

THE MEASURES TAKEN TO CHECK THE DIPHTHERIA OUTBREAK OF 1901 AT COLCHESTER.

(One Map and Four Charts.)

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The History of the Epidemic.

THE epidemic of diphtheria in Colchester, which reached its height in the Summer of 1901, followed almost without intermission on the outbreak in the Autumn of 1900.

The disease during the Autumn of 1900 was however mostly confined to Old Heath, a suburb of Colchester, situated to the south-east of the town, and first made its appearance in August, when three persons notified to be suffering from diphtheria were treated in the Mile End Infectious Hospital. During the months of September, October, November, and December, 2, 11, 5, and 8 patients respectively were treated there.

This outbreak was followed by a period of four and a half months (January 1st to May 11th) in which the mean notification rate for diphtheria dropped to one per week.

It was towards the latter half of May that the epidemic, which is the subject of this paper, first began to assume serious proportions, thirteen cases being notified during the week ending May 25th, and twenty-six during the whole month. By this time, however, the disease was no longer confined to Old Heath, but had reached the town of Colchester. It rapidly increased during June (46 cases), when the highest number of notifications for one week, namely 22, was reached.

It is of special interest to note that though a few cases during May and June occurred in other quarters of the town, the great majority came from the south-eastern portion adjoining Old Heath. Through May and June 72 cases in all were notified, and of these 80 per cent

occurred in the south-eastern district, and 43, or 60 per cent., in a small area, bounded by Magdalen Street, Wimpole Lane, Canterbury Road, and Military Road, in the centre of this district. (See Map, p. 172.)

In July there was a still further increase, 66 cases, the maximum for any one month being recorded. During this and the following months the notifications were no longer restricted to the district just mentioned but were received from all sides.

The first decided fall in the notification rate occurred in August with 38 cases, and about the same mean level was maintained during September and October, with 35 and 32 notifications respectively.

A still further reduction took place in November, when 15 persons were notified as suffering from diphtheria, and again in December, when 8 only were recorded up to the 28th.

As indicated in the above short history of the outbreak, the epidemic, contrary to common experience, was a Summer one.

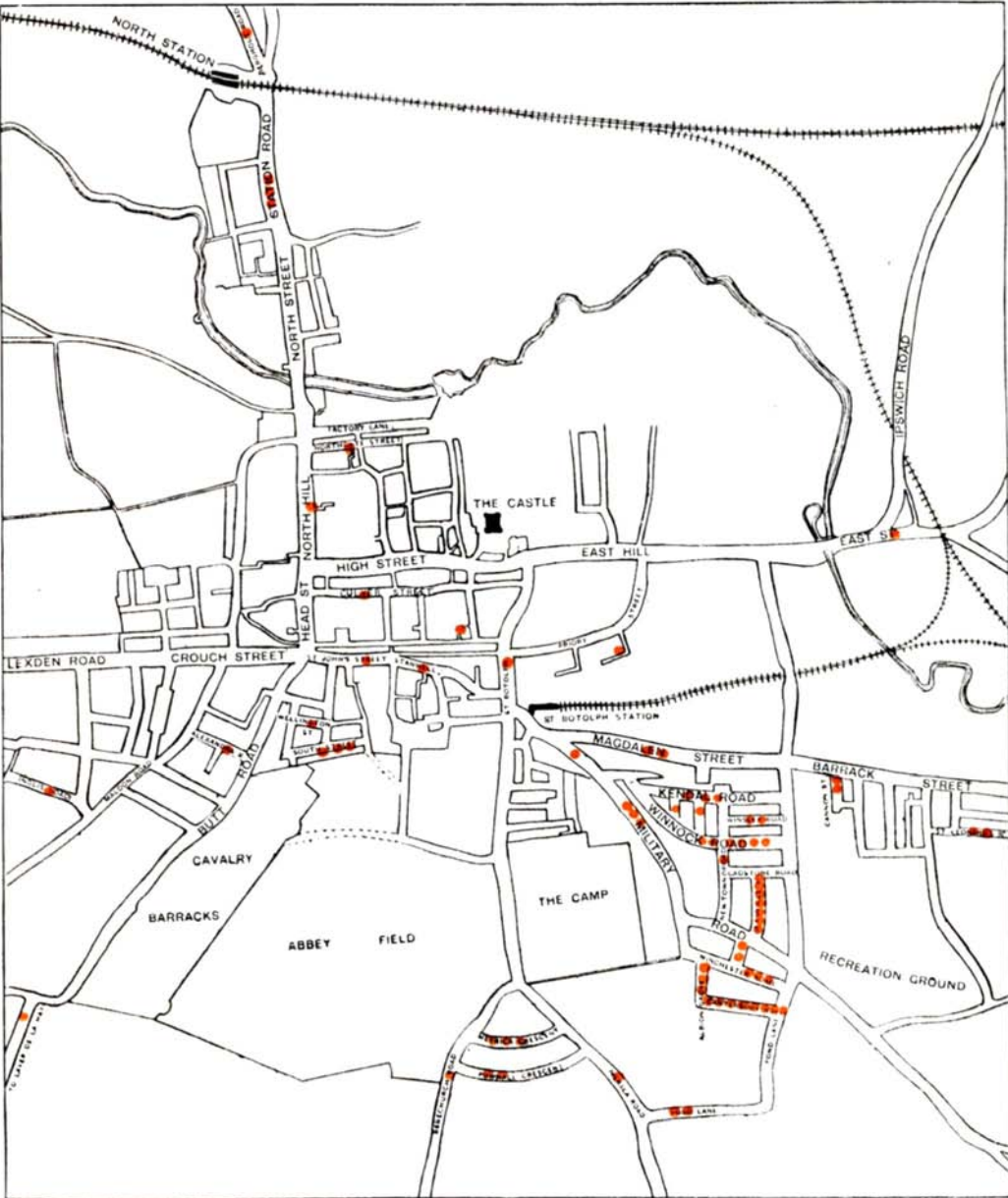
Not only was the disease widely spread, and the mean notification rate thirteen per week for the past two months, but the unhealthy period of the year was rapidly approaching before the measures suggested by Dr Cobbett for limiting the spread of the disease were employed. The efficacy of the measures was therefore put to a severe test, and the good results following their adoption are the more noteworthy.

