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*PROPHYLAXIS OF DIPHTHERIA.**

BY GEORGE DUFFIELD, M.D.

Dr. Edward Eaton, an English physician, recently made the statement "that all infectious diseases, with the exception of diphtheria, had diminished in England during the last ten years as improvements in drainage and sanitation had advanced."

It has always been supposed that damp, close, and stagnant conditions of the atmosphere in the house, coupled with faulty sanitation, aid in the production of diphtheria; but while this may be so, we must inquire further for the immediate cause. Until the recent discoveries of Klebs and Loeffler we have been dealing with an unknown quantity. Diphtheria is essentially a contagious disease and has always been looked upon as such, though the means of stamping it out have not always been efficient. We have much to learn from the sporadic cases that often precede an epidemic and that usually begin in the outskirts of our cities.

The progress of an epidemic depends upon three things:

First: The number or virulence of the diphtheria bacilli.

Second: The pathogenic or non-pathogenic bacteria

* Read before the Detroit Academy of Medicine.

associated with the diphtheria bacilli, rendering the organism weaker by their disorganizing products.

Third: Individual predisposition and carelessness.

Because of the overcrowded schools, their faulty drainage, and the utter disregard for thorough ventilation in the superheated school-rooms, the schools become an important factor in the propagation and spread of this highly contagious disease.

Epidemics of diphtheria usually begin in the fall, a few weeks after the public and parochial schools are opened, and last until summer comes to close the schools; statistics prove that diphtheria is at its minimum in July, and nearly so in June and August.

Adults have the disease oftener than is supposed, and an ordinary sore throat may be the beginning of a serious outbreak of diphtheria. Ignorance in this matter might well be called criminal carelessness, as these people frequently infect others in street-cars and public assemblies.

Vital statistics published by the Secretary of our State prove that diphtheria kills over two thousand every year in Michigan, 85 per cent. of whom are children between three and twelve years of age. If smallpox were as fatal as diphtheria, there would be a panic in our land. In Michigan, up to 1892, where one case died of smallpox seventeen died of diphtheria. Truly "familiarity breeds contempt" in this disease. It will be remembered that last year the Irving, Clay, and several other public and one or two parochial schools of Detroit were

closed because of serious outbreaks of diphtheria. One public school has been closed this year because of an outbreak. During the school year beginning September, 1891, and ending June, 1892, there were 1,150 cases of diphtheria. From September, 1892, to June, 1893, there were 797 cases. From September, 1893, to June, 1894, there were 483 cases. The number of deaths are not compiled for the school years. During September last there were 75 cases and 14 deaths; during October 106 cases and 27 deaths—a high mortality.

The duties of health officers and local boards of health, as suggested by our admirable State Board of Health, are clear and comprehensive, and it will be seen that the letter and spirit of these laws are not lived up to by our local Board of Health:

AN ACT *to specify certain duties of health officers and provide for compensation therefor in townships, cities and villages where the health officer is not otherwise instructed by the local board of health.*

SECTION 1. The people of the State of Michigan enact, That whenever the health officer of any township, city or village in this State shall receive reliable notice, or shall otherwise have good reason to believe that there is within the township, city or village of which he is the health officer, a case of smallpox, diphtheria, or scarlet fever, or other communicable disease dangerous to the public health, it shall be the duty of said health officer, unless he is or shall have been instructed by the board of health of which he is an executive officer to do otherwise, immediately to investigate the subject, and, in behalf of the board of health of which he is an executive officer, to order the prompt and thorough

isolation of those sick or infected with such disease, so long as there is danger of their communicating the disease to other persons; to order the prompt vaccination or isolation of persons who have been exposed to smallpox; to see that no person suffers for lack of nurses or other necessaries because of isolation for the public good; to give public notice of infected places by placard on the premises, and otherwise if necessary; to promptly notify teachers or superintendents of schools concerning families in which are contagious diseases; to supervise funerals of persons dead from scarlet fever, diphtheria, smallpox, or other communicable disease which endangers the public health; to disinfect rooms, clothing, and premises, and all articles likely to be infected, before allowing their use by persons other than those in isolation; to keep the president of his own board of health, and the secretary of the State Board of Health, constantly informed respecting every outbreak of a disease dangerous to the public health, and of the facts, so far as the same shall come to his knowledge, respecting sources of danger of any diseased person or infected article being brought into or taken out of the township, city or village of which he is the health officer.

