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THE INFLUENZA EPIDEMIC OF 1918 IN THE AMERICAN EXPEDITIONARY FORCES IN FRANCE AND ENGLAND

WARD J. MacNEAL, M.D.
NEW YORK

INTRODUCTION

In the spring of 1918 reports appeared of an epidemic disease in various parts of Southern France, Italy and Spain. Greater publicity was given to these reports in Spain, doubtless, in part, because that country was not engaged in war. By midsummer this disease had spread widely throughout Europe, and in the autumn had involved South Africa and America.

Numerous reports dealing with outbreaks of this disease have accumulated in the office of the Chief Surgeon, A. E. F., and in several instances special investigations of the epidemiology and bacteriology of these outbreaks have been reported. The purpose of the present paper is to give a summary account of the disease in the A. E. F., based on these reports, and to bring the observations made here into correlation with reports of the disease elsewhere. Manifestly, available reports are in many instances fragmentary, and the world's literature is not at hand for consultation, even if the necessary time could be devoted to it. Especially unsatisfactory are the reports of the disease in the military and civilian population of the belligerent countries, reports which one reads always with a suspcion that scientific accuracy may have been sacrificed to military or political considerations. It is intended to present here the known facts in regard to the disease, without regard to censorship, and it is expected that this paper will not receive publicity until the necessity for military or political censorship shall have ceased to exist. It may then become possible to obtain a sufficient number of reports from different countries so as to obtain a broad view of this pandemic and perhaps to arrive at clear and definite conclusions in regard to features now obscure.

CLINICAL MANIFESTATIONS

General Considerations.—The clinical signs and symptoms of the disease are not entirely uniform and are similar to the manifestations of the group of acute infectious fevers. Were it not for the epidemi-

ologic evidence it would be difficult to characterize the disease as a distinct and definite clinical entity. Nevertheless, when it appears in the epidemic form, the early signs and symptoms are strikingly similar. At such times the most common and dangerous mistake is the designation of early cerebrospinal fever and of various respiratory infections as influenza because of the existence of an epidemic of the latter disease.

Onset.—In the majority of cases, the beginning of the disease has been sudden, particularly in the warmer season. For example, a man would go to bed feeling entirely well, would awaken in the night with a severe headache, followed soon by pain in the back, general malaise and fever. In other instances, the man suddenly became aware of headache, weakness and pains in the somatic muscles while on duty or on attempting some bodily exertion. Epistaxis has been an early manifestation in a considerable proportion of cases. Anorrhexia, more or less complete, has been usual at the onset and nausea and vomiting have occurred in a small proportion. In some outbreaks, particularly those in the later months, a slight sore throat or a feeling of cold in the head, and in some instances a distinctly localized burning sensation in the nasopharynx was noticed twelve to twenty-four hours before the fever became evident. In a certain proportion of the cases, the onset would appear to have a relation to bodily exertion or fatigue, such as guard duty, standing at inspection, or a long march. In officers the onset has been observed after delivering lectures of instruction as well as other fatiguing duties.

The onset symptoms, although in most instances severe enough to fix the moment of onset in the patient's mind, have, as a rule, been mild enough so that soldiers would not report sick unless especially ordered to do so. The morale of the average soldier has been such that he has hesitated to go to sick call, regarding it as a confession of weakness or perhaps an indication that he desired to shirk. While this attitude is, in general, to be commended, and has undoubtedly been encouraged by medical officers, it has been a distinct source of danger in the presence of this epidemic. The failure to detect early cases has cost many lives, and the practice of encouraging immediate report at the first sign of illness has become an important feature in the control of the disease. In the presence of an epidemic it has been found wise for the medical officer to inspect every man of his organization every afternoon, to examine all who appeared ill and to transfer to hospital all with a temperature above 99.5 F. In a considerable proportion of cases the onset symptoms have been so mild as to escape early medical observation.

Prostration has been marked in some cases and a few men have fainted while awaiting examination at sick call, and many of those performing physical labor have found it impossible to continue.

Within a few hours after onset, the temperature is somewhere between 100 and 104 F.; the pharyngeal mucous membrane is slightly reddened and rather dry; the nose is remarkably clear and unobstructed; the conjunctivae are injected. The patient complains of headache, pain in the back, weakness, pain and tenderness in the eyeballs and sometimes of a burning in the nasopharynx or a slight sore throat. Loss of appetite or even actual distaste for food is observed in about half the cases. The pulse rate is slow in comparison to the temperature and the prostration. Leukocytosis is usually absent in uncomplicated cases, but appears along with the bronchopneumonia. Leukopenia has been observed early in the disease.

