OBSERVATIONS ON OTORRHOEA
AND ITS
RELATIONSHIP TO DIPHTHERIA.

by

Lloyd H. Werden. M.D. 1922.
Observations on Otorrhoea and its Relationship to Diphtheria.

This study was undertaken in the beginning of the winter of 1921, and was prompted by the statement of a colleague that many cases of otorrhoea were diphtheritic. The subject commended itself as an interesting one, and one which, in the course of my customary duties, I might follow up to the finding of some useful information. My primary object was two-fold: first, to determine what proportion of all the cases of actively discharging ears I should meet with would yield growths of diphtheria bacilli on culture by the ordinary method used in the examination of throat swabs; and secondly, to determine what evidence there was (if any) that these cases were concerned in the spread of clinical diphtheria. It will be seen by what follows that other points have received attention also; but the above has been the main object of this enquiry.

Sources of the material. In all, 42 cases have been examined, and these are all that I have met with during 9½ months commencing 5th December, 1921. The cases were encountered while carrying out the work of medical inspection and treatment of school children in the County of Monmouthshire, and while attending at some of the Maternity and Child Welfare clinics in this same area. During the per-
iod referred to, I have (unfortunately for the purpose of this enquiry) had relatively little medical inspection work to do. Had my work consisted more largely of this, I would doubtless have gathered several times as many cases as I have done. It will be seen from the accompanying maps that most of the cases I have investigated happen to be in the Urban District of Bedwellty. This does not necessarily mean any greater incidence of cases in this area than elsewhere, but merely that most of my medical inspection and infant welfare work happened to lie in this area.

Method of Investigation. Whenever a case was found in which otorhhea could be detected without the use of a speculum, the ear was swabbed and the swab sent to the County Pathologist for report re the presence or absence of diphtheria bacilli. At the same time a record of the case was made on a form like that appended to this thesis, and subsequent examinations were made in many cases. It will be seen that the completion of the case usually required the co-operation of the parent or guardian of the child in question. This necessitated a visit to the home in many cases, and enquiry was always made as to any cases of diphtheria in the family or neighbourhood. Finally, a list was obtained from the Medical Officer of Health of the Urban District of Bedwellty, showing the
Map of Monmouthshire

Black numbers indicate cases of otorrhoea not showing infection with B. diphtheriae. Red numbers indicate cases showing this infection.
Urban District of BEDWELLY.

Scale 1 inch = 1 mile.

Cases of otorrhoea showing B.Diph. marked thus: •
Cases not showing B.Diph. marked thus: •
names and addresses, ages, and (in the cases of children of school age) schools attended of all the cases of diphtheria that were notified to him during the period 1st. October, 1921 to 20th September, 1922, and this list was duly scrutinised. In all, 72 swabs were submitted for bacteriological examination, and animal inoculations were carried out in three cases.

Details of the case of M.J. One of the cases will now be set forth in some detail, as it illustrates many points typical of others, and suggests several points which will come up for discussion later.

M.J. is a girl, aged (when first seen) eleven years. That was on 8th December, 1921, and she was then going to school, where I came upon her in the course of routine inspection. The right ear showed nothing abnormal. The left presented an offensive, sanguineous discharge. Tonsils were definitely enlarged, though not markedly so. There was no evidence of adenoids. Swab from left ear sent to laboratory was reported diphtheria bacilli positive. A week later I visited the child's home. A poor home. Father a coal miner. Works a little, and appears to be off work much. Mother says M.J's ear started to discharge when she was seven months old. She had no teeth at that time. Was late in teething, and then had ulcers in mouth. Had measles when six years old, and scarlet when aged eight. Never had diphtheria or any other illness. Mother said that on this day the girl was ill, though in school. I sent and had her out. Complaint of sore throat, and pain extending from left ear to forehead. Right tonsil more enlarged than when first seen, and somewhat inflamed. No membrane or exudate. Nasal catarrh. Otorrhoea copious, purulent, not sanguineous. Temperature 100.8 in axilla. Swabs taken from (a) left ear, (b) throat, and (c) right nostril. Result: (a) diphtheria bacilli positive, (b) and (c) negative. On this visit I also discovered that two brothers living in the same house also had discharging ears. One of these (W.J.) also turned out to be positive. The other was negative.

