proved to be in the prevention of typhoid fever, and may be in the prevention of lobar pneumonia, is preventive inoculation. In the case of streptococcus, this is apparently not so simple as it might appear at first sight. Little is known concerning immunity to streptococci, and this little indicates that this immunity is much more difficult to induce artificially than is immunity to pneumococcus, for instance. It is not at all impossible, however, that with further investigation, proper methods for producing this immunity may be discovered. Finally, the detection and the isolation of healthy carriers, while theoretically of great importance, seem at present impossible and impracticable tasks. By avoiding crowding and by inculcating in the men by education a sense of propriety in caring for their nasal and oral secretions, just as they have been taught not to distribute feces and urine indiscriminately, much may be done to lessen the danger of the healthy carrier. Convalescents from the disease probably carry streptococci of high virulence and are therefore of great danger. Isolation of such persons until examination of the throat shows great freedom from these organisms should not be impossible. Protection of the soldier from influences which may lower his general resistance, such as exposure and undue fatigue, at least during the early period of training, is also undoubtedly of importance.

Emphasis should be laid on the matter of early diagnosis and especially the matter of proper isolation of cases of infectious disease, since these measures, as I have indicated, are essential for the prevention of the disease under discussion, as well as of all other communicable, acute, infectious diseases. For these measures to be carried out there are three essentials: first, knowledge by the surgeons of the early signs and symptoms in those diseases in which diagnosis is made by these features alone, notably the exanthemata; second, well-equipped laboratories in which etiologic diagnoses may be properly made (this applies especially to pneumonia and to diseases like diphtheria); third, properly organized infectious disease hospitals. It is not as well recognized as it should be that an infectious disease hospital requires a special organization, quite different from that of the general hospital. The great majority of medical patients treated in the camp hospitals are suffering from infectious and contagious diseases. These patients cannot be properly isolated in a general hospital. Therefore every camp hospital should consist of two divisions, one for infectious diseases and one for noninfectious diseases. Patients for admission to the former should be kept entirely separated from those to be admitted to the latter.

The personnel of the infectious disease hospital should be distinct from that of the general hospital. The infectious disease hospital should be supplied with separate receiving rooms, should have observation wards with individual rooms for patients, and should have a group of wards for each infectious disease. With a well and specially trained head and an intelligent staff, the spread of infections in such a hospital could be prevented. All pneumonia cases, those due to pneumococcus as well as those due to streptococcus, should be treated in such a hospital. So far as possible, patients suffering from pneumonia due to the different types of pneumococci should be treated in different wards. Patients suffering from streptococcus infections should be rigidly isolated. Measles and pneumonia patients having hemolytic streptococci

in their throats should not be placed in the same wards or rooms with those not carrying such organisms.

All this may sound utopian and fanciful to some of you, who will therefore be surprised to hear that these measures are already being carried out, at least in a somewhat modified form, in more than one camp. In one camp where the measles cases carrying streptococci have been carefully isolated from the so-called "clean measles cases," complications among the latter have been practically eliminated.

CONCLUSION

I should like to emphasize the fact that acute lobar pneumonia is an endemic disease, while streptococcus bronchopneumonia occurs chiefly in epidemic form. The reason for this is that streptococci are extremely variable in their pathogenic properties. Dr. Theobald Smith has drawn attention to the fact that streptococcus infections in animals are not self-perpetuating. They occur as epidemics, mainly as secondary, not primary infections. This is also true in man. A suitable soil is necessary. Given this, streptococci rapidly gain in virulence. Every new case of infection adds not only to the extent but also to the intensity of the epidemic. In streptococcus pneumonia, the epidemic of measles provides the proper soil. Measles in the army probably cannot be prevented. It is possible, however, that in any one place, the number of cases occurring at one time may be limited. Finally, the time to stop streptococcus bronchopneumonia is at the beginning of the epidemic. Later, this becomes extremely difficult. By the introduction, early in the epidemic, of measures such as I have mentioned, much may undoubtedly be done to lessen the incidence of this serious disease.

CONTROL OF MENINGITIS *

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Fortunately the problem presented by meningitis among our armed forces during the past winter has been smaller than that relating to pneumonia. But the conditions were not without their own degree of seriousness. At this moment we are facing the assembling of another large body of troops, and possibly the assembling may be repeated many times before the war is brought to an end.

Hence we shall doubtless find ourselves in the situation of having perpetually to guard against the prevalence of epidemic meningitis on a larger or smaller scale. Fortunately, we are in a favorable position with reference to that disease, since we know its bacterial cause and its mode of infection, and possess adequate methods of detecting the meningococcus.

There may be differences of opinion as to just what part the ordinary healthy carrier of the meningococcus plays in initiating an outbreak of meningitis, but no one disputes the fact that without carriers of meningococcus, either healthy or sick, there could be no spread of disease.

