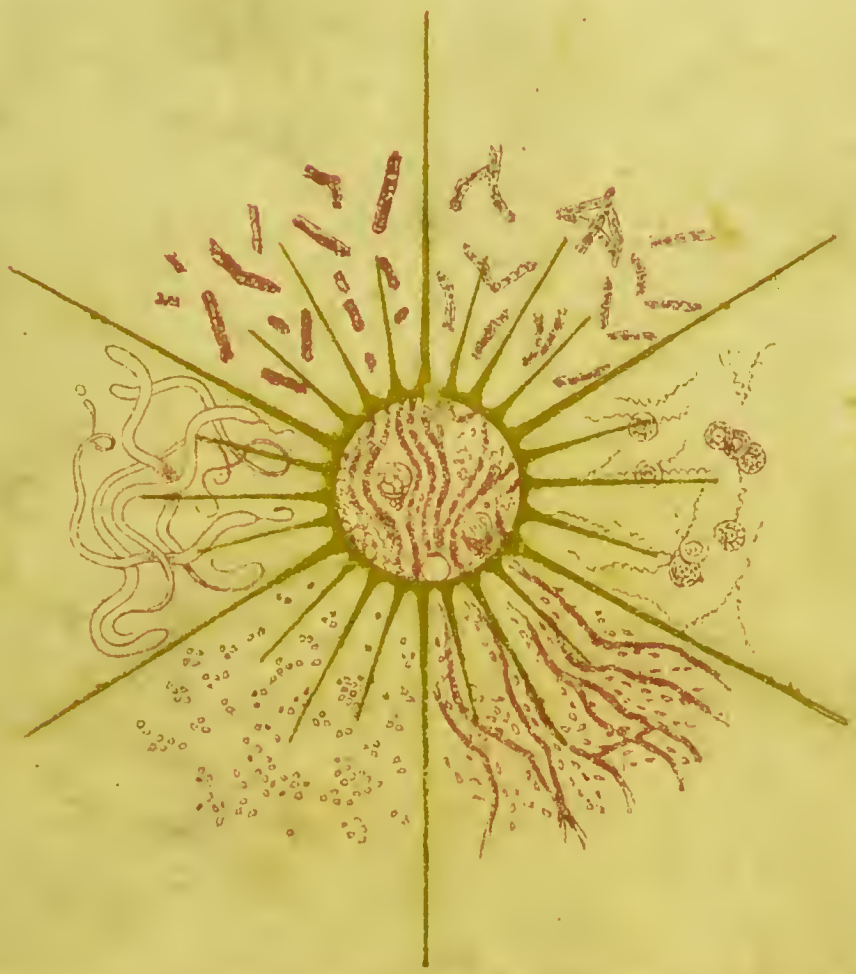
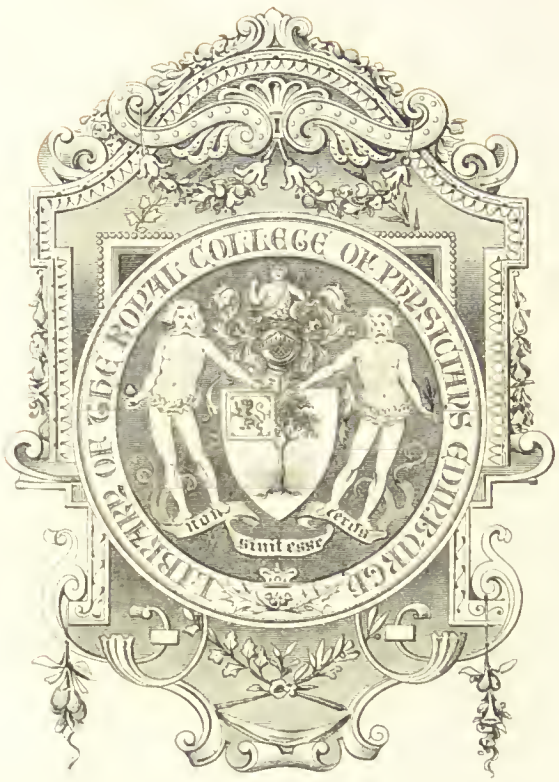
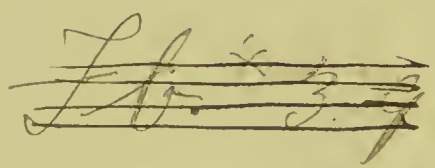
GERMS DUST AND DISEASE

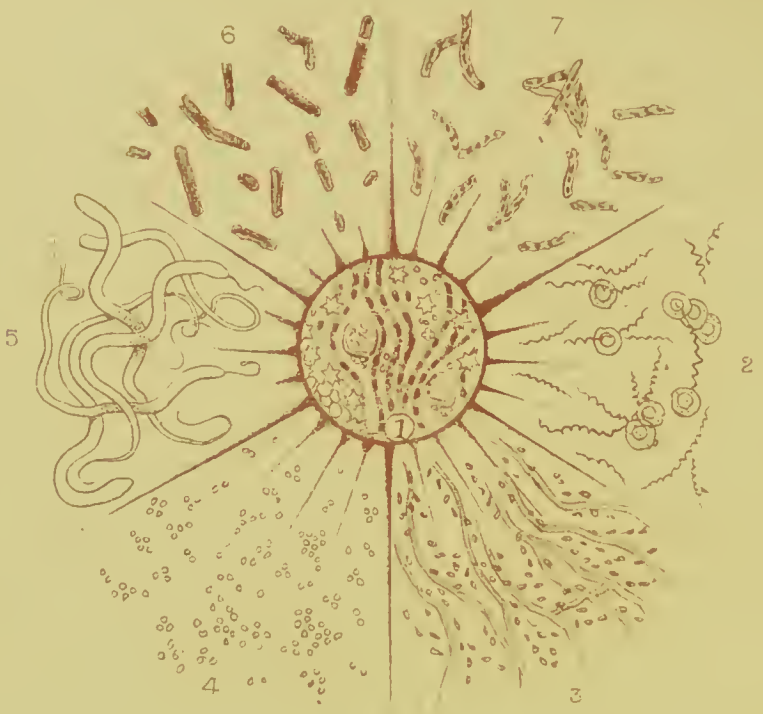


"THE BRIGHT RAY REVEALS THE FLOATING PARTICLES"

ANDREW SMART M.D







"THE BRIGHT RAY REVEALS THE FLOATING PARTICLES."

DESCRIPTION OF GERMS.

1. *Rinderpest Germ. Discovered, delineated, and published by the Author in September* 1865.
2. *Relapsing Fever Germ. Discovered by Obermeier in* 1868.
3. *Anthrax Germ (Wool-Sorters'). Discovered by Koch about* 1874.
4. *Vaccine Germs. (Probably analogous to Small-Pox Germs not yet discovered.) Sanderson,* 1869.
5. *Filaria Sanguinis. A Germ found in the blood of the affected person during night, but absent during day. Manson,* 1881.
6. *Typhoid Fever Germ. Eberth—discovered about* 1880.
7. *Consumption Germ. Koch—recently discovered.*

GERMS, DUST, AND DISEASE:

Two Chapters in Our Life History.

BY

ANDREW SMART, M.D., F.R.C.P.
EDINBURGH.

EDINBURGH:
MACNIVEN AND WALLACE.
1882

TO

MRS TRAYNER,

THROUGH WHOSE ENLIGHTENED, ZEALOUS,

AND PHILANTHROPIC INTEREST IN THE PEOPLE, THE

EDINBURGH HEALTH LECTURES WERE FOUNDED, THESE PAGES

ARE RESPECTFULLY DEDICATED BY

THE AUTHOR.

PREFACE.

THE Author, in yielding to the wish conveyed to him to republish, in their present form, the two accompanying Lectures, does so, in the hope, that the attainment of the object contemplated by them will thereby be furthered.

The first Lecture, delivered under the title of "Preventible Diseases," gave, the Author believes, the first expression, to a popular audience, of the "Germ Theory" of Zymotic Disease.

It is to the indomitable genius and philosophical sagacity of Joseph Lister that, the contest, in regard to the application of this theory to Surgery, is now virtually ended; and, thereby, one of the brightest, most benign, and even romantic chapters has been added to the history of Medical Surgery.

The battle of the germ theory, however, in its relation to the State control and prevention of infectious diseases, has yet largely to be fought; and, to assist forward this great movement, in however small a degree, is the object in republishing this Lecture.

The second Lecture sufficiently explains its aim. It is intended to direct public attention to the great, and, as the Author thinks, preventible waste of life, incurred by a large section of workmen among the industrial class, in the pursuit of their employments. The appended tables exhibit the effects,

in a great variety of occupations, in a light, for which, the mind of the country may scarcely be prepared. They seem to call for early legislative interference and prevention.

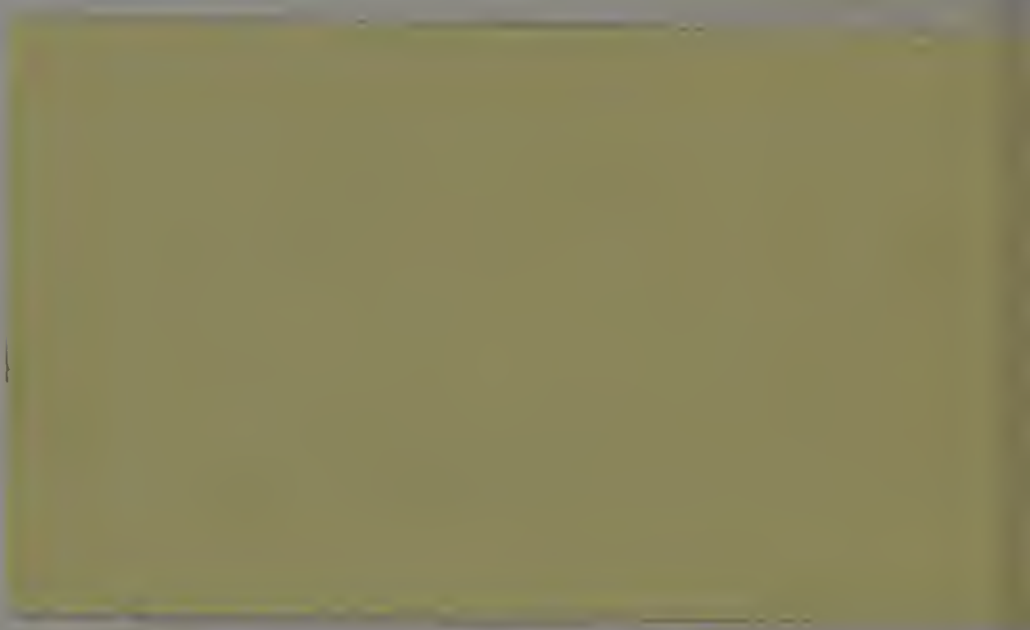
The Author takes the opportunity of claiming priority in the discovery of micro-organisms, in living tissues. His delineation—of which a drawing is given—of the Rinderpest germ was published in 1865, the next earliest being that of the Spirillum of relapsing fever by Obermeier.

14 Charlotte Square,
Edinburgh, *November* 1883.

ERRATA

Lecture I., page 8. Fifth line from foot, for "four" read "fourteen."

Lecture II., page 29. Eleventh line from top, for "twelve hundred" read "one hundred and twenty-five."



CONTENTS.

27th Thousand.

LECTURE I.

THE title of this lecture is "Preventable Diseases and their Causes," and I have chosen it to indicate as nearly as possible the nature of the subject I have to speak of. Under this title we include, for the present, only such as come under the head of Zymotics—that group of diseases, viz.: which are more directly affected by public measures of prevention, and by the conditions which affect large communities. Many other diseases which are, strictly speaking, preventable, such as arise from noxious trades and unhealthy occupations, are not here included, but will, I trust, at some future time, form the subject of an interesting and useful lecture to you. A preventable disease may be described as one which arises or spreads in consequence of the wilful, careless, or ignorant violation of those laws, the proper observance of which we know to be necessary to insure the preservation of health, and avert the spread of disease.* Those diseases—a very numerous group—which result from personal vices or from depraved habits of the community, are beyond the immediate control of public measures.