I then suggested to the County Pathologist that it would be interesting if one
could know whether or not these bacilli were virulent. On 25th December, 1921, I received the report: "Result of animal inoculations of K.L.B. cultures obtained from ear swabs from M.J. and W.J.: Virulence tests positive in each case." At this point I felt bound to regard these cases as possible carriers of infection, and I therefore had M.J. excluded from school. W.J. was under school age and not attending. Enquiry was made in the office of the County Medical Officer and also from the head teacher of the school which M.J. had been attending, but no evidence was found of the recent occurrence of any cases of diphtheria in this school.

M.J. was seen and swabbed again on 5th January, 16th February, and 16th March, 1922. In each case the report was B. diphtheriae positive. I had meanwhile tried to induce the child's mother to get the ear treated, but without practical result. At last, on 23rd March, I presented the mother with a syringe, boric lotion and drops of methylated spirit (50%), and told her to syringe twice daily (more dictu), following with the drops, but not to treat the ear at all on the mornings of the days when I would see the case again, namely, a week hence and a fortnight hence. Seen again at these times, the mother said she had followed my instructions, the discharge was less in amount and had lost its offensiveness, and the swabs taken on these two occasions were both returned negative. The girl was allowed to return to school, and I am sure treatment was discontinued. I saw her again on 27th April, 17th May, 22nd June, and 14th September. On the last three of these occasions swabs were taken. The discharge was as offensive as ever, and all three swabs were reported positive. The girl was not excluded from school again, for I had meanwhile discovered a number of other positive cases, and it was thought inadvisable to exclude all these until one had more evidence that they were really dangerous carriers.

Observations on the cases in general.

The age of the patient at the time otorrhoea was first noticed is a matter of interest. Of the 42 cases, 21 gave a history of the discharge having commenced during the first year of life. Seven were said to have started
during the second year, and the rest were spread out over the succeeding years of childhood. A curve showing the incidence is given. This might suggest that most of the cases examined were young children. The case, however, is quite the reverse. The second curve shows the ages at which these same cases came before me for examination.
It therefore appears that the great majority of cases of otorrhoea originate in infancy, and that if one gets through the first two years of life without developing this complaint, he may have good hope of escaping it altogether.

Etiology is always of interest. Since most of the cases originate during the period when the milk teeth are erupting, one seems justified in attributing many cases to the inflammatory condition of the mucous membranes which is prone to occur at that time. Of the 42 cases, nineteen seem reasonably attributable to teething, while two more cases may belong to this group, but are not included, since they are more doubtful. Three cases are attributed to measles, two to pneumonia, one to influenza, and one to diphtheria. In one further case, the tympanic membrane was said to have been broken in the attempt to extract a bead from the meatus; a few days later the patient developed influenza, and then the otorrhoea commenced. In the remaining thirteen cases, the history gave no clue to the causation of the discharge. None were attributed to scarlet fever. The presence of an unhealthy naso-pharynx, of course, might easily account for the condition, either in conjunction with or apart from other possible causes such as are mentioned above. In sixteen of the 42 cases there
was either obvious enlargement of tonsils or post-nasal obstruction or both. Of the thirteen cases whose history gave no indication of the cause of the otorrhoea, five had enlargement of tonsils either with or without adenoids, and one more appeared to have adenoids.

ANALYSIS OF THE POSITIVE CASES.

Of the 42 cases, fourteen gave positive cultures of diphtheria. These cases were found in children of the following ages: eleven years (three cases), ten years (two cases), eight years (two cases), seven years, six years, four years, two years, one year, seven months and five months.

Duration of the discharge. This varied in the positive cases from ten years at one extreme to two weeks at the other. The actual figures are: ten years, nine years, eight years, five years (two cases), four years, three years (two cases), nine months, eighteen months, twelve months, three months, two months, and two weeks. It may be worth noting here that four cases of otorrhoea were discovered which gave histories of a duration of only one week, three days, two days and one day, respectively, but in none of these cases was the diphtheria bacillus found.

The proportion of cases giving any history of diphtheria is surprisingly small.
Only three cases out of the whole 42 afforded any history of this kind at all. In one of these cases, the otorrhoea commenced when the child was ill with diphtheria in August, 1914. In another there is a history of an illness which was probably diphtheria four years ago. In the third case, another member of the family had diphtheria during the summer of 1921. But none of these three cases yielded cultures of diphtheria bacilli.

