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DIPHTHERIA: ITS ETIOLOGY AND TREATMENT.

Read in the Section of Public Medicine.

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THE etiology of diphtheria is still a disputed point. There are many reasons why this is to be regretted; the most important being that treatment must be empirical until its causation is determined with certainty. Intimately associated with causation are the sequelæ which follow upon its incidence; and no explanation will be satisfactory which does not thoroughly explain them. These latter may be divided into two sections: those which are immediate, and those which probably follow in the relation of cause and effect, but which are at present seldom associated in the mind of the medical attendant with the preceding diphtheritic condition. I propose to show the ultimate relationship between these classes of cases, and to point out that treatment to be effectual must be based upon rational lines, and be followed out on those lines to the termination of the case.

Without asserting that diphtheria and potato-disease are in any way allied to each other, except by analogy, I have been struck by the similarity of the effect produced in both diseases. The breathing-passages are impeded. There is a similar train of results, though in the opposite direction: in the one case, carbonic acid cannot get into the plant to allow the devolution of oxygen; and, in the other, oxygen fails to get admission to the blood-current, so as to allow the oxidation of carbon in the various tissues of the body. There are in both cases suffocation, and rapid death when it is immediately severe. If the course of the disease be not so rapid, and death do not arise from asphyxia, the nutritive fluid becomes altered by something which is intimately connected with the causation of the disease itself, and which leads to death either by paralysis or by failure of nerve-power in the human body, whilst in vegetable life it arises from simple loss of power to assimilate the juices upon which the life of the plant depends. There is a blighted state produced, by which the crop is destroyed sooner or later in the course of the season. If both these dangers be escaped, the fruit is permeated by a mycelium which produces seed of its own. The evil day is only postponed; for, when the store is opened in mid-winter, a large portion of the crop is found to be invaded by processes similar to necrosis. Even those potatoes which seem sound are permeated by mycelium, or have resting spores in their buds only waiting for seasonable opportunities to develop into new growths, which will inevitably destroy the potato and prevent any healthy production from that part of it which is so affected. The causation of one kind of potato-rot is recognised as produced by a fungus called *Botrytis* or *peronospora infestans*, one of the genus *Mucedines* or *hyphomycetous* fungi. They form the commonest moulds upon decaying vegetable substances, and include some parasitic families which produce great devastation in the vegetable world. Their germs are always present almost everywhere, and only want a forcing-bed in which they can develop, and then their effects are immediately manifest.

There is great doubt in the minds of some men as to the capacity of parasitic life either to injure plants or animals which are in vigorous health. It is possible that this doubt has a sound basis, and that we may agree with my great teacher, John Simon, "that a contagium of a given disease, such as small-pox or measles" (I here interpose potato-rot) "has no more power to influence the unpredisposed body than yeast has to ferment alcohol, or to turn pure water into beer." I am now inclined to think that this is so; and that, in the absence of some impurity in the blood of the animal, or in the juice of the plant—some material which is the sequence of the act of living, and which material has not been properly excreted out of the system—the germs which set up parasitic disease would fail to find a pabulum in which they could increase and multiply, and that they would be starved, so as to ultimately abort or dwindle away to nothing, and thus fail to establish a colony in their victim. I have taken up this view from a variety of reasons. It is true that it is not indubitably established that infective disease, such as diphtheria, is the result of filth in the home or in its

surroundings; but the presence of the disease, in the great majority of instances, is intimately connected with decomposing excreta. I have, therefore, come to the conclusion that, when it fails to be proved to be so associated, from the absence of any such visible cause outside the body, it is because the excrementitious matter had not passed away from the blood of the recipient, and that it was still within the curtilage of the human dwelling-house, that is, within the living precincts of its producers.

