion of carbon dioxide if one breathes out through a glass tube into a vessel containing lime-water. The originally clear fluid becomes turbid after a few breaths through the formation of calcium carbonate (ordinary chalk).

One can form an idea of the humidity of the expired air if one observes the clouding of a cold mirror with water-vapour when one breathes on it, or the visible steam which is formed by one's breath on a cold winter's day.

It is of interest to obtain, at all events, a rough estimate of the material used up. An adult uses up, on an average, from 24 to 30 grammes of oxygen (equals from about $28\frac{3}{4}$ to $37\frac{1}{2}$ pints), and gives off 40 grammes of carbonic acid (about $36\frac{1}{3}$ pints) and 20 grammes of water (about $\frac{3}{4}$ ounce) per hour.

The question has often been raised whether other harmful substances, or even poisons—anthropotoxin—besides carbonic acid are excreted in the breath. This has definitely been shown not to be the case. Ammonia when it is found in the expired air is not a product of respiration, but is derived from some impurity of the oral cavity, or from a diseased area in the lung.

Some authors consider that a connection exists between the external skin and the respiration. This is based on the fact that the covering of the body also excretes a not inconsiderable amount of water, 30 grammes (about 1 ounce) being got rid of in twenty-four hours. This is the only resemblance between the skin and the respiration. The carbonic acid excreted in this way is so small in quantity (about 4 grammes per diem) that it need scarcely be taken into consideration. It probably originates from decomposing secretion of the skin.

The complicated process of respiration is set into action by the respiratory centre, which is situated in the central nervous system, in the medulla oblongata. This centre innervates a whole series of muscles in various ways, and attains a smooth co-ordinated action.

It is stimulated by an excess of carbonic acid, and also by reflex messages, the nature of which will be described later on.

An adequate supply of food and the participation of the muscular system are not sufficient to maintain the normal temperature of 98·4° F. in a healthy person; a corresponding supply of oxygen introduced by respiration is necessary. The respiration and the circulation of the blood stand in a certain dependent relationship to one another. The respiratory movements facilitate the circulation of the blood in the lungs by dilating the vessels. In certain diseased conditions of the lungs, which are associated with a consolidation of the tissues, the expansibility of the organ is diminished or entirely abolished, and in consequence the circulation suffers.

A few special forms of respiratory movements may be mentioned here, some of which are voluntary and others involuntary. They can be regarded as products of psychical conditions, or as protective arrangements. Some of them are very complicated.

Sighing is a slow prolonged inspiration, followed by a quick audible expiration. When it happens involuntarily during sedentary occupation after prolonged inactivity, it may be regarded as an endeavour to aerate the lungs energetically. It may also express a condition of mental depression.

Sobbing is produced by a rapid inspiration through the closed glottis with lax vocal cords. It often accompanies or follows crying, and is an expression of deeply affected mood.

Hiccough follows the same mechanism as the preceding, only the vocal cords are made to vibrate and to produce a peculiar sound. It is caused by various

morbid conditions stimulating the diaphragmatic nerves.

Yawning takes the form of an extended act of inspiration, during which the mouth is opened more and more, forming one cavity with the fauces, followed by a rapid expiration. It is often associated with the stretching of the various limbs of the body. It indicates hunger, sleepiness, ennui, etc., but it can be produced voluntarily.

Puffing is a forcible expiration with closed mouth, while Huffing (breathing as one does on a glass, for instance) is the same with open mouth, and Blowing is similar with the opening of the mouth narrowed.

Sneezing is produced by an irritation of the nasal mucous membrane, and is mostly a protective arrangement for the removal of a foreign body. A sudden explosive forcing of air through the closed glottis, following upon a deep, quick, or prolonged inspiration, takes place, and the air is driven out through the nose.

Blowing the Nose is a forcible expiration with closed mouth, and a forcing of the current of air through the narrowed nostrils with the object of removing mucus or foreign material present in the nose.

Bearing Down is carried out by closing the glottis after a deep inspiration, as the result of which the diaphragm is depressed and fixed, and by the contraction of the abdominal muscles, which exercise a pressure on the contents of the abdomen, and especially on the bladder and intestines, emptying them of their contents. The respiratory apparatus occupies the same position during temporary great bodily efforts, such as the lifting of a weight or the overcoming of an obstacle.

Laughing consists in a series of expiratory efforts of shorter or longer duration, accompanied by some action of the larynx.

Clearing of the Throat is an abrupt sounding expiration with closed glottis and slightly tense vocal cords. It is completed by a short supplementary expiration. It is mostly carried out to remove mucus, but can also be voluntarily produced with varying pressure of air. Often it is used as a warning signal.

Coughing, being always a morbid condition, will be discussed later on.

Snoring takes place during sleep while the mouth is open. It is produced by the vibration of the relaxed soft palate and uvula, and is mostly associated with narrowed or blocked-up nostrils. No satisfactory explanation exists for its occurrence apart from this, nor for the fact that in some people the soft palate is relaxed in this way. The falling back of the tongue seems to play some part in this, too.

The lungs, together with the rest of the respiratory apparatus, play a very important part in Speaking, Singing, and Screaming. This matter, however, cannot be dealt with in this place.

PART II

CARE OF THE HEALTHY LUNG

Two conditions are of importance for the healthy activity of the lungs :

1. That the air we breathe should be pure, and
2. That the lungs should be able to take in and deal with the breathed air.

The correct activity of the lungs depends on the co-operation of these two factors. The more complete this co-operation is, the better will be the function of the respiratory process, and the whole organism will benefit by it.

1. *The quality of the material suitable for breathing, and the action of the same on the lung.*

In dealing with the quality of the material suitable for breathing, one has to take into consideration its chemical composition and its physical and mechanical properties.

The chemical composition of air may be taken as being twenty-one parts of oxygen and seventy-nine parts of nitrogen, while ozone, carbonic acid, and ammonia are present in varying small quantities. One may disregard the further constituents, such as peroxide of hydrogen, argon, helium, etc., since these only

exist in minute traces, and nothing definite is known as to their influence on respiration.

Ozone possesses a high power of oxidation. It is an oxygen with an altered molecular arrangement (allotropic modification), and is therefore often spoken of as 'active oxygen.' It occurs in very varying quantities in the atmosphere, and where its percentage is high the air is supposed to have an especially beneficial influence on our organism. It is developed abundantly by electrical discharges in thunder-storms, and similarly by artificial discharges of electric sparks in the vicinity of electrical batteries, and especially through the activity of the Röntgen apparatus. Our noses are exceedingly sensitive toward it, and when it is present in excess its irritant influence on the nose may produce catarrh. The proportion which exercises a useful action on the respiratory process has not yet been worked out. The development of ozone also takes place when the atmospheric air comes into contact with the ethereal oils—turpentine and its derivatives. The bleaching of the corks of bottles containing turpentine and the like depends on its marked oxidizing action on organic substances. The spraying and evaporating of such substances—*e.g.*, of the extract of the fresh leaves of *Pinus silvestris*—now so much in vogue, is said to have not only a disinfecting action on this account, but also to have a beneficial influence on the respiratory apparatus. Nothing definite, however, can be stated in this respect, since, as we know so little of the pure action of ozone, only that of the ethereal oil can be dealt with.

The carbonic acid (CO_2) content of the air is of far greater importance. It varies from 0·2 per cent. to 0·6 per cent. in various situations. These variations

are due to the following factors : The process of breathing of many persons congregated together in crowded towns, the neighbourhood of factories, the presence of processes of combustion and decomposition, the existence of abundant vegetation. Variations according to the time of day and to the condition of wind also occur. As long as the carbonic acid does not exceed the quantity stated, it need scarcely be taken into consideration ; but one must always remember that the law of small potential may apply—*i.e.*, that small quantities can act harmfully if they are allowed to act for a long time. In dealing with the diseases of the respiratory passages, it will be necessary to return to the action of larger, directly poisonous quantities, and also to deal with those gases which are inhaled in the course of certain occupations either accidentally or through carelessness.

Among the gross impurities of the air, smoke, fog, and the various substances in dust form are met with. They vary considerably in different places. The effect of this on the respiratory mucous membrane will be dealt with later. Since microbes (the smallest organisms in existence) float about in the air in not inconsiderable numbers, the contamination of the air by them is of paramount importance. Bacteria are distributed nearly everywhere, and in larger quantities than is generally believed. In the open spaces in Berlin the air contains always from 100 to 1,000 bacteria per cubic metre. There are as many as 800 on top of the tower of the Rathaus, while the air of an inhabited room contains from 6,000 to 10,000. The number found in a given space does not depend on the absolute quantity of micro-organisms only, but also on the movements of the air.

The terms used in ordinary life of 'pure,' 'impure,' 'bad,' 'poisonous,' 'suffocating' air owe their origin to the varying presence of these impurities. Although country, mountain, and sea air may be quoted as examples of pure air, in contrast to town and room air, it must be pointed out that a perfectly pure air does not exist, not even at sea or in the desert. The wind fills the former with droplets of water and particles of salt, and the latter with suffocating dust. Rain-showers clear the air thoroughly, as everyone will acknowledge. The importance of providing pure air and of taking full advantage of the same will be discussed further on. The purest air is only found in very high altitudes, and can only be reached by balloons. In rare cases, the additions to the air may carry with them certain advantages—as, for example, the particles of salt floating in the air at the seaside, which enter our respiratory tracks.

Some of the physical properties of the air breathed which deserve consideration will now be discussed.

Temperature.—The changes of temperature at different times of the day and year, and the fluctuations occurring in connection with other meteorological factors, are well known. However, only the influence of these variations on our respiratory organs need be considered in this place. Speaking generally, the human being is capable of withstanding a wide range of temperature, as is shown by the possibility of living in the tropics and in the Arctic regions. From the earliest times, one has ascribed a baneful influence on our respiratory organs to low temperatures. Cold air was supposed to cause catarrh, and even severe illnesses, and the belief in 'catching cold' still exists at the present time. Cold was formerly regarded as

one of the causal factors of diphtheria, but the occurrence of epidemics at all times of the year, and under every meteorological condition, has proved that this is not so. The most recent experiences of the Arctic explorers have shown that enormously low temperatures, reaching even to −40° C., can not only be stood, but that human beings can remain perfectly well.

The case of the renowned explorer Weyprecht furnishes us with an excellent example of this. He asked the author before starting on a Polar expedition whether he thought that the condition of his respiratory organs was such that he would be able to stand the exertions connected with his journey. He expressed his doubts. The condition of his lungs, far from getting worse, improved during his journey. He returned apparently in good health, but three months later developed a tubercular meningitis, of which this eminent man died in his home in Hessen.

However, a rapid change from hot to cold air produces an irritation in the upper air-passages (cough), but this disappears entirely after one has been in the cold for a long time. It is true that the air is warmed considerably in the nose and its neighbouring cavities. Still, one might expect that the air passing into the depths of the lung would act on the capillaries, producing a contraction, and thus cooling the blood. But this does not take place. Recent researches show that when the outer air has a temperature of −6° C., a thermometer introduced into the axilla registers 37° C., and one introduced into the left bronchus of a human being registered 37·5° C., corresponding to the temperature in the rectum. As a rule, the expired air cools down when the atmospheric temperature is low. The air expired while the outer temperature was −10° C.

was found to be 30° C., which indicates that a considerable loss of heat had taken place in the surrounding tissues. However, this is of no importance, since a more complete equalization is attained in the lower portions of the respiratory track, and the cold air does not reach the smaller bronchi or the tissue of the lung.

One can, therefore, state that all forms of respirators, which are placed in front of the mouth in order that the air must pass through various networks, are unnecessary, save perhaps in the case of occupations in which the presence of dust is unavoidable.

Warm air, too, does not do any harm to the lung, as is shown in the case of those people whose occupations compel them to remain in high temperatures for a considerable time.

The sudden change from hot to cold air cannot be regarded as being indifferent, since unequal diffusion of heat in the various parts of the body can take place, and thus lay the foundation-stone for the predisposition of certain diseases. Other properties of the atmosphere have also to be taken into account, the most important of which is humidity.

Humidity.—The refreshing sensation experienced after a thunder-storm has already been mentioned, but this is not due to the water contained in the air ; it is the result of the washing down of all sorts of floating impurities by the rain. One has to deal with relative humidity of the air—that is to say, with the proportion of steam pervading the atmosphere as compared with the volume of steam in air saturated with humidity under equal conditions of temperature and pressure. One feels most comfortable when the humidity has an average of 70 per cent. We can only feel comfortable

in dry air at moderate or cool temperatures. This is due to the fact that we give off more water when the air is dry, and thus the mucous membranes tend to dry up. Dry hot air causes a feeling of discomfort, which may amount to dryness, in the eyes, nose, and even in the throat, affecting the air-passages, where it produces a sensation of irritation and cough. On entering a hot-house, one experiences a sensation of uneasiness in the chest, which is due to the air being too warm and too moist. This leads to an increased secretion of the mucous membranes, in contradistinction to the desiccation mentioned above. Accordingly, it is of importance to preserve a correct relative humidity of the air when heating dwellings during the winter.

Fog is due to the condensation of water-vapour by cooling, when the air is saturated with humidity, and is rendered particularly unpleasant by particles of dust being carried down with it. In large towns, where the air is heavily laden with dust, the fogs may become a serious matter—as, for example, the 'yellow' fog of London.

Atmospheric pressure undergoes, as a rule, such small changes that the gaseous interchange in the lungs is not appreciably influenced by it. The influence is more marked when one ascends to higher altitudes, where the air is much rarer, or when one descends into great depths or enters rooms with increased pressures artificially produced. These influences will be dealt with more minutely in the chapter on Diseases.

The movements of the air—draughts, wind, etc.—do not exercise, as a rule, such a harmful influence on our respiratory passages as is generally supposed. Wind clears the air and acts beneficially not only out

of doors, but also in houses, when it has an opportunity of blowing through. It only acts harmfully when it carries dust with it, or when it is so strong that it actually impedes respiration directly or indirectly by rendering bodily movements difficult. That this is so is proved by the fact that every one, and especially weakly persons, gets 'out of breath' when battling against the wind, and even strong individuals lose their breath when riding or skating against a high wind. Very warm, as well as very cold, winds which are laden with dust are especially unpleasant.

Sunshine exercises a great influence on the air surrounding us, and on the processes of vegetation in the outer world. It also acts beneficially on our bodies by promoting the aeration of the lungs—*i.e.*, by increasing the respiratory movements. Besides, there is no doubt that one breathes more freely in bright sunshine. One is more inclined to go into the open air, and in this way the interchange of air in the lungs is materially assisted.

In recent times the meteorologists have been busying themselves with the conditions of electric tension of the air. Up to the present one has not been able to determine the influence of these conditions on our breathing, but, arguing from analogy, one is justified in assuming that it may be not inconsiderable.

It is necessary, however, to mention that, in judging the influence of the atmosphere on our lungs, one has to deal with not only one factor, but the sum of many factors, such as temperature, humidity, movement of the air, etc.

2. *The possibility of being able to take up the air smoothly and of dealing with it properly.*

For this purpose it is necessary that the respiratory organs should be in good condition, uninfluenced by inherited or acquired defects ; that there should be an unlimited possibility for the application of the protective arrangements which Nature has supplied to us ; and that there should be no limitation to the activity of the mechanical portions of the respiratory apparatus. An inherited or acquired narrowing of the nose affects the respiration mechanically to its detriment, and an habitual stoop does the same by preventing the muscles of respiration from being efficiently put into action.

It will be found advisable to analyse all our vital functions from this point of view, which corresponds to a great extent with those mentioned under Section 1. The ideas gained from the consideration of the above must guide one in formulating a hygiene of the lungs, both in rest and during exercise, when in the open air or in closed buildings—rooms or workshops.

One must not forget that the first portion of the normal respiratory apparatus is the nose, and that a healthy person breathes air through it. Deviations of the nasal septum, which are often congenital, may produce so considerable a narrowing of the one side of the nose that the other side is insufficient for transmitting the necessary quantity of air. Both nasal passages may be affected in this way, and thus force the subject to keep his mouth open and to breathe through it, with the result of drying up the mucous membranes of the mouth, fauces, and larynx. The like obstructions may also be produced by diseases of the nose

and of the posterior naso-pharynx. Dr. H. Neumayer, in the sixth volume of this collection—'The Hygiene of the Nose, the Fauces, and the Larynx in Health and in Disease'—deals with these obstructions. It is only necessary to mention one pathological condition in this connection, which has been more fully investigated in recent times. This is the blockage of the nose through overgrowth of the glandular tissue—the so-called adenoid tissue—in the upper parts of the fauces, and chiefly at the base of the skull. Like the tonsils, this tissue can overgrow, and form large growths, which can completely block up the nose from behind. It was formerly thought that this condition only occurred in certain countries—*e.g.*, England, Denmark, etc.—but it has now been shown that it occurs elsewhere. It appears to affect children in preference. It has been proved that this form of obstruction to breathing not only produces a peculiar idiotic expression of face, but also a number of morbid processes. Adenoid vegetations, as these overgrowths are called, may even affect the mental development of the child, and therefore our special attention must be given to them. Fortunately, they can be easily removed by operation.

Apart from the inflammatory and infective diseases which may affect the width of the lumen of the upper air-passages, one may mention those constrictions of the air-passages which are produced by tumours in the neck. One of the most important of these is the enlargement of the thyroid gland known as goître. These constrictions occasionally lead to severe difficulty in breathing. Should an inflammatory swelling of the mucous membranes, however slight, occur from catarrh, the dyspnœa may threaten to choke the

individual. It is not difficult to recognize such conditions by the noisy breathing, which is often audible at some considerable distance.

All deformities of the chest produce similar difficulties in respiration. Among these may be quoted marked curvature of the spine; deformities affecting the natural curvature of the ribs, chiefly those resulting from rickets; the condition known as pigeon-breast, in which the breast-bone protrudes markedly; cobbler's breast, in which the breast-bone is hollowed out; and last, but not least, the compression of the lower portion of the chest by the wearing of unsuitable corsets. All these prevent a complete expansion of the lung during inspiration—that is to say, a sufficient intake of oxygen. One can often recognize that the respiration is insufficient in these cases by blueness of the lips and of the face (cyanosis). Various tumours, and also effusions of fluid into the pleural cavity (usually spoken of as pleurisy or dropsy of the chest), may compress one or both lungs more or less extensively. In consequence of this, the respiratory surface becomes reduced, and even asphyxia may result. Air in the pleural cavity may produce a similar compression of the lungs. A wound in the lung or through the chest wall may let air into the pleural cavity, which condition is known as pneumo-thorax (from *pneuma*, meaning air). The pressure in the pleural cavity may reach such a height that the lungs may become completely collapsed.

A limitation of the enlargement of the cavity of the chest caused by disturbances of the respiratory muscles, including paralysis, and especially of the diaphragm, may prevent a sufficient aeration of the lungs. The author had the opportunity of observing in a very rare

case a complete cutting off of the nerve-supply of the respiratory muscles, caused by the formation of an inflammatory lesion in the spinal cord during an attack of typhoid fever. The muscles in consequence were totally paralysed, and the patient died of asphyxia.

The nose acts as an important protective organ. Mention has already been made of the considerable protection derived from the nose as an organ of smell. Dust-particles are caught up partly by the collection of small hairs in the nostrils, and partly by the moisture of the mucous surface. The deflection of the current of air at the sharp angle of the fauces acts like a sort of dust-trap. On examination, one frequently finds particles of tobacco in the posterior nares and posterior pharyngeal wall, and the author has been able to surprise patients by charging them with taking snuff.

Sneezing and blowing the nose are the most important reflex processes of protection against the irritation of all sorts of particles entering the nose. Since the nose is the proper canal for breathing, and since it possesses these important arrangements for protection, it is necessary to keep the passages open, and to remove all morbid conditions affecting these parts, whatever their nature may be.

Wherever dust is raised, be it in the street, in workshops, in schools, and even in the sick-room, we breathe with it a large number of micro-organisms, of which only a small proportion is cast out in the expiration. Although not all micro-organisms are pathogenic—*i.e.*, do not produce disease—some of them are dangerous to us. Some of them are removed by existing arrangements, and some of them are rendered harmless by other means. The most important of the

former arrangements is the act of coughing. This act produces a very energetic expiratory current of air by causing the air imprisoned in the lungs and bronchi to burst through the resistance of the closed glottis, and thus to forcibly expel any foreign bodies. However, the sensibility of the mucous membranes varies in different people, and apart from this, when the collected mucus is not got rid of at once, a certain amount of toleration is created. One can satisfy oneself of this by using the laryngoscope, when one may see small collections of mucus adhering to the tracheal wall without any desire to cough being exhibited.

Mucus, including light particles, is removed by the ciliary movement of the epithelium. The particles are gradually driven upwards by the movements of the cilia, which lash from below upwards. As soon as they reach a particularly sensitive spot in the mucous membrane, they induce a hawking or coughing reaction. Should, however, a microbe or a very small foreign body adhere to any part of the mucous membrane, it can even penetrate through the epithelium into the substance. The microbe need not necessarily become a danger to the organism under these circumstances, for it can enter into a lymphatic channel and be taken up and rendered harmless by the leucocytes; or it can be carried away to a lymphatic gland, and be temporarily or permanently deposited there; or it may be encapsuled in the tissues by an overgrowth of its cells. This matter will be dealt with later on.