SEC. 2. In the absence of regulations conflicting therewith, made and published by the local board of health, and still remaining in force, the provisions of Section 1 of this Act shall have the force of regulations made and published by the local board of health; and whoever shall knowingly violate the provisions of Section 1 of this Act, or the orders of the health officer made in accordance therewith, shall be deemed guilty of a misdemeanor, and upon conviction thereof he shall be punished by a fine not exceeding one hundred dollars, and the costs of prosecution, or, in default of payment thereof, by imprisonment not exceeding ninety days in the county jail, in the discretion of the court.

It is to be regretted that Detroit's Health Board has, since the day of its birth, been antagonistic to the State Board of Health. The older members of this Society

will remember that in 1881 the late Dr. H. F. Lyster was chairman of a committee appointed by the State Board of Health to devise a plan for a board of health for Detroit. W. G. Thompson, then Mayor of the city, not approving Dr. Lyster's plan, had another bill drawn, and the latter was passed by the Legislature. Dr. O. W. Wight, a man from outside the State and unfortunately opposed to the policy of our State Board of Health, was made health officer, since which time the local board has more or less antagonized the State board, ignoring the fact that the State board enjoys the reputation of being one of the best health boards in the country, while all know that the local board cannot be worse.

Our former health officer, Dr. S. P. Duffield, urged the immediate rebuilding of the pest-house when it was burned, but years have passed and Detroit is still without a suitable hospital for contagious diseases. He recommended that the city erect cottage hospitals, in different parts of the city, for communicable diseases, so arranged that cases of diphtheria, scarlet fever or smallpox would be separate. The mother could go with the child to the cottage, and the home could at once be fumigated. Other members of the family would be thus protected, and the father could continue at his work without danger of carrying germs of disease with him. But the plan was never considered.

The circulars of the city Health Board, left at each house by the man who tacks up the sign showing the house is infected with a contagious disease, are too con-

densed on important measures and not lucid enough on others. Many of the uneducated will not get a very definite idea as to what had best be done to protect themselves. The disinfecting solutions have no formula as to their strength—so that correct solutions cannot be made. With reference to the cleanliness of the patient (No. 5), it hardly seems right to say that "the discharges from the kidneys and bowels are dangerous and should be passed on old clothes and burned." Should this and other directions be followed out literally, most of the clothing and bedding would be destroyed by the strong disinfectants and by fire.

As to the disinfection, too many plans are offered, and there is danger of choosing the easiest, which is not always the best.

Paragraph No. 12 needs some explanation regarding the disinfection. For some time previous to the election the regular disinfector was busy seeking the office of coroner, and a subordinate filled his place. Disinfection was performed most ignorantly. From several attachés of the Health Department I learn that only one candle, of one pound weight, is burned in each room where contagious disease has been, to disinfect it, regardless of the size of the room. All rules for thorough disinfection with sulphur call for three or four pounds to each thousand cubic feet of air space. In one room of 2,450 cubic feet of air space, recently disinfected after a severe case of diphtheria, but one candle of one pound weight was used, and it was placed within a yard of the

grate and all the fumes went up the chimney, and in an hour thereafter sulphur fumes could not be detected. The sign was then taken down and the house reported thoroughly disinfected. I insisted upon the room being disinfected again, and asked that six or eight pounds be used, but my request was granted by burning two more one-pound candles and stopping up the flue. Later I superintended the fumigation, and about twenty-five pounds was used in the room, and every corner of the house was saturated with sulphur gas.

Compare the method of disinfection by our local board with that of the State board, and you will see reason enough for the spread of disease in our city.

The plan adopted by the State Board of Health is prompt and efficient. The circulars that are distributed (pamphlet No. 106 is here for your inspection, kindly sent by the Secretary of the Board at my request) are clear, giving full directions as to what is best to do, and giving the exact formulæ in making the various disinfecting solutions.

When they are notified of an outbreak of diphtheria, they take prompt measures to restrict the spread of the disease and confine it to the one house or neighborhood where it first appeared, by prompt isolation and quarantine during the attack, and afterwards using every known means for thorough disinfection.

Dr. Henry B. Baker, Secretary of the State Board of Health, recently wrote me as follows regarding fumigation with sulphur: "I have no confidence in the sulphur

candles, for this reason: Because of the law of the diffusion of gases, and the numerous crevices through which sulphur fumes may pass, the fumes do not remain long enough in the room with sufficient strength, unless the combustion of sulphur is somewhat rapid. It should be rapid and continue a considerable time. I think the best results are obtained by using roll-brimstone broken up, or flowers of sulphur, burning the sulphur in shallow tins of sufficient number and size to rapidly fill the room with the fumes, and having quantities sufficient to last for several hours. I think our experience has abundantly demonstrated that whatever may be true in the laboratory, the Loeffler bacillus is rendered incapable of causing diphtheria if the disinfection I have mentioned is done this way, without the presence of the vapor of water. This is a very important fact, because it enables us to disinfect rooms without the destruction of much property which would be entirely ruined if the vapor of water were present. After the disease is ended, have disinfection performed under the supervision of the health officer, making him responsible for its effectiveness."