In this connection I should like briefly to point out that the decline in the disease during August followed on the resolution of the Sanitary Committee to detain all the patients suffering from diphtheria in the Mile End Hospital until three successive negative bacteriological examinations had proved them to be free from diphtheria bacilli, and that the November fall followed on the more complete application of the precautionary measures.

Treatments employed in the Mile End Hospital.

In considering the treatments adopted the year should be divided into two halves.

Before July 16th antitoxin was not given as a routine treatment on the admission of the patient to the Mile End Hospital, but appears to have been administered on arrival to a few serious cases only, and to some others who developed alarming symptoms later. During this period reliance was placed on antiseptic sprays to destroy the bacilli in



MAP OF COLCHESTER.

the throat. By such methods 81 cases were treated, of whom 21 died. The case-mortality was therefore 25·9 per cent.

After July 16th antitoxin was administered in accordance with a resolution of the Sanitary Committee to every case as soon as possible after admission, unless this had been previously done, and no efforts were made to destroy the bacilli in the throat.

Between July 16th and December 28th, 119 patients¹ were treated in the Mile End Hospital on this plan, and seven died. For this period the case-mortality was accordingly 5·8 per cent.² (This does not include certain cases the notification of which as cases of diphtheria was subsequently withdrawn and that of scarlet fever substituted, but it includes cases in which no diphtheria bacilli were found, for it was possible to exclude these only from the second group, and it was desirable that the two periods should be strictly comparable.)

The fall in the case-mortality from 25·9 to 5·8 per cent., which occurred on the introduction of the systematic use of antitoxin, affords a striking example, if any were needed, of the value of that remedy.

This fall has been ascribed to a gradual diminution in the severity of the disease. The accompanying chart (No. I.) of weekly admissions and deaths from diphtheria in the hospital shows, however, that the change in the case-mortality was abrupt, and that the introduction of the new treatment was followed by a succession of sixty cases without a single death.

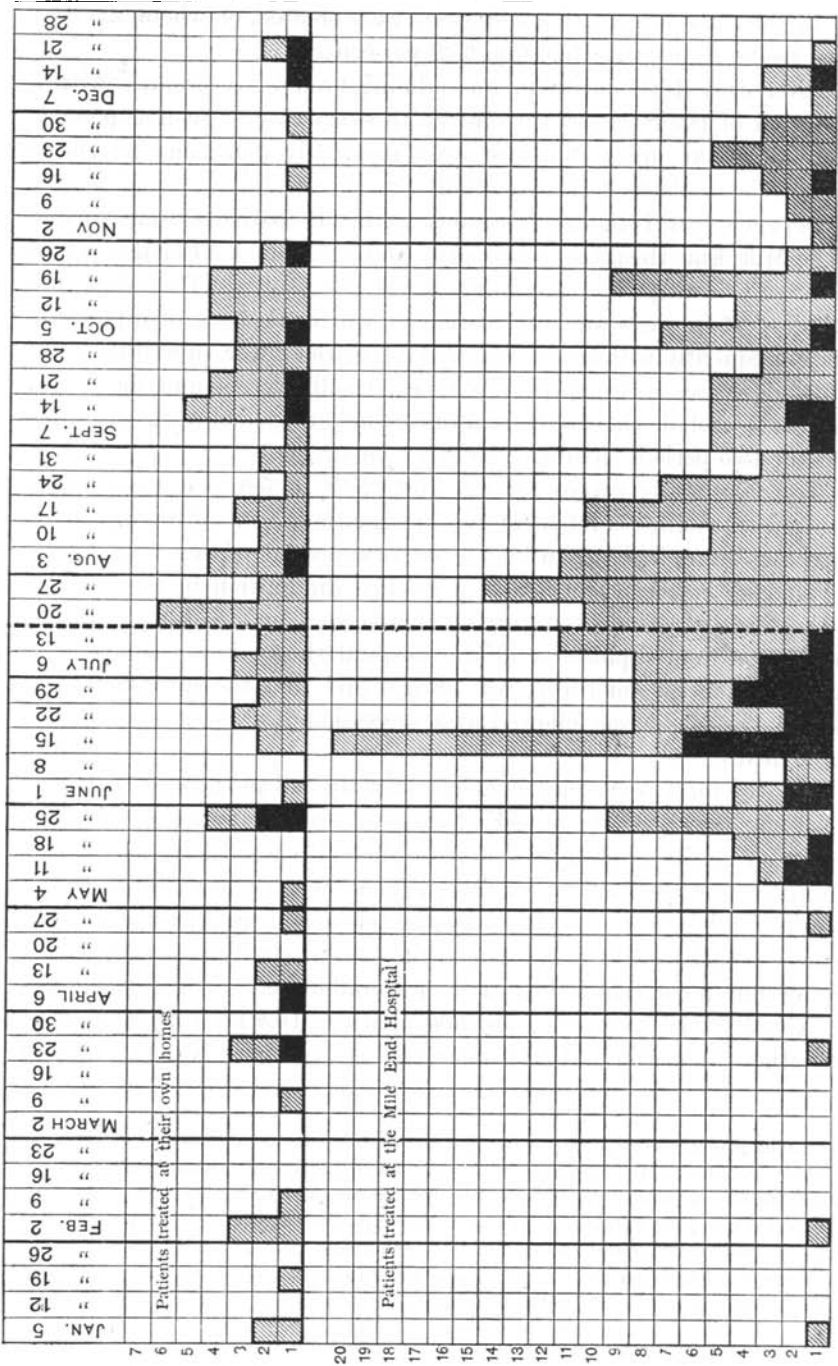
But the most convincing evidence that the fall in the case-mortality of patients treated in the Mile End Hospital was due to acting upon the resolution of the Sanitary Committee that all should have the benefit of antitoxin at the earliest possible moment, and not to a decline in the severity of the disease, is shown by the concurrent mortality of persons treated in their own homes, for upon the case-mortality of these patients the resolution could have had little or no influence.