Intelligence and education must be regarded as being among the most active means of protection which Nature has provided for the integrity of our respiratory apparatus. Every individual, on arriving at an age of discretion, ought to have found out what will harm

his own constitution, what damaging influences of everyday life his body is able to resist, and must learn to act accordingly.

A rational education will assist materially in attaining this. It will point out certain dangers, especially those which are not very apparent, and will influence the individual morally to apply his energy in avoiding damaging influences which are associated with indulgences of all kinds. The effect of smoking on the respiratory tract may be instanced as an analogy to the effect of taking alcohol on the stomach. The object of these pages is to guide the individual in all conditions, and to guard him against those damaging influences which affect the respiratory tract. The description of the hygienic conditions of dwellings will first be considered.

What should a dwelling be like to satisfy all the requirements of the hygiene of the lungs ?

Serious difficulties may be met when entering a dwelling. For instance, in some dwelling-houses, while one is climbing the stairs, the beating of furniture, the brushing of clothes, and the sweeping of floors raises a great cloud of dust. The lungs, already working at high pressure in going upstairs, have to inhale this pernicious dust. For this reason, everything which introduces dust into a house ought to be avoided ; and even if one cannot go as far as the Turks do, who take off their shoes before entering a house, one certainly should take notice of the excellent advice which meets the eye at every corner and even is woven into many a doormat.

The stairs should only be washed, and when furniture or carpets have to be beaten, this ought to be done either outside the house or in airy passages and

courts, or at least by the open window. The examination of the dust of a room shows that it includes minute pieces of glass, sharp particles of quartz, and the like, the inhalation of which cannot be harmless. In Fig. 8 the microscopical appearance of such dust is

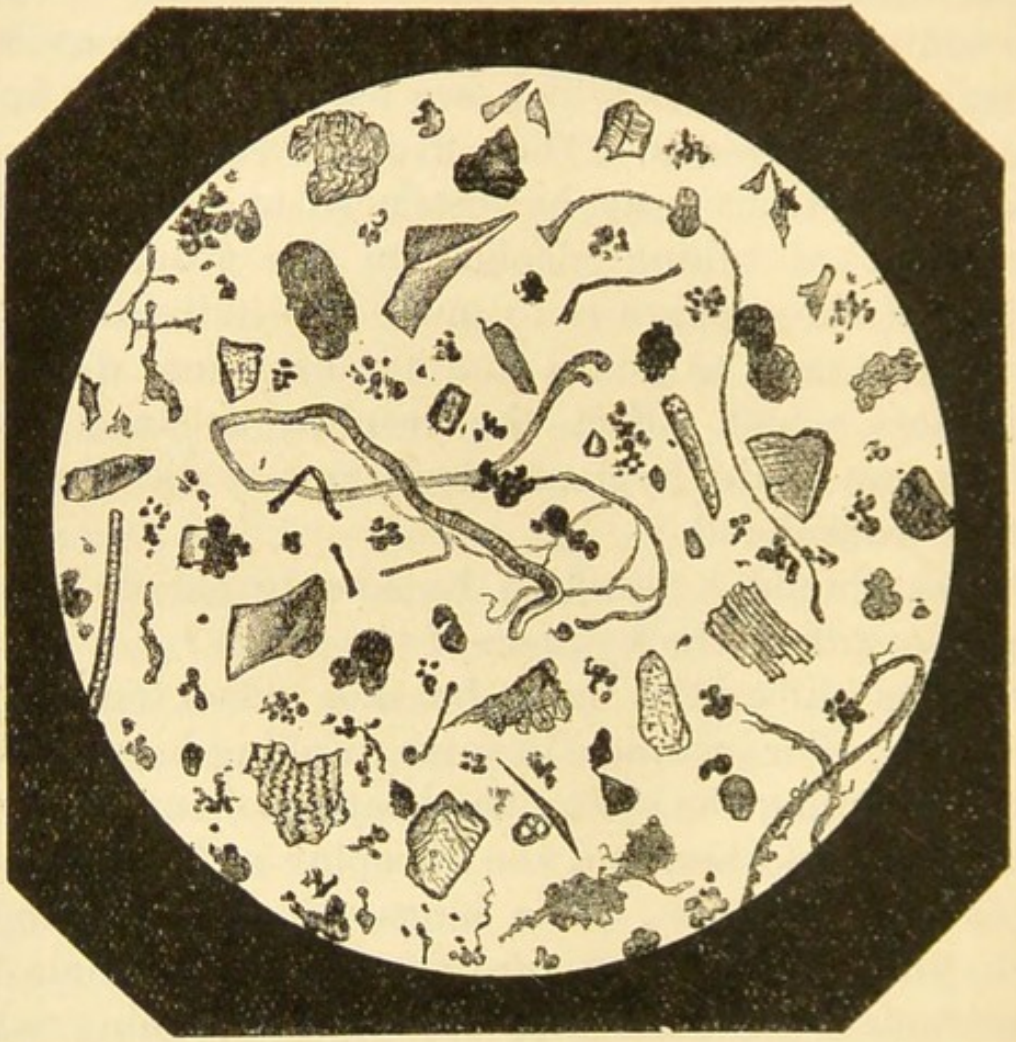


Fig. 8.—Dust of a Waiting-room.

given. All enterprising concerns which undertake the cleaning of household furniture and the like should be supported almost as one supports charitable institutions, so that a hygienic cleansing of their belongings is brought within the reach of the poor.

The introduction by an American firm of a method of sucking dust out of furniture and carpets by means

of rarefied air, and destroying the dust in the furnace, may be considered to be an advance in this direction.

The *Neue Freie Presse* published the following report :

'In 1 gramme of dust from the floor-covering of one of the chief public institutes, 6,600,000 to 21,000,000 bacteria were estimated in a scientific investigation.

'Professor Richard Paltauf has carried out this investigation in his institute with samples of dust which were placed at his disposal by the Vacuum Cleaner Company (a company which, as is well known, removes dust from carpets, curtains, and furniture by a new process, without removing them from their places).

'The report, from which the figures quoted above are taken, reveals details in the classification of the bacteria found in the dust which are calculated to excite the public interest to a great extent.

'Apart from the harmless kinds, the pathogenic bacteria included a considerable number of staphylo- and strepto-cocci (pus cocci, and the causal organisms of inflammation), and also the germs of tetanus (lock-jaw) and of malignant œdema.'

Perhaps the brushing of the trains of dresses which have been allowed to sweep the road forms the greatest danger, for the dust which originates from the dried refuse of the streets frequently contains infective matter, and this dust is inhaled. No one has a right to damage his neighbour, and therefore this should only be undertaken in suitable surroundings, with a profuse current of air. It is much easier to carry out this sort of thing in the country and in small towns than it is in large cities ; but as there is a tendency for people to leave the country to dwell in towns, and thus

to increase the crowding, large towns should be freely supplied with extensive open spaces, dust-free public gardens, and the like, while the houses in the suburbs at least should have balconies, open passages, and large courts. The objection to roof-gardens lies in the impurity of the air caused by smoke and soot. The American system of central heating of whole blocks of houses diminishes the pollution of the air considerably. It is impossible to go into more detail in this place, but special attention must be called to the importance of obtaining pure air for breathing.

What are the qualifications of a healthy dwelling ? The answer is a very simple one : The indoor air should be as pure as the outdoor air. Naturally, this applies for all cases, and should not be limited to any special locality or to any special time. But what is the use of making laws ? What is the use of telling a man that he must have at least 60 c.c. of fresh air at his disposal per hour ? There is no possibility of a general rule, since the sanitary conditions depend on the circumstances of each individual. All one can do is to formulate the claims of hygiene, and to state what is necessary. Each individual must strive to adapt hygienic rules to his own conditions. He must be open to persuasion with regard to acquired habits, and allow his interest to be awakened. In general, the rule that one should not economize with regard to one's dwelling holds good. It is a frequent occurrence, particularly in towns, that a man avoids his uncomfortable neglected home, and spends his free time in restaurants and public-houses, where not only alcohol acts perniciously, but the bad air which is breathed for hours does almost as much harm.

To amplify the above-mentioned rule that a healthy

dwelling ought to have sufficient pure air, one can state that (1) the air-space must be adequately large ; (2) provision should be made for the outlet of contaminated air ; and (3) for the inlet of pure air ; and (4) this air should have a proper degree of warmth and humidity.

The proper proportion between the size of the rooms and the number of the inhabitants, both adults and children, must be maintained. Every adult requires at least 20 cubic metres of air, and every child about half that quantity, and this air should be completely changed three times a day. Apart from the air being free of chemical impurities, it should be free of dust, and everything should be done to attain that end. The construction of floors is of special importance. This matter, which has unfortunately been much neglected, ranges amongst the least well-solved problems of architecture. A good flooring ought to be free from cracks and crevices, since not only ordinary dust, but also various forms of bacteria, collect in these, and behind the wainscoting. When stirred up and breathed, these bacteria act as the causal organisms of infective diseases, and especially of tuberculosis. Hard, closely-joined parquet flooring suits our tastes best, but is only apparently perfect. Soft wooden floors soaked with oil cause the dust to stick, and can be washed ; but dust collects in the crevices, and by wearing away quickly, these floors create dust. An excellent flooring, which is perhaps the most perfect, is linoleum. Its disadvantages, which prevent it from becoming generally adopted, lie in its high price, and in the difficulty of having it laid faultlessly. Important advances, however, have been made in recent times in the matter of flooring. All those which con-

sist of flattened, creviceless material must be hailed as improvements. As compared with cement floors, those composed of asbestos possess the advantage of being pleasantly warm. Besides, they do not possess any marked crevices, and, being impregnated with oil, lend themselves to being washed with disinfecting fluids. Under all circumstances, where brushing and dusting has to be performed, it ought to be done in the presence of moisture. Mention has already been made of the cleaning of furniture and carpets.

Curtains should be as light as possible. Heavy ones can only be tolerated where frequent thorough cleaning is carried out.

The composition of the walls, too, is of great importance. The rougher they are, the more easily will particles of dust of all kinds settle on them, and this dust may contain various forms of micro-organisms. That all unpreventable dust should be easily removable is a principle which should not be departed from. It would be ideal to be able to wash everything, including the walls. While fashion, habit, and the sense of beauty claim our attention, the introduction of the latest craze of decorative art, consisting of wall-hangings which cannot possibly be cleaned, amounts almost to an insanity. Unless the beautiful can be combined with the useful, it should be rejected.

The escape of partly-used-up air and the supply of fresh air should be provided for whenever the air-space of an apartment is insufficient for the number of people in it, or when the amount of air will probably be used up within the time the room is likely to be inhabited. This change of air can be brought about, it is true, by the so-called natural ventilation—that is, by the porosity of the walls, and by the cracks and

crevices which are always to be found around doors and windows. In England, where there are no double windows, this exchange of air is not inconsiderable. Walls which are well dried allow of a larger quantity of air to pass through than is generally accepted. One of the evils of damp walls consists in the fact that a satisfactory passage of air through them is prevented by the filling up of the pores with water. This leads to an accumulation of 'bad' air. Defective oxidation of the blood results from living in such an atmosphere for any length of time, and this produces the condition which is generally known as anæmia. A predisposition to scrofula and tuberculosis is often the indirect result of this. The influence of such conditions on our organisms for short periods need scarcely be taken into account, since the arrangements for protection are sufficient to neutralize it. However, when the damaging influences act constantly and repeatedly, they form a real danger for our bodies, and may be evidenced by ill-nutrition, pallor, disinclination for work, constant feeling of malaise, and predisposition to tuberculosis, which may eventually lead to the setting in of the disease itself.

Natural ventilation, even when it is present to a considerable degree, is quite insufficient in small rooms, especially when they are crowded. A congregation of people raises the temperature of a room as compared with that of the outer air, and thus the warmer, lighter air is readily replaced by the incoming cooler heavier air. This exchange is more pronounced during winter, when the burning fire assists it. But apart from this, one must arrange for an adequate ventilation. When the difference of temperature is marked, it is sufficient to open the window. The effect of this can be increased

by opening a door opposite, which produces a draught, and all forms of wind must be regarded as ideal ventilators. Where double windows are used, the outer window should open outwards and downwards, and the inner one inwards and upwards, as shown in Fig. 9. The colder outer air thus enters the room without hindrance, and drives out the upper layers of warmed air

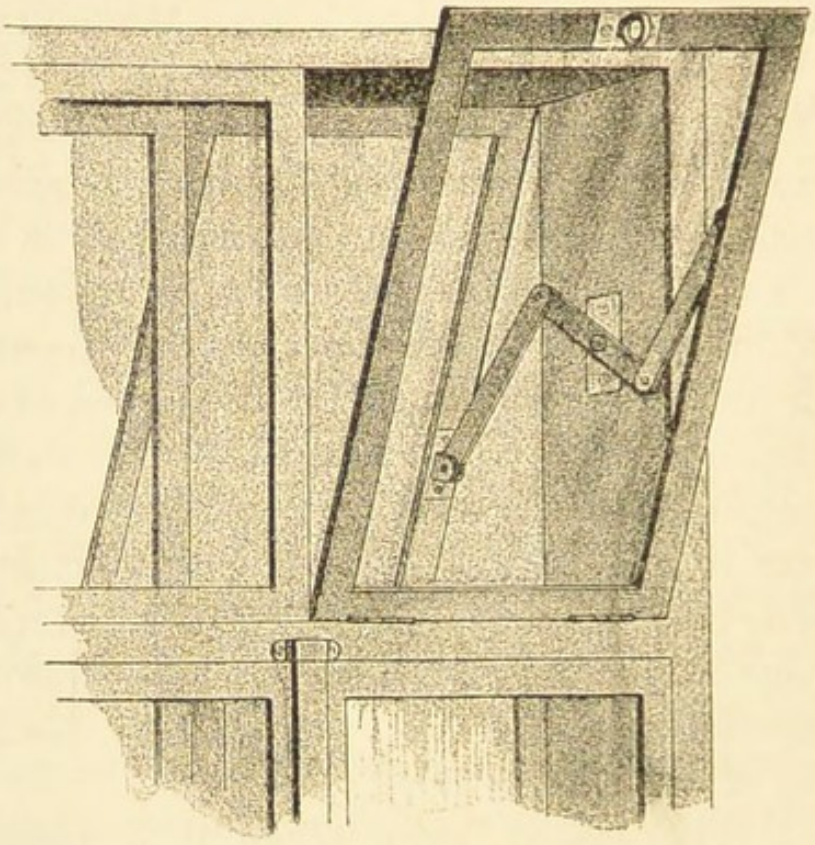


Fig. 9.—Ventilation by Means of Open Window Casement.

through the exit ventilator, which is situated close to the ceiling. The details of the more complicated systems of ventilation cannot be dealt with here.

The temperature of an inhabited room should depend on the occupation of its inhabitant. When he remains seated, for instance, writing for a long time, it must be a couple of degrees higher than it need be when he moves about. In the former case it should be about

62·5° F. Habit naturally has to be taken into consideration. Warmer temperatures are necessary for children and anæmic persons.

In arranging for the heating of a room, the following conditions should be provided for : (1) The products of combustion must be completely carried away ; (2) a sufficient quantity of oxygen—*i.e.*, of fresh air—must be supplied ; and (3) the air must not be too dry. Apart from this, it is desirable to minimize the amount of dust in the handling of the fuel. Central heating apparatus, which have already been widely introduced (including warm and hot water heating, low-pressure steam heating, etc.), fulfil these conditions satisfactorily. On the other hand, stoves or grates, no matter whether they burn wood, coal, or gas, supply an excellent ventilation. The latter have a further advantage, which must not be undervalued, in that the dust-particles (germs of infection) contained in the air supplying the fire are burned. These dust-particles are apt to adhere to the other forms of heating apparatus, and are dried up. This necessitates careful cleaning of the apparatus. When stoves are used, the air must not be allowed to be simply warmed around the stove, because in this way the particles would not be destroyed, but would be merely stirred up, which, of course, one wishes to avoid. Certain points have to be considered with regard to every form of heating. One cannot raise any objection to gas fires as long as the products of combustion are carried off up the chimney. But when the stoves are used for cooking as well, the products of incomplete combustion may be formed and accumulate in the room, and this is certainly harmful. It need scarcely be pointed out that the gas-pipes must be properly

laid, nor that a free current of air must be provided. One disadvantage of some systems is that the air is rendered too dry. When this occurs, water should be evaporated from flat vessels placed on or near the stove, or by spraying water about the room, which is satisfactorily carried out by a small apparatus devised by the author. It has already been pointed out that air which is too dry is harmful. There is no doubt that dryness of the air produces catarrh more often than changes of temperature.

The small advantage which illumination possesses in assisting natural ventilation by warming of a room is outweighed by its disadvantages. Products of combustion are liberated by all illuminants, be they stearine, petroleum, oil, or gas, to a greater or less extent, and these are always harmful to our lungs. The chief of these products are aqueous vapour and carbonic acid, while of others mention may be made of irritant acids, such as sulphuric and nitric acids, and of carbon (soot), which may be present in not inconsiderable quantities. The last-mentioned is most frequently developed by petroleum lamps, which are not properly trimmed. When the lamp is turned too high, considerable quantities of carbon issue from it, while when the flame is too low, which is often done for the sake of economy, products of incomplete combustion are formed. In recent years, fortunately, great improvements have been introduced in connection with illumination. This is largely due to the introduction of incandescent gas-mantles and electric light. The former admits of the employment of a smaller number of burners, and each burner consumes less gas than an ordinary gas-burner. The air is not heated so greatly, and remains comparatively pure. Electric light offers very great ad-

vantages in respect to the hygiene of the lung, and it would be desirable, from a medical point of view, that it were less expensive. It is not necessary to enter into the further advantages of the two last-named illuminants in this place, since the details can be found in the fourth volume of this series—'The Hygiene of the Eye in Health and Disease,' by Dr. von Sicherer.

It is very desirable that the best room—if possible, facing south—be chosen for a bedroom. As a rule, one finds, however, that the darkest, worst-situated, and worst-ventilated, and possibly the smallest room in the house is chosen. People say that any room will do to sleep in. It is to be hoped that the arrangements met with in a certain sanatorium are exceptional. In this case the patient's room faced south, while, adjoining it, a room without a window was allotted to his servant. It would seem that, while one strives to restore health to the sick person, the healthy person is allowed to lose his health.

While less carbonic acid is excreted during the night as a result of complete rest than during the daytime, it must not be forgotten that the majority of people spend at least a third of the day-time in their bedrooms, which is far too much. This ought to be taken into consideration from a hygienic point of view. Hard-and-fast rules cannot be formulated, as much depends on habits and means. In general terms, one may say that the air in a bedroom should be as pure as possible, and that things that do not belong to a bedroom should be avoided. One meets with timorous people who, from fear of catching cold, always use the night-stool in their bedrooms. These people naturally never open the windows for the same reason, and take good

care to cover themselves well up with stuffy quilts. The air in such a bedroom is indescribable.

A bedroom should have at least 30 cubic metres of air-space for each person, the temperature should vary between 55·4° and 59° F., and the room should be kept scrupulously clean. The various forms of spring and chain matresses are a great improvement on the old-fashioned straw palliasses, because they are much easier to clean. It is always necessary to air the bed-clothes well, to dry them and to expose them to light.

Ought one to sleep with an open window? This, again, depends on special conditions, and it would seem that one is inclined to exaggerate in this direction at the present day. It is not necessary to have the window open if the room is sufficiently large, and if the hygienic principles elaborated above are carried out. On the other hand, it certainly cannot do any harm as long as the necessary precautions are taken. An open window cannot have any disadvantages during the summer months. When the weather is cold, rainy, and windy, it is better to keep the windows closed, and one ought always to avoid allowing a draught to reach the bed, either by interposing a screen or by arranging the windows as shown above in Fig. 9. The window in an adjoining room can, however, always be kept open with advantage. Air, and even night air, is the friend, and not the enemy, of man. In certain cases, difficulties in the carrying out of ventilation by means of open windows are met with—for instance, where the windows have to be kept closed because the least noise would disturb a sleeper.

Walking in the open air before going to sleep acts beneficially by aerating the lungs. In the case of poor people who are forced to live, cook, and wash in one

room, a thorough ventilation must be undertaken, at all events, before going to bed. This is especially necessary, because the air is rendered impure by a number of harmful vapours, besides the excess of steam. It is quite unpardonable that in luxuriously appointed mansions (flats) the porter's quarters are often absolutely unhygienic in construction.

While one is dealing with the subject of sleep, it is in place to repeat that one ought to breathe through the nose, and not through the open mouth. For this purpose, one should see that the nasal passages are free. For hygienic reasons, it is undesirable always to keep in one position during sleep—that is, to accustom oneself to sleep on one side only.

