

The Cause and Prevention of Diphtheria.¹

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THE cause of diphtheria is a problem the solution of which has engaged the attention of scientific men in all parts of the world, and while it cannot now be asserted that our knowledge of the subject is complete, yet enough has been ascertained to enable us to formulate certain rational plans of treatment, and to guide us in our efforts to prevent the dissemination of this dread disease.

The demonstration, by Pasteur, that morbid processes in the animal body were due to the presence of micro-organisms, pointed out the line of investigation that would possibly reveal the cause of diphtheria. And, therefore, as a result of patient effort, Klebs, in 1883, and Loeffler, in 1884, isolated a bacillus that now is recognized as the agent concerned in the production of the train of symptoms and phenomena known as true diphtheria.

While it is agreed that the Klebs-Loeffler bacillus is the cause of diphtheria, yet we must not fail to note that fatal pseudo-membranous inflammations of the tonsils, pharynx and larynx occur in which the Klebs-Loeffler bacillus is absent, and instead is found a streptococcus, which appears to be identical with the streptococcus-pyogenes. Although this variety of pseudo membranous inflammation may be uncomplicated, yet it is frequently found associated with scarlet fever or measles.

Recently Professor Prudden and Dr. W. H. Park, of New York, have published the results of their investigations of the agents concerned in the production of true and false diphtheria. Prudden made bacteriological examinations in twenty-four fatal cases of pseudo-membranous inflammations of the tonsils, pharynx and larynx, and in all of them the Klebs-Loeffler bacillus was absent; in all but two cases streptococci were found. Park has reported 159 cases of pseudo-membranous inflammations, and of this number in fifty-four only were the Klebs-Loeffler bacillus

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found. In the other 105 cases streptococci were present in abundance. Martin, of Paris, in an examination of 200 children supposed to have diphtheria, found the Klebs-Loeffler bacillus absent in seventy-two, and of this class twenty-nine were croup cases. Various investigators, as Boginsky, Kolisko, Sevestre, Wurz, Bourges and others have found streptococci without the Klebs-Loeffler bacillus in pseudo-membranous inflammations occurring in scarlet fever.

From this we learn that not every case presenting the gross appearances of diphtheria is really true diphtheria in the sense that the causative agent is the Klebs-Loeffler bacillus. But in view of the fact that the other varieties of pseudo-membranous inflammations, due to the presence of streptococci, are infectious and fatal, even when unassociated with scarlet fever, the lesson to the doctor is that his duty to the patient and the family is just as grave as it would be if the bacillus of Klebs-Loeffler were present. Clinically, no distinction should be made so far as precautionary measures are concerned. Scientifically, efforts should always be made to differentiate; and this can only be done with the microscope and culture media.

Granted that the important part assigned to the Klebs-Loeffler bacillus in the etiology of true diphtheria is warranted by the results of the latest investigations, and there are but few who do not admit this, we are not thereby informed as to the laws governing its propagation and growth. Many of us know from observation that the life of the bacillus may be prolonged for many months and finally demonstrate its activity by causing the disease to develop in those brought in contact with the infected locality. Instances have been given where the contagion of diphtheria has been conveyed in clothing, in sewers, in water, and in milk; agar-tube cultures, after seven months' growth, are still alive; bits of membrane no larger than a pin point, kept in cloth, give evidence of activity after six months. These facts indicate that the germ of diphtheria is tenacious of life, and perpetuates its species under varying conditions of soil and environment; yet they do not inform us as to the circumstances dominating its development.

If we believe that the cause of diphtheria is a definite variety of living germ, with characteristics and a life history unlike any other living entity, then we must assume that there are certain positive conditions necessary for its growth and continued existence, as is the case with all other living things in nature.

To claim that its presence in a given locality is accidental, or that, because of unsanitary environment, by a process of rapid evolution, a harmless germ was transformed into one with pathogenic attributes; or, that by a special creative act it is caused to be where it did not exist before, are untenable theories.

No culture experiments have ever resulted in the development of a new type of disease germ; and we have no basis for the idea that nature is engaged in the special work of rapidly creating or evolving these minute agents of destruction, contrary to her methodical processes, as observed in the higher orders of animal or vegetable life.

We are constrained to believe that there are certain laws governing the origin and perpetuation of the bacillus diphtheriæ, but what they are cannot now be definitely formulated. But we *do* know that filthy or unsanitary conditions are co-existent with outbreaks of diphtheria, and there can be no doubt but that moisture, ordinary temperature and absence of sunlight and pure air, are important factors in developing endemics and epidemics of this disease. Farther than this, we enter into the domain of doubt and conjecture.