The chief of the zymotic diseases are:—smallpox; typhus fever; typhoid (or enteric fever); scarlet fever (or scarlatina); dihptheria; measles; and Asiatic cholera. We will consider them

* Grimshaw.

from the following points of view: *first*, the injury they inflict; *secondly*, how they originate; *thirdly*, their distinctive characters; *fourthly*, the conditions under which they spread; and *fifthly*, the means necessary for their control and prevention. "It seems certain," writes Mr Simon, Medical Officer to the Privy Council, "that the deaths which occur in this country are fully a third more numerous than they would be if our existing knowledge of the chief causes of disease were reasonably applied throughout the country; that of deaths which, in this sense, may be called preventable, the average yearly number in England and Wales is about 120,000, and that of the 120,000 cases of preventable suffering which thus in every year attain their final place in the death register, each unit represents a larger or smaller group of other cases, in which preventable disease not ending in death, though often of far-reaching ill effects on life has been suffered. . . . Then there is the fact that this terrible continuing tax on human life and welfare, falls with immense over-proportion upon the most helpless classes of the community; upon the poor; the ignorant; the subordinate; the immature; upon classes which, in great part through want of knowledge, and in great part because of their dependent position, cannot remonstrate for themselves against the miseries thus brought upon them. And have, in this circumstance, the strongest claim of all claims on a legislature which can justly measure and can abate their sufferings."*

"Diseases of this class," says Dr Farr, the Registrar-General, "distinguish one country from another, one year from another. They have formed epochs in chronology; and, as Niebuhr has shown, have influenced not only the fates of cities such as Athens and Florence, but of empires; they decimate armies, disable fleets; they take the lives of criminals that justice has not condemned. They redouble the dangers of crowded hospitals; they infest the habitations of the poor, and strike the artizan in his strength down from comfort into helpless poverty; they carry away the infant from the mother's breast, and the old

* 13th report of the Medical Officer of the Privy Council.

man at the end of life; but their direct eruptions are excessively fatal to men in the prime and vigour of age." These weighty words of the two greatest living authorities on this subject ought to be well pondered.

Mr Simon reckons the deaths from these diseases at 120,000 in England and Wales alone. If we add those in Scotland and Ireland, from the same causes, the total mortality is over 150,000, every one of which is a needless death. Does this not strike you as a frightful waste of life? If we now compute that each one of these deaths represents, at a moderate estimate, thirty instances in which there is loss of health short of death, the aggregate of needless death and suffering becomes perfectly astounding, and affords a sufficiently cogent reason why zymotic diseases are specially singled out to be dealt with by stringent enactments having for their object their prevention, and ultimately total extinction.

THE GERM THEORY OF INFECTIOUS DISEASES.

How they Originate.—The term Zymotic is applied by those who believe that in these disorders there takes place a process which bears a striking resemblance to that of fermentation. This resemblance was first pointed out by Leibig. Thus, when yeast is added to a solution of sugar, the yeast cells rapidly multiply by feeding on it—alcohol and carbonic acid being given off during the process. Yeast, I should tell you, is a rudimentary plant composed of cells, which, when placed in a suitable medium, actively multiply, living at the expense of the medium in which they exist, and ultimately changing its character. (See Diagram.) This is fermentation, as it occurs outside of living bodies, and is the starting-point of the idea that germs of different kinds—animal and vegetable—are the active agents in the production of zymotic diseases. That these germs *do* exist abundantly in the air, and elsewhere, has been proved by the experiments of many observers, and especially by Pasteur, a French physiologist. [Here describe and show Pasteur's experiments with air and liquids in sealed flasks.]

Pasteur found by experiment that certain changes which sometimes take place in beers and wines, during the course of preparation for use, and which he calls "diseases," are owing to the presence of vegetable germs, every particular change being due to a different kind of germ. Another investigation, which he undertook at the earnest entreaties of his friend and preceptor Dumas, the celebrated chemist, resulted in a discovery which throws interesting light on the same subject, by showing how animal germs may be the cause of a disease among animals of a very destructive and infectious kind. France, a few years ago, was threatened with a great calamity. For fifteen years a plague had raged among its silkworms. In 1852 the silk culture of France yielded a revenue of 160,000,000 of francs; ten years later it had fallen to 4,000,000. Pasteur found that the bodies of the silkworms which had the disease were infected by minute corpuscles, which, taking possession of the intestinal canal, spread thence throughout the body. They filled the silk cavities, the stricken insect often going through the motions of spinning without any material to answer to the act. The organs, instead of being filled with the viscous liquid of the silk, were packed to distention by these corpuscles. On this feature of the plague Pasteur fixed his whole attention, and brought the inquiry to a triumphant issue! By inoculating the healthy worms with the corpusculous matter, he found the disease to be highly infectious. He further showed how the silkworms infected one another by inflicting wounds upon each other by means of their claws. He washed the claws, and found the infecting corpuscles in the water. He next spread the infection by simply bringing the healthy and diseased into contact. The diseased worms sullied the leaves of the mulberry tree among which they spin, and by their dejections spread infection in both ways.*

These observations exemplify in the most striking manner what actually takes place in some of our own zymotic diseases.

Whatever be the difference of opinion as to the precise nature

* (Tyndall—"Dust and Disease.")

of the infecting elements in these diseases, whether they be the rudimentary forms of animal or vegetable life, or merely particles of our own bodies which have acquired a poisonous property which does not naturally belong to them, most are now agreed, I think, that such particles have a veritable existence.

With the limited time at my disposal, I can but give you the briefest account of the proofs that have recently been accumulating in support of Pasteur's views, besides those of many other observers,* that *that* something by means of which infecting diseases pass from one to another, has a real existence, is an organised solid, however minute, which is the absolutely indispensable agent in the transmissibility of these diseases. These opinions mark a great advance in the medical views of the past few years. The phantom of what used to be called an "epidemic constitution of the atmosphere" has ceased to haunt us, while sanitary and medical science are more and more mustering their resources for the utter destruction of those invisible potentialities which are everywhere about us, "both when we sleep and when we wake." Let me illustrate what I have said by means of these diagrams. You see those particles; they are so minute as to require the aid of a powerfully magnifying lens to bring them into view. They are obtained by filtration from vaccine lymph, which appears to our unassisted eye to be a clear fluid. If the lymph without the particles be used to vaccinate, it entirely fails; but if the particles be used without the fluid, it perfectly succeeds. You will better understand what I mean when I tell you that a person undergoing vaccination, is passing through a mild or modified form of small-pox. These particles may be therefore regarded as the virtual agents in the production of small-pox. Similar particles perfectly alike in outward form exist in the lymph of Glanders or Farcy, a most virulent disease which attacks horses, but is communicable to man. A horse inoculated with the fluid, without the particles, would escape, but not if it contained the particles.

In this other diagram you have a view of infecting germs derived

* Obermeyer, Klebs, Chaveau, Burdon Sanderson, Lister, Greenfield

from the vegetable kingdom (Bacillus anthracis), namely, the rod-like fungus of anthrax, a fatal disease, chiefly attacking animals such as the horse and ox, and sometimes man. These infecting particles resemble, as you see, minute rods. They grow into fibres, then fructify, each one producing a number of spores, which are the oval bodies seen in the diagram. In this disease, these germs infest the tissues and blood of the infected animal or person, and live, grow, and multiply at the expense of the tissues and blood. If now the blood containing these rods and spores be filtered, it becomes harmless, that is, it will not infect another animal. But, on the contrary, these bodies will cause the disease in its most virulent form.

This diagram shows a drawing of a section of skin in erysipelas, an infectious disease of a rapidly spreading nature, characterised by great inflammatory swelling and redness (hence named St Anthony's fire). The dotted portions indicate the lymph vessels and spaces, the dots representing minute vegetable spores (micrococci) crowding the spaces. There is no longer any doubt that diphtheria is a disease essentially due to the presence of similar parasitic organisms.

This other diagram furnishes an example of another kind. It exhibits the spirilla of relapsing fever,* sometimes called famine fever, from its occurrence during periods of scarcity. You readily distinguish the organism existing among the blood-corpuscles by its spiral or corkscrew appearance. This fever relapses for a week, then suddenly re-appears for a week, and so on, hence its name. The spirilla is found in the blood when the fever comes on, and disappears when it goes off, and finally disappears, when the sufferer recovers—thus proving its connection with the disease.

Another discovery has lately been made by Professor Klebs throwing much interesting light on the causation of marsh or malarial fever. He found a species of vegetable organism existing in the air of the Pontine marshes, which, when injected under the skin, produced that fever. Further proof of the connection

* Obermeyer.

of these organisms with malarial fever is found in the fact that they are present in the organs, and in the blood of persons who die of marsh fever.

I found rod-like germs abundantly present in the blood of animals attacked with cattle plague, one of the most intensely infectious diseases that ever visited this country. They are delineated in my reports on the subject to the Authorities. So far as I am aware, it was the first time that they were shown to exist in the blood of living animals.* A few facts will better enable you to comprehend the enormous fertility of germs and spores.

Among the larger animal germs, which are visible to the naked eye, and may therefore be counted, the late Mr Buckland found no fewer than seven millions of eggs in a single cod-fish. The Ascaris, an intestinal worm infesting man and other animals, produces about sixty-four millions of eggs; and in the vegetable kingdom some single plants yield over seventy-four millions of seeds in a season. Numerically great as these figures are, they are dwarfed by the greater productiveness of the spores of some fungus plants. They are inconceivably minute—two hundred millions, side by side, would not cover a square inch—yet they possess an inherent vitality, which, under favourable circumstances, will burst into life, reproducing the parent plant from which they sprung. Again, we are told that spores, equal in number to the entire inhabitants of the globe, placed side by side, may easily rest on a space four inches square; and that one million would find ample accommodation on the head of a pin!

Professor Tyndall was the first, I think, to make these facts, viz., the presence of particles in the air, palpable to our senses by an experiment which you can all make for yourselves. He let a sunbeam into a darkened room, through a chink or hole in the shutter. The bright ray revealed the floating dust—for it is a fact that without dust there would be no visible ray. It is the particles of dust that intercept and scatter the light and make it visible to us. A similar effect is produced when

* September, 1865.

a bright ray, for example, from the electric light, or lime light, is thrown across a darkened room. When the flame of a spirit-lamp is then placed under this ray it gives the appearance of smoke passing through it, but there is no smoke from the spirit-lamp, and the black space is produced by the heat of the lamp burning the particles floating in the luminous beam, and for the time being rendering that part void, or empty of particles. The black spot thus produced is said in scientific phrase to be " optically empty."

The experiment may be turned to practical and really useful account, by showing us that these particles may be prevented from entering the lungs. Thus, a handful of cotton is placed against the mouth and nostrils, and a full breath inhaled through it, which is easily done. The cotton is now removed, and the air in the lungs made to pass through a glass tube into the luminous ray, when a dark smoke-like space is seen, as in the previous experiment with the spirit-lamp. This shows that the air is filtered of its particles by passing through the cotton.

DISTINCTIVE CHARACTERS OF INFECTIOUS DISEASES.

Accepting, as we do, the theory that each case of infectious disease originates in the reception of a distinctly specific, pre-existing poison, and that it in turn becomes self-propagating, we now go on to speak a little in detail of each of these zymotics. There are some features which are common to the whole group. They all, for example, begin with a period of what is called "dormancy" or "latency" or "incubation," during which the poison is actively developing. But the duration of this period differs in each case. That of smallpox is twelve days; typhus fever, eight to fourteen days; typhoid fever, fourteen to twenty-one days; scarlet fever, three to six days; measles, about four days. These differences in the length of the incubation period being probably due in each case to the amount and strength of the poison received. At the termination of this period, the sickness is said to begin, although its distinctive character may not appear for some days longer. These fevers

are all ushered in by a marked, and sometimes sudden, elevation of bodily temperature, which, with variations, continues during the course of the illness. It is because of this increased temperature that they are called fevers. Characteristic eruptions now appear. Scarlatina on the second, measles on the fourth, and smallpox on the third day, and so on. Now begins the infecting period, which increases with the activity of the disease.

SMALLPOX.—The patient is now charging the air, and everything about him, with a most subtle and deadly virus, derived chiefly from the skin and mucous membranes, but not restricted to them. There is no contagion so strong and sure, or that operates at so great a distance, passing from house to house, from street to street, making sanitary precautions difficult. I regret to add that cases of this disease, imported from London, are already here.

TYPHUS FEVER once contracted is highly infectious, and essentially a disease of over-crowding and foul air from deficient ventilation, associated with squalor and want, and a deteriorated constitution from whatever cause. It chiefly infects by exhalations from the skin and lungs. The patient's bedding and clothes become saturated, and the poison clings so persistently to the walls, and to everything in the room, as to make the destruction of the latter in many cases necessary.