In a series of 125 cases examined by Major Richard C. Cabot and his colleagues at Base Hospital 6 between September 28 and October 12, 1918, the frequency of various manifestations were reported by Dr. Cabot as follows: Headache in 87 per cent.; backache and aching in bones in 64 per cent.; foot or toe pain in 18 per cent.; otitis with pain in the ear in 17 per cent.; cough in 92 per cent.; early cough, in the first twenty-four to seventy-two hours, in 80 per cent. Coryza was noticed by half the patients, but Dr. Tobey found a dark red, dry mucous membrane in 90 out of 100 cases of this series examined by him. Sore throat was complained of by 37 per cent., and Dr. Tobey found a dry red pharynx with swollen lymphoid tissue on the lateral wall in 80 per cent. Epistaxis occurred in 35 per cent.; appetite was good in 52 per cent. and vomiting occurred in only 21 per cent. In 100 cases of this series examined by Dr. Hatch, conjunctivitis was not found, but the eyes were injected, perhaps somewhat more than in most fevers. The neck was somewhat stiff in 12 per cent., but this stiffness was never marked. Herpes was observed in 17 per cent. Careful examination failed to reveal any distinctive rash. Among the 125 cases definite signs of bronchopneumonia on admission were present in 40 per cent. The otitis was catarrhal, usually with considerable pain for a few hours, but without enough exudate to bulge the drum. Dr. Cabot expressed the belief that careful examination in a quiet place would reveal consonating râles with diminished breathing and slight dulness in nearly all cases, sufficient evidence for a diagnosis of bronchopneumonia.

This series reported by Major Cabot may be regarded as fairly typical of the disease as it occurred in France about Oct. 1, 1918. The respiratory symptoms were less well marked in the cases seen in

the early months, May, June and July, and in them, cough, otitis media and signs of bronchopneumonia were very uncommonly observed.

Course and Outcome.—In the early months, May, June and July, rest in bed and a purgative were followed by subsidence of the fever and amelioration of all symptoms in twenty-four to seventy two hours, and prompt recovery without further manifestations, except slight weakness and depression. Complications were so rare as to be considered non-existent and the relatively few cases of pneumonia observed were subsequently regarded as instances of mistaken initial diagnosis.

In the later months, from about the beginning of September, the disease has been perhaps less sudden in onset, but the course has been distinctly more malignant and a complicating fatal bronchopneumonia has become alarmingly frequent; so frequent, indeed, as to suggest a new epidemic of an entirely different disease.* Probably this altered character has been due to the colder weather, particularly the cold, wet weather of early fall, the influence of which has been aggravated by the difficulty of troop movements at that time. While some of the cases still followed a course not essentially different from that previously observed, a very considerable proportion, variable in different epidemics, were of the more severe type.

In these more severe cases, distinct evidence of the tracheobronchitis and bronchopneumonia appeared, sometimes within the first forty-eight hours, but usually at about the end of the third or fourth day. In many instances the temperature would fall nearly or quite to normal on the third day, only to rise again along with the gradual appearance of physical signs of extension of the inflammation in the finer bronchi and alveolar tissue of the lungs. This complication was observed particularly in those who failed to go to bed promptly at the onset of the disease and in those who got out of bed before they should, or in those patients who were transported during the febrile period. Pleural effusion occurred in some cases; empyema occurred rarely. Gradual unconsciousness for some hours before death, with considerable extension of the thoracic dulness in the last forty-eight hours, were commonly observed in the fatal cases. When the patient recovered, the fever fell by lysis after six to twelve days.

The death rate in these pneumonias has been high, varying from 5 to 100 per cent. in different epidemics. The death rate for pneumonia of all types, as computed in the office of the Chief Surgeon, A. E. F., represents the ratio between new cases of pneumonia in hospital and deaths from pneumonia in the same period. During July this rate

* The evidence in regard to this suggestion will be discussed subsequently in the section dealing with etiology.

varied from 11.4 to 22.0 per cent. in the different weeks, but for the last week in October it reached 75 per cent.* and continued high during November. The bulk of these deaths resulted from the bronchopneumonia of the influenza epidemic.

In the series of 125 cases studied by Major Richard C. Cabot and his colleagues at Base Hospital 6, there were eighteen deaths, or 14.4 per cent. of the cases of influenza. Inasmuch as 40 per cent. of these cases showed bronchopneumonia on admission, the maximum death rate of the pneumonia cases was eighteen in fifty, or 36.0 per cent. Doubtless many others in the series also developed pneumonia in the hospital so that the death rate for the pneumonia in the series may be placed at 14.4 per cent. as a minimum and 36.0 per cent. as a maximum.

The duration of the febrile period was recorded in 87 of these 125 cases as three days in 11 cases; four days in 7; five days in 10; six days in 17; seven days in 11; eight days in 8; nine days in 11; ten days in 6; eleven days in 3; twelve days in 2; and fifteen days in one case. The relative predominance of three-day and six-day type of fever was considered suggestive of identity with the three-day fever of the spring and summer.

The fever reached a point between 102 and 106 F. at its height in eighty-five of these cases. The pulse rate ranged between 70 and 100, and in 40 per cent. of the cases between 90 and 100. No instances of extremely slow pulse, such as reported elsewhere, were observed in Cabot's series.