Some observers have thought they traced outbreaks of diphtheria to the spreading of human or animal manure upon land in the vicinity of human habitations. Others attribute its prevalence in cities to the frequent tearing up of the streets for paving, or trenching for various purposes. Some consider the prevalence of continued dry weather an important factor in developing the disease. Still others think it is due to drouth alternating with successive rain. It is supposed that variations of barometric pressure of the atmosphere, over foul and moist soils, causing "ground respiration" and possible liberation of pathogenic germs, may be one of the causes. But it is probable that the theories mentioned above represent coincidental conditions only; and they certainly do not enable us to determine why there should be a rapid proliferation of the germs at one time, under what seems to be conditions identical with those that obtain at another time, when diphtheria does not prevail.

Diphtheria is known to be contagious and infectious, and its prevalence in communities, after the appearance of one or two cases, is largely due to this fact. It is a matter of daily observation that if a member of a family takes the disease other cases occur in the household. Children sent from an infected house, as

a precautionary measure, may convey the affection to those who have not previously been exposed to contagion. The disease may be spread by the dried membrane or expectoration upon pillow-cases, sheets and articles of clothing. Investigation will demonstrate that a large proportion of those having the disease have been in contact with infected individuals or localities; and localities may be centres of infection for a year or more, if not radically disinfected. As bearing upon this point, I have knowledge of a house that was vacated the day following the funeral of a child dead of diphtheria, and it remained unoccupied for one year. It was then taken by a family consisting of parents and one child. In three weeks thereafter the child died of diphtheria. In the absence of any history of exposure to contagion elsewhere, we are forced to the conclusion that the second case in that house was the direct sequel of the first.

In my opinion the most potent agents in causing the spread of diphtheria in communities are the public schools, private and Sabbath schools. When we consider that it has been proved that the bacillus of this disease is found in the mouths of patients some days after the apparent recovery of the throat lesion, we cannot avoid the conviction that it must also be in the mouth of the destined victim for a variable period before their presence is manifest by the usual symptoms denoting invasion. Therefore that individual is a menace to her or his companions even during this period of apparent immunity. In many other instances the children are really victims of diphtheria while yet in daily attendance at school. In some of these cases, no doubt, the child, being anxious to continue its studies, does not feel ill enough to ask to remain at home. In others, where the little one speaks of feeling ill, the parents may not think it necessary to keep her from school; as it is not an unheard-of occurrence for some parents to reason that a complaining child must necessarily be a malingerer. In still other instances, the disease may be well advanced before the individual's attention is called to her condition by symptoms of pain and fever.

In any of these conditions the patient is a source of danger to her companions, and her presence at school may result in their infection and death.

I have recently had under my care a family in which five cases of diphtheria occurred. Two years ago an elderly lady died in that house with diphtheria. A few months subsequent to her

death the premises were vacated, and the present occupants moved in. This family of six small children lived there for eighteen months without illness, until two years had elapsed since the death above noted, when diphtheria developed simultaneously in four of the children. Naturally, the impression would be that here was an instance where diphtheria germs had remained inactive for two years, but finally conditions favorable to their renewed vitality had developed, and as a result a severe local outbreak occurred. But I really did not believe that was the solution of the problem, and upon questioning the mother closely I ascertained that another child had remained from school a day or two, because it did not feel well; and this child occupied a seat adjoining a scholar who had a few days previously been taken ill with diphtheria. Here was the explanation of the outbreak in that household. A child with an attack so mild that the true nature of the illness was not recognized by the family, and which, it was thought, did not require the doctor's attention, infected four other members, and caused one death.

This is but one instance in a great many where I have endeavored to trace a case of diphtheria to its source, and have been led to the school-house.

The milk supply is frequently the means of disseminating the bacillus of diphtheria, and as one of the causes of the spread of this disease it is worthy of serious attention. It is really a culture media for the germs, and is peculiarly susceptible to contamination. Within a few months past an outbreak of diphtheria in the town of Melrose, Mass., has been traced to the dairy of a man in whose family several cases of the disease occurred.