TYPHOID FEVER differs from the preceding in its being but slightly, if at all, infectious through the air. Here the seat of the attack is the intestinal canal chiefly, and the poison is mainly eliminated by that channel. It is accordingly the intestinal discharges, and clothes or bedding tainted with them, that have to be mainly looked to, and every precaution taken by disinfection and removal, to prevent their access to water sources, such as wells, or into house drains; where, by decomposing, they infect by their effluvia. These discharges acquire their maximum infective power when decomposing.

ASIATIC CHOLERA.—We are fortunate in this country in being rarely visited by this Oriental epidemic. The precautions are the same as in typhoid fever—the source of danger being alike in both cases. It is astonishing how small a quantity of intestinal discharge in these disorders, especially in cholera, will taint the water supply over a large area, which may mean death to thousands. Dr Farr estimates that in cholera, if these fluid discharges contain infecting particles in the same proportion as blood corpuscles exist in healthy blood, forty-two millions of them would be set adrift during the progress of a single case.

SCARLET FEVER.—There is perhaps not any other illness that you are all more painfully familiar with than this fever. It is a household experience, a troublesome one, which is regarded very much as inevitable.

Although no age is exempt, it is essentially a children's illness —attacking mostly between the ages of three and four, and the risk lessens after the fifth year. Its poison is most active and penetrating, and retains the power of infecting for indefinitely lengthened periods. As nearly all the fluids and tissues participate in the attack, they may all infect,—the skin by casting its outer surface, the internal membranes by a like process, tainting the secretions. Isolation, that is separation, is a necessary part in the treatment of this fever. The worst cases are associated with malignant sore-throat, which so far brings it into relation with another very infectious malady, viz., DIPHTHERIA, the seat of which is chiefly the throat and upper air passages, and the infecting channels, the breath and expectoration. I have said that these disorders are all marked by increased bodily heat. This is, however, but one of the many symptoms which signalizes their course. In most the heart's beats are doubled; the blood courses along the vessels with redoubled velocity; the respirations are doubled. The whole vital machinery is working under its highest possible pressure. Bodily waste is more than doubled. In ordinary health our bodily substance breaks up, and is parted with

at an expenditure equal to several pounds' weight per day; but during the febrile state health limits are vastly exceeded.

I leave you to draw your own conclusions as to the consequences which must follow to others, when this enormous amount of infective material is daily set adrift—for we must remember that our waste and *effete* materials, under these conditions, become charged with the virus of the disease!

I wish now to say a few words on what has been fittingly named—

THE BREEDING PLACES OF INFECTIOUS DISEASES.

For this purpose I select some of those localities from which these diseases are never altogether absent, and from which they usually go forth upon the rest of the community. Examine with me for a little these diagrams:—Of these six columns, the shortest represents the healthiest district, the tallest the unhealthiest, showing the extreme of six districts existing in different parts of a neighbouring city. The upper portion of each column represents the number of deaths from the infectious diseases which occur in each of these districts; the middle portion, the number of deaths resulting from pulmonary diseases, mostly consumptive; the lower portion, the deaths from what is called "unclassified" diseases. Now, notice that the rate of deaths steadily increases; thus, in the district represented by the shortest column, the inhabitants are aggregated together in the proportion of thirty-five persons to every acre of it, and its death-rate is nineteen persons per thousand annually. In the next they are aggregated together in the proportion of four hundred and twenty-six persons to every acre; and its death-rate is thirty-five persons per thousand annually. In the third, their aggregation is in the proportion of four hundred and fifty per acre, with a death-rate of thirty-eight per thousand. The fourth, the proportion is three hundred and fifty per acre, and the death-rate forty-one per thousand. The fifth is, three hundred and fifteen per acre, and a death-rate of

forty-three per thousand; and, sixthly, in the highest column, they are aggregated together in the proportion of five hundred and eighteen, with the death-rate of forty-five per thousand. The fourth and fifth are only *apparent* exceptions to the rule of an increasing death-rate with an increasing density of population. The inhabitants of these districts, although fewer, are more densely huddled together.

Look now, for a moment, at the composition of each of these columns, and you will observe that the death-rate from infectious diseases, not only steadily increases with the density of its population, but also that from pulmonary and "unclassified" diseases. These groups are represented in different colours, and will assist you to form a juster conception of the dangers resulting from over-crowding.

The credit of working out, and applying this important law of death-rate to density, belongs to Dr Farr.

Taking the five hundred and ninety-three registration districts into which England and Wales (not including London) are divided, he arranges them into so many groups according to their densities, beginning with the most thinly populated rural district, with only a hundred and sixty persons to the square mile, and ending with the most densely packed town districts, as Glasgow and Liverpool, with over sixty thousand on each square mile. Let us now, with the assistance of these other diagrams, note the results.

In the district with	166	on each	square	mile	there is a	death-rate of	17	p. 1000
,,	,,	379	,,	,,	,,	,,	22	,,
,,	,,	1718	,,	,,	,,	,,	25	,,
,,	,,	4499	,,	,,	,,	,,	28	,,
,,	,,	12,357	(Manchester)		,,	,,	38	,,
,,	,,	66,000	(Liverpool)		,,	,,	39	,,

Glasgow, with a density of population nearly similar to that of Liverpool, has a much lower death-rate, thanks to the enlightened exertions of its able health officer.

How comes it then, that persons living in thinly-peopled rural districts (165 to the square mile), die annually in the proportion

of 17 per 1000, while those of Liverpool perish in the proportion of 39 per 1000? What is the cause of this greatly increased mortality? I cannot answer this question better than by quoting the words of the accomplished Medical Officer of Glasgow, Dr Russell, to whom I have just referred: "Density," he remarks, "means, in relation to Glasgow, that three-fourths of those human beings live in houses of one and two apartments, that those houses are built in tall tenements, so arranged on the earth's surface as to exclude the sunlight and impede the circulation of the air, more especially that a large proportion of those tenements are arranged in hollow squares. . . . It means that inside those boxes there are ash-pits, . . . that planted among those ash-pits we have hundreds of 'back lands,' along with stables, byres, bake-houses, work-shops, washing-houses, and other smoke and effluvia producing erections, that the stairs are often close and badly ventilated, that they are at best vertical streets, with lanes and alleys branching off at the several landings. . . . It means that hundreds of factory chimneys and thousands of domestic vents, maintain over all this devoted area a dense canopy of smoke, which in summer cuts off a large proportion of the sun's rays, an extra supply of whose decomposing energy ought if possible to be secured to aid in the destruction of the organic particles which are so rife in the air of cities, and which, in the winter, descend upon us with the watery vapour of our fogs. . . . Our rivers and streams are loaded with the foulest refuse, that the subsoil is traversed by a net-work of sewers, drains, and gas-pipes, and is therefore so impure that the ground air is loaded with noxious effluvia, and the ground water is so foul that to drink it would be poisonous, if, indeed, it could be done.

"Finally, it means that for grassy fields we have stony streets, and in place of trees we have lamp-posts, and altogether we are as far shut out from the ministry of nature as the necessities of the case, combined with the aggravations of human ignorance, perversity, and wilful self-aggrandisement, can place us."

We have now to speak of

THE CONDITIONS UNDER WHICH INFECTIOUS DISEASES SPREAD.

The Carriers of the Infection.—We have seen how readily infecting germs may be dispersed, wafted by the air, carried by water, tainting our clothes, our money, and the commodities given in exchange for it. The mutual dependence of class upon class, and their unavoidable concourse, the relationships of life, as well as its vicissitudes and necessities, all tend to bring people together—in short, the entire machinery of society such as we find it, is peculiarly adapted to spread infectious diseases.

There can be little doubt that the spreading of these diseases, in the majority of cases, is brought about by the healthy coming into contact with the sick or convalescent. Children after an attack, are allowed to go back to school too soon, and the result is renewed outbreaks of scarlatina, measles, and whooping-cough. The laundress disseminates the poison of scarlatina and smallpox amongst her employers; nurses carry it from sick-beds to their own homes; the tailor and dressmaker often ply their needles close to fever-stricken patients. One doctor writes that he has seen the garments, which were thus being made at their homes, used to eke out the scanty bed-covering of a fever patient; another, that he received a patient into hospital with smallpox pustules on him, who had on the previous day been occupied in dressing ladies' hair. I myself lately entered a house of one room with eight occupants, five of whom were laid down with scarlatina. In the midst of this, the father, an enfeebled man, was trying to earn a little money by working at a couch which ere many days would too surely carry disease into some household. These persons have our deepest sympathy, and if we speak of their hard necessities, it is in the hope, and with the earnest wish that we may be able to mitigate, or remove them.

Let us vary the illustration by another example. The milk-cans, we shall suppose, at a farm-dairy have been unwittingly

washed with water contaminated with sewage; or, perhaps, a little of that element has been added to improve its quality!—then follows what is significantly called "the trail of the milk-man"—a trail marked by fever cases in perhaps every house to which the milk has been distributed.

Or there is a fever at one of our town dairies, in the back-room of the shop, for example, and the attendant on the sick also attends to the customers, who carry the milk to their homes, and with it the germs of future disease. This diagram will assist you to realise more vividly what I have just said. It represents a farm-house in which typhoid fever has arisen, by the milk becoming tainted in the way I have spoken of. This dot marks the first case which arose in consequence.

Observe how the disease spreads from this starting-point. This other dot shows the second case, which arose in nineteen days from the first, and this, the third, in twenty-six days from the first —all in the same house; but in fourteen days from the first case, a group of three cases occurred in a family, supplied with milk from this farm, and within eight weeks from the first case, a hundred and sixty-six persons were laid down with the fever.

Look now at this diagram, illustrating the growth of an epidemic of scarlet fever, from a single case.

It is a moderate estimate of the rate of progression of this fever, to say that each case produces two others. Follow these dots from the starting case, and in seven weeks from its commencement, you will see that the one case has multiplied into two hundred and fifty-six. Once more, study with me this diagram marked cholera. I have said that this disease is propagated by water, fouled by choleraic discharges. Estimating that each case produces five others, a ratio which may be taken as considerably under its usual rate of progression, there would arise six hundred and twenty-five cases within eight days. Several instances of this actually occurred during the cholera epidemic of 1866.

The presence of an epidemic of small-pox in London, and the certainty of its early advent amongst ourselves, lead me to

invite your very special attention to this other series of diagrams, which exhibit in the most convincing and instructive manner, the influence of vaccination in preventing and modifying that disease under different conditions and periods of life. They show the results, based upon a most painstaking and successful investigation, of a thousand cases of small-pox, treated in hospital during 1871, by Dr J. B. Russell. The diagram, as you observe, is divided into large squares, each being subdivided into one hundred smaller squares, so that each large square represents one hundred cases of small-pox. The colouring again, whether black, red, or white, tells you the degree of severity with which each case was affected. Those portions of the squares in *white*, show how many were attacked with the mildest, or *seldom fatal form of the disease* (with rare or sparse eruption). Those in *red* indicate intermediate, or *frequently fatal conditions of the disease* (copious eruption); while the *black* marks the dangerous, or *very fatal type of the malady* (confluent eruption).

The upper row of squares, from left to right, shows the effects of vaccination—between the periods of infancy and adult life—when *well done*; the corresponding middle row, its effects when *badly done;* and the lowest row, when *not done at all.*

By glancing at the diagrams in this order, you will at once observe, that the well-vaccinated, as they grow older, take the disease in a slightly severer form; the badly vaccinated in a much more severe form; and those who have not been vaccinated at all, are *throughout their whole lives*—from infancy upwards—subjected to the very worst and most fatal form of the disease. In other words, you will not fail to draw the inevitable conclusion, "that the influence of vaccination, well and thoroughly done, extends, with but little loss of protecting power, throughout life; while, if badly or imperfectly done, it is never so efficient a protective power, gradually loses what protecting power it had possessed, and finally leaves the badly-vaccinated individual

only a little less susceptible than he who has never been vaccinated at all." *

Each of these infectious fevers grows and spreads by conditions peculiar to itself, which depend, to a considerable extent, on the length of its incubation period.

The two first of these diagrams show sufficiently well the manner in which the recent epidemics in Edinburgh of typhus, typhoid, and scarlet fevers began, and spread; as also nearly the numbers affected, and the duration of the epidemics.

We have now to speak of

THE MEANS NECESSARY FOR THE CONTROL AND PREVENTION OF INFECTIOUS DISEASES.

The instructions intended for your guidance in emergencies which I have drawn up, based on my lecture,† are, I understand, already in your hands; and I am thus so far relieved from many details, which it would otherwise have been desirable for me to touch upon. I will ask you then to hold that part of my lecture as read; and I will now proceed in a few brief sentences to enumerate those measures for the effectual control and prevention of epidemic disease which I consider to be necessary.