When a contagious disease is reported to the local health office, a postal card is sent to the superintendent of the school the child attended, and to the public library. One should also be sent to the pastor of the church where the child attended Sunday school.

If the parents of the school children were instructed through the Board of Health, as to the first symptoms of a

contagious disease, with the means used for its prevention and the necessity for seeking the help of the family physician early, it would be a step in the right direction.

It would be a good plan if the death notices in the daily papers should state that the child had died from a communicable and contagious disease, and that the funeral as well as the burial would be *private.* This would prevent many from going to the house.

Our schools should be provided with a non-infectious drinking-cup, such as originally used at Romeo, Michigan, and adopted at public drinking-fountains in New York City. The cups are stationary on the top of the open end of a water-pipe, the water rising in the centre and flowing over the edges. When in use the running water continually overflows the sides of the cup and tends to wash away any infectious material that may collect upon its edges and sides. Its use would tend to prevent the spread of diphtheria and other diseases of specific origin. Dr. Baker, Secretary of our State Board of Health, has the history of two outbreaks of diphtheria in schools, due to the presence of diphtheria (Loeffler) bacilli on the drinking-cups.

Until within the last few months all suspected cases of diphtheria that have been sent to Harper Hospital's contagious building have had to be placed in the same wards with others affected with true diphtheria. Now they are isolated in the general hospital until it is seen what is to develop, and if it is true diphtheria they are transferred to the contagious building; otherwise they

are treated as pseudo-diphtheria, the rooms afterwards being thoroughly disinfected. Seven such cases have been under my care at the contagious hospital in the last ten days.

The bacillus of diphtheria was first observed by Klebs in 1883. In 1884 Loeffler isolated it in pure cultures and demonstrated its pathogenic power. The rods are straight or slightly curved, with rounded ends, having a diameter of 0.5 to 0.08 μ, and 2 to 3 μ in length, and are non-motile and non-spore bearing. The bacilli may be stained by the use of Loeffler's alkaline solution of methyl blue.

The *New York Medical Record* for September 29th contains a report from Drs. Parke and Beebe, of the Bacteriological Laboratory of the Health Department of New York City, showing the result of an examination of 5,611 cases of suspected diphtheria. In 3,255 cases the Loeffler bacilli were found, thus showing that about 60 per cent. of the cases examined were true diphtheria.

The method they followed for making such an examination is quite simple. One requires only a platinum rod and a sterile test-tube of blood-serum from a sheep, or better still Loeffler's mixture of three parts serum, one part bouillon, with 1 per cent. each of peptones and sugar, and ½ per cent. of salt. The platinum rod, with a looped end, is sterilized and drawn lightly over the tonsils and pharynx, and then over the surface of the culture media. The bacteria will develop in eighteen or twenty-four hours

if the test-tube be placed in an incubator and kept at blood-heat. The Loeffler bacillus is then discoverable.

The necessity of differentiating between the pyogenic bacteria and the Loeffler bacilli, between pseudo and true diphtheria, is important, for undoubtedly the former weakens the tonsils and soft palate, and makes a culture medium for the bacilli of true diphtheria.

The recent important discovery of the anti-diphtheritic serum, known as Behring's antitoxine, is the newest prophylactic and curative agent in the treatment of diphtheria, and is receiving attention the world over.

The most comprehensive report on the treatment of diphtheria by antitoxine that has come under my notice is the one from the pen of Dr. Collins H. Johnston, of Grand Rapids, Michigan, in the *Physician and Surgeon* for September (from Berlin). He says: "There are two preparations of antitoxine to be had in Berlin. One is Behring's, the other is Aronson's. To Behring the entire credit for the development of the theory and therapeutic practice of the blood-serum of diphtheria belongs. Aronson followed Behring's experiments, and, being a good bacteriologist, was taken into the house of Schering & Co., who fitted him up a complete laboratory and supplied him with all the money he needed for his experiments."