The nursery requires special attention. While absolute cleanliness must prevail everywhere, this is particularly necessary with regard to the floor, where the children spend most of their time in crawling about, picking up things, and putting them into their mouths. All that has been said above on this subject applies especially here, and there is no doubt that linoleum forms the best covering for the floor of this apartment. Next, a frequent change of air is highly necessary. Babies should only be tucked in in their cots in such a way that they can breathe freely and without restraint. The air must not have to pass through obstacles, especially if these are not too clean.

In England, the pioneer of hygienic life, and also in some other countries, villa or house residence is the most common form of dwelling. The conditions for providing purity of air are more easily carried out in houses than in flats. It ought to be borne in mind that economy is not in place in fitting up a house, and the conditions of an English home may be taken as a

pattern. The night and day nurseries should be kept separate, and should be furnished as plainly as possible. There should be no carpets, the walls should be smooth and washable, and the furniture not upholstered, so that an accumulation of dust is avoided, and thorough cleaning is rendered easy. Wherever it is possible, a room should be set aside and equipped as a sort of isolation sick-room. It is very difficult to separate the individual members of a family when one of them gets an infectious disease, the germs of which often enter through the respiratory track. It would therefore seem advisable to take this into consideration when dealing with the arrangement of a house. Such a room is best placed in an upper story, or even in the attic.

Everything which can be done for the rising generation in the matter of school hygiene stands in intimate connection with what is done for the children at home. In this way one rears a healthy and strong race, which is capable of resisting damaging influences. If one considers the number of hours which children spend in the schoolroom during the period of their greatest bodily development, and at an age which is particularly susceptible toward infective illnesses, one will readily realize that the most thorough hygiene is of paramount importance in schools. The greatest care should be extended to the respiratory tract, since the prophylaxis for the worst of all diseases—namely, tuberculosis—has to be dealt with. Although it must be acknowledged that a large amount of attention is being paid to the school question on all sides, and huge sums of money are being spent on it, much remains to be done. The arrangements existing in England must again stand as an example. The school should be not merely

a place where the mind is drilled, but also a place where the body receives proper attention. The principle of this should be carried out at home as well as at school. In the morning, when the child goes to school, it should find all adequate arrangements for learning, but should also indulge in all forms of bodily exercise and games, and on coming home in the evening should be free to enjoy home life and home comforts. Home-lessons, especially when they entail sitting up late at night, carry with them great disadvantages, and are often a source of anxiety to the parents.

In schools, as everywhere else, the purity of the air must be the first consideration. Some idea of the difficulty of obtaining this will be gathered when one realizes that a school-child expires nearly 14 litres of carbonic acid per hour. It has been shown that the quantity of carbonic acid in the air of a schoolroom increases to more than three times its original volume after three hours. Considerable quantities of aqueous vapour further contaminate the air, and, besides, the evaporations of the body contribute to it. In the schoolroom one must bear in mind that it is not only the evaporation from the skin which takes place, but that discharges of intestinal gases are not infrequent. After sitting still for a long time, we frequently take a deep breath (sigh), in order to get more air into our lungs ; but the advantage of this falls away if the air is altered in the way described above. Moreover, in winter the air becomes impurer still by the products of combustion liberated during the hours of artificial illumination. It is therefore necessary, in the first place, that the size of the schoolroom should correspond to the number of pupils attending. In many cases, how-

ever, twice as many school-children are crowded into a room as the cubic space justifies. Little wonder if the room gets close ! No doubt the headaches complained of by school-children are due to this. Next, one must provide for an ample replacing of the air by some means of ventilation. It is not sufficient to change the air by opening windows in the evening after hours of lessons. The thorough replacing of the air should take place at least every two hours, according to the climatic conditions. It is a great advantage if the school-building stands in its own grounds, from which pure air can be supplied to the class-rooms, and the capital sunk in such grounds may be regarded as a good investment. It does children good to romp about in the class-rooms between the lessons, but the raising of dust is certainly a drawback. Observations have been made which show that the number of microbes in a cubic metre of air increases from 3,000 at the beginning of the lessons to 40,000 when the school is over. Even if these microbes are not all pathogenic —*i.e.*, disease-producing germs—but are largely harmless fungi and bacteria, it undoubtedly shows that the movements of the children raise dust to a surprising extent. In order to cope with this, one must pay special attention to the flooring in the direction already mentioned. The benches and other furniture, and also the heating apparatus, must be constructed in such a way that it is easy to clean the floor underneath them. The walls must be washable, and the corners should be rounded, so that it will be easy to clean them thoroughly. Spittoons should be hung on the walls at a suitable height in the schoolroom. It is of importance that the child should learn what ought to be done with regard to sputum. Children are taught

from an early age to blow their noses. It would be specially meritorious on the part of the school-teachers if they would use their influence also in this direction. This would obviate the difficulty which is met with later in life when dealing with spitting and all that pertains to it.

Where are the children to spend the intervals during school-time ? The air in the corridors and passages where the boots are supposed to be wiped (!), and damp overcoats and umbrellas are left, is certainly not much better than that of the schoolroom. It is, therefore, desirable to have suitable well-kept open or covered playgrounds, in which the children can spend their 'time out.' Further, attention should be paid to the position which children take sitting or standing during school, since the muscles of the chest cannot act freely while the body is bent more or less forward, and the process of respiration cannot be carried out satisfactorily in such a position. This is just as important a reason as the fear that curvature of the spine might possibly ensue.

Although it is highly satisfactory that much has been done for school hygiene by instruction, laws, and rules, much more remains to be done. But who is to do it ? Many teachers, it is true, have studied the question of school hygiene, and have achieved a great deal in it.

If it is desirable that the 'house' doctor should be reinstated in the family and in the house, it is just as desirable that the school doctor should be introduced into the school. The family doctor, the friend of the family, who knows the most intimate conditions and habits, ought not only to be called in for cases of illness, but should be the hygienic adviser, who is consulted on all points in connection with the house, and

also in connection with the mode of life of each member of the family according to his or her individuality. Undoubtedly there is something to be said in favour of the custom existing in China, where the doctor is paid as long as all the members of the family remain well.

In a similar way, the school doctor should not be satisfied to examine the children's eyes ; but he ought to be the friend and adviser of the teachers, giving counsel on all matters concerning school-life, and controlling the proper carrying out of the regulations suggested.

The expenditure in connection with this would be amply repaid to the community, country, and State if it proved the means of rearing a healthy, strong race. Volume 15A of this series—'Care of the Body and Mind of Children during the Years of School-life,' by Dr. J. Trumpp—deals with this subject minutely.

All that has been said about the schoolroom applies equally to the rooms of the kindergarten. The younger the children, the more important it is to keep the floors clean. When the weather is clement, it would be highly desirable to have the children all the time in the open air, especially in large towns. Building-land and other open spaces might be used for this purpose. In this way, a common nuisance, which makes itself felt in towns, and which affects grown-up people as well as the children, would be obviated. This nuisance consists in loitering, playing, and making a noise in the streets. The advantage on the side of cleanliness is not to be overlooked. The child playing with its ball, allows it to roll in the mud, picks it up with its hands, and later puts these into its mouth, and so on. If well-adapted playgrounds existed, the

parents could be instructed to send their children there.

Plentiful and cheap means of getting about are of importance in large towns, not only from a social, but also from a hygienic point of view. Every half-holiday and every Sunday should be used to its full extent for the purpose of allowing the growing generation to bathe their lungs in an abundance of fresh air. Parks, commons, and the like ought to exist within easy reach of the more crowded parts of towns. The question of where the holidays are to be spent is also of importance. There is no doubt of the usefulness of the so-called holiday homes, either in the country or at the seaside. The institution of a large number of such homes would be a great boon, so that greater numbers of the children of the poorer classes could be sent out to them. A stay in the open air is particularly beneficial for this class after the long confinement in their cramped homes. For this reason it is necessary that the stay should be of a sufficiently long duration. A fortnight is too short for the recuperation of town children, who are often very anæmic, and in consequence possess a diminished resistance. The arrangements of the holiday homes in Salzkammergut, to which 100 boys of the public and private schools of Vienna are sent every year, may be regarded as ideal. This property is situated on the banks of the Lake of Hallstatt, which is renowned for its natural beauty. The boys stay there for two full months, and pass their time in playing in the playgrounds; taking short walks in the mountains, which are gradually extended; rowing on the lake; and during wet weather playing in the spacious gymnasium. A visit to this institution between July 15 and September 15 will

delight the schoolmaster and the hygienist as well as the philanthropist.

The air in the places of meeting, in concert-rooms, and in theatres leaves much to be desired. An increased accumulation of carbonic acid and water-vapour in the air is produced by the congregation of people. To this is added the evaporations from the skin and often excretions of a still more objectionable character, and the smell of clothing which may be either damp or soiled during certain occupations. The unpleasant smell, the discomfort, and the oppression which one notices on entering such a room is not difficult to explain, especially if one realizes that the products of combustion from the illuminants are further added, and that the oxygen in the air becomes more and more used up.

In the courts of justice, where the proceedings continue from early morning till late at night, the air is just as bad. A judge has expressed himself as follows : ' The regular procedure and the sifting of the material represent, under these conditions, a most irritating work, and attentive following in such a close atmosphere exhausts the other members of the court, including the jury, the solicitors, barristers, and the reporters. Attacks of fainting, which are so common in the law courts, are to be explained in this way, and the same applies to the frequent occurrence of temporary indisposition, which undoubtedly has a great effect on the minds of the members of the jury. Adequate ventilation would suffice to relieve this evil.'

The fact that smoking is allowed at times in some of these places makes the matter still worse, and during the hot weather the dryness of the air adds to the discomfort.

In judging the damaging influence of such an air, one has to remember that, while the accumulation of carbonic acid constitutes the main cause, the mixture of the gases already dealt with also plays a part. However, as carbonic acid is most readily estimated in the air, its presence is accepted as the index of the impurity of the air. When the CO_2 content exceeds 0·05 per cent., we become aware of the fact that the air is impure. A disturbance of the process of respiration is caused by breathing such an atmosphere, and even if this disturbance is not actually dangerous (a certain degree of tolerance may be acquired by our organism), one must remember that the influence of the smaller potential has to be taken into consideration, and that the noxious effects of prolonged exposure are sure to appear. An undoubted proof for the truth of this is the fact that we involuntarily find relief in taking a deep breath on leaving such an atmosphere. The amount of carbon dioxide present in places where people congregate together should never exceed 0·1 per cent. It ought not to be difficult to attain this. No room should be allowed to harbour more people than its cubic contents will justify, and there should be ample arrangements for letting out the bad and admitting the fresh air. Incandescent gas light, or, better still, electric light, should be installed; the room should be kept at a temperature of 59° to 61° F.; a sufficient amount of humidity should be provided; and the raising of dust at the entrances and exits should be minimized.

If one considers that millions of people spend the greater part of their lives, both day and night, in the various branches of industrial callings, the urgent necessity of paying especial attention to the hygienic

conditions in connection with these callings becomes apparent.

A man excretes roughly 1,000 grammes more carbonic acid during work than during rest. The impurification of the air becomes more apparent in proportion to the number of people who occupy one workshop. One must further take into consideration that many trades produce smaller or larger amounts of dust. The amount may vary considerably. Even in an office, in which people go in and out to transact business, to deliver goods and the like, a fair quantity of dust will be raised. But those trades in which dust is directly produced, such as the grinding of certain materials, are infinitely worse, and the air may become literally choked with the dust. The dust produced may not only act mechanically, but it may exercise a direct poisonous effect on account of its chemical properties—as, for example, in the manufacture of red lead. In extremely rare cases, the action of the dust may be even a favourable one. It has been shown that tuberculosis is exceedingly uncommon among tanners, and that people suffering from diseases of the chest have recovered on taking up this occupation. The very short time which these workmen spend in the open air need not be taken into consideration, since observations have shown that the beneficial effect has been noticed particularly in those who have been occupied at the tan mill. It would thus appear that the dust of the oak-bark is responsible for this beneficial action, and that a toleration for the unfavourable mechanical effect of the dust is soon attained. In this way only the chemical constituents of the bark exercise their beneficial influence on human beings. But, with the exception of these cases, a very large

number of observations have shown that trade dust acts harmfully. It is known that 70 per cent. of carpenters develop tuberculosis as the result of the sawdust. A further damaging influence is felt as a result of the position of the body adopted in the various occupations, by which the full function of the mechanism of respiration is prevented. An example of this is the stooping position, which is so very common. In certain trades the matter becomes infinitely worse by the addition of various factors. The miner works in a stooping position in an atmosphere which is not only soiled by the products of his own respiration, but also by various irrespirable gases, by the products of incomplete combustion of his lamp, and, lastly, by dust, which produces a harmful effect not only mechanically, but also chemically, on account of its composition.

It is impossible in a work of this size to discuss the hygiene of the lungs of each calling, and of every kind of human occupation. Nor is this really necessary, for, as the general principles have been mapped out, the intelligent reader will have no difficulty in selecting what applies to him, and in adopting those principles for himself and his family. He is not expected to do impossibilities, but should attempt to do the best in his power. In certain occupations one will always have to deal with bodily difficulties, and these must be met in the best way possible.

In the first place, the workshops must be sufficiently large for the number of people employed in them, and they should be adequately ventilated. In round figures, each workman should have at his disposal at least 10 cubic metres of air-space, and at least 3 square metres of floor-space. If 60 cubic metres of fresh pure

air per head and per hour be supplied in such a room, the 40 grammes of oxygen which a man requires hourly in his daily work will be provided.

The requirements are amply complied with in most well-organized factories, and in some in quite an ideal manner ; but in the smaller trades, and especially by home-workers, they are usually scarcely considered at all. The air met with on entering some offices and counting-houses is absolutely appalling. This is not infrequently due to an exaggerated fear of producing a draught, or, in the winter, of catching cold if the window is opened ; while in other cases it may be due to limited space, or even indifference. Medical men frequently hear complaints from one individual who longs for air, but who is opposed by the many who object to the window being open. It is necessary to keep on repeating that adequate replenishing of air should be provided. Simple means of ventilation will scarcely suffice for those industries in which large quantities of dust are developed. However, the advanced technique of the present day has at its disposal a large number of arrangements for protection, to render the air in such places perfectly healthy for breathing. The most important of these are the exhausters, which suck up the dust-laden atmosphere with great energy and carry it away. Professor K. Hartmann's little book, 'The Prevention of Accidents to Workmen,' deals with this matter and illustrates some of these apparatus. In this way one is able to achieve excellent results for the benefit of our fellowmen. The following experience has made a powerful impression on the author : When visiting some well-known lead-works for the first time, he found all the departments in the factory pervaded with an atmo-

sphere of red lead, and in places even the walls were coloured red by it. Several years afterwards, on the occasion of a second visit, the conditions were absolutely changed. The air was pure, and the walls were clean and white. A new managing director had introduced a great many improvements, including the installation of a suction apparatus and the introduction of scrupulous cleanliness. The results of these improvements were manifest. While lead-poisoning attacked the majority of the workmen formerly, the occurrence of a single mild case is now a rarity, and the men enjoy good health.

In dealing with the description of the mechanism of respiration, it has been pointed out that the body should assume a position which allows the muscles of respiration to exercise their full functions in enlarging the cavity of the chest. In some occupations it is very difficult to fulfil these requirements. Even sitting at the desk will render the action of the diaphragm laborious. What is generally described as overwork is really the effect of staying too long in a close atmosphere, and of an insufficient activity of the respiratory organs. But the effect is worse when the workman has to stoop over his work, and still worse when, apart from his position, he has to lift or carry heavy bits of machinery or other weights. Although there is a considerable possibility of improvement in this direction, relatively far less can be attained here than has been attained in preventing the damaging influence of dust on the lung when inhaled. However, several means may be adopted. In the first place, the greatest circumspection in the choice of a calling should be exercised. When a given calling proves to be damaging to an individual after he has followed it for many years,

it is often difficult or even impossible for him to change his calling, although his whole family as well as he may suffer in consequence. It would be highly desirable if the advice of the doctor, especially the family or club doctor, were sought and followed. In this way a great deal of misfortune might be prevented. The knowledge of the constitution of the individual and his predisposition toward certain diseases will enable him to give the best advice, and this certainly should be acted upon. Besides, the doctor will be acquainted with the exigencies of the different occupations. In New Zealand, workmen are only admitted to dusty occupations after a special medical examination, which is repeated from time to time. Should any signs of illness reveal themselves, they are immediately dismissed. It would be very desirable if the same arrangements could be introduced into other countries. The doctor will advise the weakling to choose an outdoor occupation, in which the work will suit his bodily conditions —*e.g.*, gardening, farming, forestry, and the like. The occupation of carrier, as long as it does not necessitate the carrying of heavy weights, is preferable to that in a workshop. He will advise others to go to sea, and especially in the mercantile marine, where posts, such as the clerk on board, offer all the advantages of the sea-climate without much laborious work. Even the army may strengthen the weakling by a gradual training of the body carried out in a proper manner. It is not unknown that an individual who has spat blood on several occasions, and who dreaded the conscription, has developed into a strong healthy man on serving. Many other occupations may also be selected. When a young man wishes to adopt the musical profession, it should be pointed out to him that the choice

of instrument is very important. The playing of a wind instrument requires not only a healthy lung with a considerable capacity, but also a muscular apparatus capable of effecting extensive and fine shades of work. On the other hand, singing is particularly advantageous to the respiratory organs as long as it is carried out in pure air.

Competent and considerate advice as to the place of abode is of great value. For some people it may become necessary to move their home to a different place at certain periods of their lives, and in this the doctor's advice should be sought.

The best remedy for the damages to our lung activity brought about by sedentary occupations in unhealthy air, or by occupations which are harmful in other respects, consists in the introduction of proper intervals of rest, and in the using of every spare moment to get an ample inflation of the lungs, either by gymnastics, walks, or outdoor games. With regard to the intervals of rest, one meets with several difficulties. The head of a family not infrequently succeeds at a considerable sacrifice in sending the other members of his family into the country, while he goes backwards and forwards to town daily. The dusty journey to and fro, the day spent in the suffocating atmosphere of his office, and the shortened night's rest, cannot be beneficial to him. It has already been pointed out how important it is that sufficient, easily available and suitable means of communication should be provided to enable one to escape from the close air of the towns as speedily as possible. The advantage gained for the health of the people would amply repay the necessary outlay.

In order to attain a satisfactory aeration of the lungs, a number of easily carried out bodily exercises may be

recommended. In doing this, one should be careful not to expect too much of the individual. Experience teaches that it is often difficult to get a patient to carry out breathing exercises morning and evening for the short space of five minutes, and it would be considerably more difficult to get a healthy person to undertake such exercises for prophylactic reasons, especially if he finds it inconvenient.

All occupations which necessitate a sitting or lop-sided position ought to be interrupted from time to time, in order to allow the muscles of respiration to regale themselves. Some advantage will be gained even by deep inspiration alone. Systematic breathing exercises carried out in pure air, and if possible by the open window, are more purposeful.

A good breathing exercise, which is suitable for all workmen as well as for weakly persons, consists in taking a deep breath in an upright position, with the chest thrown well forward and the arms hanging to the sides and the hands touching the thighs, three, four, or five times, and in repeating the same with the arms extended horizontally. It is less useful to carry out this exercise with the arms held above the head. Another exercise to be recommended is the following : The chest being well thrown forward and the arms placed akimbo, the shoulders are moved backwards in jerks as far as possible, and then a deep inspiration is taken. This exercise strengthens the whole muscular apparatus of respiration, acts beneficially on the muscles of the spine, and thus on the upright position of the body, and can be carried out in many instances out of doors while walking slowly up and down. These simple exercises, which, by the way, can be carried out with a pole, serve as a preliminary to gymnastics

proper, and to all sorts of kinetic and athletic exercises.

Gymnastics may be regarded as bodily exercises, stimulating the general processes of life, and also as special exercises stimulating certain groups of muscles, such as those connected with respiration. Such gymnastics should be carried out under medical supervision, or with the guidance of a specially trained person, since it is necessary to individualize exactly in each case. This applies particularly to exercises with poles and dumb-bells. The use of the Zander apparatus can also be recommended. But it should be remembered that if the gymnastics cannot be carried out in the open air, they should be conducted in a dust-free, well-ventilated hall, at a temperature of from 57° to 61° F. Those exercises, however excellent in themselves, which serve to strengthen the arms alone, need not be considered here. Bodily exercises should, as far as possible, occupy the mind at the same time. People soon give up purely mechanical movements, such as rowing and mountain-climbing, carried out indoors. Gaertner's ergostat represents a considerable improvement in this line, since a certain satisfaction is derived from the counting of the number of turns which are performed in a certain time, and from watching the increased amount of work achieved day by day. But one tires of this even after a time. The fact that girls are taking up gymnastics may be regarded as a great gain resulting from the advance in civilization. This was not thought of some years ago. It is a gain to the race as well as to the individual. There is no doubt that this fact is largely responsible for the introduction of the reform in women's clothes, which allows the female sex to participate in bodily exercises. The

question of clothing thus takes a position in the hygiene of the lung.