The connection of filth-diseases with human excreta is a recognised fact. Diarrhoea, cholera, and enteric fever, are certainly associated with human filth. A relaxed throat with diphtheritic exudation is also recognised as intimately connected with similar states; so that a person so affected cannot be cured whilst residing in a given dwelling-house, in which the air is impregnated with the results of sewage-decomposition. He must move into a purer atmosphere before the diseased state of his mucous membrane can be remedied; and why? he is like a man who, under ordinary circumstances, is well able to swim, but with his head just under the water because of heavy boots or other weight loading him beyond his swimming powers. The impure air prevents that healthy assimilation of food by which he would recover power and be able to resist the influence of the fungoid germs which now irritate his mucous membrane, just as some men are, from so-called idiosyncrasies, unable to resist the influence of the pollen of some kind of grasses, and become subject to hay-fever, whilst others do not notice it in the least, and are not so affected.

I do not assume that the excreta of a human being retained within his own body are necessarily hurtful, simply from retention. That is disproved every day of one's life; but I contend that it is impossible for an excretory organ to be defective for some time, and to fail in its complete and regular duty, without some minute particles of organic impurity being retained in the juices of the body in a condition which is foreign to their ordinary state. The blood is placed in that form which is analogous to that which obtains in the sufferer from hay-fever; and when a person is exposed to the germs upon which diphtheria depends for its production, he becomes the victim of that disease. If he were not in that particular condition, he would not be affected by diphtheria any more than the majority of us in this room would be affected by hay-fever if we joined a hay-making party. This view of the case will explain why we occasionally find diphtheria in exceptionally clean and healthy neighbourhoods. It will explain its hereditary tendencies and the so-called idiosyncrasies of those who appear to be especially prone to its ravages.

I have reason to believe that temperature has much to do with the sudden development of diphtheria; that, whilst it is certain that those living on ranges of hills in open country are as much liable to its incidence as the inhabitants of lower regions, it arises at clusters of cottages entirely away from sewers or general water-supply, and seems to arise *sud sponte*. It does at times follow lines of sewers in a way that shows that intimate connection with drainage which is suggestive of cause and effect; it is also propagated by milk-sellers, as is shown by evidence which cannot be disputed. It is not more prevalent in hot seasons than in the colder parts of the year, but, on the contrary, it seems more general in the colder months, producing greater mortality during sudden and violent reductions of temperature than at other times. I have always found in these isolated outbreaks that its development has been associated either with washing-day, when hot water has been allowed to flow into the cesspool or drain, or that there has been a communication between the sewer and some steam-engine, which has elevated the temperature of the sewage to blood-heat. It is to this point that I especially wish to direct the attention of those who are inquiring into the outbreaks of diphtheria. The connection of tub-night with croup is not unknown. I believe it was in Edinburgh that, about forty years ago, at a conference of medical men, it was discovered that Saturday night was the night upon which the majority of the attacks of so-called croup took place among the poor; and that it was shown to be intimately connected with the Saturday night tubbing with which the Scotch were then accustomed to treat their children; and, as a consequence, also with the steamy condition of the rooms in which they slept bringing into sudden activity the germs upon which I believe the disease to depend for its development.

That a particular form of micrococcus is always present in diphtheritic exudation, and that the germ is capable of setting up the disease has been established upon a sound basis. The germ has been cultivated in the vitreous humour of the eyeball, passing through several generations; and the operator ultimately has been able to reproduce the same disease in another animal in a way which shows its complete identity. These micrococci are excessively minute, probably less than one thirty-thousandth of an inch in diameter. They have a life-history of their own; and, though not identical with *botrytis* or

pernicious, they must have reproductive organs, and, probably resting spores, as well as ordinary spores; and I think that they follow the life-history of the algae, as well as being endowed with some of the properties of the fungal tribes.