Amongst the latter the case-mortality was 10·8 per cent. before the resolution (37 cases) and 14·5 after (48 cases) (chart No. II.). From

¹ Eight patients admitted immediately prior to July 16th are included in group II. all of whom had antitoxin previous to admission. The quantity of antitoxin and the date of administration in each of these cases is known to me, and they have been transferred from period I. to period II. in order that a true comparison may be made between the two forms of treatment. Seven others, none of whom died, also received antitoxin before admission, but I have left these in period I. as my information about them is not so exact.

² Even if sixteen persons, notified to have diphtheria, in whom no diphtheria bacilli were found, be deducted, the case-mortality during this period was only 6·6 per cent.

CHART I. Weekly notifications of Patients suffering from Diphtheria at Colchester during 1901.



■ represents a notified case of Diphtheria. ■ represents a notified case of Diphtheria which terminated fatally. July 16th, systematic use of Antitoxin introduced into the hospital.

CHART No. II.

	Total		Hospital Patients				Patients treated at home			
	Notifica- tions	Deaths	Admissions	Deaths	Case Mortality	Notifica- tions	Deaths	Case Mortality		
January	8	--	2	--	0 0/0	6	--	0 0/0	Mean Case Mortality 10.8 0/0	
February	1	1	1	--	0 0/0	1	1	0 "		
March	5	1	1	--	0 "	4	1	25 "		
April	26	7	20	5	25 "	6	2	33 "		
May	46	13	38	13	34 "	8	--	0 "		
June	27	3	19	3	15 "	8	--	0 "		
July										
Before 16th										
After 16th	39	1	31	--	0 "	8	1	12 "		
August	38	5	29	3	0 "	9*	2	0 "		
September	35	4	22	2	13 "	13*	2	15 "		
October	32	1	19	1	10 "	13	2	15 "		
November	15	3	13	1+	7 "	2	2	0 "		
December	8	3	5	1+	20 "	3	2	66 "		

* One case in each of these months treated by a private medical man without antitoxin in the hospital and transferred to this column.

+ Patient died within one hour of admission. Had been ill several days and received no antitoxin.

these figures it is evident that the severity of the disease did not decline, and it may fairly be concluded that the adoption of the anti-toxin treatment was the means of saving many lives.

Measures taken to check the spread of the disease.

As has been already shown the epidemic began to assume serious proportions in May, and continued to increase till July. The following were the measures adopted up till that month in the hope of checking the spread of the disease.

Patients suffering from diphtheria were during this period isolated either in the Infectious Hospital or in their own homes, but in the majority of cases no bacteriological examinations were made, either with the view of confirming diagnosis, or of determining when convalescents were free from the presence of diphtheria bacilli in their throats.

Members of the families from which the notified persons came, who were attending schools, were excluded from them for a short period. Provided no other person in the house had contracted the disease within a fortnight, the scholars were allowed to return to school after the disinfection of their homes.

It was also deemed advisable to close the public elementary schools about the middle of June, following the notification of twenty-two persons, all school children, during the week ending June 15th.

Towards the end of July the Town Council through Professor G. Sims Woodhead, of Cambridge, invited Dr Louis Cobbett to meet certain members of the Council in order to discuss with them what means should be adopted to check the epidemic, and at their request he put his proposals into writing in the following letter.

PATHOLOGICAL LABORATORY,
CAMBRIDGE,
July 31st, 1901.

To the Town Clerk—for the Chairman of the Public Health Committee.

DEAR SIR,

In accordance with the suggestion which you made at our meeting held in your office this afternoon, I send you the following proposals for dealing with the outbreak of diphtheria in Colchester.

In the first place I would point out that, in the absence of evidence of the propagation of the disease in your town by milk or infected animals, it is most reasonable to conclude that it is being spread by personal contact.

In this connection it must be remembered that those who suffer from recognised diphtheria are not the only sources of infection. Quite as important are those who suffer from so mild an attack that medical advice is not sought, and those who having come in contact with cases acquire the bacillus, and carry it in their throats and noses without any illness whatever. Indeed I think that those who belong to these last two categories are more responsible for spreading the disease than are the notified cases, because no precautions in regard to them are usually taken.

It is therefore of first importance to discover as many of these persons as is possible, and that without delay, and this can be done by bacteriological examination. Such infected persons when found should be isolated until they have been proved free from infection. Seeing that they are only to be found among those who have come into intimate contact with cases of the disease or with others infected like themselves, it ought not to be difficult to determine what persons should be examined.

In order to limit the necessary amount of work involved in carrying out this proposal, it is desirable that the diagnosis of all notified cases should be founded in part on bacteriological evidence; for experience in the London Metropolitan Hospitals and elsewhere has shown that from a quarter to a third of all cases notified as diphtheria on clinical evidence alone are not really instances of that disease, but suffer from membranous sore-throat of another kind.

Secondly, the very beneficial results obtained recently in Cambridge from prophylactic injections of 500 units of antitoxin given to those who have come in contact with cases of diphtheria induce me to strongly recommend this measure also.

Now as to the means of carrying out these proposals I would recommend that:—

(1) A practical Bacteriologist be appointed to make the necessary examinations, and that he be provided with a suitable laboratory and laboratory servant. (While this is being arranged swabs might be sent to Cambridge and examined there.)

(2) That a house and garden be taken, put in charge of a trained nurse, and opened as an Isolation Home for healthy infected persons. (The house might be situated on the outskirts of the town.) All persons admitted to the Home should have a prophylactic injection of antitoxin.

(3) That a circular letter be sent to all the private medical practitioners,

(a) Advising them of what it is intended to do.

(b) Offering them bacteriological examination for their poorer patients free of charge, as well as a free supply of antitoxin.

(c) Requesting them to submit swabs from all cases which are in the least suspicious, as well as from those which they notify; and from all children and young persons living in houses where these cases occur. (I do not think that the parents themselves should be examined, but would suggest that they should be instructed to make use of some antiseptic throat-wash night and morning.)

(d) Informing them that if they do not wish to be troubled with the examination of healthy "Contacts" the Medical Officer of Health is prepared to undertake this himself and to give prophylactic doses of antitoxin. The notification form might be made to contain a space in which the medical practitioner could state whether he wished the Medical Officer of Health to undertake this work.