Firstly, We must aim at the promotion of cleanliness of every description, by the employment of those legal powers contained in public health enactments, which are amply sufficient for the purpose if carried out.

Secondly, At placing all building operations—such as the construction of houses, selection of healthy sites, house and general drainage—under strict sanitary inspection and supervision.

Thirdly, At preventing over-crowding, alike in dwellings or in districts. This measure comprehends the constant inspection of houses, the width of streets, the height of houses, the removal of old and insanitary dwellings, the promotion of open spaces,

* Lectures on the "Prevention and Control of Infectious Diseases," by Dr J. B. Russell.

† See Appendix.

and the opening up of thoroughfares through dense and insanitary neighbourhoods. Thanks to the efforts of our late Lord Provost Chambers, a good beginning has been made in this direction in this city.

Fourthly, It will be found utterly impossible to prevent infectious diseases without a more stringent act in regard to their registration. *Nothing short of the compulsory registration of these diseases will effect this end.* To prevent their spread it is essential that the authorities should be early apprised of the existence of every case.

Fifthly, Following from this the authorities should be entrusted with the discretionary power of compulsory removal. This power will never be abused; and,

Sixthly,—Such powers imply, and, indeed, necessitate, on their part, the providing of ample accommodation for the reception of infectious diseases, as will suffice to meet the emergencies of epidemics; for the reception of actual cases, convalescent cases, suspected cases; and further, for the reception of patients who may voluntarily desire to be treated in hospital. There are many such, who, though comfortably circumstanced in their own homes, would gladly avail themselves of this provision. It may interest you to know that the late Sir James Simpson expressed his determination to be treated in hospital in the event of his suffering from an infectious illness. All such arrangements would require to be carried out in a liberal interpretation of the acts. For example, the greatest difficulty is experienced in the removal of children, from the unwillingness—a natural one—of mothers to be parted from them during their illness.

Mothers, under certain restrictions, should be admitted to the hospital to nurse their own children.

It is proposed to acquire the ground and buildings of the old Royal Infirmary as a hospital of this kind, under the entire control of the civic authorities. This is a step in the right direction.

We enjoy the services of an able and energetic medical officer, whose heart is in his work—but without such powers and provi-

sions as I have indicated, the best efforts of the authorities and of their medical officer will fail of their object.

I have only, in conclusion, to add that it is most desirable to have our people thoroughly informed in regard to sanitary matters, in order that they may heartily and intelligently assist in promoting what is really necessary for their own and their neighbours' good.

To further this desirable movement has been, I know, the cherished object of the promoter of these "Health Lectures for the People."

At the close of the lecture Dr Smart showed Professor Tyndall's experiments by means of the lime-light.

APPENDIX.

ON PREVENTABLE DISEASES AND THEIR CAUSES.

GENERAL PRECAUTIONS.

1. The following preventable diseases (called also zymotic) are all *infectious*. The chief of these are :—Scarlet fever, typhoid (or enteric fever), typhus fever, smallpox, measles, diphtheria, whooping-cough, and Asiatic cholera.

2. When any of these illnesses (except whooping-cough) enters a household, the patient should be, if possible, at once separated from the rest of the inmates (especially from the bread-winners); the children who are in health kept from school, and as much as possible from mixing with other children.

3. The sick-room to be divested as much as possible of every article of needless furniture, especially of woollen fabrics, such as carpets, curtains, cushions, &c.; to be well ventilated by means of a fire constantly burning, and the strictest cleanliness observed.

4. A large vessel (a tub) to be kept in the room, containing a couple of gallons of water mixed with carbolic acid, in the proportion of one wine-glassful of the liquid acid to each gallon of water. Into this, every article of clothing, bed-clothes, &c., removed from the patient, should be immediately plunged, and kept there for twelve hours, and then washed apart.

5. A basin containing water, having two tablespoonfuls of Condy's Fluid added to it, to be always in readiness for cleansing the attendant's hands, or sponging the patient when necessary. This solution should be renewed when it is seen to lose its bright purple colour.

6. A sheet dipped in the carbolic solution named, should be hung over the door of the sick-room, reaching to the ground, and kept constantly damp by means of sprinkling or a sponge. Only the attendant to enter the sick-room.

7. The dress of the attendant should be of cotton, or of some washable material, with smooth surface.

8. Food that has been in the sick-room, on no account to be used by the other inmates. It is desirable for many reasons, that the attendant do not take her meals in the sick-room.

9. Dishes, and vessels of every kind used about the patient, ought to be thoroughly cleansed before being used by others.

10. *All* discharges from the sick to be received into vessels containing disinfectants (Calvert's or Macdougall's Carbolic Powder), and, if convenient, deposited in the ground to the depth of about two feet. If disposed of by w.-c., it should afterwards be freely flushed with the carbolic solution.

SPECIAL PRECAUTIONS.

SCARLET FEVER.

11. To prevent infection by the particles which peel off from the skin, the patient should be anointed once a-day with carbolic oil, made with one part of carbolic acid, to fifty of olive oil. The efflorescence (or peeling off) is first seen on the skin of neck and arms, and begins sometimes as early as the fourth day. The anointing should be complete, including the head, the oil being freely applied to the roots of the hair. This should be continued for six weeks, a warm bath being given weekly during that time. After this period (six weeks), the patient may mix with the other members of the family; but children should not return to school for two weeks longer.

MEASLES.

12. The same rules as above to be observed, with the addition that the discharges from the mouth and nostrils should be received on cloths which may be destroyed by burning.

TYPHOID FEVER.

13. The poison by which this fever spreads is chiefly contained in discharges from the bowels. These may infect the air of the sick-room, the bed, and body-linen of the patient, and the w.-c. and drains connected with it. If thence they escape to the soil by soaking into wells, they poison the drinking-water. This is a common and dangerous way by which this fever spreads. To prevent such consequences, the discharges should be disinfected on their escape from the body as previously directed. This is the *chief* precaution to be attended to, and if effectually done, removes almost all the risk of infection.

TYPHUS FEVER.

14. This is a much more "catching" fever than the preceding, and is caused by over-crowding and deficient ventilation. It is apt to attack those who are much exposed to it for the first time. It is therefore better to have a nurse who is protected by a previous attack. The poison is thrown off by the skin and lungs and readily infects clothing, furniture, etc.; so that the chief precautions are those of ventilation and disinfection.

SMALLPOX.

15. The perfect protection from this disease is *efficient vaccination.* This is known by a *good large mark*, or *scar*. Re-vaccination after the fourteenth year is advisable. An unvaccinated case of smallpox in Scotland is so rare, that precautions in regard to it are needless. Should such a case occur, the precautions already named should be most strictly adhered to, as it infects at a greater distance than any other infectious disease.

DIPHTHERIA.

16. Diphtheria poisons by means of the breath and expectoration ; and the utmost precaution to avoid contact with these on the part of those about the patient is absolutely necessary. The expectoration should be received into a vessel containing Condy's Fluid, or on cloths that may be at once burnt ; and the throat frequently gargled with a solution of the same, of the strength of a small teaspoonful to a quart of water. A mother should on no account kiss her children during this, nor, indeed, any of the other infectious illnesses.

WHOOPING-COUGH.

17. Whooping-cough is a disease to which children are more especially susceptible, and most fatal to children under two years of age. It is so extremely fatal to infants, that every effort should be made to keep them out of the range of the infection by separation. The poison comes chiefly from the mucous secretions of the lungs and air passages, and is readily imparted to the clothes of those who nurse the patient. These secretions are infectious from the beginning of the illness.

ASIATIC CHOLERA.

18. This only occasionally visits this country. As in typhoid fever, it spreads by means of the bowel discharges ; and the same precautions are necessary.

GENERAL STATEMENTS.

19. In any of these infectious diseases, where there is not sufficient accommodation for fully carrying out these precautions, it is urgently recommended that the patient be removed at once to the Hospital appointed for the reception of such cases. It need hardly be added, that no time should be lost in obtaining medical advice when any of these diseases appear.

20. We abstain from giving directions as to the disinfection of a house either after death or recovery, as the authorities gratuitously and efficiently do this when applied to ; besides making ample compensation for any articles of furniture, &c., they consider it necessary to destroy.

*Microscopical Examination of Dust suspended in the Air.**

INTERNAL (OR WARD) AIR.

1. *Epithelium from the Mouth.* 2. *Ditto from the Skin.* 3. *Mineral Dust.* 4. *Flax Fibre.* 5. *Striped Muscular Fibre.* 6. *Animal Cells.* 7. *Cotton Fibre.* 8. *Unstriped Muscular Fibre with Fat Globule adherent.* 9. *Fungi and Spores.* 10. *Woollen Fibre.*

EXTERNAL AIR.

1. *Epithelium Cell from the Mouth.* 2. *Ditto Scales from Skin.* 3. *Linen Fibre.* 4. *Mineral Dust.* 5. *Cotton Fibre.* 6. *Hair.* 7. *Woody Fibrous Tissue.* 8. *Woollen Fibre.*

VEGETABLE DUST.

1. *Linen Fibre.* 2. *Hemp.* 3. *Cotton.* 4. *Pine Wood.*

MINERAL DUST.

1. *Flinty Granules with sharp edges.* 2. *The same with edges rounded off.*

* *The examinations of the Ward and External Air were, at the author's request, kindly made by Dr Wood, House Physician, Old Royal Infirmary; to whom he is also indebted for the accompanying Sketch.*

LECTURE II.

It would, doubtless, have added to the interest of the subject, had the limits of my topic allowed me to include, however briefly, some notice of those occupations which we are accustomed to speak of as the "professions." It could not fail to interest, as well as instruct you, to know why our Divines, by which I mean the clergy generally, pre-eminent by their learning, eloquence, piety, active benevolence and public spirit, should add the further distinction of being the longest lived; or why the legal profession, in its different branches, certainly, not less eminent in this metropolis, by their great talents, learning, literary tastes, solidity of judgment, forensic skill, and unique business capacity, should rank only second in the enviable possession of longevity. Or again, curiosity, if no other motive, might prompt in you the wish to know why the average life of the medical man should fall so considerably short of that of the preceding. But these professions and other interesting occupations do not come under the designation of "unhealthy," to which category I am restricted. But let me say, that, apart from them, I find that my theme is sufficiently—if, indeed, not too ample. And there is this further drawback, that the subject has not hitherto received, at least in this country, the attention to which its importance entitles it.

We are, accordingly, almost without any reliable statistical data or facts.* I am therefore obliged to seek for them else-

* Thackrah's work, published in 1833, is not based on statistical data.

where, and to construct and arrange the evidence upon which I wish all my statements to rest.* Should I, in doing so, tax your time, or tire you with calculations, I must bespeak your indulgence; but it shall be my endeavour to avoid this.

Nearly all trades and manufacturing processes are attended by the evolution of dust, or of volatile particles, more or less considerable and more or less hurtful.

Persons habitually breathing a dust-laden atmosphere of this kind, acquire a liability to diseases of various sorts; but as the inhaled dust is necessarily, in every instance, brought into contact with the lungs, it is accordingly the pulmonary organs that chiefly suffer in the end. I propose, in this lecture, to direct your attention, as fully as time will permit, to the injurious effects of certain occupations upon the health of those employed in them; and, to enable me the more succinctly to do this, I shall state what I have to say under the following heads :—Firstly, the effects of metallic dust; secondly, the effects of mineral dust; thirdly, the effects of vegetable dust; fourthly, the effects of animal dust; fifthly, the effects of certain gases and volatile emanations; sixthly, the effects of constrained bodily position, conjoined with defective ventilation; seventhly, the effects of dust from poisonous metals; and eighthly, certain considerations as to the prevention of these effects.

Metallic dust is of different kinds; and we shall speak first of that which is emitted during the processes of iron and steel working. You have all, doubtless, curiously watched the operations of the street scissor-grinder as he plies his vocation. Each time the blade touches the swiftly revolving wheel, the grinder's head, as he bends over it, is enveloped in dust and sparks. Now, this peripatetic steel-grinder encounters no risk from his occupation only because it is carried on out of doors; but were you to enter one of the busy workshops of Sheffield, and, for a time, amid the turmoil of machinery, attempt to breathe its stifling atmosphere, charged with minutely pulverised dust, emitted by hundreds of wheels, you would have a practical experience of the cause why few, if even one, of all the workers there will ever reach their fortieth year.