From analogy, we may assume that the resting spores are much less destructible than the ordinary spores, and are capable of preservation under conditions which enable them to reproduce their kind whenever the conditions arise which are required for the purpose. What are these conditions? The presence (1) of certain forms of excreta; (2) of a certain elevated temperature, not much below blood-heat, but below that requisite for the coagulation of albumen; (3) of an atmosphere saturated with moisture, and, probably also (4) an excess of carbonic or some other acid in the air, by which the growth of the germ is determined; and (5) some other meteorological or electric manifestation at present entirely unknown. If these states coincide, the resting spore becomes active; it finds material which it can assimilate; and the disease is set up, commencing in the mucous membrane of the throat, that being the very place in which we find moisture, warmth, and carbonic acid. The way in which such actions take place is manifest from the fact that the spores of a mushroom cannot be cultivated unless they have been in contact with the mucous membrane of some of the equidæ tribe; so diphtheritic germs, like the pollen of plants which fall upon the stigma of an appropriate carpel, as soon as they touch such a mucous surface, at once put forth all their vigour; an invisible mycelium is put out; a change takes place in the character of the fluids of the part; and the disease runs its course, and passes through the various changes which indicate its presence. A felt-like mass forms in the throat; the patient dies asphyxiated; or the blood is so altered by the action of the microderm or micrococcus that the blood-corpuscles no longer perform their duty, and oxygen gradually ceases to be assimilated. This leads to a failure of action in certain nerve-centres, and paralysis may result. These micrococci have a life-history of their own—a definite course to run. They are expelled by some of the excretory organs: and those which escape expulsion die in the course of time, leaving behind them spores similar to resting spores; which may set up sequelæ in an unexpected manner and at unexpected times. Returning to the conditions, let me say that, as regards the character of the excreta, this must be peculiar; that, as scarlatina probably has its origin, when apparently arising *sud sponte*, in the blood of animals which are not in a healthy state, and which is undergoing decomposition or metamorphosis of some kind, so the diphtheritic germ has its apparent origin *de novo* from morbid matter produced in the tissues of animals. It is probable that the excreta of vegetable-feeders do not furnish germs which could develop into a diphtheritic micrococcus *sud sponte*.

If the conditions be present, the cells are hatched, and they then are capable of extension by so-called contagion; but even then it is requisite that the recipient shall be in a state fitted to receive it, and, like to the carpel of a fruit, ready for the pollen which is peculiar to it; otherwise, the cell fails to find fitting pabulum for its extension and the development of its reproductive organs.

An elevated temperature is necessary, together with an atmosphere saturated with moisture. I conclude that this is so, because I have always found the coincidence in first outbreaks, and the consensus of opinion points to the necessity for moisture, or dampness, or stagnant water, whenever the disease is epidemic.

I go also to analogy, for the potato-disease spreads more rapidly in the damp atmosphere which is found among the rank vegetation of overgrown haulms; or on those days in which the sun is obscured by clouds and the air itself close, full of moisture, and the temperature high. Sunlight and dryness soon remove the incidence of potato-blight. The latter, however, probably does not require the elevated temperature which is requisite for the hatching of diphtheritic spores; but the warmth of a day in which thunderstorms abound, but the sun obscured, is sufficient for the purpose.

That carbonic or some other acid must be present is probably the case, because it has been shown that minute fungi grow much more rapidly and much more luxuriantly in such an atmosphere. It is probable that water, which is free from carbonic or some other acid in solution, will not be able to propagate even typhoid germs for want of the necessary pabulum; and this accounts for the fact of certain water, apparently free from suspicion of the presence of any infective principle, suddenly developing such a tendency, from having lost its power of neutralising the carbonic acid, or of discharging it into the atmosphere. In this case, typhoid germs rapidly multiply in the water, and disease is spread by its means; and so it is that diphtheria suddenly springs into activity. There is a rapid fall of temperature out of doors, lasting for a day or two. The school-managers in a given school are not prepared for the change; fires are not lighted, but the

cold and usually damp air is shut out as much as possible, and the atmosphere of the school becomes highly charged with carbonic acid; and, if it should happen that a child with an infectious throat is present, the disease spreads as rapidly as potato-rot spreads on a favourable day; and, if there be excreta of such people in the sewer, the admission of large quantities of hot water force out a steamy air into the closed-up passage from the defective drain.