(e) And finally requesting them not to regard their patients as free from

infection after a certain lapse of time, but only after bacteriological examination has been made with three consecutive negative results.

I should also suggest that the Medical Officer of Health seek out, and cause to be bacteriologically examined, all persons whom he thinks likely to have come in contact with infection, or cases of suspicious sore-throat of which he may be informed by his inspectors and others, where no medical man is in attendance. In this work he would probably require assistance, which might be afforded by a young qualified medical man.

It is evident that to carry out these measures it will be necessary to have the cordial cooperation of the medical profession and the public. It has been our experience at Cambridge that with patience and tact it is possible to induce parents to consent to the desirable measures.

I am, Sir, yours truly,

(Signed) LOUIS COBBETT, M.D., F.R.C.S.

This letter was read at a meeting of the Sanitary Committee held on August 9th, and after a careful and lengthy discussion the proposals were adopted with the exception of the provision of an Isolation Home, and Dr Cobbett was given the authority necessary to put these proposals into practice.

In the above letter to the Sanitary Committee Dr Cobbett points out that in his opinion diphtheria is very largely spread either by persons suffering from so mild an attack that medical advice is not sought, or by persons who harbour diphtheria bacilli in their throats and yet remain perfectly well. In other communications he specified some of the ways in which the two classes of persons just described, and more especially the children amongst them, disseminate the disease. He gave as examples, the custom of allowing two or more children to sleep in one bed; their congregation at school; the fact that their toys, pencils, and school implements freely pass from one to another; and finally their habit of putting these and other things into their mouths. In explanation of why infected persons may remain well, he quoted the fact that about 50 per cent. of healthy persons have diphtheria antitoxin in their blood.

During the outbreaks of diphtheria which occurred in Cambridge in the Autumn of 1900, and Spring of 1901, he was in a position to test the soundness of these views by finding and isolating such persons as he considered to be spreading the disease. The results gave some degree of justification for considering that his opinions were correct and the measures he adopted of practical value¹.

¹ See *Journal of Hygiene*, vol. 1., no. 2.

All the measures which he suggested for checking the outbreak at Colchester were based on these observations, and the considerable degree of success achieved is additional evidence in support of his view.

Experiments made at the Mile End Hospital and at the laboratory add further confirmative evidence of the correctness of his theory. Plate cultures were exposed in the wards of the hospital in various positions, but failed to demonstrate the diphtheria bacillus in the air of the wards. Similar experiments were made in the laboratory with like results.

The application of the measures proposed by Dr Cobbett.

On August 15th a circular letter was forwarded to all the medical practitioners in the borough in the terms suggested in section 3 of Dr Cobbett's letter to the Sanitary Committee, and by August 21st¹ a laboratory had been fitted up in Dr Chichester's house and work was commenced there.

As a result of these measures a considerable number of swabs were submitted for examination by the resident practitioners, and the diphtheria patients in the Mile End Hospital were bacteriologically examined, and none discharged till three consecutive negative examinations had shown them to be free from bacilli.

In accordance with these plans all patients admitted since July 16th had been detained in the hospital in order that their throats should be bacteriologically examined, and by these means it was discovered that several of them, who by this time were apparently well, still harboured diphtheria bacilli in their tonsils. Although the majority of these soon became free from their bacilli, and were discharged, two retained them for nearly twelve weeks longer, despite continuous efforts to destroy the parasites by the application of antiseptics.

Apart from the patients already admitted into the hospital a few persons, who had been treated in their own homes, were found to be in a similar condition, and some patients with suspicious sore throats were proved to be suffering from diphtheria, whilst in the case of others it was shown that the specific organisms of diphtheria were not present.

Mention has already been made in the foregoing history of the epidemic of the fact that the first fall in the notification rate per month occurred during August, and that the level of this month was maintained during September and October. This decrease in the number

¹ Between August 14th and 21st swabs were sent to Cambridge for examination.

of the cases notified, and more especially the continuance of the lowered notification level during months which are commonly the worst for diphtheria, may, I think, be fairly ascribed to the measures employed.

During the first few weeks the work was almost confined to the examinations described, but while they were being conducted a system for dealing with current cases as they arose, and with those who came in contact with them, was gradually being evolved, which, however, did not reach its ultimate form till after the examination of the school children had been completed. Details of the course adopted in connection with these cases will be fully explained presently.

Re-opening of the Public Elementary Schools.

The public elementary schools had been closed since the middle of June, and owing to the diminution in the notification rate it was decided to reopen them on September 9th. At the meeting of the Sanitary Committee, in which this step was decided on, a resolution was also passed instructing me to examine all the scholars bacteriologically. At the next meeting I pointed out that owing to their number (6,000) this could not be done in any reasonable time, and Dr Cobbett wrote to the Chairman showing with what a risk of increasing the prevalence of diphtheria the opening of the schools would be attended unless measures were taken to exclude the infected children.

As a result of these communications it was arranged that: (i) those schools in which diphtheria had chiefly occurred during the last few months should be kept closed till September 29th, and that the others should be opened on September 15th. (These latter accommodated rather less than half of the school children of Colchester.)

(ii) Those children living in houses in which a case of diphtheria had occurred later than June 1st should be excluded from school until they had been ascertained by bacteriological examination to be free from diphtheria bacilli.

The following means were used for carrying out the work.

With the aid of Mr Wells, the Inspector of Nuisances, a list was made of children who lived in houses in which a case of diphtheria had been notified since June 1st, and these children were classified according to the schools which they attended. With the concurrence of the school authorities the various head-masters and mistresses were notified by letter on no account to admit children whose names were on the

lists until they had received a notice stating that bacteriological examination had shown them to be free from diphtheria bacilli. The parents were also notified of this decision by letter, and were requested to send their children up to Dr Chichester's surgery for the necessary examinations. This invitation was well responded to, the parents being anxious that their children should return to school. In a few instances only was it necessary for the Sanitary Inspector to make a personal visit, and remind parents that the decision would be strictly adhered to.

Further, a meeting of the head-masters and mistresses was called to discuss with Dr Cobbett the best means of dealing with the pens, pencils, slates, and other school implements.