One can say in general terms that all forms of clothing can be approved of which do not hinder the movements of the body, and which allow of modifications according to varying temperatures. It is unreasonable to wear the same garments in the open air and in the concert-hall. With regard to dressing, it is necessary for one to consider one's neighbour, and this is not done by those ladies who, despite all warnings, stir up the dust by dragging their trains in the street. These trains may be in place in the drawing-room.

In dealing with the hygiene of the lung, those movements of the body which must not be hindered are naturally those carried out by the muscles of respiration. In the first place, the muscles which embrace the girth at the shoulders should have perfect freedom, because it is particularly important that the possibility of expansion of the apices of the lungs should not be limited. Clothes which hang heavily on the shoulders, and especially which grasp the neck tightly, are unsuitable. Special notice should be taken of this in choosing winter clothing. Next, there should be ample room in the lower regions of the chest to allow of a free expansion of the costal arch and descent of the diaphragm. This applies for all conditions of life and for all ages. The tight binding of infants, which is still in vogue in some places, is in direct opposition to this principle.

It is next necessary to consider the question of the use of corsets, and of the fastening of petticoats and skirts. Men's attire offers less difficulty. Broad braces resting on the shoulders, and not too tightly drawn, are perfectly in place. There is also no harm

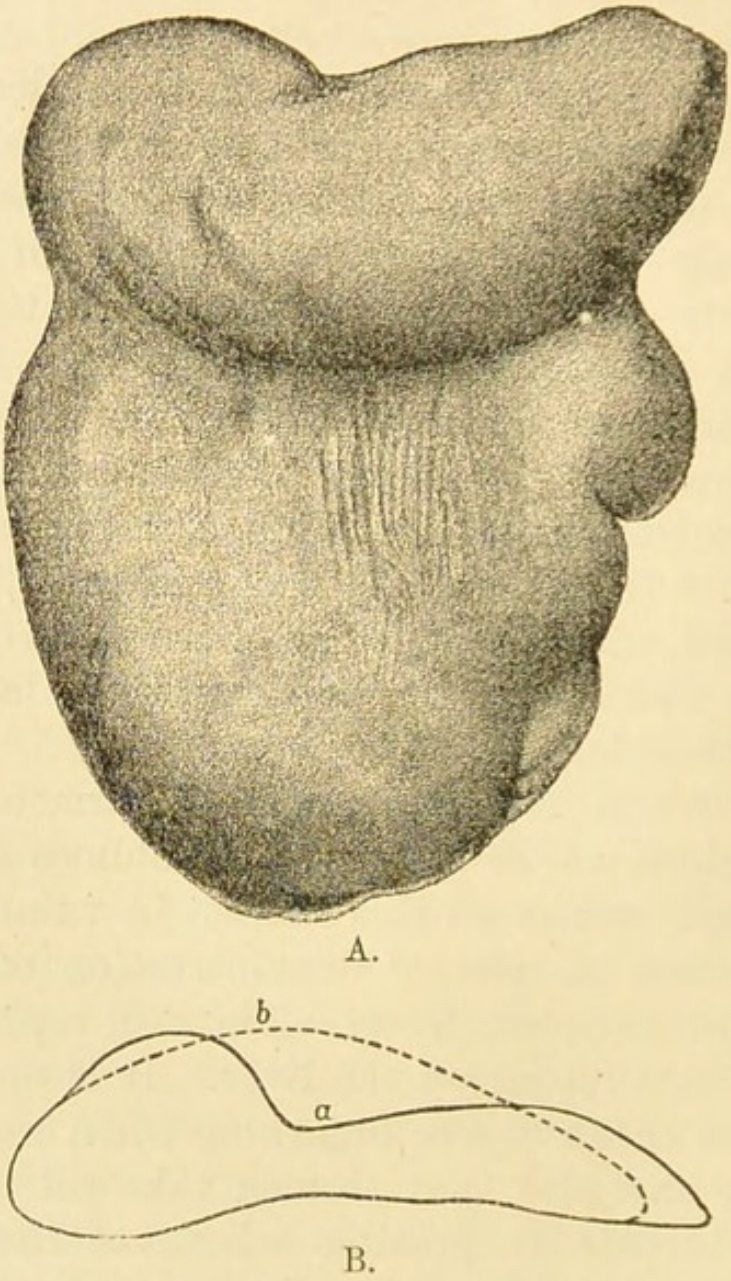
in using a broad belt around the waist to keep the trousers in place, or in having the latter sufficiently tight, so that they will keep up without. Under no conditions should a narrow belt be used.

The majority of women tie their petticoats much too tightly around their waists. A brownish indentation which is very frequently seen on the abdomen immediately below the ribs is proof of this. It indicates a disturbance of the circulation in the skin, and also a pressure which must injure the internal organs, and prevent the free movements of the diaphragm. It is, therefore, advisable to use braces, which should be wide, for fastening these garments. If the weight is considerable, it should be divided, and should be born partly by the shoulders and partly by the hips, tight lacing being carefully avoided.

The corset, a stiff, casement-like garment, is under no conditions to be tolerated. Volumes have been written and spoken on this subject in vain, and stays are still worn in spite of demonstration of deformed chests and crippled livers. Fig. 10 represents the effect of tight lacing on the liver. It is obvious that one cannot speak of free breathing when wearing such a cuirass, and also that women take off this instrument of torture if possible whenever they have to make a special bodily effort. In certain cases in which it is necessary to apply special binders, such as hanging breasts, floating kidneys, etc., the form of the binder should be decided on by the doctor.

On the burning question of women's reform dress, which has become so prominent, three authorities should be consulted—the doctor, the artist, and the dressmaker. The doctor's opinion should be taken

first, because he has to deal with questions of health; next the artist, who deals with the æsthetic point of



A.

B.

FIG. 10.—LIVER, SHOWING A CONSTRICTED LOBE.

A = front view. B = section. Line *a* shows constriction; line *b* shows the normal shape.

view; and then the dressmaker, who has to carry out the technical details.

There is no doubt that a distinct advance has been brought about by women taking part in different forms

of sport and games, and that a satisfactory solution will soon be arrived at.

Preference must be given to all those games and pastimes which are carried out in the open air. Everyone, no matter what his calling, should take up some form of sport which is suited to his special conditions, but this sport should be varied from time to time, to avoid a partial development of the body, since only a few will be able to afford more than one form of sport at a time.

The exercises which are most suitable for the health of the respiratory organs are rowing, riding, and mountain-climbing.

Sea-sculling, which is carried out with one oar placed in a row-lock at the stern of the boat, the sculler standing and performing a sort of lever movement, something like the movements of a gondolier, is particularly adapted for this purpose. The advantages are as follows : All the muscles of the body participate almost equally, and the very favourable position of the body leads to a full development of the chest-muscles. Since the weight of the oar is scarcely felt on account of its fixation in the row-lock, the exertion is not a very great one, and the breathing is not impeded, for even when bending forward no pressure is exercised on the abdominal contents, the flexion taking place at the hip-joints. The respiration is thus increased in pure air, and, besides this, the mind will be occupied by having to attend to the steering. Wherever this kind of sculling can be introduced, it may be thoroughly recommended. Arrangements have been made in Vienna to cultivate it on the Danube. Sailing is also beneficial to the lungs, since one is kept in the open air for a long time by it.

The reasons why riding is one of the best exercises for the body are : (1) Because it necessitates an upright position ; (2) because it strengthens the muscles of the chest, the shoulders, and the ribs, and not, as is generally accepted, only those of the lower extremities ; and (3) because it favours the aeration of the lung by increasing the respiration. It is erroneous to suppose that the diaphragm is impeded in its action. It acts perfectly freely as long as the correct position is maintained. Some limitation may result when the rider bends forward to avoid a heavy wind. One should not ride against a strong north or north-east wind for this reason. These winds may act harmfully on certain individuals, and especially in actors and singers, who have to use their voices in the following of their calling. Riding affords full enjoyment of fresh air, and opens up a wide field of mental satisfaction.

The advantages of mountain-climbing are manifold. The weight of the body has to be carried up a certain height. To accomplish this, the work of the muscles is increased, and the result is an increased using-up of oxygen and an increased production of carbonic acid. The breathing must be deeper to satisfy the increased demand for oxygen, and will become adapted in proper proportion to the work of climbing. Fresh air is admitted into those parts of the lungs, the apices, which, as a rule, do not participate in respiration to any great extent, by this energetic ventilation of the lung.

A more powerful action of the heart takes place during mountain-climbing, but one should be careful that this is not forced too far. The advantages gained can easily be nullified by overtaxing the heart. Long walks on Sundays, which are so much in vogue, should

be approved of on account of the good they do to the lungs; but one should not exaggerate them, nor attempt more than the time allows. There is no doubt that many of the Alpine fatalities are due to exhaustion. Slow climbing, without unnecessary waste of energy, and with appropriate pauses to allow the heart and respiration to recover, is advantageous. One should not talk too much while one is walking. It is hardly necessary to point out that one should be properly dressed for climbing. The neck should be free, and the shoulders should only carry a certain weight, which draws them backwards, and which allows the expanded chest to breathe freely. What weight there is should be supported by broad shoulder-straps, which do not impede the breathing. The climber is then able to enjoy the pure ozone-laden air, and revel in the beauties of Nature without being trammelled in any way. There is no reason why one should not tramp in the winter, but one must be prepared for inclement weather, which can appear at any time, and one must have gone through a sort of training to ensure that one is fit for the undertaking.

Although hunting is an excellent exercise in the open air, it has this disadvantage—that one does not hunt in all seasons, and that it often entails very violent bodily exertion.

Cycling can be mentioned in the fourth place only, since it combines with its many advantages several disadvantages which affect especially the organs of respiration. The cycle has proved itself to be an excellent, almost indispensable, means of getting about, not only for business purposes, such as for postmen, carriers, etc., but also to allow townsfolk to get into the country quickly, and thus to counterbalance to

some extent the baneful influences of close houses and offices. As a pastime, cycling can only be approved of conditionally. Cycle-racing has long since proved itself to be absolutely harmful. But the ordinary riding should not be done mechanically with the feet only ; the intelligence should guide the movements. There is no pastime in which the danger of exaggeration exists to such an extent as it does in cycling. Spurred on by the possibility of covering a long distance in a relatively short time without much exertion, one often overlooks the onset of tiring on account of the exhilarating effect of the mental excitement. No objection can be raised against quiet riding on good roads for not too long a time, as long as a correct position of the body is maintained, which allows of an unimpeded action of the muscles of respiration. On the other hand, long rides against the wind on dusty roads, often done, for the sake of sociability, uphill or following in the track of carriages, is strongly to be discountenanced. Too little consideration is given to the amount of work done and the consumption of oxygen it entails. The consumption of oxygen increases by 10 per cent. when riding at the pace of about fourteen miles an hour as compared with the speed of ordinary walking. The danger to the heart resulting from this has already been dealt with. The breathing becomes deeper and more rapid while cycling, which is often carried out with the mouth open, and the dust of the road thus inhaled must of necessity damage the lungs. Heavy meals, especially when taken hurriedly, during cycle-rides must be condemned, since the distension of the stomach impairs the free movement of the diaphragm during inspiration. For the same reason it is advisable to avoid

bending over the handlebars, save, perhaps, for a short time to escape a heavy gust of wind. Riding with folded arms, which is occasionally done out of conceit, or using handlebars which are too short, is certainly unwise, because the chest cannot expand freely.

As long as one does not stand about half dressed for hours, or indulge in similar nonsense, swimming is also an excellent exercise. But it is necessary to indulge in it within proper limits, since it not only stimulates the respiration, but at the same time puts a considerable tax upon the heart. It is not necessary to discuss in this place the temperature which the water should have for each individual.

Cricket, lawn-tennis, and similar games act beneficially on the whole organism, since they include purposeful movements in the open air. When carried out without moderation, the overheating resulting therefrom may lead to harm, but in any case the respiratory tract does not derive any direct benefit.

Skating may be indulged in by weakly individuals even during severe cold as long as there is no wind, but it requires to be limited in the manner described above.

One could write a separate volume on the hygiene of travelling. One can only wish that all those arrangements which have been spoken of as necessary in dealing with the hygiene of dwellings were applied to travelling. The introduction of the notices prohibiting spitting in public places, such as public vehicles, including railway compartments and the like, is invaluable. It is in the interest not only of the travelling public, but also of the employés on the railways, that spitting is forbidden, especially on those routes which lead to health resorts for consumptives.

It will be an enormous advantage when electric traction is substituted for the old smoking steam-engines, and our delight would know no bounds if one could do away with the old quarrel about open compartment windows. The maxim that air is the friend, and not the enemy, of man cannot be repeated too often. It is, however, necessary to avoid draughts, because they are unpleasant.

All that has already been said with regard to the hygiene of floors, walls, and furniture applies especially to railways and hotels. When choosing an hotel, one should be guided by the cleanliness of the rooms and whole house rather than the splendour of the dining-room. This point will be again referred to in detail in a subsequent chapter.

Dancing is mentioned last intentionally, the author regarding it as the least beneficial exercise of all. When properly carried out, there is no harm in it; but, unfortunately, this is rarely the case. One would come to no harm if one danced from eight o'clock till midnight in a large, clean, well-ventilated hall, kept at a temperature of from 60° to 65° F., provided that the pauses were long enough, and also that one were suitably attired. But, as a rule, dances are held in a steaming, hot, dusty room, and the dancers romp wildly through the whole night till daybreak.

Girls suffer more than men, because they are, as a rule, wrongly dressed. As has already been mentioned, the corsets do not allow of a free movement of the ribs and a full expansion of the chest, both of which are necessary during the increased movements. In this way a number of damaging influences act simultaneously, which might be avoided if one

could only overcome the absurd dictations of Dame Fashion.

There is no reason to regard the much-dreaded iced drinks as a particular danger. They are not the cause of a galloping consumption, following upon a night spent in dancing. It will be shown later that this is brought on by quite different causes.

PART III

ON DISEASES OF THE LUNGS, INCLUDING THE EFFECTS OF IRRESPIRABLE GASES

NOTWITHSTANDING all the efforts that are being made to secure the best hygienic conditions for our mode of life, certain morbid changes may develop in the bronchial tree and lungs, and these, again, may exercise, by their manifold effects, a damaging influence on the organism as a whole. These changes are produced partly by external influences, and partly by influences which lie within the human organism. They will be analyzed in the following pages.

It would lead too far to quote all the diseases of the bronchi and lungs. The more important of these alone will be dealt with, and only those details which are necessary for a general understanding of the subject will be considered. A little knowledge is dangerous, and this applies in particular to a 'little knowledge' in medicine. The erroneous impression which people have formed of a bacillus, for example, has led to much unnecessary anxiety, and has wrecked many a useful undertaking. A bacillus is not necessarily the cause of an infection. Water, which contains only harmless micro-organisms, may be used for watering the streets and gardens without fear of an epidemic breaking out. It is just as necessary to point out the dangers which

should be guarded against, and which can easily be guarded against if one knows of them, as it is to instruct the laity that many of the supposed dangers, which are often associated with superstitions, are in reality not dangers at all, and need not be feared in the interest of health. But, as has already been pointed out, the advice of the medical man should always be sought, and the lay person should be taught to recognize those symptoms which necessitate consulting the medical man. The latter should instruct the patient on the nature of his disease, so that he (the patient) will be able to assist him in his endeavours. This applies not only to the treatment of the individual case, but also in a greater degree to the measures adopted for the prevention of disease, to sick-nursing in general, and to everything in connection with it. It is a mistake, on the other hand, to discuss the actual medical treatment with the patient, and to explain every prescription. Every medical man has experience of the harm done by the injudicious interference by lay persons, who act with the best intentions, but who are prompted by insufficient knowledge. The harm done by the quack is greater still. An occurrence which is frequently met with in daily life may be quoted here : Casually, on a walk, in a restaurant, or in an omnibus, the doctor is asked for advice or a prescription for some apparently insignificant little ailment. It is necessary to point out that the most insignificant symptom may be a sign of a beginning, or even developed serious condition, the consequences of which may be quite unforeseen, and may require very careful treatment. It is often difficult to refuse a request of this kind, and having acceded to it, the medical man often experiences uneasiness about the

possible consequences. A thorough examination of every case is absolutely necessary before the proper advice can be given.

There are certain means of examination which enable one to gauge the condition of the lungs.

A skilled medical man will be able to form an idea as to the probable presence of a disease of the thoracic organs from the account which his patient gives him of the illnesses which have occurred in his family and of his past history, including the diseases of childhood, the occurrences of catarrhs, attacks of spitting of blood, pleurisy, and the like. This idea may be strengthened by the description of the patient's occupation—*e.g.*, a miller or a carpenter, who necessarily inhales a great deal of dust—and by the appearance of the patient. In this way an excessive length of the body, a long, thin neck, a long, narrow, flat chest, and prominent shoulder-blades have been regarded from time immemorial as a certain sign of consumption. An experienced man will be careful not to draw rash conclusions. It has been shown that a person of this description can be healthy, while a thick-set man may be tubercular. A thorough examination remains necessary, not only for the diagnosis of the disease, but also in order that its degree and extent may be determined.

The prominence of the veins in the neck and the degree of redness or pallor of the mucous membrane in the throat are of importance.

A well-formed chest, which expands freely in all dimensions on taking a deep inspiration, with well-developed muscles and a fair covering of fat, indicates healthy organs of respiration within. The circumference of the chest varies according to age and sex. An

average measurement at the level of the nipples may be taken at 31½ inches in expiration, and 35½ inches in deep inspiration. However, the so-called physical methods of examination by percussion (tapping the chest) and auscultation (listening) are more important. Percussion permits one to determine whether the portion of the lung examined contains the normal quantity of air, whether the tissues are consolidated or not, whether it is compressed or covered by some other structure, and, lastly, what the limits of the various organs are. Auscultation tells one whether the mucous membranes of the bronchi are swollen or not, whether they contain any secretion, whether the air can enter the alveoli freely, or whether they are blocked up in any way. Besides these, both methods of examination are capable of revealing the existence of destruction of the lung and cavities, both small and large. It need scarcely be pointed out that considerable practice is requisite to prevent one from making serious mistakes.

The spirometer (see p. 11) is an exceedingly valuable diagnostic instrument, but inasmuch as it necessitates a certain amount of practice on the part of the patient, the results obtained are not always reliable. Radioscopy (inspecting the chest illuminated by Röntgen rays) is a valuable addition to the methods of examination. As a rule, it confirms in a most satisfactory manner the results of percussion. The consolidated patch of the lung appears as a heavy shade, while cavities appear as translucent zones, and so forth.

With regard to the sputum, one can draw certain conclusions from the naked eye appearance and from the smell, but microscopical examination is of much greater importance. Pus cells, fragments of disinte-

grated tissue, elastic fibres, particles of new growths, and the like, can be seen by its means.

The bacteriological examination of the sputum is capable of demonstrating the presence or absence of certain bacteria. It is carried out by various staining procedures, and by cultivating the micro-organisms on various media.

The foregoing are the more usual methods of examination; the more complicated ones need not be dealt with. By their means it is possible to determine the most minute changes in the respiratory organs.

Before turning to the diseases of the lung proper, it is in place to mention those disturbances of health which are produced by the inhalation of poisonous gases. These include the products of dissociation or decomposition of organic substances, such as marsh gas, gases produced in certain factories, etc. Accidental inhalation of poisonous gases and suicidal attempts belong to this category. It will be impossible to discuss every form of poisoning by gases which either exist in Nature or are produced by incomplete combustion, or in factories, such as metal works, foundries, etc. It will be sufficient to deal with the more important forms.

The most common noxious gas is carbonic acid. The baneful influence of an accumulation of carbonic acid as it occurs in localities which are badly ventilated, where large numbers of people congregate in workrooms, schools, and halls, has already been dealt with. There is no doubt that being for a considerable time in rooms in which the quantity of carbonic acid is slightly raised, under the conditions already mentioned, causes a feeling of uneasiness and oppression which ought to warn one of the suffocating influ-

ence of such an atmosphere. It is true that air containing 12 volumes per cent. of carbonic acid can be inhaled for a short time, but the presence of from 0·05 to 0·1 volume per cent. cannot be immaterial. Well-marked discomfort is felt when the air contains 1 volume per cent. of carbon dioxide. Symptoms of poisoning appear when the volume percentage reaches 6, such as a dazed feeling, dancing before the eyes, slight trembling, sweating, etc.; while after inhaling such an atmosphere for a long time, or one containing more carbon dioxide, a narcotic effect is produced which increases to complete unconsciousness. Death results when 30 volumes per cent. is inhaled. In the Dogs' Grotto in Naples, the various stages of poisoning are demonstrated on dogs. The dogs are lowered to varying levels, and are kept there for varying times to show the milder and more severe symptoms of poisoning. The fact that carbonic acid is specifically heavier than air explains this phenomenon, and the lower layers are composed of this gas. This same condition is met with in some wells, in the neighbourhood of lime and brick kilns, more often in rooms where fermentation is going on, in distilleries, and most of all in the places where yeast is manufactured. It has been observed that strong workmen employed in these places become accustomed to air containing up to $2\frac{1}{2}$ volumes per cent. of carbonic acid without showing any signs of poisoning. But weakly individuals show toxic symptoms under the same conditions. This shows that the personal factor plays some part in these occupations. However, even healthy, strong persons cannot withstand 6 volumes per cent. for long. In those unfortunate cases in which children have been shut up in boxes or cupboards, or prisoners have been

incarcerated in places too small for their number and have perished, death resulted from suffocation. The deficiency of oxygen is as much responsible for the poisoning in these cases as is the excess of carbonic acid in the air, leading to an accumulation of the latter in the blood.