But how will this explain the sequelæ which frequently follow upon diphtheritic mischief? I mentioned the fact that potato-rot is known to be propagated by the agency of resting spores. These are spores or germs which are shut up in a very resistant envelope, which enables them to retain their vitality in adverse circumstances; so that heat, if it be not much above 212°, and the cold even of zero, will fail to destroy it. These spores may by analogy be fairly assumed to exist. The ordinary spores are evacuated from the system as the patient recovers; but the resting spores remain in contact with the lining membrane of the blood-vessels, or are carried by the blood-current into some of those parts of the body which usually act as filters, and retain matters which are foreign to the blood-current. Perhaps they attach themselves to lining membranes, such as the valves of the heart. They may there, as they develop, set up ulcerative endocarditis; and being detached from the valves as they increase in size, they irritate the membrane; and, being carried on by the blood-current, they produce emboli at the spot to which they are carried. There they multiply, sooner or later, and the sequences of the disease appear as if they were separate and independent diseases, and as such are often registered among the causes of death as totally independent of the preceding diphtheritic condition.

I have the history of a considerable number of cases in which inflammations of different organs have come on a few weeks after the patient has suffered from a moderately slight throat-affection, which has not been recognised as diphtheria, but which has been coincident in point of time and place with true diphtheritic attacks. I have been inclined to look upon the so-called inflammations as having been caused by diphtheritic emboli, and have treated them accordingly. I now advise that course, in the majority of cases in which the inflammatory attack appears to be idiopathic, that is, not preceded by some known chronic diseased state of the suffering part. That treatment has been the use of ammonia as the proper stimulant, so as to reduce the acidity of the blood; for I have generally found these cases in constitutions which are either rheumatic with the lactic acid diathesis, or gouty from the excess of lithic acid in the constitution. I have generally given alkalies, as lithia, or potass in combination with it; and when there has been an elevated temperature, which has indicated excessive chemical action in the invaded part, I have given the sulpho-carbolate of soda, with the greatest possible benefit. This salt reduces temperature, most likely by its antiparasitic power; for, as soon as a few doses have been given, the fever subsides, and the patient is much relieved; but, if the medicine be left off too soon, there is certain to be a relapse. This is very disappointing, and, if the practitioner be disheartened, and try another remedy, his patient will probably die. But if he return to his sulpho-carbolate, he will ultimately destroy all the developing resting spores in the tissues of his patient, and lead him on to a perfect recovery. It is curious how, in these cases, organ after organ becomes involved in the disease; it is also curious, but highly satisfactory, that the congestions or embolisms follow one another in point of time, otherwise there would be very little chance for the patient to recover. I would urge the practitioner to continue the sulpho-carbolate, in small doses, first with the ammonia, and, after a time, with quinine, avoiding altogether the mineral acids, as such appear to allow a more rapid development of the resting spores and a further relapse.

As regards the local treatment of diphtheria, I have been accustomed to treat it on scientific principles, and attack the disease just as my gardener attacks the oidium upon grapes, and other parasitic disease upon vegetables generally. I apply the powder of washed sulphur to the throat very frequently, blowing it into the fauces, and applying it by means of a brush with a little glycerine or honey, alternating the application with a little sulphurous acid in solution. It is not a painful application; it destroys the mycelium and the ordinary spores which produce the disease. If this be done quickly, so that the growths do not penetrate to the deeper tissues, no resting spores will find admission to the body, and there will be no following sequelæ. I have also been accustomed to advise that creasote be kept in the room, so that the air may be placed in that condition which diminishes, if it do not destroy, the growth and development of hyphomycetous fungi.

The salary of Dr. Wolpley, medical officer of Bandon Dispensary, has been raised to £120 per annum.