As a result of this conference the school teachers became informed about the possible ways in which diphtheria bacilli might be passed from one child to another, and measures were adopted for insuring that each child should have its own pens, pencils, and slate, and for the systematic disinfection of these articles. The teachers were also requested to send notice to the laboratory of any cases of sore-throat or other suspicious illness which might come to their notice.

As an additional precaution it was decided to remove the cups from the public drinking fountains, and a little later the water was cut off in order to prevent the children drinking from the spouts.

The work of examining the suspected persons was necessarily heavy and was finally completed about October 15th.

Four hundred and seven scholars from nineteen schools were examined as well as fifty-nine persons either above or below school age, members of the families to which the school children belonged, and fifty-three children from the Colchester Union, making in all five hundred and nineteen persons, from whom 861 swabs were obtained. Of these 519 persons 54 (10·4 per cent.) were found to be harbouring diphtheria bacilli in their throats, though they themselves remained in perfect health.

All these infected children together with the other members of their families of school age were excluded from school.

Owing to the stress of work some of these were not again examined for three weeks, but at the earliest opportunity all were re-examined, and if found free from diphtheria bacilli were, after three negative examinations, allowed to return to school.

On October 15th there remained fifteen of these children, who still retained diphtheria bacilli, and all were treated daily at Dr Chichester's surgery by means of antiseptics applied to their throats. Although in

a few days the children could tolerate the application of strong anti-septics to their tonsils, the treatment was not found to be very successful in freeing them from their bacilli, but was thought to render them less liable to communicate the bacilli to others.

On November 14th six remained and these were admitted to the Isolation Home (see below).

Since the Autumn and early Winter are as an almost universal rule by far the worst times for diphtheria, the outlook during September was very disquieting, and the opening of the schools was watched with anxiety, the more so as the mean notification rate was still eight per week. In spite of these adverse conditions the results of the measures just described were highly satisfactory, and lend very strong support to the view held by Dr Cobbett that diphtheria is largely spread by healthy persons harbouring diphtheria bacilli in their throats.

Chart No. III. has been constructed to illustrate the results of these measures upon the dissemination of diphtheria amongst the school children. It shows that after the completion of the examinations on October 19th, and the exclusion from school of the healthy children harbouring diphtheria bacilli found in the course of them, no case of diphtheria was notified amongst the scholars except from the Barrack Street, St Mary's, and Kendall Road Schools.

In the case of Barrack Street School a period of eight weeks elapsed and three cases were then notified. (One died before any cultivations could be taken, and no diphtheria bacilli were found in the other two patients.)

In St Mary's School two cases occurred during the week ending November 23rd, both confirmed by bacteriological examination.

At the Kendall Road School, on the other hand, there was a small outbreak extending over four weeks, in the course of which seven cases were notified.

These patients were all scholars in the Infants' department. The children attending this department (112) were all bacteriologically examined on November 30th, and five of them, harbouring diphtheria bacilli, were excluded from school.

Since that date no further case has been notified from the Kendall Road School.

Measures adopted for dealing with those who had been in Contact with Fresh Cases.

While the arrears of the past three months were being worked off the method of dealing with current cases was gradually organised.

Notifications of diphtheria were received at the laboratory. As each notification came to hand the Inspector was sent to the house in which the patient was living to make a list of all the inmates, their ages, and schools, if any, which they attended. He was also instructed to inquire whether any other children were intimate with the patient and to add their names to the list.

The parents of all these children were informed that none of them would be allowed to go to school until they had been bacteriologically examined, and all the children then in the house had been found to be free from infection; and they were requested to bring their children to Dr Chichester's surgery to be examined. In some cases, however, the necessary swabs were obtained through the doctors in attendance.

Notices similar to those already described were sent to the schoolmasters and mistresses concerned, warning them not to receive the children until further notice.

Prior to the opening of the Isolation Home, when a child harbouring diphtheria bacilli was discovered all members of the family of school age were excluded from school, but subsequently this was only done when the parents refused to allow the infected child to be isolated.

The Isolation Home.

At a meeting of the Sanitary Committee held on September 18th, the question of isolating healthy "contacts" who were found to harbour diphtheria bacilli in their mouths was again raised, and a list of twenty-five persons was submitted. It was thereupon resolved to refer the question to a special meeting to be held on September 25th.

On that day the Sanitary Committee unanimously resolved to obtain a house wherein such persons could be isolated and treated, and the Borough Surveyor was instructed to take steps to obtain Severall's Hall for the purpose, a farm-house with a considerable amount of ground suitable for the recreation of the inmates, situated about two and a half miles from the centre of the town.

This house was obtained and put in order, but owing to its requiring many repairs was not ready for the reception of infected persons till

November 14th. It contains two sitting-rooms for isolated persons and bedroom accommodation for fifteen, besides accommodation for a matron, nurse, and two servants.

Owing to the delay in opening the Home the infected children discovered early could not be isolated. On November 14th only six of these children still remained infected, and these were accordingly admitted.

Three "contacts" with more recent cases were also received, but the parents' consent to the isolation of three others could not be obtained.

Under the circumstances the Isolation Home could not have played a very important part in bringing the epidemic to an end, though it will doubtless be of great value in the future. Better results might have been obtained had the Isolation Home been available for the healthy "contacts" at an earlier period.

The most effective step actually taken was probably the exclusion of the infected children from the schools, and the constant application to their throats of antiseptics, which though it seemed to have but slight influence in freeing them from their bacilli, probably made them less dangerous to others than would otherwise have been the case.

From the foregoing account it is seen that the parents of infected children, and other healthy adults, who might have come in contact with cases of diphtheria, were not systematically examined. This course was adopted, firstly, because it was thought impracticable to isolate those who were earning the living of the family; and, secondly, because if it had become known that certain persons, in whom diphtheria bacilli had been found, were not isolated, it might have led to difficulties in procuring the isolation of children who, it cannot be doubted, are from the nature of their habits and the circumstances of their lives more liable than adults to convey to others any micro-organisms that they may have in their mouths (see p. 178).

Decline of the Epidemic.

In November the recorded cases fell from thirty-six, the mean rate of the previous three months, to fifteen, and this was followed by a further decline in December, when only eight persons were notified as suffering from diphtheria, up to the 28th.

