A REPORT ON AN OUTBREAK OF DIPHTHERIA INVOLVING THE USE OF THE SCHICK TEST.

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WITH A NOTE APPENDED

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In order to give a comprehensive account of the manner in which the occasion arose to utilize the Schick test in this small series of cases, it is necessary to summarize briefly the sequence of events in the outbreak, including the incidence of cases, local conditions, and the measures taken and recommended for its control.

The outbreak occurred in an infantry battalion quartered in barracks in the centre of a large city.

Incidence of cases showing location and dates of occurrence:

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Barrack room</th>
<th>Date of incidence</th>
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<tbody>
<tr>
<td>1</td>
<td>17 D</td>
<td>June 7, 1923</td>
</tr>
<tr>
<td>2</td>
<td>8 B</td>
<td>July 13, 1923</td>
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<td>3</td>
<td>23 E</td>
<td>August 25, 1923</td>
</tr>
<tr>
<td>4</td>
<td>18 D</td>
<td>August 30, 1923</td>
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<tr>
<td>5</td>
<td>13 C</td>
<td>September 8, 1923</td>
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<tr>
<td>6</td>
<td>13 C</td>
<td>September 9, 1923</td>
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<tr>
<td>7</td>
<td>1 A</td>
<td>September 15, 1923</td>
</tr>
</tbody>
</table>

Concurrently with this incidence of diphtheria there had been a number of admissions to hospital for tonsillitis from the same unit; cases of both these diseases showed a wide distribution amongst the barrack rooms. No particular company or platoon was especially affected. Spot maps, showing all the cases, indicated that these cases were scattered over each barrack room, the spread of infection not being confined to men in beds adjacent to the patient. Presumably this was due to a high degree of general immunity, the susceptibles alone being infected. As regards the spread of infection in barracks, the sporadic incidence of most of the diphtheria cases suggested the existence of a carrier, or a chain of contact carriers, amongst the troops in quarters. To detect any such carriers, investigations were made on the following lines, with negative results at first as regards any definite conclusions.

The bacteriological examination of the throat swabs from:

(a) All contacts in the barrack room.
(b) Any suspects, i.e., contacts from a previously infected barrack room, known to have associated with any man who subsequently developed diphtheria.

(c) Any diphtheria case recently discharged from hospital (convalescent carrier).

(d) All men found to be suffering from rhinitis, tonsillitis, or chronic enlargement of the tonsils.

Amongst the men examined was a regimental bootmaker, a possible carrier under both (b) and (d) of the above headings. From a throat swab taken from this man, organisms morphologically and culturally identical with the diphtheria bacillus were obtained. He was therefore kept in the detention ward, until the subsequent guinea-pig virulence tests showed the strain to be non-virulent. As regards the origin of the infection, apart from the spread of the disease in barracks by means of carriers, the prevalence of diphtheria amongst the civil population in the vicinity of the barracks may have been a potent factor as a source of this outbreak. Inquiries made, however, failed to trace any case in barracks to a definite source of this kind.

Local Conditions.—Some mention must be made of the immediate environment of the troops, to which special attention was at once directed in view of the prevalence of such diseases as tonsillitis.

The situation of these barracks conferred upon them some protection from road-dust, and the open spaces in the immediate vicinity of the barrack blocks were kept well watered.

The barracks occupied by this unit were built before the middle of the last century, and did not conform to modern hygienic standards of ventilation and lighting.

When to these disadvantages were added other factors, such as some degree of overcrowding together with insufficient spacing out of beds in the barrack rooms, the opportunity for the dissemination of such diseases as are usually spread by "droplet infection" was present.

It should be stated that in dealing with this outbreak one of the first measures was to urge that steps be taken without delay to remedy these defects.

The due spacing-out of beds to allow six feet of wall space to each, the allotting of the number of men only to each barrack-room as would ensure the minimum of sixty square feet of floor space per man, and such alterations to existing windows as were required to obtain adequate ventilation, were in brief the essential points dealt with.

The question of expense alone has delayed the completion of these necessary hygienic improvements.

The General Measures taken to prevent spread of the infection included the routine methods for isolation and disinfection, vide A.M.S. Regs., Appendix 2. All contacts were segregated and medically inspected daily for seven days, and gargling parades were also instituted after throat swabs
A Report on an Outbreak of Diphtheria

had been taken. Orders were issued to the effect that any man complaining of sore throat or nasal discharge should report sick at once, and from such cases swabs were taken for examination. The necessary measures were taken to ensure the immersion in boiling water of cups and other such utensils in use in mess, coffee-bar or canteen, in order to lessen the chances of the spread of infection by such means. Any suspected carriers of diphtheria were segregated in the Detention Hospital until investigations determined their freedom from virulent diphtheria organisms.

The Use of the Schick Test.—On the occurrence of three cases of diphtheria within one week in September last, it was decided to apply the Schick test in order to detect the susceptibles in the unit, with a view to their subsequent immunization with toxin antitoxin mixture, in accordance with A.M.S. Regulations, Appendix 2, para 11.