Carbon monoxide, the product of incomplete oxidation of carbon, is an odourless gas which burns with a blue flame. It is produced in certain works, such as gas, coke, and coal works, blast-furnaces, and the like, and particularly in those heating apparatus used for drying new buildings in which the combustion is incomplete. It can also be formed in stoves which have an insufficient draught, especially when this is brought about by the use of the regulator—now, fortunately, a rare occurrence—which served to economize in fuel.

Box-irons which are heated with glowing—*i.e.*, incompletely oxidized—charcoal produce carbon monoxide. Where they have been used, the ironers have suffered from severe headache, nausea, and dyspnœa, and have had either to lie down for some hours to recover or to give up the work entirely. Although an open window would have obviated some of the bad effects, there is no justification for retaining this form of iron.

The danger of the use of such an iron may be gathered from a case reported in a daily paper, in which an ironer suddenly dropped down unconscious during her work, and had to be admitted into a hospital.

Carbon monoxide may escape into a room from a source near at hand, or it may be derived from a considerable distance. Smouldering rafters and faulty chimneys may develop it, and it may percolate through brickwork and plaster into a dwelling-room. It is met

with on occasions in the shafts of mines. The inhalation of carbon monoxide produces headache, giddiness, nausea, vomiting, and unconsciousness. The vapour enters the blood through the lungs, and combines with the hæmoglobin of the red blood-corpuscles. These cells are thus prevented from carrying their usual supply of oxygen, so that death may occur from suffocation. One can form an idea of the danger of this gas when one realizes that 0·5 volume per cent. inhaled for forty minutes may produce death. The affinity between carbon monoxide and hæmoglobin is about 300 times greater than that between oxygen and hæmoglobin.

Since, as has been mentioned above, the cause of poisoning cannot always be easily detected, it is necessary to devise a special method of determining it. Apart from the bright pink colour of the body after death, the presence of carbon monoxide in the blood can be determined by the spectroscope, which reveals certain characteristic bands of absorption. Poisoning by the inhalation of carbon monoxide is particularly dangerous, because severe changes in the digestive and nervous systems appear later on in those cases in which recovery from the acute stage has taken place.

Poisoning by coal gas, apart from suicidal attempts, does not occur so easily as that by carbon monoxide, as the characteristic smell of the former mostly puts the person on his guard, and may even awaken him out of his sleep. On the other hand, the danger connected with an escape from a leaking gas-pipe is very great, since the low specific gravity of the gas allows it to diffuse rapidly under the floor through loose masonry, causing it to lose its smell. The signs and symptoms of coal-gas poisoning are similar to those of carbon

monoxide poisoning, inasmuch as the injurious effects are due to the carbon monoxide content of the former. The danger of the various illuminant gases, therefore, increases with the amount of carbon monoxide they contain, and the gas made from wood is consequently the most noxious. Where gas is used as an illuminant, it is absolutely necessary to take care that no escape occurs. Some persons are apt to turn the gas out when going to bed without seeing that they leave the tap closed.

Although large doses of the gas lead to severe or fatal results, small doses must not be neglected. A small escape from the tube of a reading-lamp may cause disinclination for work, a dazed feeling, and even slight attacks of giddiness.

When a large escape of gas has taken place in a room, the first thing to do is to produce a draught of fresh air as quickly as possible by opening the door and windows. The latter should be broken if any time can be saved thereby. The occupants should be taken to the open window or out of the room as quickly as possible. Those persons who show only slight signs of poisoning will recover spontaneously in the fresh air. More energetic measures are necessary for those who are severely poisoned. The mouth is to be kept open by inserting a cork or piece of wood or other handy material between the molar teeth, and the tongue pulled forward by means of a cloth. Having done this, one resorts to artificial respiration, in imitation of the natural process. Placing one's hands on the lower ribs at the sides of the chest, one exercises a pressure inwards and upwards, which pushes the diaphragm up. This has to be repeated sixteen to twenty times in the minute. The diaphragm sinking

in response to the elasticity of the intestines, imitates, as it were, its own active contraction, and in this way air is sucked into the lungs. Another method is to stand behind the patient, to seize his arms and raise them above his head, thus causing the upper part of his chest to expand. At intervals one can apply cold water to the chest, or if one has a syringe at hand, one can direct a stream of cold water on to the epigastrium. Both of the last-named methods are efficacious means of stimulating the respiration. Everything else must be left to the doctor. Oxygen may be regarded as a specific in the treatment of carbon monoxide and coal-gas poisoning. It would, therefore, be advisable if a cylinder of this gas were kept in readiness in those places where accidents might be anticipated —as, for example, where a large number of people frequently congregate. The doctor would then be able to apply it immediately he finds it necessary.

Sulphuretted hydrogen is capable of producing signs of poisoning and death by suffocation, even when the atmosphere only contains very small traces of it. It acts by depriving the red blood-corpuscles of their oxygen. It occurs as a by-product in some manufactories. Another by-product which must be regarded as a powerful poison is ammonia. It is produced in large quantities in many works, and is made use of again in others. It attacks the mucous membrane of the eyes, mouth, and respiratory tract directly, and causes spasm of the glottis, cough, and retching.

Sewer gas consists largely of a mixture of the two last-mentioned gases, with carbonic acid. It generates in badly kept and insufficiently ventilated drains, and also in cesspools which have been stagnating for a long time. Death from suffocation results almost

immediately on inhaling this gas, preceded only by a short spell of feeling unwell and then unconsciousness. A continuous leakage of sewer gas into dwellings must of necessity be harmful, even if it is not so dangerous as one used to think. Many of the more serious infectious diseases used to be attributed to this cause. In order to avoid such a leakage, whenever water-closets are connected with drains, the pipes should be properly trapped. It is highly probable that sewer gas may act harmfully by increasing the susceptibility toward the causal micro-organisms of diphtheria, cholera, and typhoid fever, as well as by the direct action of its component gases. The same applies to different other gases present in certain factories, such as carbonic acid, carbon monoxide, sulphuretted hydrogen, carbon disulphide, and the like. All these gases produce a damaging effect on the blood-corpuscles, and thus diminish the resistance against disease.

In certain mines, especially in coal-mines, mine gas (fire-damp) may collect, which presents a double danger. When it contains a large proportion of marsh gas and sulphuretted hydrogen, the gas becomes highly explosive. Apart from the danger of the explosion itself, the resulting product (after-damp) is exceedingly poisonous. Improved modifications of the Davy lamp serve to indicate minute traces of fire-damp. The fact that coal-dust may also explode forms an additional danger to those working in the mine. When mine gas contains carbonic acid and carbon monoxide, in addition to the gases mentioned above, the respiration may be further affected by the deprivation of oxygen. When the air of the shaft does not contain more than 15 per cent. of oxygen, it becomes

practically irrespirable. The miners get unfit for work, weak and tired, and complain of a pressure on the chest. Death follows, if they are not careful, from suffocation during convulsions. This is not surprising when one considers that the respiratory passages are covered with a black, slimy, tar-like secretion, which may block them up completely.

The vapours of chlorine, hydrochloric acid, sulphuric acid, hydrofluoric acid, and the like, irritate the respiratory tract in the same severe way as ammonia does. When these substances are employed in industrial enterprises, especial precautions have to be taken to minimize the risk of poisoning.

The introduction of the amorphous modification of phosphorus, which was discovered by A. von Schroetter, has robbed the manufacture of matches of its great danger. Red phosphorus used to be employed in this trade, and the inhalation of the vapours emanating from it had a toxic effect, implicating the whole organism, and especially causing inflammation of the periosteum of the bones, and leading to necrosis or death of the bones, chiefly of the face. This innovation must, therefore, be considered to be one of the great advances.

Carbon disulphide is largely employed in the vulcanite industry, which has made such strides in recent years. Carelessness in the manipulations and while the gas is being developed may expose the workmen to carbon disulphide vapour, and this may result in headaches, giddiness, and various nervous symptoms and digestive disturbances.

All persons who are exposed to adventitious gases or vapours during their occupation should take plentiful exercise in fresh air whenever this is possible, and

should bring about a thorough aeration of the lungs by repeated deep inspirations. It is scarcely necessary to repeat that the dangers of poisoning by the above-mentioned gases in the various industries increase when the workman is obliged to assume an unfavourable position of body, thereby preventing a proper and sufficient expansion of the lungs. This applies especially to miners and borers. It is true that much has already been done for them by hygienic measures, but they should be incited to use their time of recreation in summer as well as in winter for all sorts of breathing exercises.

Diseases due to Changes in the Atmospheric Pressure.

The small variations of the barometer, such as occur constantly in one and the same place, have no influence on the health of the human being.

A brief description of the effect of compressed air, which is met with in certain occupations—in the diver's bell and in the caisson, as well as in the pneumatic chamber, which is used for the purposes of treatment, etc.—will be given here.

In building the piers of bridges below the level of the water, iron compartments (caissons) are sunk. The air inside these compartments is compressed to such an extent that, as the earth is being dug out, the water cannot enter on account of the positive pressure. While working in such caissons, the workmen feel quite well, and are unaware of the slight slowing of the pulse and respiratory rate. It is only when they are brought back to the ordinary atmospheric pressure that the danger appears.

As the result of the sudden diminution of pressure,

the excess of nitrogen which was absorbed by the blood and tissue fluids under the increased pressure is set free. The gas bubbles formed in this way in the vessels cause severe disturbances of the heart's action by their mechanical effect, and on being carried away to the vital organs—especially the spinal cord—cause serious destruction of tissue resulting from the obstruction and blockage of the blood-supply. This may lead to paralysis, and even to death. It has been shown, however, during the construction of the harbour in Nussdorf, near Vienna, that, if the caissons are slowly raised, all danger can be avoided. This has to be done at a rate corresponding to the increase of atmospheric pressure, two minutes being allowed for every additional tenth of an atmosphere. Besides this, other precautions have been introduced.

It was thought that increased atmospheric pressure would produce a beneficial influence on certain diseases of the lungs by causing the blood to take up more oxygen and by modifying the mechanism of respiration. For this purpose air-tight iron structures, called pneumatic chambers, were built, in which the pressure can be raised at will by means of a pump. The patients certainly feel an improvement while they are in the chamber, but a lasting result is only rarely achieved.

The conditions of rarefied air are met with in the partially exhausted pneumatic chamber, in high altitudes on mountains, and in balloons. These conditions are similar in all three cases, and the effects can therefore be compared.

The action of properly carried out mountain-climbing on the vital processes of the human organism, stimulating respiration and increasing the aeration of

the lungs, has already been discussed. But when a man reaches an altitude of approaching 10,000 feet, a peculiar complex of symptoms generally known by the name of ' mountain-sickness ' may appear. Some people are attacked by this sickness earlier than others. The symptoms are more or less pronounced tiredness, which may amount to complete exhaustion, shortness of breath, palpitation, acceleration of the pulse, pallor, blueness of the face, a feeling of coldness in the extremities, and marked loss of appetite, or even absolute incapability of taking food. Hæmorrhages from the nose, lungs, and ears have been erroneously attributed to this disease ; but although they occur at considerable altitudes, they depend on other causes.

The argument that these symptoms depend on the diminished pressure, which produces an unequal distribution of blood in the surface and deep vessels of the body, and that the hæmorrhages are caused by an insufficient pressure from without on the walls of the vessels, as a result of which they give way, cannot be substantiated. It is much more probable that mountain sickness depends on chemical changes. The oxygen available for the blood-corpuscles and the combination of the oxygen with the hæmoglobin may be insufficient as a result of the diminished oxygen content of rarefied air, which leads to a lowered tension of the air mixture in the pulmonary alveoli. The oxygen supply to the tissues suffers, and it is particularly the vital organs which are affected.

As compared with the air at sea-level, the air at an altitude of 10,000 feet contains only 68·7 per cent. of the full amount of oxygen, and at an altitude of 16,500 feet only 53·5 per cent. of the full amount of oxygen.

Since it has been shown that, when the air contains less than 10 volumes per cent. of oxygen, alarming symptoms must appear even during rest, it is clear that bodily exertion such as ordinary mountain-climbing, and more so ascending to great heights, may produce these symptoms, even when the oxygen content of the air is not quite so low as 10 per cent. On the other hand, the length of time required for reaching exceptionally high altitudes renders it possible for a certain amount of toleration of the conditions to appear. The degree of this depends largely on the individual fitness of the tourist. This constitutes the main difference between the mountain-climber and the aeronaut. The latter attains to enormous heights without any bodily exertion, but with great rapidity, so that there is no time to become adapted.

A deepening of inspiration which sets in at heights of about 12,000 feet is the adapting means of increasing the tension of the oxygen in the alveoli, and those who live in high-lying places are said to adopt this mechanism of breathing. People who breathe superficially are more readily attacked, even at lower altitudes. Deepening of inspiration alone is insufficient for extreme altitudes, but direct inhalation of oxygen can supply the deficiency. To avoid the appearance of mountain-sickness, it is necessary to have recourse to oxygen early. Should one miss the proper moment, such a degree of weakness and want of energy may appear that it will be no longer possible to apply the proper remedies.

An increase in the number of the blood-corpuscles is brought about in high altitudes. Nature uses this as a protective means. The possibility of living in high

climates permanently is explained by these reactionary processes.

The occurrence of mountain-sickness depends on a number of other factors besides the mere height of the mountain. The height at which the symptoms appear is not the same in all parts of the world. The critical height seems to be lowest in Europe, being between 10,000 and 14,000 feet. In the Andes it is over 14,000 feet, and in the Himalayas it is over 17,500 feet. It depends on the influence of the various meteorological factors, such as humidity, temperature, sun-rays, wind, and the conditions of electric tension in its various combinations.

Observations have shown that even on the same mountain mountain-sickness tends to occur in certain places.

This disease seems to be favoured by marked dryness of the air. Guessfeld found relief when suffering from dyspnœa at a height of 20,000 feet by lying flat in the snow and breathing with his mouth close to the snow, with the object of getting the maximum amount of moisture.

Individual body habit plays a part in resisting the attack. Some people remain quite well at a considerable height, while others succumb under precisely similar circumstances. Practice and habit certainly exercise their influence, since bodily overexertion and fatigue constitute the difference between the effect of mountain-climbing and ballooning. It is important to distinguish symptoms which are due to mountain-sickness from those which are due to overtiring. It sometimes happens that, having arrived at the summit of the mountain, not only loss of appetite, but even a complete inability of masticating the food which one

has in one's mouth, is met with. It is known, however, that a similar condition arises after exhausting marches on level ground as a symptom of pure tiredness. Sustaining food and sleep are necessary for the prevention of this disease. The author has had experience of the truth of this when mountain-climbing in Lapland. Although in good training for climbing, he experienced great difficulty in crossing the Sulitelma, which is only 6,000 feet high, from Sweden to Norway during a moderately severe snowstorm. He was unable to get sufficient food, and had spent disturbed nights partly in the open and partly in tumble-down huts, where the excessive heat of the fire contrasted sharply with the icy cold without. In consequence of this, he suffered from difficulty in breathing and accelerated pulse-rate.

There is a number of further conditions which influence the development of mountain-sickness. It is not possible to deal with all of them in detail here, but the discussion of a few of them is justifiable because mountain-climbing has become so common, because ballooning is no longer a rarity, and because the question of high altitudes has become an important one, since the construction of mountain railways has greatly increased. Special regulations are necessary for those using the railways, and especially for those employed in the construction and working of the same. Persons suffering from lung diseases should avoid mountain railways. Oxygen, which is produced on so large a scale at the present day, should always be kept in readiness, and a suitable mask for inhalation should also be at hand. The employés on the railways should be subjected to an examination, and special attention should be paid to their power of resistance.

The diseases of the lungs referred to above consist, in the first place, of those in which the lung is prevented from expanding to its normal extent. Among these may be mentioned the various curvatures of the spine and deformities of the chest ; extensive adhesions of the visceral with the parietal layers of the pleura, resulting from previous attacks of pleurisy ; tumours in the chest ; and those conditions of the abdomen which limit the movements of the diaphragm. Affections of those muscles which take part in respiration also influence the free expansion of the lungs.

In the next place, there are those diseases which prevent the lungs from functionating altogether. Collections of various forms of fluid in the pleural cavity may become so extensive that this may not only cause the one lung to collapse, but may also compress the other one to such a degree that the area available for respiration is no longer sufficient, and death follows in consequence. The accumulation of air in the pleural cavity (pneumo-thorax) acts in a similar manner. The last-named may be produced by injuries to the chest-wall or to the lung, or by the bursting of an abscess of the lung into the pleural cavity, or, lastly, by the opening of tubercular cavities in the lung into the same space. However interesting this subject may be from a chemical and physical point of view, it is impossible to deal with it in this place.

Bronchitis.

Bronchitis, or bronchial catarrh, like gastritis, or catarrh of the stomach, is one of the most common diseases known. It may occur independently, or may accompany some other morbid condition. The most

apparent symptom of this condition is cough, which may be mild or severe, and which is provoked by a feeling of dryness, roughness, or irritation in the throat, or by an ill-defined sensation of soreness, which may extend to the chest, chiefly in the region behind the breast-bone. Cough may further be produced by a collection of pus or muco-purulent material in the respiratory passages.

Bronchitis may exist as a dry catarrh in which there is only a redness and swelling of the mucous membrane of the bronchial tubes. The area affected may be large or small. It may also exist as a moist catarrh, under which conditions there is a secretion of tenacious or semifluid mucus. The mucus expectorated may be of a greenish or greyish black colour, according to the amount of pigment or dust particles enclosed. In severe cases the expectoration may be purulent.

Bronchial catarrh, especially in its early stages, may be accompanied by fever.

Cold used to be regarded as the chief cause of all the affections of the respiratory mucous membrane, from a simple 'cold in the nose' to the severest bronchitis, and this view is still fairly widely accepted. Our views on the effect of cold have been greatly modified in recent times, although it must be admitted that rapid changes of temperature may stimulate the nerves governing the size of the vessels, and that if there be a rapid local lowering of temperature, the bloodvessels of the affected part at first contract and later on dilate, so that an unequal distribution of blood results. There is also no doubt that a disease may set in after a prolonged cooling-down of the surface of the body. The action of cold is only the final cause. It smoothes the way for the causal micro-organisms

of disease, which are present nearly everywhere, to establish themselves in our organism. In this way, an already existing disease may be aggravated by the effects of exposure to cold. It has already been stated that cold of itself does not produce disease, save in the case of extreme cold, which may freeze the body. There is no doubt that the low temperatures of the Polar regions are well tolerated because of the purity of the air ; pathogenic micro-organisms are not met with in these regions. Cold drinks when one is overheated may have a deleterious influence on the mucous membrane of the stomach, but certainly will not produce a disturbance of the lungs. In its passage to the stomach, the cold fluid may depress the temperature of the surrounding parts slightly, but this will only be temporary, since the circulation of the blood will rapidly rectify it. A catarrh of the stomach may arise in this way, and therefore frequent drinking of large quantities of cold water or beer should be avoided, especially when one is hot. No ill-effects are likely to accrue from taking small sips of cold liquids, as long as bodily exercise is carried out immediately afterwards.

