few trained health officers will leave their work to join the fighting forces without having trained others to do their work in city and state health departments. That the nation may wage war with the greatest possible effectiveness there will be a pressing need for more extensive and efficient health supervision by state and municipal governments. There will be need of increasing the number of people engaged at this work by recruitment where possible from those not available for military duty or for work in the strictly war industries.

The federal, state and municipal health services have a work to perform which will demand their closest cooperation and will tax their resources to the utmost.

RESULTS OF STUDIES ON EPIDEMIC POLIOMYELITIS.

E. C. Rosenow,
Mayo Foundation, Rochester, Minnesota.

Presented before the Laboratory Section of the American Public Health Association, Washington, D. C., October 20, 1917.

I ACCEPTED the invitation to present before the American Public Health Association the results of my studies on poliomyelitis with some hesitation, since the details of much of the work have not yet been published. However, I consented to do so in the belief that it might lead to a better and a wider understanding of the disease in its various manifestations.

Ever since Landsteiner and Levaditi and Flexner and Lewis demonstrated the virus of poliomyelitis to be filtrable, bacteria of ordinary size growing on ordinary media under aerobic conditions have been considered of little or no etiologic importance in this disease. My own studies were undertaken to determine, by methods used in other diseases, whether there is present in the infection atrium (tonsils, throat, adenoids, etc.) and in the involved tissues themselves, bacteria of the above type which might localize electively in the central nervous system of animals.

From July 21 to August 10, 1916, there were studied seven typical cases of epidemic poliomyelitis which occurred in Rochester. The cultures obtained from material expressed from the tonsils, injected intravenously in young animals (chiefly guinea-pigs and rabbits) was followed by flaccid paralysis in some of the animals in each case. On the basis of these striking results I decided to go to New York where these experiments might be repeated and where post-mortem material might be available. From August 12 to October 6, during the height of the epidemic in New York, in conjunction with Dr. E. B. Towne and Dr. G. W. Wheeler, the above results were verified with tonsil strains and extended to strains from brain and

cord. At a later date, by the use of similar methods, similar results were obtained with brain and cord strains by Mathers, and Nuzum and Herzog. The extirpated tonsils of patients who were not convalescing as they should be and particularly those obtained in fatal cases, were found to contain peculiar abscesses in which this streptococcus was present in enormous numbers. Cultures of the brain and cord in each of twelve fatal cases yielded the identical streptococcus which also showed a marked tendency to invade the central nervous system of animals. The same organism has been isolated from the brain and cord of every monkey paralyzed either with fresh human virus, with glycerinated human virus, glycerinated monkey virus or with filtrates of virus. Moreover, it has been repeatedly isolated from glycerinated human and monkey virus months after glycerination and from filtrates of virus which were proved to produce poliomyelitis in monkeys.

Control cultures in numerous normal guinea-pigs and rabbits, and in inoculated monkeys dying of ulcerative colitis, showed streptococci in small numbers in a few instances only, and these were either culturally or immunologically different from those isolated from poliomyelitic tissues. On blood-agar plates the organism produces fine, dry, non-adherent, slightly green colonies, at times showing in forty-eight hours a narrow hazy zone of hemolysis. On this medium, as well as in ascites-dextrose agar, the organisms are quite uniform in size and resemble pneumococci, but are usually smaller and free from demonstrable capsule. In tall tubes of ascites-dextrose broth with or without sterile tissue there is usually an early diffuse turbidity, or there may be a flocculent growth which collects along the side of the tube and gradually settles to the bottom. Early smears show short chains of diplococci resembling pneumococci, a smaller number of medium-sized cocci in pairs, and occasionally very small coccus forms. In ascites fluid containing sterile tissue the growth appears as a slight haziness near the bottom of the tube on the fourth or fifth day when cultures are made of human or animal brain and cord. In a very few instances the early smears have shown the tiny globoid bodies described by Flexner and Noguchi in apparently pure culture, but usually there have also been a certain number of medium-sized diplococci in short chains, which Flexner and Noguchi and others have considered contaminations. Transplants from one to another of these liquid mediums disclose a marked tendency of the microörganism to change to the form characteristic of the medium in which it is planted. Thus, an apparently pure culture of the very small globoid bodies in ascites tissue fluid when transferred to ascites-dextrose tissue broth grows out rapidly, often in twenty-four hours, into the characteristic polymorphous streptococcus. Similarly a transplant from broth to ascites fluid tends to grow slowly smaller.