Several of the cases were followed up with the view of ascertaining the duration of the positive state and also, if possible, the effect of treatment. One of these cases (that of M.J., described above) was still positive nine months after she was first seen. During this period, and after the treatment indicated in the account of her case, two negative swabs were obtained; but after the treatment was stopped, the condition became positive again. A second case continued positive for six months, and then one negative swab was obtained. No treatment was given. A third was found to be negative in two months without treatment. A fourth was positive for three weeks, then received treatment, and was negative in six weeks. A fifth was negative in three months without treatment. Two other cases were still positive after one month and three months respectively, and were not followed up further. In another case, the discharge ceased in
less than two months without treatment. From the above it is evident that the positive state may continue for a long and seemingly indefinite period. Not one of the above cases could be discharged as definitely no longer a carrier. Concerning the effect of treatment, little can be said at present. Parents and practitioners alike, soon weary of discharging ears. In only two of the cases did I feel at all sure that treatment was really being carried out. Both these cases subsequently gave negative swabs, but one of them (after giving two negatives) became positive again when the treatment was stopped.

**EVIDENCES OF INFECTIVITY.**

Mention has been made of the ways in which an attempt was made to find some connexion between the cases of otorrhoea showing diphtheritic infection on the one hand and cases of clinical diphtheria on the other. In every such case, one had two questions in mind: (a) Where has this infection come from? and (b) Is there any evidence that this infection has been passed on to anyone else?

The enquiry in the children's homes yielded nothing but consistently negative results. In not one of the positive cases could the parent give a history of any case of diphtheria in the house
or in the near neighbourhood.

In the endeavour to scrutinise the notifications of diphtheria above-mentioned, both those notifications and my own positive cases of otorrhoea must be grouped geographically. My fourteen positive cases fall definitely into two groups. The first group consists of five cases all living at Aberbargoed. Of these five cases, two were infants under a year old, while the other three all attended the same school (Aberbargoed Girls' and Infants'). But no cases of diphtheria were notified to the Medical Officer of Health from Aberbargoed at all during the period 1st October, 1921 to 20th September, 1922. The second group consists of the remaining nine cases. Of these nine, seven attended the Fairview School (Pengam), while the other two were younger brothers (below school age) of two who go to make up these seven. Meanwhile, one finds among the notifications of diphtheria only one case of a child attending this school. More evidence of this negative kind meets one as the enquiry is continued. For instance, in Cefn Forest School four cases of otorrhoea were investigated, and not one was positive. But meanwhile there occurred four cases of diphtheria among the children in this school. The positive cases of otorrhoea and the cases of diphtheria have
also been examined with a view to ascertaining if any of the cases of the former were near neighbours to those of the latter. No instances of close proximity have been found.

One can not leave the question of infectivity without noting that although the search for any relationship between cases of otorrhoea showing diphtheritic infection on the one hand and clinical diphtheria on the other has so far yielded consistently negative results, still there has emerged a marked grouping of the positive cases of otorrhoea. This is plainly seen in the group of nine cases referred to in the preceding paragraph. In all, only ten cases of otorrhoea were found in Fairview School; and of these ten, seven gave cultures of Klebs-Loeffler bacilli. Two of these children lived at Cefn Forest, but went to Fairview School. One readily sees how, in a school, an infection of this kind may spread from case to case. Few of the cases I have observed come to school with plugs of cotton wool in their ears, and in some cases the discharge is profuse. The schools in this County are equipped with dual desks, which necessarily bring the children into close proximity to each other. Also, these schools are provided with common wash-hand basins and roller
towels. It may be that they use these on occasions.

There is yet another fact that suggests a relationship between the positive cases. In the whole series of 42 cases of otorrhoea, four instances were found where more than one child in the same family suffered from this complaint. Let us call these four instances cases (a), (b), (c), and (d). In case (a), two children in the family were affected, and they both gave negative results as regards the diphtheria bacillus. In cases (b) and (c), two children in each family were affected, and all four children gave positive results. In case (d), three children were affected, and two of them gave positive results while the third turned out to be negative. The negative finding in this last child was surprising, inasmuch as it was found that he actually slept in the same bed with one of the others who consistently gave positive results. The negative finding was verified by a second swab, and the case would have been investigated further but the ear unfortunately dried up.

CONCLUSIONS.

It appears, then, that carriers of diphtheria in whom the infection is located in a diseased ear are very common. The existence of such cases does not mean that these persons have themselves suffered from diphtheria and that the
infection has persisted in this situation. The infection appears to be picked up otherwise, and be super-added to the bacterial flora which is primarily responsible for the otorrhoea. Here the diphtheria organism lives a saprophytic existence; possibly there is a symbiotic relationship between it and some of the other organisms in the ear.