When one considers that a large number of pathogenic micro-organisms are widely distributed, and may be found even under normal conditions in the nasal and oral cavities—*e.g.*, the causal organisms of pneumonia, influenza, etc.—one will be able to understand how it is that only an apparently small determining factor will produce an outbreak of an illness. In order to keep these micro-organisms at bay as far as possible, it is necessary to adopt all those protective measures which have already been fully dealt with. Dust forms the chief danger. It acts mechanically by producing

direct injury, or as a vehicle for micro-organisms, or by preparing the tissues for the further development of the latter. The effects of the introduction of objects of some size will be dealt with first. Foreign bodies found in the air-passages may be of various shapes and sizes. Some people have the bad habit of putting all sorts of things into their mouths—for example, when walking on a country road, such a person may pluck an ear of corn and chew it. A portion of the ear of corn, or anything else one may have in one's mouth, may be sucked into the depths of the air-passages during talking, laughing, or breathing deeply. Unless it is immediately removed by coughing, it may become impacted in the bronchus, or in one of its branches, according to its size and shape. The effect of this depends on various conditions. Under the most favourable circumstances, if it was quite clean, the foreign body only acts mechanically. It becomes encapsuled by the reactionary overgrowth of the tissue, and may remain *in situ* without doing any harm. On the other hand, if it was contaminated by micro-organisms of disease, and if it damaged the tissues in such a way as to favour the further growth of the germs, a more serious condition ensues. At first a catarrhal condition is produced, which may increase into a permanent chronic inflammation, or may lead to the formation of a localized abscess, or may even result in a gangrenous condition of the lung tissue, according to the nature of the micro-organisms. The bacteria of putrefaction find the most favourable conditions for their further development in the lung. These include warmth, moisture, and organic material for them to live on. Pieces of bone, studs, bits of meat, and the like, have often been found in the air-passages. Fig. 11 depicts

the right bronchus, in which a sharp fragment of bone has lodged, and the damage caused thereby. Experience has taught one to look out for possibilities of this kind, even when the patient has no recollection of

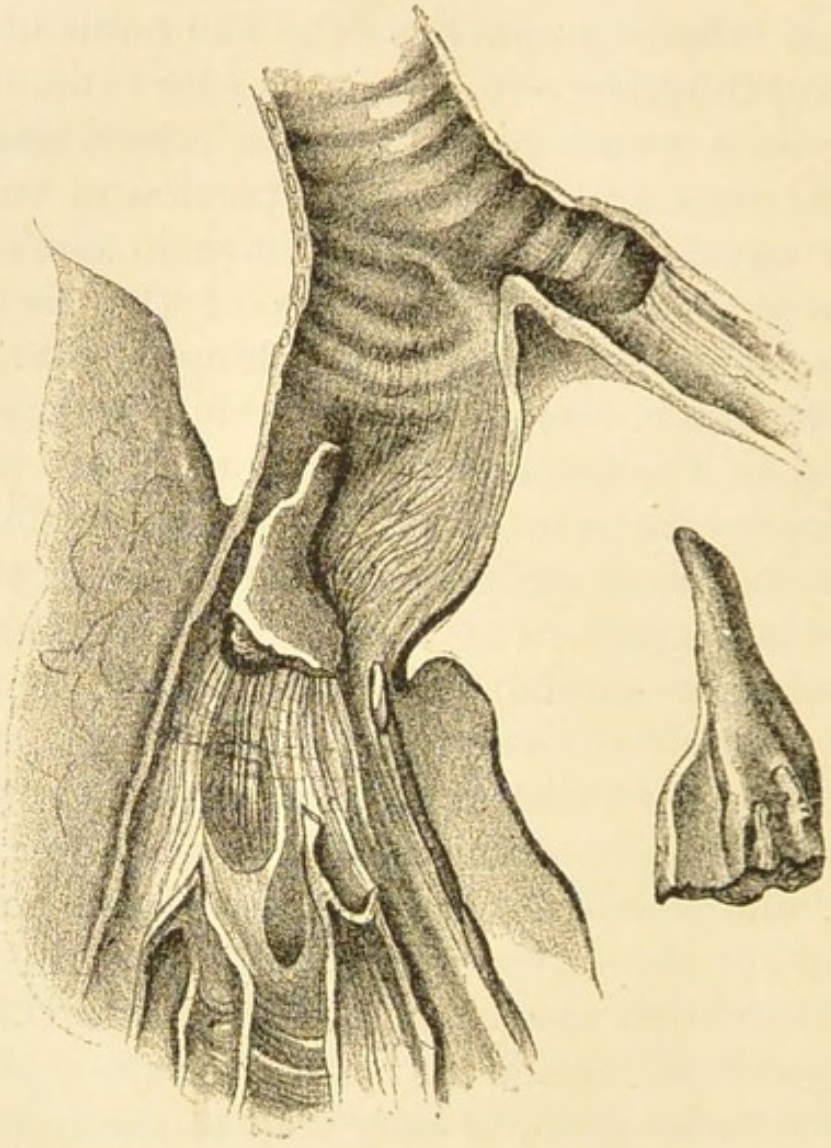


Fig. 11.—A Sharp Bone in the Right Bronchus.

having swallowed such a foreign body. It is possible to recognize these cases by means of the various methods of examination in use, among which radioscopy may be specially mentioned, and to effect a cure in the same by carrying out certain manipulations.

The effect of the introduction of particles of minute size, which may even be invisible to the naked eye, will be dealt with next. One can gauge the amount of particles of soot and dust contained in the air of certain German and English manufacturing towns, after having been in the streets of these towns for a few hours, by the condition of one's linen and of one's handkerchief, which one has used to blow one's nose with. The particles of uncombusted coal, ash, and carbon only reach the upper air-passages, as a rule, and are expelled again to a great extent by the existing protective arrangements. The accumulation of smoke becomes dangerous when it replaces the atmosphere, and more so when it is admixed with poisonous products of combustion, carbon monoxide, carbon dioxide, and the irrespirable hydrocarbons. Under these circumstances—as, for instance, at fires—suffocation may result. Inhalation apparatus, which provide a sufficient supply of pure air or oxygen, enable firemen and those employed in factories where much smoke is generated to enter places filled with smoke, and to follow their occupation without encountering harm. Fig. 12 represents an Austrian fireman provided with an oxygen receiver. The oxygen is inspired from the bag through the tube leading to the nose, while the expired air passes into the bag filled with soda lime, which absorbes the carbon dioxide.

It is necessary to say a few words on the bad habit of smoking in this place. The fact that the exhaled smoke is only about one-half as dense as the smoke inhaled suggests that this habit is harmful. In other words, the particles of the smoke are retained in the respiratory tract, mostly, however, in the upper portions. The occurrence of smokers' catarrh of the

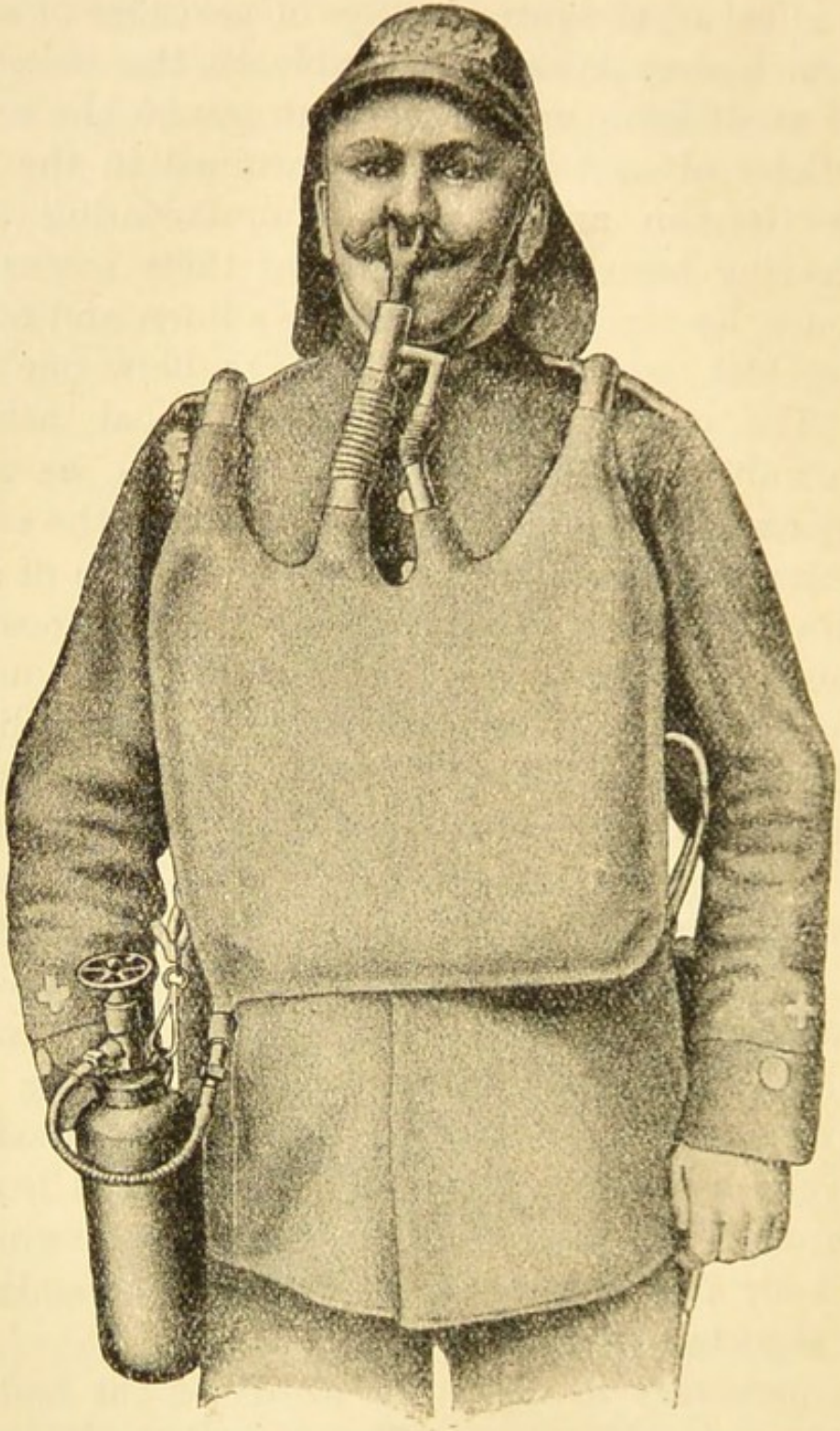


FIG. 12.—FIREMAN WITH OXYGEN AND SODA LIME RECEIVER.

fauces and larynx proves this. Inhaling smoke undoubtedly affects the lower parts of the respiratory tract. The chief damage done to the organism by

smoking is a chemical one. The richer the cigar in nicotine, and the less pure the tobacco (leading to the generation of sulphuretted hydrogen and pyridin bases), the greater is the harm done. However, the heart and the bloodvessels are more affected than are the lungs; the reader is therefore referred to the eleventh volume of this series—'The Hygiene of the Heart,' by Professor Eichhorst.

Every possible form of dust is met with in the street. This originates partly from the wear and tear of the roadway, and partly from the material brought there by man and beast as the result of traffic. One of the most important questions which the town hygienist has to deal with is that of the choice of paving material. Lime-dust is particularly harmful, but granite stones are worse still, on account of the very fine sharp-pointed splinters chipped off. Wood-paving would be preferable to all other forms, because there is less noise from heavy traffic, which usually affects the nerves so much; but one has to realize that the amount of dust given off from wood-paving, unless it is kept very moist, is considerable. The dust formed by the wearing away of the surface is less likely to carry with it infective germs if the wood has been well impregnated with tar.

Preference must, therefore, be given to the use of asphalt, which can be easily kept clean. A thorough cleansing of the streets, which is best done at night by means of free flushing with water, should be carried out under all circumstances.

The pulling down of old houses presents a special danger, since the dust it creates contaminates the air with a variety of impurities. The water-hose should be freely applied to the walls and débris of the building,

and at times a thorough disinfection should be associated with this.

The danger of the dust produced in certain trades, partly issuing from the material used and partly from the wearing away of the implements, is of great social hygienic importance, and it claims the attention of the medical profession, as well as of the authorities, since a large number of people are affected thereby.

Although dust always acts as a foreign body, and by producing a local irritation causes an intense local congestion, certain conditions may modify the effect of the various forms of dust.

Considering the extremely wide distribution of dust, it is very surprising that so few diseases are caused by it. This is due to the fact that certain conditions are required to allow the dust to penetrate into the deeper regions of the lungs. To reach the smaller bronchi, it must be very finely divided. Less fine particles are deposited on the walls of the upper air-passages. Increased inspiratory efforts, such as accompany laborious work or violent exercise, are required to suck the particles far in. When the particles are deposited on the walls of the upper passages, and a semifluid secretion results, the same efforts will carry them downwards, and deposit them on the lower passages.

The state of division of dust varies considerably. Street dust can be readily seen—a ray of sunlight may illuminate otherwise invisible dust—while that which is still more finely divided can only be detected under the microscope. The specific gravity is also of importance, as the lighter particles are more easily carried up in the air than the heavier ones.

The shape of the dust particles has a special significance. Pointed and sharp-edged particles, like those

of mineral or metallic dust, are capable of damaging the mucous membranes easily. The danger of this is particularly well exemplified in trades like needle-grinding. The dust in this case consists of very fine needles of quartz, which are detached from the grinding-stone, as well as of minute fragments of iron.

Other forms of dust produce a damaging influence by their capability of adhering tenaciously to the mucous membranes. Wood dust (sawdust) is one of these. A Carpenters' and Joiners' Trade Union report states that 74 per cent. of the deaths among the workmen are due to tuberculosis. This terribly high percentage is probably dependent to a large extent on the cause just mentioned. Flour dust, wool dust, and the dust produced in handling down and other feathers, etc., act in a similar way to sawdust.

On the other hand, those dust particles which do not adhere to the surface may irritate the mucous membrane of a considerable area by being carried backwards and forwards during breathing. Some substances may, after damaging the mucous membrane of the lung, penetrate it, and by damaging the blood-vessels, give rise to inflammatory processes.

Besides producing local damage, dust of a certain chemical composition may, on being absorbed by the blood, injure the whole body. An example of this is met with in lead dust, which is produced on a large scale in the manufacture of red and white lead, and on a smaller scale in the setting of type. It may lead to the various forms of lead intoxication. Lime dust has a similar double action. Besides exerting a chemical action, it destroys the mucous membrane directly. A product gained in the process of extracting phosphorus from iron ore, called Thomas slack,

mixed with lime, is widely employed as an artificial manure. Its use is associated with considerable danger, for not only do the sharp glass-like flakelets of silicates and the particles of phosphate of calcium act mechanically, but the lime contained exercises a chemical action.

As has already been mentioned, the fact that dust frequently includes parasitic micro-organisms renders it especially dangerous. The ray fungus, although rarely affecting the lungs, is capable of producing extensive changes in our organism. It gains an entrance into the body through the mouth either by means of dirty fingers, or with articles of food, or else as a result of the bad habit, already referred to, of sucking ears of corn, on which it is known to exist. It is probably very rarely introduced with the respired air. Carious teeth are said to harbour the fungus. The preventive measures include avoiding the bad habit of sucking ears of corn, etc., and brushing one's teeth and keeping one's mouth in a healthy condition.

Those bacteria which are contained in the air we breathe are of great importance. The dust containing these bacteria is raised in the course of human intercourse, or in the processes of the various trades. One must regard the chief source of infection of tuberculosis as arising from the sputum of consumptives containing bacilli, which has dried and become dust. A very high percentage of pulmonary diseases is caused during the preparation of horse-hair and hogs' bristles. The preparation of hogs' bristles may also introduce various infective illnesses, among which anthrax may be mentioned.

The dust adhering to 'rags and bones,' too, not only acts mechanically in virtue of its sharp-edged com-

ponents, but as a vehicle of infective material it can give rise to measles, scarlatina, small-pox, tuberculosis, anthrax, and rag-sorter's disease.

An experiment with rabbits shows how the inhalation of dust is capable of weakening the organism, and thus predisposing it for infection. Twenty rabbits were inoculated with tubercle bacilli, and then exposed to a dusty atmosphere; eighteen of these died. Of the twenty control rabbits which were inoculated in the same way, but not exposed to the dust, only three died.

A number of special conditions, to some of which attention has already been drawn, may influence the body to fall a prey to infection. Those persons employed in works where a large amount of dust is created run a greater risk if they have to do their work in closed workshops than if they can work in the open air. The workmen who can move about freely, and especially who can exercise their respiratory muscles well, have a great advantage over those who are compelled to work in a cramped stooping position. The miner's occupation may be taken as an example of this. It is little wonder that there is an exceedingly high frequency of illness among miners. The factors leading to this include the dust to which they are exposed, the cramped position which they are forced to assume, and the high percentage of carbon dioxide in the air they breathe. Seltmann was able to show that 62·1 per cent. of 293 miners who were constantly employed in dangerous shafts suffered from emphysema.

Every one has experienced the unpleasant sensation in the throat which follows on a long walk or drive on a dusty road, particularly when a strong wind is blowing. As a rule, one is able to remove the irritant by

hawking and coughing. At times, however, the dust may lead to a mild catarrhal condition of the air-passages, while in very susceptible people, or when the dust is particularly virulent, a severe catarrh may ensue. Repeated exposure to such influences, including those connected with certain trades, even when they are little dangerous, such as the dust of flour, may lead to a chronic catarrh or to other changes of a lasting nature. Long-standing affections of the smaller air-passages and constant attacks of coughing may diminish the elasticity of the lung and lead to emphysema. Foreign bodies which have found their way into the bronchi may penetrate through the epithelium of the mucous membrane, especially if they are pointed and sharp-edged, into the lymph-passages, and thence into the lymphatic glands. Some of them, no doubt, may be retained in this situation, but others will migrate into the neighbouring tissues of the lungs and pleura, where they will settle. In these situations they give rise to chronic inflammatory processes, which lead to induration and destruction of the lung tissue and contraction of the same, and also to the formation of cavities from the dilatation of the bronchi. Repeated inflammations associated with destruction of the neighbouring tissue may take place. This induces the disappearance of large areas of the lung, and the condition is spoken of as pneumonokoniosis (derived from the Greek *pneumon*, lung, and *konis*, dust). The varieties of this condition are called anthracosis (coal-dust pneumonia), chalicosis (stone-dust pneumonia), and siderosis (iron-dust pneumonia). The symptoms of pneumonokoniosis are cough, free expectoration, at times hæmorrhage, dyspnœa, and wasting. It not only has a great similarity to tuberculosis of the lung, but

is frequently complicated by the latter. Under these conditions, death may follow from the phthisis before the general weakness of the pneumonokoniosis has had time to kill. The following figures show how serious this disease is : According to Sommerfeld, of 952 stonemasons who died in Germany, 84·2 per cent. died of tuberculosis of the lung. Moritz examined 1,250 grinders, and found that only 16 per cent. of them were quite healthy, and all of these were under forty-five years of age. The importance of distinguishing between pneumonokoniosis and tuberculosis, considering their great similarity, is apparent, since the former offers a better chance of recovery when suitable hygienic measures are resorted to.

It is necessary to inquire into the cause of every case of catarrhal affection, whether accompanied by fever or not, since, as has been pointed out above, the prognosis depends on this.

Systematic 'hardening,' started early in life, is the best method of protecting against what is known as 'catching cold.' Those who have to live in changeable climates must learn to adapt themselves to the conditions. In the first place, it is necessary that the laity should realize that there is no need to fear that every little draught and every drop of water is going to do them harm.

It may be in place to say a few words on the process of hardening. The choice of clothing should be adapted to the time of year, and in winter it is particularly necessary to do this. Underclothing (vests, etc.) should only be worn in extremely cold weather, or by those who are obliged to carry out violent exercise at low temperatures, and who sweat profusely in consequence. Chest protectors made of cats' skins and

the like should be avoided. Bodily exercise and proper nourishment are efficient means of preventing cold, because they stimulate the circulation. Cold sponging and rubbing down of the chest and back do much good, the temperature of the water being modified according to the season. Even delicate people should not be shy of fresh air, but should go out as much as possible. It is unwise to start the process of hardening during the inclement months of the year. This should be done in spring or summer. The same applies to cold baths, and anæmic people should not remain in them too long. Most surprising results can be attained by accustoming persons to these influences. When one is accustomed to the effect of cold water, in all probability the vessels of the skin do not contract so readily to the stimulus of cold, and in this way excessive suffusion of the internal organs is avoided. The nineteenth volume of this series on the 'Care of the Body by the Application of Water,' by Professor H. Rieder, deals with this matter in detail.

In the same way the mucous membrane may become accustomed to the inhalation of dust, which is evidenced in a diminution of irritability. Not every miller has a cough or suffers from one of the results of dust inhalation. All factories in which large quantities of dust are created ought to be provided with suitable precautionary arrangements—perfect ventilation, the installation of exhaustors, and the like. A striking example of the results of these precautions is to be found in the red-lead works in Villach, in the province of Carinthia. In the German needle-grinding factories, in which provisions exist for sucking out the dust, the average age attained by the workmen is fifty years, while in the English factories, where no such arrangements are pro-

vided, the average duration of life varies between thirty-five and forty years. Those employed in such factories should seize every opportunity to be out in the open air. Stringent regulations should exist in all workshops, not only for thorough cleanliness of the place itself, but also for the bodily cleanliness of the workmen. Cold shower-baths can easily be provided, and have the additional advantage of stimulating the respiration. Special attention should be paid to the condition of the mouth, since, as has already been pointed out, the micro-organisms of disease may find their way into the body through the mouth. This subject is discussed in Volume 7 of this series on the 'Hygiene of the Teeth and of the Mouth,' by Professor Port.

Cough should not always be suppressed. When secretion of the bronchial mucous membrane is present, it ought to be got rid of by coughing. This forms the first step in clearing the air-passages. It is as necessary to clear the bronchi of the dust inhaled in dusty occupations as it is to wash one's hands. Inhalation of aqueous or other vapours, properly carried out, will do this, just as rain will clear the air.