The test was carried out on September 26, 1923, upon twelve contacts from Barrack Room A 1, where the most recent case of diphtheria had occurred, all of these men having volunteered to undergo the test. The results of these Schick Tests were as follows:

- Negative reactions (acquired immunity to diphtheria), ten.
- Positive reactions (susceptibility to diphtheria), one.
- An anomalous reaction which was classified as a giant pseudo-reaction, one.

Of the ten negative reactions, three showed a pseudo-reaction due to protein sensitivity. These were readily detected by means of the control test. The positive reaction called for no comment, the result was clear-cut and well-defined. This patient is at present being immunized with toxin antitoxin mixture.

The anomalous reaction proved to be of the greatest interest and its probable significance is dealt with in the note by Lieutenant-Colonel H. Maríarian Perry. Its interpretation materially assisted in the detection of the convalescent carrier, who in all probability was the cause of the outbreak.

It may be noted that this reaction in view of its intensity was at first thought to be a positive reaction, but the strong local reaction (redness and edema) shown in the control test arm, which eventually developed to an equal extent and duration with the reaction in the Schick test arm, indicated rather a marked anaphylactic response. Whilst this patient was attending for his daily inspection as regards the reading of the Schick test it was noticed that he had a well-marked muco-purulent nasal discharge, and swabs taken from this discharge showed diphtheria bacilli in almost pure culture. These organisms proved to be virulent on animal inoculation. The condition of his throat was normal in appearance. In view of these facts, it seems obvious that this man had been an unrecognized case of nasal diphtheria, who subsequently as a convalescent carrier of virulent organisms was probably the origin of the sporadic cases in these barracks. His movements considered in connexion with the incidence of the most
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recent of these diphtheria cases tend to confirm this view. His arrival on September 11, 1923, in Barrack Room A 1, where no previous case had occurred, was followed by a case of diphtheria in that room on September 15, 1923.

This carrier is now in hospital for treatment of his nasal and throat condition until such time when, as far as can be ascertained, he will no longer be a danger to his comrades.

It may be added that since this man has been segregated no further case of diphtheria has occurred in this unit.

Not allowing for the margin of error in dealing with such small numbers of cases, these results of the Schick test showed a percentage of susceptibles of 8.3 which is somewhat lower than the average for adults of the same age quoted by Schick, by Monckton Copeman and other authorities.

It was unfortunate that military exigencies necessitated the move of this unit on October 3, 1923, thus preventing any immediate opportunity for further investigations with regard to this series of cases by means of the Schick test. All ranks showed a keen and intelligent interest and willingness to participate in the work and there is little doubt but that the whole unit would very soon have been graded by this means into susceptibles and immunes, as far as diphtheria is concerned.

Our thanks are due to Colonel P. Evans, C.M.G., A.D.M.S. London District, for kind permission to publish this report. We are much indebted to Lieutenant-Colonel H. Marrian Perry, O.B.E., R.A.M.C., Professor of Pathology R.A.M. College, for much valuable advice and assistance with regard to the carrying out of the Schick test.

Note by Lieutenant-Colonel H. Marrian Perry.

The short series of Schick tests recorded in the above paper is of very great interest in connexion with the scientific investigation of outbreaks of diphtheria amongst military communities.

Although the movement of the unit concerned precluded the carrying out of the test on a larger group of individuals, its application resulted in the detection of a carrier of virulent diphtheria organisms, and it is understood that no further cases have occurred since the infected individual was segregated.

The details of the reaction given by the subject who subsequently was proved to harbour virulent B. diphtheriae are briefly as follows:—

Within forty-eight hours following inoculation, both forearms showed a marked erythematous zone around the site of inoculation. In the case of the left arm (which had received the inoculation of unheated toxin) the affected area was tender, edematous and markedly reddened. The right arm (which had been inoculated with heated toxin) showed the same reaction in lesser degree. These zones of inflammation gradually subsided within the next three days.
Some difficulty was experienced in interpreting the result of this reaction, as it was obvious that its intensity was greater than could be accounted for by simple protein sensitivity, and it was at first believed that it was an example of a "combined" reaction, and, therefore, indicated a susceptibility to diphtheria. Further consideration, however, led to its classification as a "giant pseudo-reaction" to which reference is made by Dudley in the Medical Research Council Special Report Series, No. 75. In that report comment is made on seven subjects who showed especially severe reactions comparable to the reaction outlined above; it was subsequently determined that all of the individuals had recently recovered from diphtheria. Dudley explained the essentially severe reactions in these cases as following on an undue sensitivity to some products present in the Schick test solutions which was induced by a recent attack of diphtheria.

Whatever may be the explanation, the bacteriological examination of swabs taken from the individual with whom we were concerned resulted in the isolation of virulent diphtheria organisms. His clinical condition and history also showed him to be suffering from nasal diphtheria. Examination of the antitoxin content of his serum, which was kindly undertaken by Dr. O'Brien, proved that he possessed 1/10 of a unit of antitoxin per cubic centimetre, an amount amply sufficient to yield a negative Schick reaction.

It is, therefore, presumed that the anomalous reaction of this individual which led to his more detailed examination and the establishment of his carrier condition, is to be explained by the development of a degree of allergy caused by repeated auto-inoculations with diphtheria toxin.