* Vide appended Tables.

Take the following examples. The average duration of life among the dry-grinders of forks is twenty-nine years; of razor-grinders, thirty-one years; edge-tool grinders, thirty-two years; spring-knife and file-grinders, thirty-five years; and saw and sickle-grinders, thirty-eight years.

The cause of this excessive mortality will be apparent, if you will now examine this table of figures. It shows that in every hundred sick among the needle-makers, seventy are consumptive; and that among the file-makers, sixty-two in the hundred are consumptive; and, taking the steel-grinders all round, rather over forty in the hundred are consumptive.

It is a recognised fact that, in these particular branches, the quantity of dust is not only excessive, but finely comminuted, and the amount of injury inflicted by it, is, on that account greater. The effects of metallic dust on the lungs are, in the first instance, only mechanical, but afterwards, by their continued irritation of the organs, ulceration is induced, which terminates in consumption.

The next group of workers, includes those who are exposed to the action of copper-dust. It comprehends the lithographers, moulders, engravers, &c.; and it will be observed that, while the hurtful effects of the inhaled dust of this metal are more uniformly distributed over each class, consumption is here also, as among the steel-grinders, the predominant disease.

In every one hundred sick lithographers, one half nearly is consumptive (48·0).

The moulders and watch-makers have each thirty-six, and the engravers twenty-six cases of consumption per hundred. The average duration of the life of the entire class is about forty-eight years.

Lead-miners, painters, plumbers, workers in white lead, and occasionally compositors, and all who work with lead, are exposed to the risk of poisoning by that metal. The symptoms generally are those of some form of paralysis.

The most frequent and best known of those kinds of paralysis are lead-palsy, painters-colic, and wrist-drop. White-lead is that form of the metal most generally used. It is the chief ingredient in paint, and largely enters into the composition of enamel-colours

enamels, and glazes. The glazing, which is, as you are aware, an important branch of industry carried on in potteries, is often attended with serious consequences. And in the enamelling arts, in which lead is used, there is always considerable risk to the operatives.

By comparing the table which shows the effect of lead dust as a cause of consumption, you will observe, that it is less productive of that disease than are the effects of copper dust.

It is, nevertheless, the cause of an excessive mortality. Thirty-four type-founders, and twenty-five each of the dyers and enamellers die of it in every hundred of each class. The painters and printers follow with a mortality of twenty-four and of twenty-one per hundred respectively.

The average life of this class is probably not over forty-eight years.

We now turn to the second head of our subject:—

THE EFFECTS OF MINERAL DUST.

The table under this heading furnishes a list of the chief industries, in the carrying on of which the workmen are injured by the dust—in this case mineral—emitted during the manufacturing processes.

Notoriously over-topping all the other dusty occupations in their effects upon life and health, are those of the grind-stone makers, flint cutters, and glass polishers.

The conditions, under which their work is carried on, are, in the highest degree, favourable to the production of pulmonary disease.

They work in an atmosphere loaded with sharp spiculæ, which lacerate the lungs, and quickly induce consumptive disease.

Every grind-stone maker is cut down with it at, or soon after, the age of twenty-four. Hardly one escapes.

The flint-cutter and glass-polisher have each eighty deaths, per hundred sick, of consumption, and their average life is under thirty years. Again the stone-cutters—a term equivalent to that of our stone-masons (not builders), terminate their average life at the age of thirty-six years—thirty-six, in every hundred sick, being consumptive. A glance at the rest of the column will

at once inform you what occurs to the artificers employed in the other branches of this same group.

THE EFFECTS OF VEGETABLE-DUST.

The occupations, which are productive of vegetable-dust, include a somewhat promiscuous and apparently incongruous variety of workers. Among these we have the cigar-maker, and the tobacco and snuff-worker. Although they enjoy an average life of fifty-five years, they nevertheless, head the list with thirty-six cases of consumption in every hundred. This unexpected result is, doubtless, owing chiefly to the irritant effects of tobacco-dust on the lungs; but in some degree, I am of opinion, to the chemical ingredients superadded during the manufacturing processes. Amongst the different classes of workers in textile fabrics, the weavers, engaged in the cotton, flax, and hemp branches, are unquestionably the chief sufferers. The mortality from consumption, at one period, was so great as to lead the Privy Council to inquire into its causes. Dr Greenhow, who undertook the investigation, showed that it was during the preparatory processes, that most dust was given off, and the greater amount of disease engendered. These processes are known as "hackling," "carding," "sorting," and "dressing." *

It is stated, on the best authority, that three-fifths of the flax mill-workers of Belfast—the chief centre of that textile manufacture—are consumptive. In other words, sixty in every hundred die of that disease.†

The average life of the weavers of this restricted class is forty-four years, whilst that of weavers in general is about fifty-seven.

Carpenters, joiners, and cabinet-makers, are affected by their dusty occupations—each group having fourteen consumptive cases in every hundred. These facts afford conclusive evidence that their work is considerably less hazardous than that of the stone-masons. I find it generally, but erroneously stated, and taken for granted, that the risks of the former class are equal to those

* Vide Report of the Medical Officer of the Privy Council for 1858-60.

† Vide Essay on Health of Belfast by Dr Purdon.

of the latter. The average length of the lives of the two classes respectively is a further proof of this mistaken view—that of the carpenters, joiners, and cabinet-makers being forty-nine years, as compared with thirty-six years of the stone-masons.

Compare now the operations carried on by the flour-miller with that of the grindstone maker, or of the needle-grinder. The atmosphere of a flour-mill is, certainly, much more dusty than that of the workshop in which grindstone making or needle-grinding goes on, but you will not fail to mark the great disparity in the effects of the different sorts of the dust. In every hundred of sick millers, ten are consumptive, and his average life is forty-seven years.

The bread-baker is on a parity with the miller as regards his average length of life, but his occupation is less productive of consumption.

While flour-dust is not, in these occupations, a sufficiently powerful factor to make consumption the predominant malady, it, nevertheless, conspires with the unfavourable surroundings of the workmen to produce other ailments scarcely less mischievous. Thus the miller, owing to the draughty nature of the premises in which he is accustomed to work, together with the irritation induced in the lungs by the inhaled flour, contracts a liability to acute inflammation of the pulmonary organs, from which, his class suffers in the proportion of twenty in the hundred. The baker again, immured for the most part in an underground workshop, for twelve or fourteen hours a-day, in an over-heated air, laden with flour-dust, often tainted with the poison of coal or sewer-gas, acquires a liability to acute disorders of the air-passages—chiefly bronchitis, in the ratio of thirty in the hundred. This, in his case, becomes the predominating and fatal malady. It is interesting and instructive to notice the last-named occupation on this table.

It is generally believed that the coal-miner's occupation is one most highly productive of pulmonary disease, and on that supposition, when consumption occurs in the coal-miner, it is designated "miner's-phthisis." I feel bound to state that in my experience—hospital and otherwise—I have not been able to confirm this prevalent belief, nor do I believe it to be well-founded.

In every case of so-called "miner's-phthisis" which I have seen, there has been a distinct family-history of the disease.

A man predisposed hereditarily to consumption, developes it, not more readily as a coal-miner, than in any other employment. The black expectoration seen in miner's consumption, proves no more than that the coal-dust has reached the lungs—certainly not that it is the cause of the disease. Coal-dust—or, to call it by its proper name—carbon, from its highly antiseptic properties, acts as an excellent protective to the pulmonary organs. The figures on the table very strikingly corroborate this view. You will notice, perhaps with surprise, that among twelve hundred sick miners, only one case of consumption occurs!

THE EFFECTS OF ANIMAL-DUST.

Animal-dust is evolved in the processes of brush-making and hair-dressing, in the operations carried on by the skinner, tanner, and hatter; and in those of the button, harness, and clothmakers.

I allude, of course, to these occupations as they are carried on upon a great scale in large manufacturing centres, where there is machinery, and where workmen are massed together in large bodies under one roof.

In such a city as this, with its limited and well-regulated industries, it is difficult to one, not directly conversant with their details, to realise what such operations really imply. When, for instance, I name hair-dressing as one of the occupations of the present group, the term is intended to include all the processes connected with the preparation of hair for its artistic and commercial uses. So that the name, in this connection, suggests little, if anything, in common with the comparatively healthy avocation of the perfumer and hair-dresser familiar to us. I may as well remark here, to prevent misunderstanding, that this statement applies generally to all the occupations now under consideration. We have already observed that the excessive mortality prevailing among the cotton, flax, and hemp-weavers, has its origin chiefly in the irritation induced by the contact of shreds of these substances with the lungs.

We have all experienced, I suppose, the trouble which a

hair causes when lodged in a sensitive part of the air-passages; and how much greater the discomfort if it happen to be a bristle from a tooth-brush. Now, if we hold in remembrance, that it is owing chiefly to the action of sharply cuminated particles from bristles that the brush-maker is exposed to, the fact will sufficiently account for his high death-rate of forty-nine in every hundred, from consumptive disease.

The hair preparers—for that is their proper designation—have also a large proportion of deaths from consumption; the number being thirty-two per hundred. To those exposed to the effects of inhaled animal dust, there is moreover, the additional risk of poisoning, derived from the diseased animals from which the hair has been taken.

There is a special liability in some of the lower animals to be attacked by a very fatal and contagious malady called anthrax. Should the hair of the infected animals unfortunately find its way into the market, and thence to the hands of the wool-sorter, he is certain to be attacked by the disease, and equally so to die of it. Special attention has lately been given to this disease, and much light thrown upon it in connection with the occupation called wool-sorting.*

THE EFFECTS OF GASES AND VOLATILE EMANATIONS.

Asthmatical and bronchial affections are those induced by inhaled gases of an irritant character. When, however, such occupations are associated with a sedentary posture and confined air, they induce considerable consumption. Thus, straw-hat makers, who are mostly women, are exposed to the fumes of sulphurous acid; and jewellers, in the refining processes, to nitrous acid vapours. Consumption, in both, prevails to the extent of eighteen in each hundred; and inflammation of the lungs (pneumonia) to the extent of eight in each hundred.

Bleachers are exposed to chlorine gas and alkaline vapours. As a class they are not generally healthy, but their average life is comparatively good, being fifty-eight years. The operations

* We are indebted to the careful researches of Professor Greenfield for much of what we know of this disease.

connected with soap boiling, tanning, parafine-making, and candle-making, belong to this class. On account of the disagreeable odours emitted, they are, in the Public Health Act, designated noxious trades. It is remarkable that these occupations have, from time inmemorial, and in all countries, ranked amongst the healthiest of the industrial employments. The average life of the workers is over sixty years.*

Will you notice that, in one hundred sick among the charcoal burners, there are only two consumptives. This is the next lowest death-rate to that of the coal-miner; and for the reason previously mentioned, that the carbon is protective to the lungs. Parafine-makers, although exposed to powerful vapours, enjoy a similar remarkable immunity from consumptive disease. This is accounted for by the antiseptic properties of parafine.

Of those who are affected, not so much by dust, as by

THE EFFECTS OF CONSTRAINED BODILY POSITION CONJOINED WITH DEFECTIVE VENTILATION,

we restrict our attention to three well-known classes. These are, firstly, the needle-women of every class, including milliners and dressmakers; secondly, tailors; and thirdly, shoemakers. Their surroundings in their essential features are alike; they all work under the disadvantages of a sedentary and constrained bodily posture, in over-crowded and ill-ventilated work-rooms. They are but little addicted to out-door exercise, and their habits of dieting are extremely faulty. From their excessive tea-drinking, they are, with few exceptions, confirmed dyspeptics. Pale in complexion, spare in bodily condition, they age prematurely. The women are afflicted with anœmia, which means the loss of red blood, giddiness, palpitation, shortness of breath, weak and trembling limbs, and, generally, the complete suspension of those functions upon which their health and usefulness depend. These symptoms, for the most part, terminate in consumption, unless their occupation is timeously relinquished. The conditions under which they carry on their respective employments, are so analogous that we

* It is mentioned, as a matter of history, that during the plague called the "Sweating Sickness," tanners, curriers, and such as were employed in unpleasant smelling businesses, all escaped infection.

should expect each class, in a nearly equal degree, to suffer from the same maladies.

The results of a perfectly independent inquiry into the case of of each class, remarkably corroborate this anticipation, as you may readily satisfy yourselves from the appended tables.

The tailors and needle-women, you will observe, have each nineteen deaths from consumption per hundred sick. The shoemakers fall short of that number only by a fraction, being 18·7.