A vessel containing about a pint of hot water or of a weak aromatic infusion (elder-flower or marsh-mallow tea) will suffice for this purpose. A towel or roll of paper should be held so as to cover the vessel as well as the nose and mouth of the person, and the vapour should be inhaled for five minutes several times a day. The disagreeable sensation of dryness of the throat, and the cough accompanying it, is often relieved in this way. Fig. 13 depicts an apparatus with a rubber tube, by means of which these inhalations can be adequately carried out. It also allows of the addition

of volatile substances, such as friar's balsam, to be inhaled with the steam. The introduction of the method devised by the Frenchman, Sales-Girons, of producing a spray of saline fluid, which is so fine that it can be inhaled, is a valuable one. This method

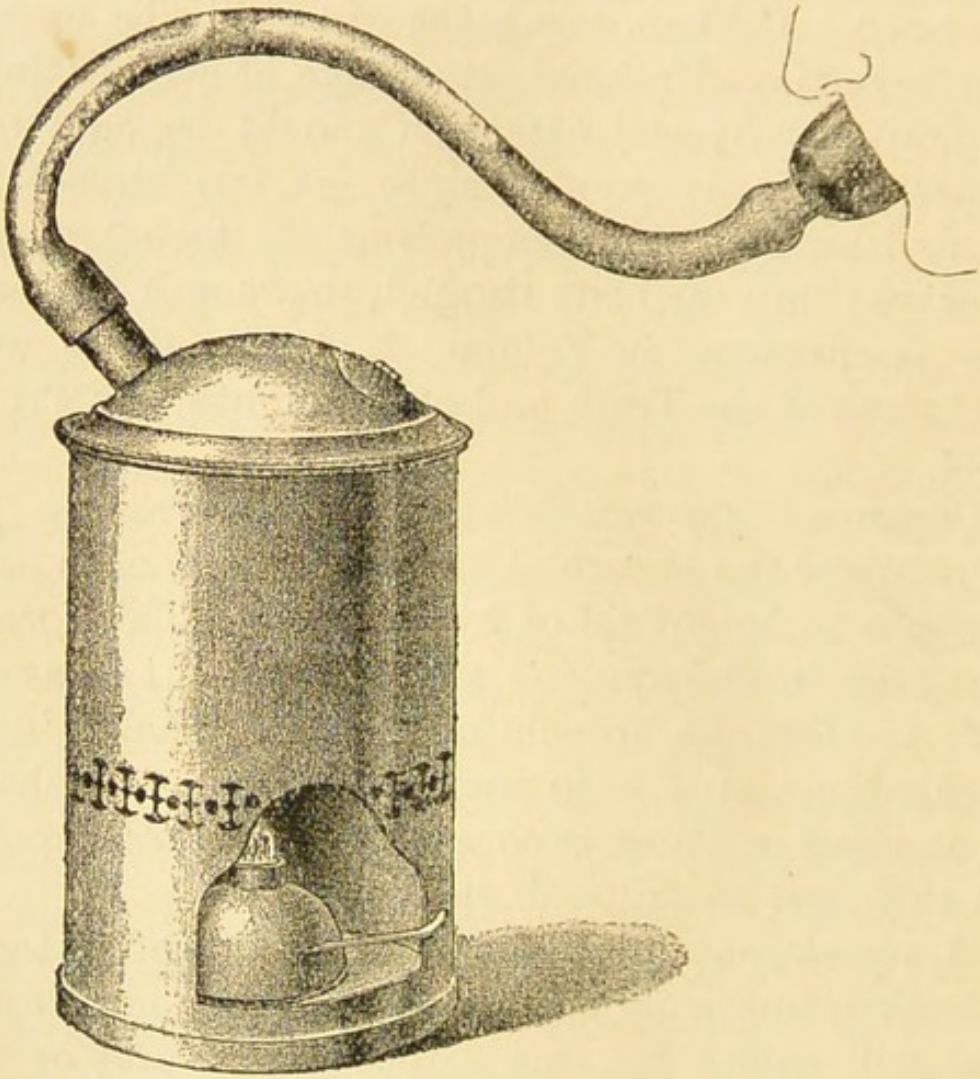


Fig. 13.—Mudge's Inhalation Apparatus.

has been simplified and improved on in various ways. Fig. 14 shows an apparatus planned by the author, which is inexpensive and easily manageable, and by which a profuse very fine spray can be produced. The best apparatus of this kind is the one introduced by Dr. Bulling of Reichenhall. In this apparatus the

fluid to be sprayed is transformed by a stream of compressed air into a state of extremely fine division, in which it remains. The minute droplets thus formed are capable of being carried into the deepest portions of the bronchial subdivisions, and of cleaning them out. The lung can absorb finely divided droplets of

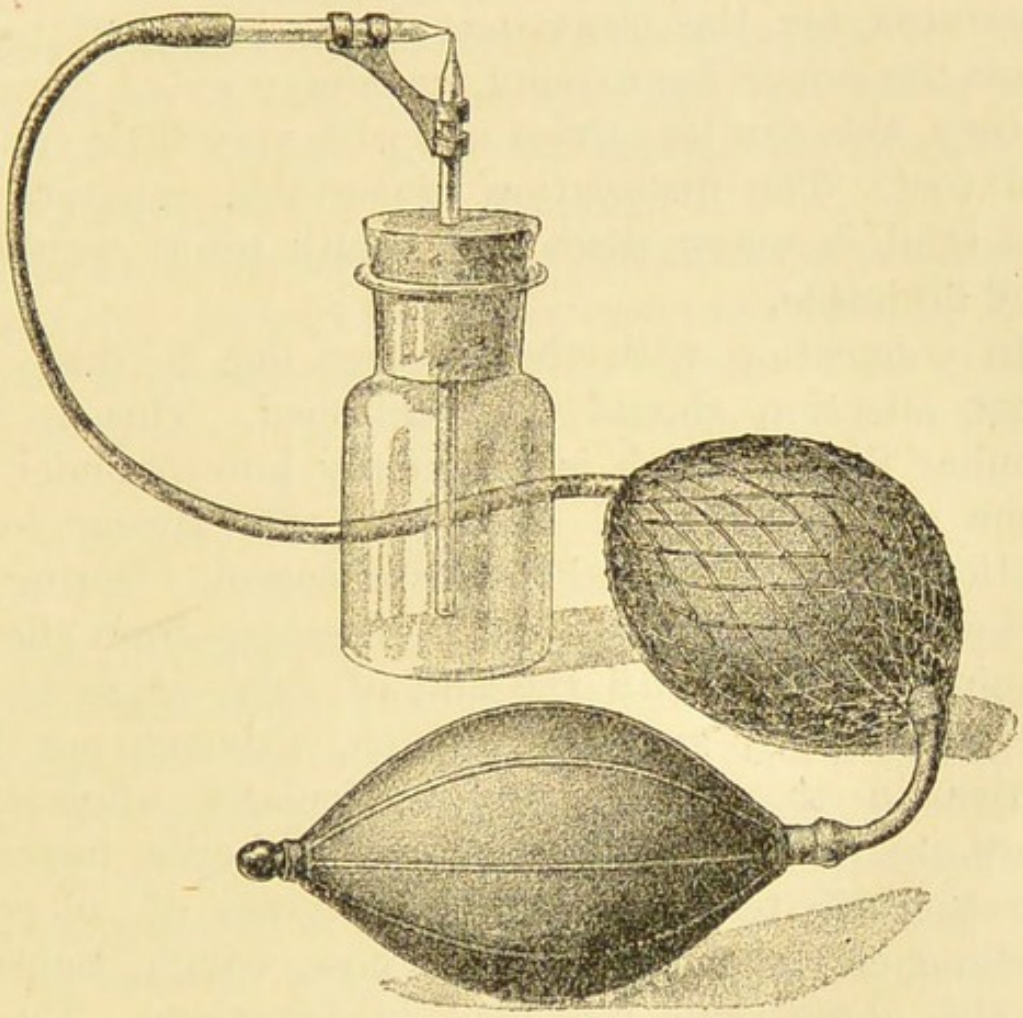


Fig. 14.—Von Schrötter's Spraying Apparatus.

fluid just as it can gaseous bodies, and it is not necessary for the mucous membrane to be defective in order that solid particles may pass through it. Medicaments can thus be applied in the form of inhalations, provided that they are finely divided. The fact that treatment by inhalation stimulates the respiratory mechanism to

effect deep inspirations is a distinct advantage. In this way an improved aeration of the individual portions of the lung, especially of the apices, is attained, and the ejection of the secretion is furthered by vigorous expiration and cough, which is of particular importance in cases where cavities exist. Every large factory ought to be equipped with some form of apparatus for the cleansing of the bronchial track. Since the power for driving machinery exists in every factory, this can be carried out with very little trouble and cost. The installation of suitable apparatus of this kind in every town and health resort would be very desirable.

In connection with the diseases due to dust, one other affection should be mentioned. This is that peculiar illness which is commonly known under the name of 'hay fever.' Certain people appear to be particularly predisposed to this affection. During the period when the grasses are in blossom—from the beginning of June until the end of July—these people are attacked by symptoms which, although not dangerous in themselves, are particularly unpleasant. They are itching and burning of the eyes, increased secretion of tears, violent paroxysms of sneezing, swelling of the mucosa of the nose, cough, tightness of the chest, and difficulty in breathing. Up till recently none of the known forms of treatment have proved efficacious.

It has been recognized for some time past that the pollen of certain plants, chiefly of grasses, when inhaled, attack the mucous membrane of the nose, and produce the symptoms detailed above. Dunbar of Hamburg, after careful experiments, succeeded in separating a component of the amyloid substance of

pollen which is soluble in water and also in the nasal secretion. This substance, when inhaled by predisposed persons, causes an attack. Having succeeded in preparing this substance in a pure condition, Dunbar injected it into the veins of rabbits. The serum of these animals was found not only to protect persons against an attack of hay fever, but also to alleviate the symptoms when once the attack had set in. When this serum cannot be obtained, the only thing to be done is to attempt to avoid coming in contact with the causal agent of the affection.

The blossoms and seeds of certain trees, such as the plane-tree, are said to cause similar symptoms. If this be so, horticulturists should be influenced by it in the choice of trees when laying out parks and gardens.

Spitting of Blood.

Not infrequently a young patient comes to the doctor and states that during an attack of coughing he suddenly noticed that he was spitting blood. He had felt quite well up till then. Every catarrh and attack of violent coughing may be accompanied by the expectoration of mucus tinged with blood. This is not necessarily serious. But when blood is coughed up in larger quantities, either mixed with mucus or pure, the condition is more serious. When the bleeding issues from the lung, it is spoken of as hæmoptysis.

Heart disease may lead to a congestive condition of the lungs, which gives rise to a hæmorrhage in response to the giving way of a small vessel. When hæmoptysis occurs in the absence of heart disease, one should always think of tuberculosis of the lung. The rarer causes

cannot be dealt with here. Tuberculosis of the lung is by far the most common cause of hæmorrhage, which may be the first indication of the disease, or which may occur later on, when the ulcerative process attacks the walls of the vessels. When hæmoptysis occurs as the first indication, it is unnecessary to become alarmed or hopeless, since the disease will frequently become arrested by proper treatment. Experience teaches that an advanced age has been attained by many people who have been attacked on several occasions by hæmorrhage. Still, hæmoptysis must be regarded as a serious condition. It is an indication either of the bursting of a large vessel into the air-passages (aneurysm), or of ulceration of a vessel in the course of various disease processes. The most common cause of the ulceration is tuberculosis in an advanced stage, but it may also be pneumonokoniosis.

In all cases of hæmorrhage it is essential first of all to ascertain where the bleeding is issuing from. One must be careful not to fall into the error of confusing hæmoptysis with bleeding from the nose. It not unfrequently happens that the blood, instead of flowing from the nostrils, passes into the back of the throat and over the larynx, and is expelled by an attack of coughing. Another condition from which hæmoptysis must be distinguished is hæmatemesis (bleeding from the stomach). This is not always easy. The patient often complains of vomiting of blood without knowing where the blood comes from. In any case, he should keep quite still until the doctor arrives. He must avoid all excitement, and should go to bed if the bleeding has been at all severe, and apply cold to the chest. There is no objection to the carrying out the old remedy of drinking water in which a tablespoonful

of common salt has been dissolved. Everything else is to be left to the doctor.

Pneumonia (inflammation of the lungs) is one of the most common and general diseases, and attacks men more frequently than women. One attack does not protect against a future infection, as is shown by the fact that some people have many attacks. The cause of the common form of this disease has been fully made out. Pneumonia used to be regarded essentially as an illness produced by cold, and was mostly ascribed to a draught, or a cold drink, or to exposure to a cold north-east wind. It is now known, however, to be caused by one of two micro-organisms described by Fraenkel-Weichselbaum and by Friedlaender respectively. Since these small bacteria are frequently present in the oral and nasal cavities of healthy individuals, they can easily be carried in the inspired air into the deeper portions of the lungs, and thus set up the disease. However, apart from the presence of the causal organisms, certain conditions are necessary to call forth the disease. Individual (local or temporary) predisposition, catarrhal conditions, various external influences, such as a blow on the chest, running up against an obstacle, and the like, may be quoted as final causes. Although the micro-organisms mentioned above are the undoubted causes of pneumonia, it is very interesting to learn that they can produce inflammations and morbid processes in other organs —*e.g.*, the trachea, the pleura, and even the meninges (membranes covering the brain).

Pneumonia is one of those diseases which may attach itself to one dwelling, and attack the inhabitants one after another. This disease must be regarded as a serious one, which knocks over even strong individuals

at once. It frequently begins suddenly with a marked rigor (shivering fit). A coagulable exudation takes place in the air-vesicles and smallest bronchioles, blocking them up, and preventing the entrance of air into them. The respiratory surface is diminished in proportion to the extent of the disease. The respiratory distress and the rapid breathing are explained in this way. These symptoms are in part due to the pain which accompanies the disease in the shape of a 'stitch' in the side, and which limits the expansion of the lung. This pain is, however, caused by the accompanying inflammation of the pleura, and not by the changes in the lung itself. The patients cough up the well-known 'rusty' sputum, and rarely pure blood. The illness usually terminates with a sudden fall of temperature, which is known as the crisis. It generally appears on the fifth, seventh, or ninth day, the seventh day being the most common. Sequelæ or late complications are, however, not uncommon.

Pneumonia occurs as an independent disease, but at times certain forms of pneumonia complicate other diseases, and these often end fatally. The average mortality of this disease is given at 20 per cent. The prognosis is favourable in early and middle life, while past fifty years of age it is either uncertain or bad. However, one not infrequently meets with patients between seventy-five and eighty-five who recover.

Only general hygienic measures are available for prophylactic or preventive action, and here again the cleanliness of the mouth is of paramount importance.

Up to the present no specific remedy which attacks the causal micro-organism of the disease has been found. Still, one may hope that the experiments with the serum of immunized animals now so largely under-

taken will lead to the discovery of such a remedy. In treating this serious disease one is, therefore, limited to the treatment of the symptoms, and to the means which strengthen the whole organism. Nevertheless, much can be done in this way. The recognition of the fact that the application of cold not only does not harm the patient, but actually relieves his distressing symptoms, and has a beneficial influence on the whole course of the disease, must be regarded as a distinct advance.

During convalescence from pneumonia the lungs should be treated carefully, and strengthened. This can best be done by a prolonged stay in pure air, and by suitable, graduated bodily exercises.

Among the sequelæ of this disease, special mention must be made of one in which an induration of the lung tissue, followed by dilatation of the bronchi, and leading to the formation of cavities in the lung, are the main characteristics. In this condition a large quantity of evil-smelling sputum is expectorated. It is called bronchiectasis, or bronchial dilatation, and may resemble tuberculosis very closely, since it is pathologically a consumption of the lung. It is frequently mistaken for tuberculosis, and those suffering from it are often considered to be consumptive.

Emphysema (overinflation of the lung) is also a common condition, which occurs especially in old people. In it the normal elasticity of the lung is lost, and the pulmonary tissue is destroyed. The individual air-vesicles burst into each other, in part through the canaliculi which normally connect the alveoli of the lung, and in this way large cavities are formed. The enlargement of the organ, however, is mainly due to the loss of elasticity. It has already been shown that

pneumonokoniosis—the disintegration of the lung consequent on the inhalation of dust particles—and induration processes following pulmonary and pleural inflammations are lung consumptions in an anatomical sense. The process in emphysema leads to an actual disappearance of lung tissue in all its component parts. The chief cause of this condition is catarrh, which has already been dealt with. The elasticity and contractility of the tissue gradually suffers when the catarrh is very severe, and has lasted a long time, and when it is situated in the finest bronchioles and in the terminals. In this way the connection with the causal agents described in the paragraphs dealing with diseases due to the inhalation of dust is established. Emphysema, as well as indurative conditions of the lung, frequently accompany these diseases. Excessive action of the lungs and overexertion of the same have been described as causes of emphysema, and it certainly would not be surprising if the organ lost its normal elasticity by a continuous distension during inspiration, especially if this be accompanied by an obstruction to expiration. Emphysema also follows on any constriction of the air-passages, from the nose down to the bronchioles. These constrictions are mostly complicated by catarrhal conditions, which play an important part in the causation of emphysema. The blowing of wind instruments, and also the use of the blow-pipe in soldering, are said to be causes of emphysema. The glass-blower suffers very frequently from emphysema, but he also suffers from catarrhs. He works in an atmosphere which is charged with much dust and finely divided glass fragments, and is further exposed to other harmful influences. The fact that many musicians who play wind instruments do not

suffer from emphysema shows clearly that other factors besides the distension of the lungs play a part. Congenital weakness of the lungs, and sequelæ of other diseases, such as pneumonia, etc., may be mentioned.

The chief symptom of this affection is dyspnœa, which is proportionate to the severity of the changes, and which may be increased by bodily exertions, and may even amount to a true air-hunger. The patients generally sit up in bed, supporting their arms, in order that the elevators of the ribs may be placed in the most favourable position to carry out their work. They wear an anxious expression, and their colour is slightly bluish. The latter is due to congestion in the small vessels and insufficient oxidation of the blood, caused by a number of pulmonary capillaries being put out of function. A marked prolongation of the expiration is noted, and numerous râles are heard all over the chest. These are due to the catarrh which is practically always present. This affection, as will easily be understood, is an extremely distressing one, particularly so because it cannot be cured. Once the lung has lost its power of contractibility, it may be compared to an overstretched elastic band, to which one cannot restore its lost elasticity. One can, however, do a great deal to prevent the occurrence of this disease. In choosing the profession of musician, it is necessary to be extremely careful with regard to the choice of the instrument, as has already been pointed out. In the same way, all those damaging influences which may lead to catarrh must be avoided. This need not be difficult in a variety of employments. Next, even the mildest catarrhal conditions must not be neglected. The proper treatment should be adopted

with as little delay as possible. This is particularly necessary on account of the close connection between emphysema and catarrh, and especially so, since every fresh attack will render the emphysematous condition worse. The method of treatment by inhalation described above, in which a variety of medicaments is employed, does good here. Relief can at times be obtained from exposure to compressed air.

Asthma is a definite disease, which is evidenced by difficulty in breathing, occurring in attacks of varying duration, and in which the expiration is chiefly affected. The laity commonly apply the term 'asthma' to all forms of difficulty of breathing, independent of its cause. Not infrequently it is associated, either from the beginning or in its further course, with bronchial catarrh, and with a decrease of the elasticity of the lung. On this account it may terminate in paralysis of the lung. There is no doubt that asthma depends on nervous processes, which in their turn may originate from divers causes, some of which have no connection whatsoever with the respiratory track. The most commonly recognized form of asthma is that which is caused by swelling of the mucous membrane of the nose, or by polypi in the same organ. In this form one is able to demonstrate the causal connection, since the asthma is cured when one cures the nasal affection. The importance of a free passage of air through the nose, which has been dealt with above, may be offered as an explanation of this. It is, therefore, necessary for every asthmatic patient to have his nose examined by an experienced medical man, even when there are no symptoms pointing to any trouble in this organ. It is often exceedingly difficult to discover the cause of the attacks when no changes can be

found in the nose. Attention has already been drawn to the similarity between this affection and hay fever.

Tuberculosis.

Tuberculosis leads to the disintegration of the substance of the lung, just as those diseases mentioned above do. The term 'consumption' of the lung is reserved for this disease, because it is the most common and widely spread disease which, by its destruction of lung, may lead to a fatal termination. The persons attacked by this disease are known as 'consumptives.'

Tuberculosis may affect all the organs. The glands, bones, joints, intestines, and larynx are amongst those which are frequently affected. But the most common situation of tuberculosis is the lung. Simultaneous affections of the lung and larynx and of the lung and intestine are of considerable interest, but only the discussion of the affection of the lungs can be entered into in this place.

Tuberculosis has created more extensive ravages among the human race than any prolonged war or any of the many severe epidemics which have broken out from time to time have done. It must therefore be regarded as the greatest enemy of mankind. It is generally accepted that about one-seventh of the population die of it. The importance of this disease from the point of view of social economy is best illustrated by the fact that from five to six times as many people die of this disease during the wage-earning age as compared with those who die of it early or late in life. Apart from this, the danger and material loss which arises from this disease is increased by the fact that

it also attacks, albeit in a somewhat different form, all domesticated animals, and is especially prevalent among cows.