In an article by Behring, read at the International Congress of Hygiene, and reported by Dr. V. C. Vaughan to the Michigan State Board of Health, are detailed the experiments in rendering goats and horses immune

against diphtheria. Dr. Behring left his method practically a secret; but in a paper read before the same Congress by Dr. Roux, of the Paris Pasteur Institute, are given the details of the process. In a personal letter from Dr. Vaughan, he says: "I met Roux last summer, heard his paper on the treatment of diphtheria with the antitoxine. I think he is doing better work than anyone else in his line."

There are several different methods of immunizing an animal. It can be accomplished by using either the bacteria or their ptomaines alone, or both together.

Aronson uses a two-days-old virulent culture of Loeffler bacilli. A small amount of this culture is injected into a horse; this is followed by reactionary fever of short duration, and on its subsidence the animal is inoculated with a larger amount of the culture. This plan is continued until the horse fails to respond to large doses of the most virulent cultures. The animal being thus immune, blood is drawn from the jugular vein or carotid artery, and the serum tested as to strength. This serum is three times stronger than that used by Behring.

I extract the following from Dr. Roux's paper regarding the mode of administering the serum in children: "Twenty cubic centimeters is injected under the skin of the thigh, or between the shoulder-blades. This is not renewed if the patient is found not to have the true Loeffler bacillus in the throat; otherwise a second injection is made twenty-four hours later of twelve to fif-

teen minims. This has usually been found sufficient to bring about recovery."

The amount of the serum injected, as a general rule, equaled one-thousandth part of the body-weight, and in exceptional or malignant cases one-hundredth part.

Dr. Roux and Dr. Aronson believe that the serum of the horse is most efficacious, taken from animals immunized with cultures through which a current of oxygen has been passed.

The remarkable decrease in the death-rate, as the result of these experiments, is worthy of note. The first use of antitoxine on children was in the Kaiser Friedrich Children's Hospital in Berlin, March 14, 1894.

Dr. Cyrus Edson, Commissioner of Health, of New York, has made the following statement: "As tested by Professor Koch and those associated with him, in 250 cases the antitoxine treatment produced the results noted below: When the treatment was applied within the first twenty-four hours all cases were cured. When cases were inoculated on the second day of the disease, 97 per cent. recovered; when inoculated on the third day, 87 per cent. recovered; on the fourth day, 76 per cent.; on the fifth day, 57 per cent. By the treatment, any person who has been exposed to the disease can be made free from further hazard if the symptoms have not developed. If cases are treated within thirty-six hours, the mortality can be reduced to practically nothing. It can be seen how wonderful the treatment is when it is understood that the average mortality of true diphtheria is 27 per cent."

Dr. M. Roux gave the statistics of the treatment of diphtheria with antitoxine at the Hôpital des Enfants Malades, Paris. From February 1st to July 24th, 1894, 448 children were thus treated, the mortality being 109, or 24.33 per cent. The average mortality from 1890 to 1894 was 51.71 per cent. in a total of 3,971 children. The benefit from the antitoxine treatment, the conditions being the same, was therefore 27.38 per cent. Within the same period 500 cases of diphtheria were entered at the Hôpital Trousseau—316 (or 63.20 per cent.) of whom died. Of the 448 children treated by antitoxine, 128 were found, by bacteriological examination, not to be suffering from true diphtheria; 20 other cases were in a dying condition when brought in. Of the 300 cases remaining, there were 78 deaths, or 28 per cent., instead of from 50 to 60 per cent. as in former statistics before the use of antitoxine.

Dr. Aronson, of Berlin, treated, from March to the end of July, 192 cases of true diphtheria by means of the serum, 14 per cent. dying. Of these children, 23 were moribund when brought into the hospital, leaving 169 cases with 19 deaths, or a mortality of 11.2 per cent. In the same hospital the mortality in 1891 was 32.5 per cent. in 203 cases; in 1892, 35.4 per cent. in 341 cases; in 1893, 41.7 per cent. in 426 cases; and from January to March, 1894, 41.8 per cent. The serum treatment was also employed in 82 cases in other hospitals, making 274 cases, with a mortality of 15.3 per cent.

Dr. Aronson states that he has used this serum to

render immune the children of families in which diphtheria had occurred. The dose used was a cubic centimeter (15½ minims). Out of 130 such exposures, only two were affected with diphtheria, and that of a mild form.

A third of the cases of diphtheria, according to statistics, show albuminuria; and this having been present in only 4 out of the 120 cases treated with serum, it seemed evident to M. Roux that the remedy diminished the frequency of the symptom.