Under the head of

THE EFFECTS OF DUST FROM POISONOUS METALS

are included workers in phosphorus, in mercury or quicksilver, and in arsenic. Lucifer match-making is the sole occupation which exposes those who work at it to the action of phosphorus fumes. The inhalation of phosphorus vapours is productive of a frightful disease, namely, death of the jaw bone, necessitating its removal by a severe operation.

The prevalence of this disease led, some years ago, to an inquiry into its cause, with the result, that a different kind of phosphorus (amorphous), unaccompanied by these effects, was substituted.

The average life of the lucifer match-maker was formerly as low as forty-four years. Work people much employed in the use of mercury or quicksilver in the arts, are liable to a peculiar kind of paralysis, with salivation, tremors (called "trembles" by the work-people), and stammering. Chief among those affected in that class are the water-gilders, when an amalgam of gold and mercury is used. This process is now happily superseded by electro-plating; while, at the same time, recent improvements in looking-glass making, further permit that branch of the art to be carried on with comparative immunity.

The leading sufferers from mercury are now those who work in the quicksilver mines.

Mercury, although a ponderous metal, is, nevertheless, volatile at ordinary temperatures. Every fourth man accustomed to inhale its fumes dies consumptive, and the average life of the quicksilver miner is forty-seven years.

Arsenic, besides being an invaluable medicine in the hands of

the physician, is much prized in many of the arts for the great brilliancy and cheapness of the colours made from its salts.

The chief of these is that pigment popularly known under the names of Emerald-green, Brunswick, or Vienna-green. This pigment is of two kinds, known to the chemist, the one as Scheele's, and the other as Schweinfûrt's green.

The former contains fifty-five, and the latter fifty-eight per cent. of white arsenic—that is to say, more than a half of the pigment is pure arsenic.

It is from this material that wall-papers in every shade of green, artificial flowers, fruits, feathers, dresses, &c., derive their colour. It is estimated that in England alone, seven hundred tons of this green are every year thrown into the market for use in these arts.*

It is remarkable, that workmen employed in roasting the arsenical ores, and who are much exposed to arsenical dust, are less affected by it than others whose business it is to apply it to its industrial uses. It is believed by Dr Guy, and other eminent authorities, that these workmen suffer comparatively little, if at all. You will however see, from the tables, that this conclusion is not warranted by the facts of the case. In every one hundred sick among the arsenic makers, eleven are consumptive, and their average life is forty-seven years—being the same as that of the quicksilver miners. If you will now compare these facts with the case of those who are engaged in the conversion of the arsenic into arsenical pigments, it will be seen that every fourth man among the latter is consumptive (25·0) ; and his average life, is in a proportional degree, lessened. Once more, let me call your attention to the fact, that the artificial flower maker has a still greater mortality—his death rate being one in three (36·0) or thirty-six in every hundred sick.

Let us here pause and for a moment contemplate some of the possible results which may attend the introduction of such substances into our social and domestic usages. Here is a piece of a favourite and much-used arsenical wall-paper. An ordinary sized room, with one thousand square feet of wall surface covered with it, would contain twenty thousand grains of arsenic.

* "Manual of Hygiene," Cameron.

The arsenic is held loosely adherent to the paper, and is easily detached and diffused through the room as dust. This dust, found on the shelves, and on other articles in the room, when analysed, yields arsenic.

All those green papers, so much used in general merchandise, contain arsenic in varying proportions. Size-greens, sold at a cheap price, are now much in vogue for size-painting walls. They vary in strength from seven to thirty-six grains of arsenic in each square foot of wall. A child's picture-book has been found to contain fifty grains; but what shall we say of those bright poisonous colours so alluring to the young, which garnish their toys, and even sweetmeats? Here is an article belonging to the textile fabrics—one of many treated to the arsenical process. A dress of this material, as now made, contains two thousand grains of arsenic. An artificial wreath, such as I show you, contains probably not less than ten grains of the poison.*

The case of a young woman of nineteen is reported, who died under symptoms of arsenical poisoning after being eighteen months employed in artificial green flower making.† Examination after death showed that the poison had penetrated the tissues.

It has been well said that, the feeling which prompts people to keep off the appearances of age as long as possible, sometimes leads them into practices which shorten life. Among the numerous articles used in this way, we must include those nostrums widely advertised as hair-restorers, which are reputed to preserve the pristine colour of the hair, or to restore it if lost. These dyes, for the most part, contain lead, and numerous cases of poisoning by their use are recorded. Face-enamelling—the occupation of those artistes who profess to beautify their clients for ever—is liable to similar objections.

Cochineal, supposed to be harmless, and employed to give a peachy bloom to the cheek, contains, as stated by Tardieu, arsenic, mercury, and lead. And even the present fashionable

* See excellent article on arsenic in "Common Things," by Dr Stevens on Macadam.—*Sanitary Record.*

† "Public Hygiene," Cameron, Dublin.

colours derived from coraline red, and aniline, are not free from suspicion.

Having regard to the effects produced upon the health of those employed in the poisonous arts and manufactures, and to the grave consequences resulting to the community from their unrestricted use, the question naturally arises, is it right, or desirable to allow the manufacture and sale of articles attended with so much risk? Arsenic, as such, cannot be procured without certain legal precautions, such as a medical certificate, and the name and address of the purchaser; but I have just said that seven hundred tons of arsenic—a moderate estimate of the quantity—in England alone are sold as pigments, some of them containing more than 50 per cent of arsenic.

Quantities of these may be bought for a few pence without any question being raised. No one, surely, would object to the prohibition of this traffic on the ground that such an act would infringe the liberty of the subject! Might it not, on the contrary, with more reason, be alleged that our liberty suffers by the legalised continuance of such a state of matters? "An excess of liberty in any commonwealth," remarks the great Roman commentator,* "degenerates to the opposite extreme in licentiousness and tyranny." It may be instructive to ascertain how this subject has been dealt with by some of our enlightened neighbours on the Continent. The German Government, for example, deeply impressed with the conviction that the manufacture and sale of such articles were incompatible with the liberty and safety of the subject, on the 1st May 1882, laid before their Parliament a decree of which I give, in effect, the substance. The preamble states that the object of the Act is the prohibition of poisonous pigments; and the following substances are described as coming within the meaning of the Act, namely, antimony, arsenic, barium, lead, cromium, cadmium, copper, mercury, zinc, tin, gamboge, and picric acid. Secondly, the preserving and packing of food stuffs intended for sale, in wrappers coloured with the above cited poisonous colours, are prohibited. Thirdly, the employment of poisonous colours,

* Tacitus.

enumerated in the Act, is prohibited in the manufacture of playthings. Fourthly, the use of arsenical colours for the manufacture of paper-hangings, or for materials of dress, is prohibited. Fifthly, the sale of food stuffs, or food products, preserved or packed contrary to these regulations, is prohibited. Sixthly, the enactment shall come into operation on the 1st of April 1883. Now, you will perhaps characterise this proceeding on the part of the German government, as a bold, if not a sweeping and summary measure. Let us see what came of it. Germany is, as you are aware, the great manufacturing workshop of these pigments, and of the arts to which they are applied. Here, then, is an act that threatened the extinction of these industries, with its consequent widespread commercial ruin.

In view of this disaster, we may believe there were no lack of appeals, remonstrances, and even threatenings. The government, however, remained firm in its determination to waive every consideration except those which had regard to the best welfare of the people. Now notice what comes of doing what is right regardless of consequences. The dreaded 1st of April — the day on which the Act would come into force —at length arrived, but with it, not the expected ruin. How was this? How often—as in this case—has necessity proved the "mother of invention," especially when it touches that sacred depository of the public conscience—the pocket? In short, before the fated day, by the joint aid of money and science, new and poisonless pigments were devised, tried, and found to fully meet all the requirements of the case. Thus, Germany at this moment, has the proud satisfaction of having initiated a great sanitary reform.

You have not, I am sure, failed to be struck with the fact that these effects of unhealthy occupations culminate, in an extraordinary degree, in the production of one particular disease. It is unfortunately the most prevalent and fatal of our maladies; and it is on that account that I have chosen pulmonary consumption as the crucial disease by which to test the ill effects of these occupations.

A high death-rate, amongst any class, from consumption, im-

plies a coincidently increased number of deaths from most other disorders. The statistical tables afford evidence in corroboration of this fact. The proofs already submitted have sufficiently, I doubt not, impressed you with the extent of the evil to which they are intended to direct your attention. It is a question, to which attaches great interest, to know how many workmen in the United Kingdom are, by means of their employments, directly exposed to these effects. Have we any means of arriving at the knowledge of this important fact? We are certainly without any positive data to guide us, but I shall endeavour to arrive, as nearly as possible, at a correct estimate of their numbers.

Taking then, as the basis of our calculation, the recently published census for the ten years previous to 1881, we find that the whole industrial class has, during that period, increased by one hundred and eighty-one thousand; and that in their aggregate strength, they at present constitute a fourth part of the entire population of the United Kingdom (24·97). That gives them, as you will see, a numerical strength, say, of eight millions, five hundred thousand:—the entire population of the United Kingdom being thirty-four millions, six hundred and twenty-eight thousand, three hundred and thirty-eight.

Carefully scanning the various employments embraced by the entire industrial class, I reckon that a proportion of one-tenth of their number suffers—that is to say, eight hundred and fifty thousand are thus exposed to the injurious effects of their occupations. The first and immediate effect of this is, that every member of this eight hundred and fifty thousand has his life reduced to an average of forty-five years.

Taking fifty-five years as a fair average standard to which each ought in favourable surroundings to attain, it follows that every one of these workmen loses ten years of his working life. Now we may assume that a working man enters on active employment at an age not later than fifteen, and from this it will appear that the average lifetime after beginning work is about forty years. But in the case of those whose average duration of life does not extend beyond the average of forty-five, there will be only thirty years of life after beginning work, or three-fourths of the normal period. It therefore follows, as three times fifteen complete the

average life of forty-five, that every fourth man, of the number above stated, drops out of account as completely as if he had not existed. This represents a loss of two hundred and twelve thousand, five hundred—a number nearly equal to the population of this city—in each successive group of eight hundred and fifty thousand men. But the same cause which removes this number of workmen leaves behind, at least, that number of persons who were dependent upon them, and who are thus impoverished.

There can be no question that two-thirds, if not the whole, of that number are not only impoverished but pauperised, and in the end find their way on to the parish roll. The origin of our pauperism is one of the vexed questions of the hour. At a conference held lately at Aberdeen, intemperance and improvidence were, by common agreement, believed to be its chief causes. The advocates of such views would, I am disposed to think, entrench themselves in a more logical position, besides having a foundation of incontrovertible facts to rest upon, were they to accept the explanation I have now offered. Intemperance and improvidence are not causes, but the effects of causes which require to be themselves accounted for.

But the mischief does not stop here. It is certain, that each of the two hundred and twelve thousand, five hundred, will, on a moderate estimate, leave at least one descendant, who will probably, in course of time, develop the hereditary disease of which the parent died. We very safely assume that each of the number stated has died of pulmonary consumption. Here then, we have brought before us most probably, the chief cause which accounts for the increase of consumption in this country. The question is often asked, where does all this disease come from? And there is, doubtless, an implied reproach on medical science and on the healing art, when it is said, that they are comparatively powerless in dealing with it. I would only here take occasion to say in regard to that, that in the case of no other disease has there been so much lately added to our knowledge that is substantial alike as to its nature and treatment. But fed, as it perennially is, by constant streams from those quarters which may be regarded as its natural breeding places, is it not mockery to speak of dealing with it by means of treatment?

In the face of an evil of such growing magnitude, there cannot, I affirm, be any remedy short of its prevention. In the meantime, however, those who, in increasing numbers, are seeking our help must be cared for. The difficulty experienced, in doing this, is only really known to medical men, and more so to those connected with such an Hospital as our Royal Infirmary. Drawn to it, no doubt, by its fame, and to Edinburgh by the known benevolence of its citizens, we have to encounter the task daily of sending away crowds who cannot be admitted to its wards. You are, I daresay, aware that it is barely within the scope of that Institution to receive cases of the kind, partly, because it is a serious disadvantage to the other patients on account of the troublesome night cough with which such sufferers are afflicted. Nevertheless, be it told, alike to the credit of the Managers and of the Medical Officers, that there is not a ward which has not its full complement of them; but, I need not say that this is a most undesirable state of matters. Let me here plead guilty to having gone a little aside from the main drift of my theme to speak of this matter. I have taken the opportunity of doing so that I might direct attention to, and perhaps awaken an interest in, the subject. Whilst London has its half dozen hospitals for consumptive cases, and other considerable cities are not without some provision for them, Edinburgh, which owns a great medical school, is, it must be confessed, in the position of not having a single bed set apart for so necessary an object! It would be a great and truly useful work to devote an edifice to so benevolent a purpose, and to the good Samaritan who should do so, there would be the reward—I say, not of the approbation of his fellows, or the thanks of the medical profession, or the lasting gratitude of those who would reap its benefits—but the enviable consciousness of a deed that would perpetuate the relief of a sadly numerous and interesting class of sufferers.