From this, it seems obvious that we command as many of the factors controlling the disease as possible. The meningococcus is, of course, the essential and

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central factor; but without doubt, subsidiary factors play important parts. Among the latter would appear to be excessive fatigue and concurrent respiratory infections of slighter degree, such as colds. That the unusual conditions surrounding the military life exert an influence at the outset is indicated by the circumstance that it is the fresh recruit and not the seasoned soldier who especially suffers from epidemic meningitis.

The source of meningitis in the Army and Navy is, in the first instance, the civilian population. Because healthy carriers of the meningococcus exist there, they have been introduced among the troops. Once there, they are menacing, apparently, according to fluctuating circumstances.

If we disregard, for the sake of our argument, the secondary factors that bear on the induction of infection, and concentrate attention on the meningococcus itself, two essential facts appear: first, that numbers of meningococci thrown off with the nasopharyngeal secretion, and second, that the bacteriologic type or variety of the organism play a large part in determining the result. Thus the healthy carrier who harbors many meningococci in his nasopharynx is relatively a much greater potential menace than the one who harbors few; and some types or varieties of meningococci are more pathogenic than others.

There is universal agreement among bacteriologists that the meningococci compose a complex group rather than a single, fixed type of micro-organisms. Recent studies also indicate that this group contains two immunologic varieties (so-called types) of meningococci which are responsible for from 75 to 80 per cent. of all cases of epidemic meningitis. The remainder of the cases are produced by meningococci of less fixed qualities and of less parasitic properties.

Studies of the meningococci among the general civilian population and military personnel, under conditions in which cases of meningitis are not frequent, show that the healthy carriers tend to harbor not the highly parasitic, but rather the less pathogenic varieties of meningococci. Once cases become frequent, however, the number of healthy carriers of the parasitic kind rises.

We are permitted, therefore, to view, tentatively at least, the class of meningococci somewhat as we now view the pneumococci. We distinguish among the latter parasitic and saprophytic varieties or types. The miscellaneous pneumococci composing the so-called Type IV group, notwithstanding the fact that certain ones may occasionally cause pneumonia, are still regarded as saprophytes and as practically always present in the mouths of a high percentage of normal persons. Similarly it may well be that normal persons not very infrequently carry the more saprophytic forms of the meningococcus.

Should we therefore proceed in the case of meningococcus as we have in that of pneumococcus, we should regard as menacing only the carriers of the parasitic varieties. Now, since in all our operations to conserve the health of our troops we must take into account the military exigencies, a distinction between dangerous and less dangerous meningococci would materially affect our practice of segregating meningococcus carriers and withdrawing them from active military training.

This distinction in types may now be readily made on the basis of specific agglutination with monovalent immune serums derived from rabbits. The subject, as

I have outlined it, is in its early stages. It is to be hoped that the experience of last winter in the Army and the Navy and the intrinsic importance of the matter will lead to a critical study of the meningococcus carrier problem from this point of view, in the hope and expectation that the control of epidemic meningitis may be made thereby simpler, more effective, and less disturbing to the training of our troops.

AN EXPERIMENTAL STUDY OF PAROTITIS*

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The subject of the etiology of parotitis has been investigated from a bacteriologic standpoint, and cocci have been isolated from the blood, saliva, and fluid aspirated from the swollen parotid gland.¹ Attempts to reproduce parotitis in animals by the inoculation of such cocci proved entirely unsuccessful, showing that these earlier studies had not solved the problem of the etiology of mumps. The cocci are probably contaminations. In 1908, Granata² first used saliva filtrate from parotitis patients for animal inoculation, suggesting that the virus of parotitis may be a filterable one. Since then investigators have tried to reproduce the disease in laboratory animals rather than to isolate a bacterium from human patients. Granata worked with rabbits; Gordon³ inoculated monkeys intracerebrally. Nicolle and Conseil⁴ injected material into the parotid glands of monkeys. The results of all these investigations were only suggestive as far as the reproduction of mumps in animals is concerned, and Gordon's attempts to transfer the disease from one monkey to another proved entirely unsuccessful.

Three years ago material was obtained in the following way from a number of children acutely ill with parotitis: The patients were allowed to rinse the mouth with sterile physiologic sodium chlorid solution, and the washings were filtered through a new Berkefeld candle N. The resulting filtrates were proved sterile by aerobic and anaerobic culture methods and were injected into the parotid glands and testes of healthy, half grown cats. During the past winter the prevalence of parotitis in Army camps near New York City provided the opportunity for repeating the work with material from adult (soldier) patients.⁵

EXPERIMENTAL

Cats were selected as the experimental animals because they are known to be subject to attacks of parotitis and it might reasonably be inferred, therefore, that they are not possessed of a natural immunity to the disease. Old cats proved unsuitable because the thick connective tissue on the side of the face over the parotids makes inoculation difficult, and such old

* From the Laboratories of the Rockefeller Institute for Medical Research.

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5. I am indebted to Captain Meader for the privilege of obtaining material at Camp Mills; and to Captain Monaghan for many courtesies at the Army Hospital at Secaucus, N. J.