Before closing my paper, let me give in detail a history of a case that came under my care and was successfully treated with antitoxine.

Miss C. W——, aged 20, contracted diphtheria September 25, 1894. She came under my care September 28th. Thin diphtheritic membrane was on the tonsils (one of which was chronically enlarged). Temperature 103°; pulse 136. For ten days the diphtheritic inflammation was confined to the tonsils. My patient had a habit of biting her lips when worried, and such a bite caused an infection of the lip on the seventh day that spread along the side of the cheek and upon the gums. Dr. Jennings saw the case in consultation at this time. The membrane extended over the tonsils and to the uvula. Local astringent and antiseptic solutions were applied to the buccal mucous membrane and to the tonsils, with slow and satisfactory results. After nearly every sign of diphtheritic inflammation had disappeared, seventeen days after the first attack another bite caused another

infection of the cheek on the opposite side which extended to the floor of the mouth; the membrane under the tongue was very dense and adherent.

Learning that I could obtain some of Aronson's antitoxine from Mr. A. E. Holt, I procured a bottle. The following directions and explanations accompany each bottle: "The solution for immunization as sold by us is guaranteed to be of such strength that 0.001 Cc. will render ineffective as much diphtheria poison as on subcutaneous injection would kill guinea-pigs in thirty-six to forty-eight hours. If a mixture of 0.001 Cc. with the same amount of poison be subcutaneously administered to guinea-pigs, not only are no symptoms of disease caused, but also no local symptoms are observable, especially no infiltration at the place of injection."

The antitoxine solution contained 2.4 per cent. of egg albumen, and a further admixture of 0.4 per cent. carbolic acid (or trikresol) for preservative purposes.

I sterilized my hypodermic syringe and needle by boiling and then with alcohol. I injected 15 minims in the thigh, and then noted the results. The pulse had been at 112, temperature 101°, steadily.

There was no pain at the point of injection. In three hours the temperature lowered almost to normal and the pulse dropped to 84. There was a perceptible change in the membrane after twelve hours—it looked shriveled and began to be detached around the edges; by twenty-four hours from the time of injection it had rolled up and could be easily removed; the mucous

membrane under the exudate looked pink—not dark red and congested, and not ulcerated, as it had done before.

No more membrane formed on the throat or buccal mucous membrane, since which time the case has made a continuous and uninterrupted recovery.

Until recently we have considered that the contagion of diphtheria disappeared with the membrane. Dr. Billings, in his report at the conference at Buda-Pesth, stated that in 752 cases he examined microscopically it was absent in 325 three days after the disappearance of the membrane, but in the remaining cases the bacilli were present from five days to five weeks.

Dr. Johnson states that a culture made from the secretion from his daughter's throat, six weeks after the disappearance of the membrane, when injected into a guinea-pig caused its death in thirty-six hours with all the symptoms of diphtheritic poisoning, such as fever, pleural effusion, swelling and reddening of the suprarenal capsules, and hæmorrhages into the lymphatic glands. The case I have reported with the two relapses shows conclusively that virulent Loeffler bacilli were present and ready to attack new points of abraded surfaces.

We should urge the local Board of Health to establish at an early date a bacteriological laboratory for the examination of the secretions from all suspicious sore-throats, and until cultures are proven to be non-diphtheritic the placards should remain on the houses, and not until then should the patient be allowed to associate with others.

In the foregoing paper you will see that I have emphasized the following points:

1. That the local Board of Health should not be a political ring.

2. That the health officer should be a scientific medical man who has devoted a large part of his time to the study of sanitation and public-health matters.

3. That the local Board of Health harmonize and co-operate with, and aid, the State Board of Health.

4. That the local Board distribute literature to the public, so that they (the people) may guard themselves against an epidemic and learn how to act when a case is in their homes.

5. Disinfection of rooms occupied by cases of contagious disease should be done more thoroughly and should be performed under the direction of the health officer.

6. More prompt methods should be used in restricting cases of diphtheria and other contagious diseases. Isolation should be carried out in all cases, and the nurse should not be allowed to mingle with the rest of the family, even at meal time.

7. Besides notifying the superintendents of the day schools and the public library, the pastor of the church whose Sunday school the children attend should also be notified, so that our Sunday schools should not be a source of these diseases. The overflowing drinking-cup referred to should be put into the schools at once.

9. We should urge the local Board of Health to establish a bacteriological laboratory, with a competent director, for the use of the physicians, where suspicious secretions from sore throats may be sent, so that mild cases shall not be overlooked, and where the true diagnosis can be made in twenty-four hours.