We have now to speak of

THE MEANS OF PREVENTING THE EFFECTS OF UNHEALTHY OCCUPATIONS.

You will have observed that, in the case of almost every occupation I have spoken of, the injury is inflicted through the agency

of inhaled particles, or by personal contact, on the part of the worker, with poisonous substances, or by the breathing of irritant gases, or vapours, exhaled from them. In order to change the character of an unhealthy, to a healthy occupation, it is only necessary to free the air of its suspended matter, such as dust or other foreign bodies. To accomplish this object, many contrivances have been devised and tried; but, as we shall see, without their having conferred any substantial benefit. The steel-grinders are provided with the magnetized wire-gauze respirator, which was proved to effectually prevent access of steel-dust to the lungs. Stone-cutters and millstone-grinders are likewise provided with a respirator, which would equally well protect them; while the flax-workers of the north of Ireland are familiar with an instrument known as the "Baker respirator," specially designed for their benefit.

The efficiency of an ingenious respirator, constructed to enable the London Fire Brigade to inhale an atmosphere of dense smoke, otherwise suffocating, was some years ago devised and successfully tested by Professor Tyndal. It is made of cotton wool, moistened with glycerine, and mixed with pieces of charcoal.

Here is another instrument, a respirator, which I devised some time ago for a different purpose; it is more complex, but the same in the principle of its construction as those I have named to you; its objects are to warm, medicate, and filter the air in its passage to the pulmonary organs. From what I have said, you will have perceived that there is really no practical difficulty in depurating the air of its dust, and other hurtful foreign matter, by means of mechanical adaptations such as I have spoken of. The difficulty, as we shall afterwards see, is of another kind. In my lecture on "Preventible Diseases" to the Health Society, I took the opportunity, by means of an interesting experiment, to show you the important fact that cotton-wool held over the mouth and nostrils effectually frees the air of its suspended particles. I have had this cotton-wool prepared so as to remove its impurities, and at the same time enhance its absorbing property. In virtue of these combined properties, it is, not only an efficient dust filter, but also, by absorbing

them, arrests the access of noxious vapours to the lungs. These qualities are still further improved by the wool being pressed into a kind of loose cloth such as I show you. Again, chemical and other vapours are rendered comparatively harmless when inhaled through cotton. The vapour of mercury may be made less hurtful to the workmen if the floors of the workshops are sprinkled with ammonia. In the case of all, whose work brings them into contact with poisonous metals, certain obvious precautions are necessary; such as that the hands and mouth should be washed before eating, and the wearing of a washable overall dress. By all who work among lead, water acidulated with sulphuric acid, should be taken freely as drink. It need hardly be added, that, to the worker in poisonous metals or arts, the constant use of the bath is indispensable to his safety. Efficient, as are these appliances when made use of, we must nevertheless regard them as subsidiary to the paramount question of ventilation. In a time, such as ours, when sanitary knowledge is as popular as it is widely diffused, it would be idle to argue that a certain quantity of pure air requires to be inhaled in a given period. The standard amount necessary for each individual to support life and maintain health is, as you know, five hundred cubic feet daily; or, to express it differently, three thousand gallons during that period. In other words, the imperative requirements of health impose on each of us the necessity of inhaling two gallons of good air every minute of our lives. To infringe this rule would be to court disease; and to live in the habitual disregard of it to encounter premature death. To impress this fact upon your memory, it will only be needful to mention a case or two in point.

Dr Edward Smith, the distinguished sanitarian, in his report to the Government on the condition of the London tailors' workrooms, states, that the cubic space in these ill-ventilated places allowed to each operative *and the gas-light*, is one hundred and fifty-six feet. It is necessary to explain that each burner consumes about as much as an individual. Dr Smith states that the death-rate of the tailors working in these rooms is one-third greater than of persons of the same ages who pursue their occupations in good air. Dr Guy, in an inquiry into the health of

the London bakers, points out that thirty-one of them per hundred are consumptive, a fact, which he ascribes to their ill-ventilated workshops. You are now in a position, from what I have already stated, to modify these views of Dr E. Smith and Dr Guy, as to the degree of mortality and its causes prevailing among the tailors and bakers. Referring to a London printing office, in which, only two hundred and two cubic feet of breathing space were allowed to each man, the same authority remarks that the deaths from consumption followed as fast on each other as deaths from some contagious fever.

It was no doubt this frequency of death from that disease, occurring in ill-ventilated workrooms, that first led to the belief that consumption was an infectious malady.

I do not say—for I cannot speak from personal knowledge of the fact—that, in our great manufacturing workshops, the statutory amount of space is not given, but I do affirm, that, it would be an altogether inadequate space in an atmosphere constantly replenished with pernicious materials derived from the manufacturing operations.

It must be obvious that their requirements are of a different kind from those of a dormitory or dwelling, or the wards of an hospital, and that the question of the proper ventilation of these places cannot be settled by the off-hand rule of so much space to so many individuals. The problem to be solved is this ; how to environ each worker in the prosecution of his work with a pure atmosphere ? It is not for me to undertake the solution of this problem, because I hold that to be a matter for which the responsibility rests upon the Legislature. I am nevertheless free to express my confident conviction that this result appears to me to be only a question of certain, simple, practical, mechanical adjustments, requiring no effort of genius, or even outlay, where there is so much already existing machinery.

Let us pause and ask here :—how do those who have most to gain or lose regard those proposed ameliorations which we have been considering ? It would appear, that in some instances, they are not viewed with favour, and, owing to this want of unanimity, it is to be regretted, that they have not been generally adopted. Any

changes of the kind indicated, again it is alleged, are objected to on the ground that the effects would be to increase the number of working hands, cheapen labour, and make it more scarce. But this feeling is, I believe, chiefly confined to the steel grinders. I hope you will all agree with me that this is an altogether mistaken view of the case; and that feelings, of whatever kind, which thus stand in the way of their using the means provided for their benefit, ought not to be encouraged. Past experience has made it quite evident that all such measures ought, as in the case of the Davy safety-lamp, to be made compulsory.

Have we any means of knowing how such matters are viewed by the employers? In the first place, it is certain that they are not themselves fully aware of the extent of the mischief; and secondly, that, although having at heart the best wishes for their people's welfare, their good intentions are apt to be frustrated by conflicting interests, arising out of rivalry and increasing competition, with reduced and precarious profits; and thirdly, they do not feel that the *onus* rests upon them of taking the initiative—the legislature having, by means of the Factory Acts, and otherwise, assumed the responsibility of regulating such matters.

It would seem, then, that we must necessarily fall back upon government regulation and control as the only available remedies for these evils. Previous to the passing of the Factory Acts the ill effects of their work upon the health of the workmen were so notorious that, in response to the wish of the country, a Commission was appointed in 1833 to inquire into their causes. The Factory Acts were, at that time, undoubtedly a great boon to the people; but it is evident that they are not now fitted to accomplish the object for which they were intended in the sanitary regulation of our industries.

The facts which I have eliminated and brought before you, fully, I think, prove this, and also, that an inquiry is urgently necessary. The vast increase in the country's industrial resources and population since 1833, together with corresponding improvements in machinery and in chemical appliances, have altered the entire complexion of our industrial occupations, and have led to

insanitary conditions which demand a remedy as much as did those for the removal of which the Factory Acts were originally passed.

It is, however, neither consistent with our traditions nor experience to believe that measures of the desired kind will be vouchsafed without some decided expression of public opinion, perhaps pressure, or, it may even be a lengthened process of State education. To the class most interested, I would venture to say, —remember that union is strength, and that you cannot unite for the attainment of a more desirable or legitimate object than the protecting of your health and the surrounding of it with every possible safeguard. I am glad to observe signs that the workmen of this country are about to assume their proper position in relation to sanitary questions affecting them; and, perhaps, I may be allowed to quote an instance which I deem worthy of example. The Trades' Union Congress, at their meeting held in Dublin in September 1880, passed the following resolution :—"That the Parliamentary Committee be requested to continue their exertions on behalf of those engaged in wool-sorting, with the object of attaining for them protection against blood-poisoning caused by the use of imported wool-hair infected with a malignant and dangerous disease, and to which wool-sorters are liable in pursuing their occupations." While addressing you on the effects of animal dust, associated with a specific poison, you will doubtless remember that I specially directed your attention to this disease. Whether we regard the terms in which this resolution is couched, or the dignified attitude of the Congress in passing it, it will, I am sure, commend itself to your respect, and I feel justified in congratulating the Congress on a step which marks a new departure in their relation to such questions.

In an address delivered to the British Association last autumn by a well-known English professor,* the working-classes are advised that, if they would reach a higher social platform, they must summon resolution to raise themselves above what is depressing in their immediate surroundings. Let me say frankly that in reference to the whole class whose occupations form the subject of this lecture, I regard the exhortation as simply impractic-

* Professor Leone Levi.

able, so long as the real cause of that depression continues to exist; and that cause is to be found in the unhealthy character of these occupations. Will you, with me, take a momentary survey of what the surroundings are?

The strongest and hardiest among the workers are soon sensible that there is a loss of energy. Then, as the seeds of their insidious malady are being daily sown, there steals over them a lethargy and apathy which no effort of will can bid away.

Then comes loss of appetite and the increasing burden of their daily toil to which they feel unequal. This is the moment of supreme trial to most of them, for it is then that they seek to rally their sinking spirits and failing strength by recourse to stimulants. There is not, I maintain, any *a priori* cause why our countrymen, more than others, should be addicted to intemperance, except it be through their unhealthy occupations superinducing a condition—a disease I call it—which craves for it. It might be well if our social reformers would regard our prevailing intemperance from this point of view, for I am satisfied that it is an incredibly fruitful, if not the chief, source of it.

I find that I have inadvertently used an expression to which attaches a kind of political significance. Let me at once disavow any such intention in speaking of "educating" the State, and, at the same time, explain to you what I mean by that expression.

It is almost trite to remark that every nation has its own individual life history. Its childhood, youth, and maturity are each a period fraught with its own peculiar and fitting education. That part of history, which shows us how those lessons have been learnt upon which a nation's ultimate stability depends, is not the least instructive. Let us, for example, take the matter of national health. We have it on the authority of Niebuhr that the prevalence of plagues, more than ethical or political causes, influenced the destinies of such cities as Florence and Athens; and, that the decline and fall of such an empire, as the Roman, were brought about, not, as we are accustomed to believe, by a species of moral dry-rot, but by the pestilences which carried off the adult male population, and left the then proud mistress of the world an easy prey to the barbarian. Who can read the long continuing death-tax of our

own nation, without asking, what has saved her from a like fate? A brief historical retrospect will show you this. During the fourteenth century our ancestors had to grapple with that fierce plague named the "Black Death," which destroyed nine out of every ten whom it attacked. The fifteenth and sixteenth centuries found them struggling with the "Sweating Sickness," killing its victims in a few hours, and leaving a heavy death-roll. For three centuries prior to the close of the eighteenth, that terrible distemper called "Gaol Fever," taking its origin in our prisons, never ceased to infect the Army, Navy, and the civil population. Another plague, called the Oriental, prevailed through much of the sixteenth and seventeenth centuries; its smallest death-toll being one in five, but often three in five. Then, there followed Asiatic cholera, with its attendant epidemic dysentry; and lastly, unvaccinated small-pox, not less ghastly in its death-rate or repulsive concomitants. This dark catalogue of pestilences was more or less associated with those fevers confusedly known under the various names of spotted, typhus, relapsing, famine, and typhoid. With our greater light, it is difficult to understand why the nation so slowly awoke to the full comprehension of the enormous jeopardy and cost of these invasions. It was only with the advent of John Howard in 1794 that there came also the dawn of an epoch marked by a regard to public health, whose growth and influence are, I believe, the causes of our being now in the van of civilization. You all doubtless know what is meant by John Howard's parliamentary triumph. Single handed he obtained—at a time when such concessions were a great victory—an Act to inquire into the state of our prisons. What were the results of this Act? These pestilential dens, which, for centuries, had poisoned every stream of our national life, were abolished, and, as a matter of fact, our prisons are now the healthiest places in the country. What I wish you to particularly note here is the fact that the second step in this great reform was brought about by an Act of the Legislature—the first being that of Howard's representation of the facts.