Tuberculosis is present in all the inhabited regions of the world. A geographically distributed immunity does not exist, although the distribution of this disease varies considerably in intensity in different places. Statistics show that the number of deaths from it in large towns is indeed terrible. In one town, between fifteen and seventeen deaths from tuberculosis occur daily, and one quarter of all the deaths which are registered in that town are attributed to this disease. It is true that the mortality has decreased slightly in latter years. This has in part been achieved by the improved hygienic conditions. However, one must realize that all statistics undergo variations, and that years must elapse before definite deductions can be drawn. Up to the year 1884 human tuberculosis was regarded as a veritable death-trap, and every attempt to cure this disease was considered to be hopeless. From time to time sporadic therapeutic measures were attempted. However, at the present time the matter wears a totally different aspect.

One could not close one's eyes to the following considerations : One found in the post-mortem room that signs of healed up tubercular lesions were present in every fifth corpse, and that many of the patients had died, not of their tuberculosis, but of some other disease. This demonstrates not only that tuberculosis is an enormously widely spread disease, but also that the possibility of a cure exists. Physicians of experience, when dealing with living subjects, have pointed out the possibility of a cure. No one emphasized this with more insistence than did Skoda of Vienna, prob-

ably the best authority on tuberculosis of his day. This physician claimed the possibility of recovery even in advanced cases. In using the terms 'healing up' and 'cure,' one does not wish to convey the impression that the lung substance which has been destroyed is regenerated.

Even in olden times, the view was occasionally held that tuberculosis was an infective disease, and in some countries regulations were enforced against a possible contagion of the disease. At a later date, a few doctors, among whom Skoda may again be mentioned, called special attention to the infectious nature of the affection. This opinion was supported by the results of more or less convincing experiments, and by the experiences of other medical men. However, it was not until Robert Koch discovered the tubercle bacillus that the infectivity of the disease was conclusively proved. The tubercle bacillus is a rod-shaped bacterium, measuring about 4 micromillimetres ($\frac{1}{7000}$ inch) in length. This discovery provided a sound basis for the correct understanding of this disease, and is of very great importance, notwithstanding the fact that no direct cure was gained thereby. The recognition of the cause of the disease led to the introduction of an effective prophylaxis, and also paved the way for a rational treatment. It is now known with certainty that tubercle bacilli are to be found in every tubercular lesion, and that tubercular processes can be produced by the transmission of the tubercle bacillus. The conditions of existence of this bacillus have been thoroughly investigated. It possesses marked resistance against the influence of cold, of drying, and even of decomposition. It multiplies by cleasion—*i.e.*, division. It grows only at temperatures between 30°

and 40° C. on a suitable culture medium in the presence of moisture, but cannot withstand the action of light, especially direct sunlight. The latter kills the bacillus rapidly.

It is important to determine how the tubercle bacillus gains an entrance into the human body. It is now generally accepted that only under very rare conditions does a direct inheritance of the disease from the mother occur. It therefore follows that the bacillus gains an entrance into the organism from without during the course of independent life. Inhalation is by far the most common mode of infection. The dangerous and dirty habit of spitting on the ground in a room, in the street, or in a public place is responsible for the almost ubiquitous presence of tubercular material in dust, in consequence of the large number of persons suffering from tuberculosis. The sputum dries up, and is powdered into dust in the course of traffic, in which form it can be inhaled. Apart from this, when a tubercular patient coughs, tiny droplets enter the atmosphere, which contain bacilli, and these can easily be inhaled. The recognition of these facts in itself suggests important measures for the prevention of infection. These will be dealt with below.

Although inhalation is by far the most frequent source of infection, there can be no doubt, judging from the enormous prevalence of tuberculosis, that other modes of infection exist. One must assume that infection through the digestive track takes place. This infection is to a large extent brought about by the drinking of milk derived from tuberculous cattle. Von Behring's important investigations and conclusions on the acquisition of tuberculosis in early childhood deal with this matter. Meat of tubercular animals and

food-stuffs contaminated with tubercle bacilli are less common sources of infection.

Infection through wounds inflicted by instruments soiled with tubercle bacilli is comparatively rare. When it does take place, the affection generally remains a local one, or spreads only into the immediate neighbourhood.

No matter how the bacilli have entered, they may cause an infection in the nasal or faucial cavities. In the former case, the infection generally remains a local one. In the latter case, the bacilli may attack the glandular tissue, especially of the tonsil, and thence, traversing the lymphatic channels, spread to the cervical lymphatic glands and the apices of the lungs. The bacilli may also be inhaled directly into the deeper air-passages, and from this situation may penetrate in various directions, to start on their work of destruction. At times they may be deposited in stagnating mucus in a small bronchus, and finding a suitable nutrient medium, may develop further, and attack the mucous membrane; or they may pass into the mucous membrane through a minute wound; or, lastly, they may pass through the epithelial layer without damaging it, and thus find their way into the tissues. Having once reached the tissues, the bacilli can easily be carried in the lymph-vessels to the lymphatic glands situated at the root of the lungs, and thence into the blood-stream. The blood may carry them further into the various organs—*e.g.*, the meninges, etc.

It is well known that tuberculosis first attacks the apices of the lungs, mostly the right apex, and from this situation spreads downwards. Several circumstances obviously help to bring this about. In the first place, there are the mechanical factors. The

limitation of movement of this part of the lung, and in consequence the slight degree of aeration, favour the retention of plugs of mucus, chiefly in the posterior bronchi. This retained mucus forms a very excellent soil for the growth of the bacilli. In the second place, one may mention the weaker circulation in these portions of the lung. The chief cause of the marked susceptibility lies in the fact that the apices possess less power of resistance than other tissues. Experiments show that the first-named causes only play a contributing part.

It has been shown that the opportunities for tubercle bacilli to enter the organism are very manifold. It is therefore necessary to discuss the reason why the number of persons suffering from tuberculosis is not considerably larger than it is.

Two conditions are necessary for the development of a disease in man—viz., a definite causal agent, and a predisposition toward the disease in question. There is no doubt that a tubercular predisposition can be inherited. Although the exact nature of this predisposition is not known at present, it can be recognized by certain body habits. The most important of these is that peculiar habit of body which we call weakly or delicate. Next, there is a typical figure—a long, thin neck, a long, flat, narrow chest, with small lung-capacity, and prominent shoulder-blades. Besides these, pale complexion, pallor of the mucous surfaces, reduced power of resistance against external influences, tendency to catarrhs, etc., are often present. Influences which do not harm other persons undoubtedly produce an attack of the disease in people possessing these peculiarities, and when the disease is present, they keep it going with marked obstinacy, even though

they may not be able to intensify it. There is much to support the theory that a peculiar condition of the lymphatic glands exists which is incapable of calling into action those immune bodies which act against the bacillus once it has entered the organism. Not only the virulence of the infective material, but also the degree of predisposition, may vary at different periods. Under certain conditions, it may even be acquired. Conditions of life altered for the worse may produce this predisposition, and recent illnesses—*e.g.*, measles, whooping-cough, etc.—may accentuate it. Alcoholism plays a big part in this. Trouble and care, and, above all, insufficiency of food and want of fresh air, do the same. Attention has already been called to the damaging influences of unhygienic conditions. Damp, low-lying dwellings, with bad ventilation and want of sunlight, may favour the development of tuberculosis ; but when hard work and insufficient nourishment are added to this, the chances of infection are still more probable. The conditions in which the poorer classes live are, therefore, the worst with regard to this disease, and one might say with justification that tuberculosis is the sister of poverty.

The tubercle bacilli, having penetrated into the tissues, create a local irritation, not only by their own action, but also by the action of the metabolic products which they produce. This irritation leads to the formation of nodules, or tubercles, and of larger lesions. These tubercles and larger lesions undergo further changes, which are evidenced in the degeneration of the newly formed cells as a caseation, in the disintegration of the tubercular masses, and of the tissue which they have infiltrated, and in the formation of small or large cavities in the lung, arising out of the ulcerative

destruction of smaller or larger areas of tissue, opening out into the bronchi. The whole organism, and especially the nutrition, suffers under the infection, and as the disease progresses, the patient becomes more and more reduced, and presents a true picture of consumption.

It must not be supposed that the tubercle bacillus alone causes all the damage done. A number of other micro-organisms find the conditions required for their existence in the lesions produced by Koch's bacillus. Thus a mixed infection replaces the simple infection, and the organism becomes further affected by fresh inflammatory processes and continued fever.

The signs and symptoms of the disease, and the appearance of the consumptive, are so well known that it is unnecessary to deal with them at length here. In the usual chronic cases, the symptoms at first are so slight that the patient scarcely takes any notice of them ; the occasional short cough does not alarm him. The patient only realizes that he is ill when he loses strength and flesh, when his temperature begins to rise and night-sweats appear, when the cough becomes so troublesome that his night's rest is disturbed, and when his breath becomes short on slight exertion. The patient has become very ill by this time, but he has not consulted the doctor before, because he has not had any pain. Even when the patient looks bad, and is occasionally feverish, he finds all sorts of excuses for not going to the doctor, and in that way the proper time for favourable treatment has been allowed to go by. There is one symptom, however, which alarms the patient very much, and which impels him to seek medical advice without loss of time. This symptom is

spitting of blood. The significance of this symptom has already been dealt with.

Except when the disease is complicated by implication of the larynx, severe pleurisy, pneumothorax, and the like, it does not entail much suffering, and only its long duration causes distress to the patient, until his incessant cough is silenced in death.

It has been the aim of numerous investigators to determine how far the disease is amenable to treatment.

Nature has pointed out definite lines along which a cure can be effected. The formation of cicatricial tissue, cutting off the affected areas from their surroundings, may lead to a temporary or permanent arrest of the disease. This is the most common method of cure. In other cases the altered and disintegrated tissue may burst through into a bronchus, and may be completely cast off by the efforts of coughing. The virulence (degree of infectivity) of the bacilli may be diminished, their further development may be limited, and scar tissue may be formed as the result of the formation of connective tissue. In this way only is a cure possible. The tissue of the lung, once it has been destroyed, cannot be regenerated, and thus the disease can only be arrested. A deposition of lime salts takes place in the newly formed connective tissue, which completes the destruction of the original tissue.

The object of prophylactic and curative treatment is to assist Nature in carrying out this work or to imitate her.

One of the most important advances of modern medicine consists in the fact that while the physician treats individual cases, he regards the prevention of disease as his most important duty. Everything must be done

to prevent a person from becoming tuberculous and to guard him from infection, since no one is born tuberculous. The predisposition which is inherited must be attacked and eradicated. There is no doubt that children born of tuberculous parents and showing marked tuberculous body habits often do not become tuberculous. Prophylactic treatment aims at achieving this end. In the first place, it is necessary to educate the masses on the nature and prophylaxis of tuberculosis, so as to substitute purposeful action for ignorant callousness, since the fate of thousands is involved. In Vienna a society exists which has distributed thousands of pamphlets free of charge, setting forth suitable instructions in a simple and clear form. Similar societies exist in most other countries, whose aim it is to prevent tuberculosis from purely humanitarian motives. A passage may be quoted here from the Viennese pamphlet : ' For this reason, marriage between tuberculous individuals should be prevented whenever it is possible ; newborn infants of tuberculous parents should not be suckled at their mothers' breasts, to avoid infection, and should not be allowed to remain in the same room, where the air may be soiled by tuberculous sputum. They should be removed into favourable surroundings, preferably into the country, where they can be looked after by a healthy nurse, and be properly brought up by natural or artificial means. By general hygienic measures, by strengthening and hardening the body, and later on by the choice of a suitable calling, the inherited predisposition in the child of tuberculous parents is combated, and the individual is protected against the dangers to which he is exposed.'

All children should be subjected to hygienic measures,

but especially those who show tubercular predisposition. It has been pointed out, when dealing with catarrhs, that compensatory arrangements are present in our bodies which counterbalance variations of temperature. These arrangements are, however, not equally developed in all individuals ; in some they are naturally present, while in others they have to be artificially awakened by hardening. Similar measures to increase the resistance against other damaging influences should be employed also.

The importance of the choice of a suitable calling has already been pointed out. Those predisposed toward tuberculosis should choose callings which can be carried out in the open air, or which allow of a considerable time being spent out of doors. It need scarcely be pointed out that sufficient and strengthening nourishment is of great importance. The harmful effects of the abuse of alcohol have been spoken of, but it may be in place here to mention that light beer or wine taken in very moderate quantities is not necessarily injurious. Spirit-drinking should be forbidden under all conditions. The urgent necessity of the most scrupulous cleanliness, from a hygienic point of view, cannot be insisted upon too forcibly. Special attention should again be drawn to the care of the mouth and hands.

The disposal of the sputum forms perhaps the most important item in the prophylaxis of this disease, because on it depends the extent of the prevention of the infection. This subject is dealt with in the pamphlet mentioned above as follows : ' To avoid infection, expectoration containing tubercle bacilli should always be discharged into suitable vessels, and never into a handkerchief or on to the floor. A bowl filled with water

suffices for this purpose. The contents of the vessel should be poured down the closet. It is a duty of every one never to spit on the floor, and not to allow others to do the same, especially in common workrooms and dwelling-rooms, since the spread of tuberculosis is chiefly due to this bad habit, which leads to the contamination of the air by bacilli. Patients who are still able to get about will find pocket flasks, made entirely of glass, most useful. Fig. 15 depicts the pocket flask used in the Sanatorium Alland, near Vienna, which is quite inexpensive. A bowl filled with water will be found more convenient for those who are kept in bed. Fig. 16 illustrates an

Fig. 15. — Pocket Spitting-flask.

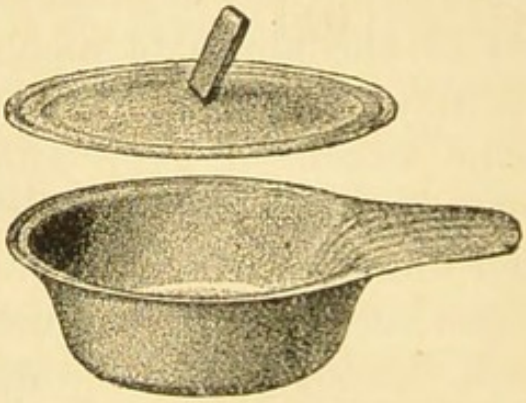


Fig. 16.—Papier-maché Spittoon.

excellent bowl for this purpose, devised by Professor von Schroetter, and made entirely of papier-maché, which can be easily burned. The use of ash, sand, earth, sawdust, and other dry material in spittoons should be avoided, since it does not prevent the blowing about of the dried sputum—that is to say, the bacilli. Those who look after a consumptive

patient should never take their meals in the sick-room, and should always wash their hands carefully before leaving it.

Apart from this, it is necessary to hold a handkerchief in front of the mouth when coughing, as bacilli may adhere to the droplets which are sprayed in the act of coughing. For the same reason, the moustachios and beard should be kept very clean. Bacilli undoubtedly may stick to portions of mucus in this situation, and also on the lips. It is therefore advisable to exercise care with regard to kissing. Under no circumstances may strangers be allowed to kiss children.

It is not going too far to state that when these precautions are taken, when scrupulous cleanliness is observed, when no spitting on the floor or into the handkerchief is indulged in, and when the sputum is not sprayed during coughing, the tuberculous patient is not dangerous to his fellow-creatures. The possibility of infection is entirely connected with the above-mentioned factors, and is very different from that of measles, scarlet fever, small-pox, cholera, and even diphtheria. A thorough disinfection of the rooms must be undertaken in all cases when a tubercular patient who expectorates freely changes his abode, or in the case of his death. This can be carried out very easily by means of the formaline lamp without damaging the furniture, but it is not quite reliable. Thorough washing of the walls and utensils with a good disinfectant is preferable.

In treating individual cases of tubercular disease, the following principles should be adopted: The diagnosis should be made as early as possible, because the earlier the treatment is begun, the more favourable

is the prognosis. It has already been pointed out that a cure is possible. One is, unfortunately, not able to imitate Nature in producing cicatricial tissue around the lesions. Improved methods of inhalation might possibly be of use. The extraordinary fact that tanners —and especially those who are exposed to the dust of the oak bark—are practically free from tuberculosis certainly seems to point to this. It has been shown that dust acts as an irritant, and leads to the formation of pneumonokoniosis. It is quite conceivable that a harmless cicatrization might be induced by some form of inhalation. It is impossible to employ substances to kill the bacilli, since the organism cannot tolerate the concentration necessary for this purpose. It must be admitted that a specific remedy against tuberculosis does not exist at present, and that while the countless drugs which are introduced on to the market daily, and the various methods of treatment, may be of use in easing the symptoms, they are not able to effect a cure of the disease. Their use is justified in certain cases in which the experience of the doctor leads him to expect satisfactory results. The following consideration, however, is of great importance. It is known that the capability of resistance of the organism can be so raised by the employment of those agents which are usually termed 'physical,' such as the climatic and hygienic influences, and by plentiful nourishment, that it (the organism) is capable of combating and overcoming the bacilli. The question as to whether the patient should be sent to certain climatic health resorts, or whether he should be sent to the South or to a mountainous district, has been widely discussed. Experience has taught that a cure of tuberculosis can be effected under all climatic con-

ditions. Large numbers of persons who cannot afford to travel about benefit by this circumstance. Experience shows that cures effected in the patient's own climate are more lasting than those effected in the South. It would, however, be unjustifiable to dispense with the South altogether, where the warmth and bright sunshine not only produce a pleasant feeling to the patient, but also do a great deal in improving his nervous condition. An occasional cold night is of no consequence, as the patient should be in his room and in bed. Those who can afford a stay in the South, when this is likely to prove beneficial, should seize the opportunity. The speed and comfort of modern railways enable one to escape from the wintry, dull regions into the bright sunshine of the seaside, and those suffering from tuberculosis should take advantage of this to as large an extent as possible. No doubt every climate has its advantages, but at present Science cannot determine which cases do best in mountainous climates, which do best at high altitudes, which in pure forest air, and which at the seaside, where the air is free from bacteria, be it in the north or in the south. Investigations which are at the present time being carried out with improved methods may be able to elucidate definite indications with regard to this subject. It is unwise to send a patient too far away from his home into climates which differ too widely from the one he would have to return to. Exception may be made in cases in which the patient can afford to return to his old climatic conditions in easy stages. It would be useless in a work of this kind to recommend any special health resort. The doctor will have to consider a large number of factors before deciding on a place in each individual case. The

bodily condition of the patient, as well as his degree of education, his inclinations, his predilection for quietude, the advisability of sending some one with him, and his means, have to be thought of. It thus appears that the choice of a health resort depends, not only on the special advantages of any given health resort, but also on the intimate knowledge of the patient's characteristics, which only the house doctor can possess. Besides, many of the reputed health resorts are by no means perfect. Places where consumptives are sent to should be absolutely free from dust. It is not sufficient to lay the dust in a few roads and in a concert-hall, but large sums of money must be spent to ensure complete freedom from dust over a large area. Under certain circumstances, it may not be unwise to allow a patient to stay at a hotel or boarding-house in a suitable place. Some of them are models of hygiene and comfort, and an obedient and careful patient, who will follow all medical orders, possibly under the supervision of a doctor, may safely be sent there. The necessary conditions for successful treatment, however, are mostly to be found in well-situated and well-conducted sanatoria and homes for consumptives. There is no doubt that when a poor man is seriously ill of tuberculosis he is best removed from his ill-conditioned surroundings and from his family into a sanatorium for the poor. Not only he, but also his relatives, benefit by this. In such a sanatorium all the hygienic requirements which have been discussed above are minutely carried out under the supervision of a specially trained medical man. Everything depends on the strict observation of the necessary regulations. It is important to prescribe the proper amount of rest and

exercise in each case. Lying in *Liegehallen* (sort of open shelters, where the patients can lie protected from wind and rain) constitute an important remedy for strengthening the heart and improving the patient's condition. The condition of each patient will influence the doctor in determining how many hours a day he will have to remain in these *Liegehallen*. The results obtained in well-conducted sanatoria are undoubtedly better than any derived from treatment by drugs. On an average, from 60 to 70 per cent. of the patients treated in this way are improved to such an extent that they enjoy good health for a considerable time, and are capable of again earning a living. Some of them are permanently cured. As compared with the hopeless conditions of former days, this must be regarded as a magnificent gain. There is every reason to believe that the results will be still better in the future. Beside the hygienic method, rational remedies based on scientific investigations will be employed. The outlook is fairly promising. It is doubtful whether the chemist will be able to present Medicine with a specific remedy. The prospect that serum-therapy may succeed in producing natural immunizing substances is a better one. Von Behring's results with animals justify this assumption.

The social importance of tuberculosis is so great that no excuse is needed for the amount of space allotted to this discussion. In this a number of facts has been dealt with in detail which play an important part in the various diseases of the respiratory organs. A certain amount of satisfaction must be felt in learning that a disease which hitherto has been so disastrous is now amenable to treatment, and offers excellent chances of

complete cure in the future. Not many years ago the laity, as well as the doctor, were face to face with an apparently insoluble puzzle.

It is necessary in future to continue to pay attention to the calls of hygiene, to be prepared to make any sacrifice in her cause, to proceed with the struggle, and to follow out new lines, until a permanent victory is gained, to the benefit of humanity.

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