The mechanism by which the large forms become small has been demonstrated. Cultures of Berkefeld N

filtrates of emulsions of brain and cord of rabbits dead from paralysis following intravenous injection, with suspensions of broth cultures showing only the large forms, have repeatedly grown out in this characteristic form in each of these culture mediums. Cultures showing the small forms have been filtered, and cultures of the filtrate have grown, but no growth has been obtained from filtrates of cultures of the same strains showing only large forms. The same emulsions filtered through dense porcelain candles have, with few exceptions, always been sterile.

In all the liquid mediums during the early days of growth, chains are often found in which there are single members of all sizes and shapes—large diplococci, large coccus forms, small diplococci and small coccus forms. Frequently, elongated forms resembling diphtheroid bacilli or distinct rods are found in chains which are made up chiefly of typical diplococcus forms. This has occurred in strains that have been fished successively several times from single colonies of shake and plate cultures, and in those from filtrates, and are therefore believed to be variations of one organism and not contaminations.

The importance of immunologic studies with this pleomorphic streptococcus to determine the exact relation between this organism and virus as generally understood, was recognized very early in the work. Recently isolated cultures were found to protect monkeys against virus (9). Horses have been immunized, one with cultures isolated a short time previously from brain and cord of monkeys paralyzed with virus, and another with those isolated from the cases of human poliomyelitis which occurred last summer (6). By means of these sera it has been determined that the strains isolated from human poliomyelitis and experimental poliomyelitis in the monkey (following injection of virus) are immunologically identical, both being cross-agglutinated specifically in high dilution by these sera respectively. Moreover, by selecting particularly sensitive strains with the immune horse sera, it has been found that the serum of patients and monkeys having recovered from poliomyelitic attacks likewise agglutinated specifically the strains both from human and monkey poliomyelitis. The serum from the horse (Horse 1) injected from Nov. 2, 1916, to May 10, 1917, with recently isolated strains from monkeys was found to have definite protection and apparently curative power against virus in monkeys.

The effect of this serum was tested recently on 56 cases of human poliomyelitis during the epidemic at Davenport, Iowa. The technic of the preparation and administration of the serum, the diagnostic tests and the results obtained in 44 cases have already been published. The details of the cases will appear later (7). Suffice it to state that all the 16 patients who received the serum before paralysis had set in recovered promptly without paralysis. All the 17 patients with slight paralysis who received the serum likewise recovered. In only one of these did the paralysis extend, and

then only slightly. In all the others paralysis was arrested and recovery took place promptly. All will undoubtedly have complete restoration of function. Twenty-three patients had advanced paralysis when serum treatment was begun. Ten of these died, giving a mortality rate of 18 per cent. Seven were practically moribund when the serum was given, and hence cannot be counted against the serum. In the 3 remaining fatal cases the serum had time to act. One was a baby 11 months old, semicomatose with spasms eight days after the onset of the illness when the serum was first given. One, a boy 2 years old with cyanosis, marked tremors, high fever, severe gastro-enteritis and beginning respiratory paralysis on the second day at the time of the first injection; and one, a girl 11 years old, with high fever and paralysis of the face on the third day when the first dose of serum was given. Hence this makes a mortality of about 6 per cent. in sharp contrast to the 9 deaths which occurred in 23 untreated cases; a mortality rate of 35 per cent.

The epidemic in Davenport differed from those studied last year in Rochester and in New York in that gastrointestinal symptoms and the symptoms referrable to the central nervous axis were more pronounced, and that the mortality rate was higher in the cases in which serum treatment was not used. The results obtained last year with reference to the tonsils as affording an important place of entrance for the infection, have been verified and extended. Glandular enlargement was found in many cases to be in proportion to the evidence of infection in one or both tonsils, as obtained on examination of the patient and on dissection of the tonsils after death.