While it is not definitely known that prominent outbreaks of diphtheria are due to contaminated water, yet it is reasonable to suppose that in some instances this is the case. It is known that colonies of the bacilli will survive for months or years in favorable situations, and it is not improbable that the germs may remain active in water for a short time, at least. Wells in proximity to cesspools may thus become a source of danger to those who drink therefrom; and the water supply of cities, contaminated with sewage, may cause the diffusion of the specific poison. It is a well known fact that epidemics of cholera and typhoid fever have occurred in this manner, and it is not improbable that the prevalence of diphtheria, in certain localities, has been due to this cause. The folly, not to say criminality, of allowing cities, con-

taining thousands of inhabitants, to take their drinking water from a source polluted by the refuse of a city containing hundreds of thousands, should be fully appreciated; and let us hope a day of advanced enlightenment may come when the police power of a State can be successfully invoked to save the people from themselves. The importance of guarding the water supply from contamination should be so thoroughly appreciated by all that the question of cost will not be a deterring factor. The so-called contagious diseases—diseases communicated through the agency of living germs—can never be eradicated as long as a large percentage of the people use water contaminated with human excreta.

In concluding this division of my subject, it may be stated that it is not known positively what are the conditions necessary for the infection of the individual, but it is supposed that a lesion, an abrasion of the membrane of the nose or throat, favors it. No doubt individual or family susceptibility is a predisposing cause.

Having what we may now deem to be definite knowledge that the cause of diphtheria is a living germ, we are in a position to understand the importance of preventive measures, and are enabled to intelligently resort to such agents as investigation and clinical experience have shown antagonize its propagation and growth.

The problem of preventing diphtheria has been simplified by the discovery of its bacillary origin, for we know that if we destroy the germ we will remove the cause.

The destruction of the bacillus may be affected by the various agents known as antiseptics or bactericides, and by a temperature of 212° or more.

It is unnecessary to enter into the details of isolating and caring for patients; of cleansing and disinfecting bedding, clothing, premises and attendants; the rules to be observed by the family in the event of the recovery or death of the patient; the precautions as to ventilation; the mode of sterilizing the discharges from the patient's throat, and the duties of undertakers. These points have been admirably set forth by Dr. Ezra M. Hunt, the able secretary of the State Board of Health, in the annual reports and in special circulars, and they are accessible to everyone.

But we may, with propriety, consider some of the questions of public policy in relation to the management of diphtheria, whether it occurs as an isolated case or a general outbreak.

Probably one of the most serious questions that may present itself to the health authorities is that of domiciliary quarantine. If thoroughly enforced, combined with disinfection of the premises and the effects of the occupants, there can be no doubt of its efficacy as a measure for the suppression of epidemics. But the hardships entailed upon the occupants of the house thus isolated from the community is fully recognized, and frequently the proper authorities hesitate to inaugurate this extreme measure of repression. The legality of house quarantine does not enter into this problem as a distinct issue, as it is a settled point of law that municipalities, in common with nations and States, may resort to this measure as a safeguard to the public health. But when we consider that the family quarantined may have been infected because of some previous dereliction upon the part of the health authorities of the city or town, the question of compensation might be raised.

In instances where, due to the lack of means, individuals ill with diphtheria cannot receive the proper attention or isolation at home, they should be removed to a hospital provided for this class of contagious diseases. Frequently several members of a family are infected consecutively because the premises are too small to allow of perfect isolation of the original case. It is to this class that removal of the patient to a hospital is particularly applicable; and it then becomes a measure of consideration for their own safety.

Prophylaxis involves supervision of the schools, both the week-day and Sabbath-schools. There can be no doubt that this disease is largely propagated through the instrumentality of these agencies, where large numbers of children gather and intimately associate during the hours of study and play. As between the sexes, the relations existing between the girls of a school are more intimate than the fellowship between the boys; and herein is an element of increased danger to the girls. The reprehensible practice of indiscriminate kissing is largely in vogue in the female department of schools, and is directly responsible for the transmission of this disease in a certain number of cases. As bearing upon this point, my own experience has been that the large preponderance of school children attacked have been girls. When we consider that, after invasion, there is undoubtedly a period of local activity, without pronounced symptoms, during which the germs are elaborating the ptomaine that will subsequently infect

the entire system, we can understand what a menace a child unconsciously affected with diphtheria in this incipient stage must be to her companions in a school room. I have met with a number of instances where children ill with diphtheria have passed directly from the school to the sick bed.

Therefore, as a measure of safety to the young, in whom there exists marked susceptibility to this affection, during the prevalence of diphtheria all public schools should be closed, and what are known as the infant classes of Sunday-schools should be dismissed until such time as the disease is in abeyance. If this were done, there can be no doubt that the progress of diphtheria in any community would be largely controlled before its ravages had made so many homes desolate.