Of these twenty-three notified persons eighteen were treated in the Infectious Hospital, but in seven of the latter the diagnosis was not

confirmed by bacteriological examination, though several cultures were obtained from each of them.

Including these persons the mean weekly notification rate of the last nine weeks of the year was 2·5, as against 8 in the previous nine, and 13 in the eleven weeks preceding the latter.

Finally on December 28th only two patients, both convalescent, remained in the hospital and two in the Isolation Home.

The decline in the epidemic followed so closely on the measures for dealing with the scholars of the public elementary schools that it can scarcely be doubted that it was brought about by these measures, and I consider that there is good reason to think that if these precautions had been employed in May and June, when the area in which the disease prevailed was limited, the further spread of the outbreak might have been considerably reduced.

The Bacteriological Examinations.

The carrying out of these measures involved the bacteriological examinations of 1891 swabs, 693 from the hospital, 337 from general practitioners, and 861 obtained directly from school children and others whom it was thought desirable to examine on account of their having come more or less closely in contact with actual cases of diphtheria.

Diphtheria bacilli were found in 436 cultivations (23 per cent.).

On the subject of the pseudo-diphtheria or Hofmann's bacillus the observations made at Colchester are in accordance with Cobbett's views on this organism.

As the result of his investigations at Cambridge¹ in 1900 and 1901 he came to the following conclusions:—

(1) That the experience of the outbreak at Cambridge gave no reason for thinking that the pseudo-diphtheria bacillus is other than perfectly innocuous to man.

(2) That the frequent presence of the pseudo-diphtheria bacillus should not be allowed to weaken our efforts to detect and isolate those who harbour the virulent bacillus.

His observations during the Spring outbreak at Cambridge², of 1901, tended to confirm his belief in the opinions just quoted.

¹ "The result of 950 bacteriological examinations for diphtheria bacilli during an outbreak of diphtheria at Cambridge and Chesterton." Louis Cobbett, M.D., F.R.C.S., *Journal of Hygiene*, vol. 1, p. 258.

² "Observations on the recurrence of diphtheria at Cambridge in the Spring of 1901." Louis Cobbett, M.D., F.R.C.S., *Journal of Hygiene*, vol. 1, p. 494.

At Colchester, although full particulars of all the micro-organisms found are not enumerated in a few instances, the pseudo-diphtheria bacillus is recorded as present on 586 occasions, or 31 per cent., of all swabs examined—and amongst the 112 scholars of the Infants' department of the Kendall Road School, 66 or 59 per cent. harboured this bacillus.

From these figures it can be seen how commonly this bacillus made its appearance in the cultures, but it probably occurred even more commonly than is here represented, for in 157 cultures only the presence or absence of diphtheria bacilli is noted, and in many others when diphtheria bacilli have once been found no further search for the pseudo-diphtheria bacillus was made.

Further, it was noticed in this epidemic, as it had been at Cambridge, that the pseudo-diphtheria bacillus was most frequently found in the throats of the children of the poorer classes, and also that it seldom, if ever, appeared to exercise any influence on the person in whom it was discovered.

The Persistence of Diphtheria Bacilli in the throat.

Following the practice adopted at Cambridge and other places¹ it was decided that a patient should only be considered free from infection after three consecutive negative examinations, and the following facts appear to indicate that this course gives a practical measure of safety, if the last two examinations are made after all local antiseptic treatment has been discontinued².

Of the patients discharged from the hospital during period II. thirty were re-examined on subsequent dates and all but three³ were found to be free, and, moreover, in no case, with one doubtful exception,

¹ At the South-Western Fever Hospital the patient is detained till the bacilli disappear as evidenced by three consecutive daily examinations. *Guy's Hospital Gazette*, vol. xv., p. 294.

The Boston Board of Health, U.S.A., require for hospital patients three consecutive negatives. Paper by H. W. Hill, M.D., *Journal of the Massachusetts Association of Boards of Health*, vol. viii., Oct. '98.

² Antiseptic applications, if any were being used, were not applied within the twenty-four hours previous to a swab being taken. If the result of the examination showed that diphtheria bacilli were no longer present treatment was entirely discontinued (unless they occurred on a subsequent occasion) in order that the presence of antiseptics on the swab might not hinder the growth of the organisms on the culture media.

³ One of these suffered from a second well-marked attack of diphtheria and another had been in contact with a recent case immediately previous to examination.

was it brought to my notice that a discharged patient was an agent in spreading infection.

Amongst the hospital patients, if a few exceptional cases are excluded, the mean duration of the period during which the diphtheria bacilli were found to persist was 28 days from the date of notification, but in some of the exceptional cases they lingered up to 87 days.

A few of the healthy children, found to be harbouring diphtheria bacilli, also retained them for long periods, in one case up to 94 days.

A small proportion of these persons, in whose throats the bacilli obstinately remained, had very large tonsils, but in the others no abnormal conditions could be found to account for their long persistence.

Ages of Persons notified to be suffering from Diphtheria.

Between January 1st and December 28th 285 persons were notified, of whom 77 were above, and 208 below, fifteen years of age. 72·9 per cent. of all notified persons were consequently below the age of fifteen.

In 1900 the proportion of patients treated in the infectious hospital over, to under, fifteen years was about the same; 71·4 per cent. being under that age.

These figures afford an explanation of the marked fall in the notification rate which occurred when the disease was almost stamped out amongst the children of school age.

It is also interesting to note that after this occurrence not only did the notifications decline, but a decided change took place in the proportion of adults to children notified, as is shown in the following table.

	Persons notified		
	Total	Above 15	Below 15
Week ending October 19th	13	7	6
" " " 26th	5	2	3
" " November 2nd	1	1	—
" " " 9th	2	—	2
" " " 16th	4	1	3
" " " 23rd	5	2	3
" " " 30th	4	2	2
" " December 7th	1	1	—
" " " 14th	4	1	3
" " " 21st	3	2	1
" " " 28th	—	—	—
	42	19 (45 %)	23 (54 %)

Up to the week ending October 12th, 75·6 per cent. of notified persons were under fifteen years of age.

The Case-mortality of Patients above, and below, fifteen years of age.