The identical streptococcus has been found in enormous numbers in the characteristic abscesses in tonsils. It has been isolated from brain and cord in all fatal cases in which cultures were made, and from monkeys paralyzed with the new virus. As occurred last year, injection of recently isolated cultures into animals was followed by characteristic localization. Very little or no evidence of contact-infections could be found. The occurrence of more than one case in a family was rare and in such instances the attacks were close together. A careful study of the state of health of others in the family in which typical cases occurred, and of the general health of the community at the time of the epidemic, the details of which will appear subsequently, brings with it the conviction that a large proportion of the population harbored the infection and that only one case out of the usual number (1 in 600 to 1 in 1,000 inhabitants) developed the typical symptom complex recognized as poliomyelitis. From the studies detailed here the infection appears to be due to a form of streptococcus (using this term in the broad sense) having peculiar localizing powers. In this connection it is of interest to note that the incidence of poliomyelitis in families and the community at large during epidemics in summer, is about that of rheumatic fever or pneumonia during the colder seasons when the more viru-

lent streptococcal respiratory and tonsillar infections occur in epidemic form.

REFERENCES.

1. FLEXNER, S. and LEWIS, P. A.: The nature of the virus of epidemic poliomyelitis. Jour. Am. Med. Assn., 1909, liii, 2095.

2. FLEXNER, S. and NOGUCHI, H.: Experiments on the cultivation of the microörganism causing epidemic poliomyelitis. Jour. Exper. Med., 1913, xviii, 461–485.

3. LANDSTEINER, K. and LEVADITI, C.: La transmission de la paralysie infantile aux singes. Compt. rend. Soc. de biol., 1909, lxvii, 592–594.

4. MATHERS, G.: Some bacteriologic observations on epidemic poliomyelitis. Jour. Am. Med. Assn., 1916, lxvii, 1019.

5. NUZUM, J. W. and HERZOG, M.: Experimental studies in the etiology of acute epidemic poliomyelitis. Jour. Am. Med. Assn., 1916, lxvii, 1205–1208.

6. ROSENOW, E. C.: The production of an antipoliomyelitis serum in horses. Jour. Am. Med. Assn., 1917, lxix, 261–265.

7. ROSENOW, E. C.: The treatment of epidemic poliomyelitis with immune horse serum. Preliminary report. Jour. Am. Med. Assn., 1917, lxix, 1074–1075.

8. ROSENOW, E. C. and TOWNE, E. B.: Bacteriological observations in experimental poliomyelitis of monkeys. Jour. Med. Res., 1917, xxxvi, 175–186.

9. ROSENOW, E. C., TOWNE, E. B. and WHEELER, G. W.: Observations on immunity of monkeys to experimental poliomyelitis. Jour. Am. Med. Assn., 1917, lxviii, 280–282.

10. ROSENOW, E. C., TOWNE, E. B. and WHEELER, G. W.: The etiology of epidemic poliomyelitis. Preliminary note. Jour. Am. Med. Assn., 1916, lxvii, 1202–1205.

THE EVOLUTION OF COUNTY HEALTH WORK.

W. S. RANKIN, M. D.,

Secretary, North Carolina State Board of Health, Raleigh, N. C.

Read before the Public Health Administration Section, October 17, 1917, at Washington, D. C.

UNDER this heading I wish to direct your attention to three phases of the county health problem, to wit: (1) The field of county health work, (2) the nature of county health work, and (3) the natural growth of county health work.

THE FIELD OF COUNTY HEALTH WORK.

A permanent and large field of county health work rests upon due observance of two important principles of our government. The first of these principles is that which provides unrestricted opportunity, and the second principle is that which recognizes the wisdom of limited assistance.

The principle of unrestricted opportunity is provided through the division of the central government into a descending series of smaller governments. This arrangement permits the smaller division to move forward without waiting for mass movement, naturally clumsy and slow. A state without waiting for national prohibition may adopt state prohibition. A county without waiting for state prohibition may have local option. Just so in the field of human conser-