My convictions upon this subject are very decided, and I feel that too much emphasis cannot be placed upon the assertion that attendance at school during the prevalence of contagious diseases constitutes one of the most grave perils of childhood. I am well aware of the difficulties that attend the solution of the problem, for we all admit the importance of these agencies for the education of the youth of our land. But when we reflect how many valuable lives have been, and may be, lost by reason of the dissemination of infectious diseases among school children, the closing of the schools during the prevalence of such diseases in neighborhoods should be considered one of the most important measures to be instituted for their eradication.

One of the potent factors in the dissemination of disease, and one to which but too little heed has been given, is the vacating of houses after the recovery or death of a patient ill with a contagious disease, and its occupancy by another family that up to this time was free from infection. As in the instance that I have noted, many houses are vacated as soon as a patient has recovered, or soon after the funeral; and in some instances almost immediately re-occupied by another family, who are ignorant of the danger they incur. It should be the province of health boards to prevent this. Physicians are required to give information of cases of contagious disease, and to report deaths due to such causes. For the purposes of preventing the evil above referred to, the original notice of the existence of a contagious disease in a house should be sufficient, and it then should be the duty of the inspector of the local board of health to caution the head of the family not to vacate the premises without first notifying the board of such inten-

tion to move, under the penalty of a fine sufficient to exert a deterring influence.

After the health authorities have received such notification of intention to move, then all the effects of that family should be thoroughly disinfected before they are allowed to be taken from the premises.

After the house is vacated, it should be unlawful to rent it again until it has been properly cleansed and disinfected; and the cleansing and disinfecting should be under the supervision of the Board of Health.

Boards of health should also be vested with authority to prevent families from vacating infected premises when in their judgment such removal would be detrimental to the health of the community.

As inspectors of boards of health are public agents, charged with the grave and responsible duties of stamping out contagious diseases, it should be mandatory upon them to give personal supervision to the cleansing and disinfection of premises *immediately* after notice has been given by the attending physician that such disease prevails in a house; and not wait, as is now the custom, until the malady has spent its force in the family. Then, after the recovery or death of the patient, the premises should be re-disinfected. Failure upon the part of a health inspector to personally examine infected houses at least once during the progress of a case of contagious disease should render him liable to penalties equally as severe as may now be visited upon the physician who fails to make prompt report of the existence of such patient in his practice.

To enact sanitary laws for the guidance of busy doctors, and impose penalties to insure their observance, and at the same time make other sanitary regulations and select men at a liberal salary to carry out their provisions, without the imposition of a penalty for non-observance of duty, is an unfair division of the responsibility of conserving the public health.

It should be impressed upon all who have to deal with this disease, whether in the capacity of sanitary officials or as medical advisors, that prophylaxis is the true and, perhaps, only sure way of combatting diphtheria.

If we accept as true the bacillary origin of the disease, then must we acknowledge that it is *primarily* a local affection, followed later by systemic involvement. But it is the *general*

symptoms that first attract attention to the patient, and frequently while yet there are no signs of pharyngeal invasion. Now, if the general involvement is due to a poison generated at the seat of local lesion, we must assume that such poison had been formed *prior* to the onset of malaise and fever. If so, then there is but one conclusion to be arrived at, and that is that the bacilli were present in the nares, pharynx or larynx, and had already generated sufficient poisonous products to infect the system *before* the characteristic exudate was apparent to ocular inspection. Thus, when the doctor is called upon to treat the patient, what was a local affection has now become a systemic disturbance, with perhaps, even at this stage, only slight evidence of localization. Hence it is now too late to prevent general infection, although treatment may modify the progress of the malady. Unfortunately the chances are that farther advance of the disease will not be prevented, for we must admit there is no known specific for this affection once it has seized a victim. Despite all treatment, the seemingly mild cases are liable to die of heart paralysis, and the severe cases may pursue an uninterrupted course to the grave. But this sweeping assertion must be qualified by saying that the death rate has been lessened within recent years, as the value of the recumbent posture as a life preserver is better understood; and the early use of antiseptic washes does modify, in some instances, the severity of the systemic poisoning. But, after all, these agencies are not specifics.

But if we anticipate the results thus depicted, and when the disease threatens a community or family, institute pre invasion treatment of the cause by cleansing the unclean places, isolating those who are sick or have been exposed to the contagion, and remove the risk of the healthy coming in contact with infected localities, we may then have the satisfaction of securing the ideal results contemplated by the votaries of sanitary science.