But while such appears to be the case, we see that as far as this research has gone, evidence of these carriers acting as spreaders of the disease commonly recognised as diphtheria is conspicuously lacking. Why has no evidence of this been forthcoming? There are several ways in which an attempt may be made to answer this question.

1. It is obvious that an infection in the ear will not be spread about with the facility that would be the case were the infection lodged in the throat. Unless the otorrhoea were a copious one, one would think an infection in the ear would find little opportunity of spreading itself. But even so, one would expect to find some evidence of the kind referred to.

2. The virulence of the organism has been called in doubt. This was tested in two cases, and in both cases the virulence was proved. It was tested in a third case also, but the organism in that case was morphologically distinguishable
from the Klebs-Loeffler bacillus.

3. The proportion of immunes in a population is a factor which must not be lost sight of. Since the introduction of the Schick reaction, much has been learned in this regard; and it has been found that among children of school age, and especially among the lower classes, the proportion of immunes is very high. In the school population of poor districts of New York, for instance, Zingher found it to be over eighty per cent*. It was my desire to carry out some tests of this kind in connexion with this study, but it was not wise to attempt it in this area, lest popular prejudice should be aroused.

4. The identity of the organism may be doubted. The bacteriological work in connexion with this study was carried out by a very competent pathologist,** and he has assured me very emphatically that the organisms in these cases were real diphtheria bacilli. Now, it has recently been shown that there are several varieties of the diphtheria bacillus, which can be distinguished by agglutination with appropriate sera.*** Pell claims to have differentiated three varieties,** but has had other strains of B. diphtheriae which would not go into any of these groups.

** R. W. Catto, M.B.,B.S.,D.P.H., to whom I owe many thanks.
** B.M.J., 11th Feb., 1922, p.252D.
May it not be that in these positive cases of otorrhoea we have a variety of the diphtheria bacillus which does not readily invade the throat, but which has a great tendency to complicate the infection in cases of otitis media?

Pending further elucidation of the subject, however, it is evident that these positive cases of otorrhoea must be regarded with suspicion. The practitioner who undertakes to treat a case of otorrhoea should bear in mind that the possibility of diphtheria bacilli being present in the discharge is by no means a remote one, and careless disposal of material removed from the ear may lead to cases of diphtheria. Also, when on the hunt for the source of infection in a sporadic case of this disease, one should remember that the source may possibly be found in a running ear.

**SUMMARY.**

1. Cases of otorrhoea showing infection with the diphtheria bacillus are much more frequent than is usually supposed. In a series of 42 cases, fourteen were positive.

2. Positive cases occur in very young children as well as in older ones; in recent discharges as well as in those of many years' standing.

3. The virulence of the organism has been proved in two cases, -- the only positive cases in which virulence tests were carried out.

4. Enquiry has so far failed to find any correlation between these positive cases of otorrhoea
on the one hand and cases of diphtheria on the other. There has been found, however, a suggestive grouping of the positive cases of otorhoea.

5. The condition in the cases under discussion is probably a saprophytic one so far as the diphtheria bacillus is concerned. It may be that a special variety of this organism is involved.

6. Pending further elucidation of the subject, these cases must be regarded as possible sources of infection.
Copy of Case-sheet.

<table>
<thead>
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<th>Case No.</th>
<th><strong>OTORRHOEA</strong></th>
<th>Date.</th>
</tr>
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<tbody>
<tr>
<td>Name:</td>
<td></td>
<td>Age.</td>
</tr>
<tr>
<td>Address.</td>
<td></td>
<td>Sex.</td>
</tr>
<tr>
<td>Date when otorrhea was first noticed.</td>
<td>School Attended.</td>
<td>I.W.C. Attended.</td>
</tr>
</tbody>
</table>

Subsequent History.

Condn. on Examination.

Right Ear.

Left Ear.

Tonsils.

Adenoids.

History of:

Teething.

Measles.

Scarlet.

Diphtheria:

a) In this child.

b) Other cases in family or neighbourhood.

Other Diseases.

**Bacteriological Findings.**

**Subsequent Examinations.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Treatment</th>
<th>Condition</th>
<th>B.Diph.</th>
</tr>
</thead>
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