Two years later, there occurred another Parliamentary triumph when the discoverer of vaccination was voted £30,000 to extend the

benefits of his discovery. Here also, you will again observe, that an Act of the Legislature is the crowning event. I have said that I am arguing on the assumption that our unhealthy occupations ought to be dealt with by legislative measures. I am accordingly adducing historical evidence of the efficacy of well-directed sanitary legislation, while I am, at the same time, seeking to impress upon you the desirableness, and even urgency, of your representing to the Legislature such considerations as will satisfy it that fresh and more cogent measures are needed. The beneficial effects resulting from such measures are constantly brought under our attention. I select one out of a multitude of instances. One of the household regiments—the Foot Guards—was found to have more deaths from consumption than prevailed among the soldiers of the Horse Guards. The former had thirteen deaths per thousand, the latter seven. The Army Sanitary Commission appointed to inquire into the case, reported, that the cause of the discrepancy was a deficiency in the breathing space allowed to the former. The defect was no sooner rectified than the abnormal death-rate disappeared.

Taking the whole of the occupations, to whose condition I have specially directed your attention, I find, that *twenty-six* of these, in every hundred, die of consumption; while the proportion of deaths from that disease among the general population is only twelve in the hundred.*

It is a matter of history that this long-continued State education, in its reference to national health, culminated on the 1st of June 1774, when Lord Howe achieved the all-decisive victory which gave to Britain the supremacy of the seas. On that memorable occasion, for the first time in the annals of our naval engagements, perfectly healthy crews, numbering in all seventeen thousand two hundred and forty-one, went into action against the more heavily armoured and manned fleet of the enemy, but with this difference — that the enemy's crews were less

* As this 12 per cent. among the general population includes all deaths from consumption arising from the unhealthy occupations referred to, it would be necessary in order to institute a fair comparison to exclude the latter. The result would then show a still greater disparity, as the rate among the general population would then be reduced to ten in the hundred at the outside.

efficient through disease. It may be fairly questioned whether we owe the victory more to Lord Howe than to his physician, Dr Trotter, to whose discretion he wisely left the entire sanitary equipment of the fleet. But, in any case, its immediate and ultimate effects were not less notable in their sanitary than in their political and diplomatic consequences.

It is my contention, as you will perceive, that our great operative industrial classes are entitled, equally with the combatant, to be cared for and protected, as to their health, in the pursuit of their avocations. They have a claim to it in respect of their numbers, social and political standing, and usefulness. They are the back-bone and sinews of the nation's strength, and its capital and wealth makers.

The number of men withdrawn from peaceful occupations for fighting purposes, during the whole of the twenty-two years that our country was engaged in the revolutionary wars, did not exceed a quarter of a million. I estimate that a quarter of a million nearly of these workmen is continuously lost to the State —a loss which covers the whole period of each man's working life. For a moment, consider the effects of this from a merely economical point of view. Taking the figures, as I have already given them, to be two hundred and twelve thousand, five hundred, and reckoning each man's wages at one pound a week, there is thus a yearly loss in wages to the industrial wage class amounting to upwards of eleven million pounds ! * If we now add to this the loss of the wealth that would have been produced by the workers so cast off, there results the grand total of thirteen millions, seven hundred and fifty thousand pounds, the whole of which is annually lost to the country ! In point of fact, that sum, would, in about fifty-seven years, clear off the whole of the national debt. So much for the money aspect of the question. But what of the needless waste of life and its attendant sickness : of the consequent impoverishment, pauperism, and demoralisation; and the increasing legacy of hereditary disease?

Were I to attempt the rôle of the historic Glendower, and summon spirits from the vasty deep, my performance would, I

* Taking into account the natural increase of the industrial population there will be a yearly increase to this money loss of over £20,000.

fear, be as unproductive as that of the original. But will you permit me, in form at least, to invoke the shade of our great countryman—might I not say townsman?—Adam Smith. We should not certainly expect the renowned economist to indite a new "wealth of nations," from a modern stand-point, a century after his great work was given to the world; for what he wrote in 1776 appears to have been given for all time. But looking back, and gathering up the lessons of the past, one can imagine that he would, at least, add a prefatory note somewhat in these words; that is, if I may be permitted to suggest words to so great an oracle:—There are two primary and fundamental considerations upon which national stability and permanency rest. The first regards the health of the people—the other its education. Any system of government, without full provision being made for these, will be incomplete: and, in regard to the former, the best guarantee of a nation's security will be wanting. Therefore, above all things, let no government, in its administrative capacity, be without its health department, presided over by a wise and energetic Health Minister, whose supreme duty it shall be to create and to vigilantly administer laws, the aim of which shall be to protect the health of every subject, and especially to surround that of the dependent industrial population, with every possible safeguard. Then, addressing his own countrymen, might we not suppose the philosopher, with increased emphasis, to add:—A nation, such as ours, of thirty-four millions, with a vast manufacturing industry, a most busy and flourishing commerce, an Indian Empire to govern and maintain, colonies to attract the most vigorous and enterprising of our people, great fortresses to man and defend, cannot afford to waste the lives of its citizens, any more than those whom it has chosen and trained to fight its battles. Are not labour and capital the two pillars upon which a free commonwealth rests? Disease paralyses labour and wastes capital. It ought then to be the primary object of an enlightened State to prevent disease, preserve health, and prolong life; and to maintain the whole people in the highest efficiency alike for the labours of peace, or the struggles of war.*

* For part of closing sentence *vide* "Public Health," *passim*, Dr Guy.

TABLES

Showing the Effect of Different Kinds of Dust upon the Health of the Workers.*

TABLE I.

Metallic Dust.

	In every 100 Patients among	Are Consumptive.	Mean Duration of Life.
Steel Dust	Needlemakers, . .	69·6	50·0
	Filemakers, . .	62·9	54·0
	Grinders (steel), .	40·4	40·4
	Pinmakers, . .	12·5	
	Cutlers, . . .	12·2	
	Lock-Smiths, . .	11·5	49·1
	Farriers, . . .	10·7	55·1
Copper Dust	Lithographers, . .	48·5	
	Moulders, . . .	36·9	
	Watchmakers, . .	36·5	55·9
	Engravers, . .	26·3	54·6
	Bellmakers, . .	19·7	
	Tinmen, . . .	14·1	47·0
	Workers in Copper, .	9·4	48·6
Lead Dust	Typefounders, . .	34·9	
	Dyers, . .	25·0	63·7
	Lacquerers (enamellers),	25·0	45·0
	Painters and Colour Grinders, .	24·5	57·6
	Printers (including Compositors), .	21·6	54·3
	Lead-Mine and White Lead workers, .	20·0	51·7
Brass Dust	Workers in Brass, .	6·0	

* Dr Ludwig Hirt, die Krankheiten der Arbiter, Beiträge. Leipzig, 1873-78—modified and adapted.

TABLE II.

Mineral Dust.

In every 100 Patients among	Are Consumptive.	Mean Duration of Life.
Grindstone-makers,	90·0	4·0
Flintcutters, Glass cutters and Polishers,	80·0	
Stone-cutters (including Masons),	36·4	36·3
Workers in Glass,	35·0	42·5
Plasterers,	19·0	
Porcelain workers,	16·0	42·5
Potters,	14·7	53·1
Diamond workers,	9·0	35·$\frac{1}{12}$
Cement workers,	8·10	50·0

TABLE III.

Vegetable Dust.

Cigar-makers (including Tobacco workers),	36·9	55·0
Weavers,	25·0	51·7
Cotton, Flax, and Hemp Dressers,	60·0	44·0
Ropemakers,	18·9	44·0
Joiners (including Cabinetmakers, Upholsterers, and Carpenters),	14·6	49·8
Millers,	10·9	45·1
Bakers,	7·0	
Chimney Sweeps,	6·5	45·3
Miners (Coal),	0·8	

TABLE IV.

Animal Dust.

Brush-makers,	49·1	
Hair-dressers,	32·1	57·9
Skinners,	23·2	50·5
Turners,	16·2	57·4
Hatters,	15·5	51·6
Button-makers,	15·0	
Harness-makers,	12·8	
Cloth-makers,	10·0	

TABLE V.

Animal Dust with Specific Poison.

In every 100 Patients among	Are Consumptive.	Mean Duration of Life.
Wool-sorters,		
Rag-pickers,		
Paper-makers,		37·6

TABLE VI.

Gases and Volatile Emanations.

Straw-hat makers,		
Jewellers,		53·0
Bleachers,		58·0
Soap-boilers,	9·3	61·3
Tanners and Curriers,	9·2	61·3
Charcoal-burners,	2·0	
Parafine-makers,		
Candle-makers,		62·0
Grinders of Oleaginous Grains,		

TABLE VII.

No Dust, Constrained Bodily Position, and Bad Ventilation.

Needle-women (of every class),	19·0
Tailors,	19·0
Shoe-makers,	18·7
Glovers,	
Writers' Clerks,	10·0

TABLE VIII.

Dust from Poisonous Metals.

Phosphorus	Workers in Phosphorus,		44·0
Mercury	Workers in Quicksilver,	25·0	47·4
Arsenical Dust	Workers in Arsenic,	11·0	47·0
	Arsenical Green Pigment-workers,	25·0	
	Workers in Arsenical Blue, Artificial Flower-makers in Arsenical Green,	36·0	

TABLE IX.

Showing Diseases and Average Life among Farriers, Cutlers, Lock-makers, and File-cutters.

In 100 Patients.	Consumption.	Chronic Bronchitis.	Emphysema.	Pneumonia.	Acute Maladies.	Digestive Maladies.	Rheumatism.	Heart Diseases.	Average Duration of Life.
Farriers. . .	10·7	9·8	0·5	6·6	37·5	24·2	9·8	0·9	55·1
Cutlers . . .	12·2	12·2	3·7	3·2	35·3	27·1	6·3	2·0	...
Lock-makers .	11·5	9·2	2·6	5·8	38·2	19·4	10·3	3·0	49·1
File-cutters .	62·2	17·4	...	12·2	17·6	...	...	...	54·0

TABLE X.

Diseases among Workers in Wood.

In 100 Patients.	Consumption.	Chronic Bronchitis.	Emphysema.	Pneumonia.	Acute Maladies.	Digestive Maladies.	Rheumatism.	Heart Diseases.	Average Duration of Life.
Joiners . . .	14·6	10·1	3·9	6·0	34·0	18·4	10·4	2·9	49·8
Carpenters .	14·4	0·5	0·9	0·9	29·2	14·4	17·4	4·3	55·7
Wheelwrights	12·5	0·2	1·3	5·2	11·6	18·7	9·2	1·3	...

TABLE XI.

Relative Frequency of Chest Disease from Animal Dust.

In 100 Patients.	Consumption.	Chronic Bronchitis.	Emphysema.	Pneumonia.	Acute Maladies.	Digestive Maladies.	Rheumatism.	Heart Diseases.	Average Duration of Life.
Brushmakers .	49·1	28·0	3·4	7·0	12·2	3·7	...	..	...
Hairdressers .	32·1	47·8	2·5	10·7	25·4	14·6	...	...	51·9
Saddlers . .	12·8	7·5	2·5	5·0	40·1	22·6	7·6	1·9	53·5
Upholsterers .	25·9	11·7	2·7	10·3	24·9	27·7	4·0	...	...
Farriers . .	23·2	10·7	4·7	8·1	23·3	10·9	12·6	2·5	50·5
Hatters. . .	13·5	6·7	1·0	5·6	53·3	28·7	5·5	...	51·6

TABLE XII.

Relative Diseases among Tanners, Catgut-makers, Butchers, and Soap-makers.

In 100 Patients.	Consumption.	Chronic Bronchitis.	Emphysema.	Pneumonia.	Acute Maladies.	Digestive Maladies.	Rheumatism.	Heart Diseases.	Average Duration of Life.
Tanners . .	9·2	7·4	7·4	7·4	31·9	12·9	16·8	...	61·2
Catgut-makers	...	...	...	...	...	...	...	...	60·2
Butchers . .	7·9	6·3	1·1	9·9	42·2	17·6	13·3	0·7	56·5
Soap-makers .	9·3	18·0	5·3	8·9	37·5	14·5	5·3	...	61·3