During the year 36 of the 208 persons under fifteen years of age notified to be suffering from diphtheria died (17·31 per cent.) and only three of the 77 above that age (3·9 per cent.); consequently the mortality amongst the children was nearly four and a half times as great as it was amongst adults.

At the Mile End Hospital the percentage case-mortality for each class was much higher in period I. than in period II. The records for period I. (p. 171) show that twenty persons under, and one over, fifteen years of age, died, making the case-mortalities 27·4 per cent. and 11·1 per cent. in each class respectively.

With the introduction of the systematic use of antitoxin during period II. a very marked reduction in the case-mortalities became apparent, for while no person over fifteen died, only seven deaths of patients under that age occurred, the resulting case-mortalities for each class being 0 and 9·09 per cent.

From August till the end of December Dr Louis Cobbett acted as Consulting Bacteriologist to the Town Council, and every measure adopted was in accordance with his proposals. On several occasions also he was present and assisted in the practical part of the work.

Dr E. Chichester, in whose house the laboratory was established, not only took all the swabs from the hospital patients, but also very kindly allowed us to make use of his surgery for examining, swabbing, and treating contacts and other persons. Throughout he rendered every assistance in his power, and especially offered valuable suggestions as to the local treatment of infected throats, which he put into practice on hospital patients who obstinately retained their bacilli.

At a meeting held on December 18th the Sanitary Committee decided to appoint Dr Chichester to carry on the work on the lines indicated.

Dr J. R. Watson also rendered great assistance at the time when the school children were being examined and the pressure of work was very great.

To Mr Wells, the Inspector of Nuisances, a great part of the credit for the effectual application of these precautionary measures is due. From the outset he thoroughly grasped the principles on which the work was being conducted and brought to bear on the part intrusted to him great tact and energy.

Summary.

Finally I wish to draw particular attention to the following facts:—

1. The striking diminution in the case-mortality at the Mile End Hospital which followed the systematic use of antitoxin.
2. The subsidence of the epidemic during the season when diphtheria is commonly most prevalent.
3. The opening of the schools in September without any increase in the prevalence of the disease.
4. The persistence of diphtheria bacilli for long periods in certain of the convalescents and contacts.
5. The success of preventive measures based upon the belief that diphtheria is spread mainly by personal contact, and through the intermediation of healthy persons and others who by the means usually employed are not recognised to be suffering from the disease.

ADDENDUM.

Considering the extent to which the outbreak had spread it could scarcely be hoped that we had succeeded in finding every person harbouring diphtheria bacilli even amongst the scholars of the elementary schools, and consequently I was not surprised to learn that several fresh cases of diphtheria had been notified in the early part of the year 1902.

Between December 28th and February 23rd twenty-seven patients have been notified, the weekly returns being 7 during the week ending January 4th, and 4, 5, 2, 5, 3, 1 in the weeks following.

Fifteen of these were either scholars of Barrack Street School or persons connected with them, and five were connected with the Culver Street or Wesleyan School, and the main part, if not the whole of the outbreak in these two schools, can, I think, be traced to the neglect of bacteriological examinations in two instances.

Chart IV. has been constructed to show the lines along which I am inclined to think the specific organisms were carried to the various persons in connection with these schools who developed the disease.

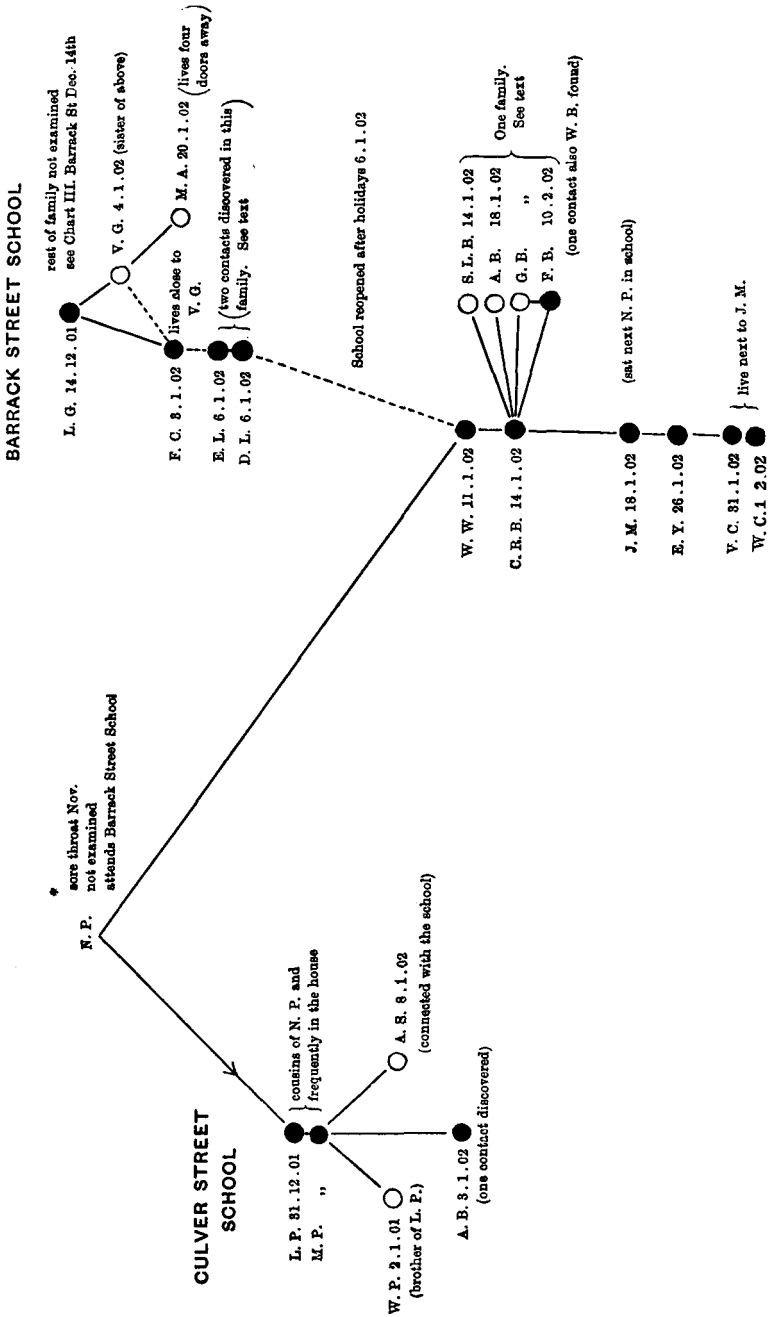
The child mainly responsible for the outbreak I believe to be N. P., and L. G. seems to have been also an agent in spreading the disease.

Neither was proved by bacteriological examination to have diphtheria bacilli in her throat. N. P. was not examined because at first no information concerning her reached me, and later because her parents refused to allow a swab to be taken. L. G. died before any examination could be made.

N. P., who was a scholar of Barrack Street School, suffered from a sore throat in the early part of November, which was considered by the neighbours to be diphtheria, but as stated, no bacteriological examination was made. This child

CHART IV.

Children attending the Barrack Street and Culver Street Schools, and others in connection with them, notified to have diphtheria since December 28th.



* N. P. returned to school on 6. 1. 02, when it reopened after the holidays, and attended till 14. 1. 02 when she was excluded. Parents consent to examination could not be obtained.

- signifies a scholar notified to have diphtheria.
- signifies other persons connected with scholar.
- Initials and dates of notification given for each case. Straight line indicates probable line of infection, directly or through intermediate contacts; dotted line possible line of infection.

remained at home till January 6th when the school reopened after the holidays, and then she again commenced to attend and continued to do so till January 14th.

L. P. and M. P., cousins of the above child, were frequently in the house, and on December 31st were notified to be suffering from diphtheria. Both were scholars of the Culver Street School and continued to attend until the commencement of the school holidays immediately before Christmas.

These two were the first cases recorded in this school since September 14th.

Subsequently their infant brother was attacked and two other persons, one connected with the school and the other a scholar, and one healthy contact was found in connection with these cases. No further cases occurred at this school.

At the Barrack Street School ten scholars suffered from diphtheria and five persons apparently connected with them.

Three scholars and two others were notified before the opening of the school and the return of N. P. These seem to be connected with the case of L. G., a scholar, who was notified as suffering from diphtheria on December 14th (Chart III.) and died before a swab could be obtained. That the disease from which she suffered was diphtheria appears to be certain from the fact that her sister V. G., who was not a scholar, was notified on January 4th. These two seem to have communicated the disease to F. C. and M. A., children who lived close to them, the former being a member of Barrack Street School.

On January 6th two children, both members of the same family, and scholars of this school, were notified, and two contacts were found in the family, who may have been responsible for passing the disease from L. G. to the other two members of their family.

This small epidemic shown on the Chart IV. in the right upper corner, appears to have arisen from the case of L. G. and was not I think connected with the outbreak after the reopening of the school, although some unknown contacts with these cases may have been instrumental in handing on the disease to some of the patients subsequently notified.

N. P., who seems to have been the original cause of the outbreak in the Culver Street School, returned to the Barrack Street School when it reopened after the holidays on January 6th and continued to attend till the 14th, when she was excluded.

Five days after the opening of the school a scholar, W. W., was notified and three days later another, C. R. B. Shortly afterwards J. M., who had been sitting next N. P., developed the disease, and subsequently two children who lived in the next house to her. The course of these events can be followed in the diagram.

All the children notified are not members of the same class, but all meet in the playground and cloakroom.

The small outbreak in the Culver Street School evidently started by L. P. and M. P., who were frequently in contact with N. P., combined with the fact that N. P. suffered from a sore throat of such a nature that the neighbours considered it to be diphtheria, and which kept the child away from school for two months, seem to point to the disease from which N. P. suffered being diphtheria. Additional weight is lent to this view by the spread of diphtheria at Barrack Street School when she again attended as a scholar, and also by the fact that the outbreak came to an end about a fortnight after her exclusion from school, and that the school has remained free for three weeks afterwards (date of writing).

These arguments might have been much strengthened had it been possible to obtain the parents' consent to the examination of her throat, but in the absence of bacteriological evidence, the several facts stated suggest that she was one of those patients who suffer from a mild attack and afterwards harbour the bacilli for a long time.

The case of C. R. B. is of especial interest, for by the use of the bacteriological test the further spread of the disease by means of this family was probably prevented.

C. R. B. and S. L. B. were notified on January 14th and diphtheria bacilli were found in the throats of four other members of the family. The throats of all four appeared normal and they complained of no illness. No antitoxin was given, but they were isolated. In the course of a few days two of them developed the disease, and one three weeks later.

Of the seven remaining cases one is particularly noteworthy. A. S., the sister of R. S., was notified on August 6th and was treated in the hospital. On September 19th, in the course of the examination of the infected scholars, R. S. was found to be harbouring diphtheria bacilli. He was isolated and treated until December 15th, when he appeared to be free from bacilli and was sent home. On January 14th he was notified to be suffering from diphtheria. This is the only case recorded in the St John's Green School between October 19th and February 23rd.

Two cases occurred amongst the nurses in the hospital, who probably derived their bacilli directly from the patients.

I can offer no explanation as to the origin of the last four cases, having received no information about them apart from the statement that they attended certain schools, nor do I know whether the diagnosis was confirmed by bacteriological examination.

One notified on December 30th attended the Kendall Road School, one Lexden School, one Shrub End School and one Greenstead School.

The last three schools are placed in Chart III. under the heading "Other Schools." All are situated on the outskirts of the town and in none of them had a case been previously notified during the year.

This recrudescence of the disease has consequently been almost confined to the Barrack Street and Culver Street Schools; and every other school within the town, with the exception of Kendall Road, with a small outbreak in November and one case later, and St John's Green with one case, have remained free from October 19th, the date of the completion of the examination of the infected children, till the time of writing (February 25th) a period of eighteen weeks.

Of the 27 persons notified, 15 can apparently be traced to N. P., 5 to L. G., and 3 also of the remaining 7 can be accounted for.

Dr Chichester has most kindly furnished me with the results of many of his bacteriological examinations, and Mr Wells has supplied me with much information about all these cases, which must have cost him much time and trouble to procure.