Another series of cases reported by Major Thomas K. Martin at Base Hospital 8, Oct. 25, 1918, evidently originated on the transports during voyage from the United States. In this series there were four cases of lobar pneumonia, one of them primary and three secondary to influenza, with one death; 156 cases of bronchopneumonia, of which one was primary, 148 cases secondary to influenza, and seven secondary to bronchitis, with fifty-two deaths. Pleural fluid was found in thirteen cases. It was clear in nine cases, turbid in four cases. Bloody sputum was observed in 118 cases. The fever terminated by lysis between the eighth and tenth day in forty-seven cases; between the tenth and thirteenth day in sixty-one cases. Twenty-two cases of pneumonia developed in the wards, twenty from influenza, one from bronchitis and one in a case of paraplegia. There were 268 cases of influenza at the same time, of which 246 were respiratory; one nervous;

* The rate of 75 per cent. pneumonia case mortality as quoted is probably erroneous owing to (1) the great delay in receiving full reports of total new cases, and (2) to the failure to diagnose and report many of the pneumonias actually developing among the influenza cases.

nine gastro-intestinal; and twelve febrile. Ear complications and sinus involvement were uncommon. Bacteriologic examinations showed the presence of the influenza bacillus and of pneumococci in almost every case. Hemolytic streptococci were not found. The death rate in the pneumonia was 32 per cent.

Designation.—Without regard to the bacteriologic findings or questions of etiology the disease is certainly properly designated as influenza on the basis of its epidemic and clinical characters alone.

PATHOLOGIC ANATOMY

General Considerations.—In the early months of the epidemic the disease was so benign in character that deaths which did occur were invariably ascribed to other cause. Since about Aug. 15, 1918, deaths have become much more frequent and the records of necropsy in this disease have become very numerous. From the clinical evidence it appears that the bulk of the necropsy records are based on complicated cases. The pathology of these later cases will be discussed first.

The Respiratory Organs.—The larynx, trachea and larger bronchi showed swelling, edema, injection and infiltration of the mucous membrane, which was covered by frothy muco-purulent, often blood-stained exudate. The smaller bronchi and bronchioles were also involved in the same process and some of them plugged with mucus.

As a rule, all lobes of both lungs were involved; both lungs were large, dark, heavy and firm. On section, the cut surfaces were very moist, dripping a bloody, frothy fluid; the color was somewhat variegated, often showing a few firmer grayish patches of older consolidation centrally located. Invariably the lower lobes were more severely involved. The whole process in the lungs might be designated as an example of massive, pseudo-lobar form of bronchopneumonia of a very malignant type. Considerable variation in the appearance of the lungs occurred even in the same series. Some prosectors, as for example, Capt. Arthur U. Desjardins, were able to distinguish a type showing more or less fibrinous pneumonia and a type in which this was not present and to foretell from the gross appearance the bacteriologic demonstration of pneumonococci in the former. In some instances gross evidence of hemolysis indicated the presence of hemolytic streptococci which was subsequently confirmed. The following is quoted from a report of necropsy service at Evacuation Hospital 2, A. E. F., by Dr. Desjardins:

"Influenza and its complications: During the recent epidemic about 800 cases were admitted to the hospital from two divisions moving out of a neighboring sector. Of these, twenty-six patients died from pulmonary complications. A remarkable feature of this pneumonia

was its mixed character. In general, the picture was that of a coalescing bronchopneumonia of great virulence, but in several cases it was associated with a certain amount of fibrinous pneumonia. Empyema was present in but two cases. In the development of all these cases at least two organisms were implicated, and in many there were three or even four. It was almost always possible at the necropsy to determine by the appearance of the lungs those cases in which the pneumococcus was present and those in which it was not."

Major George Baehr has enumerated the conditions observed in sixty-seven necropsies performed during the first fifteen days of October, 1918, at the Beau Desert Hospital Center, in a report dated October 21, as follows:

"Necropsies on the individuals dying of influenza pneumonia (Spanish Flu) revealed the following characteristics: (1) Frequency of an associated hemorrhagic tracheo-bronchitis; (2) extensive though irregular involvement of multiple lobes in massive areas of lobular pneumonia consolidation; (3) frequent existence of a much older focus of central pneumonia near the hilus of one or both lower lobes; (4) evidence of an explosive-like spread of the pneumonic process from this central focus to large areas of the adjacent lung parenchyma within the last day or few days before death; (5) relative infrequency of suppuration, empyema thoracis being found only in two cases."

Serous Cavities.—The pleural surfaces were fairly normal or only slightly dulled in luster in many instances; in others, a slight increase in clear fluid with or without a tinge of hemoglobin was noted; in from 5 to 30 per cent., in different series, a large pleural effusion was present, usually serous, but sometimes serofibrinous or purulent; in 10 to 20 per cent. a plastic fibrinous exudate existed on the pleural surfaces. In short, the conditions within the pleural cavities were exceedingly diverse. Pericardial effusion and pericarditis have been observed in a few instances. When large volumes of fluid were found in the chest, the changes in the lungs were less advanced and extensive than usual.

Subcutaneous Emphysema.—This was observed in comparatively few cases in several different outbreaks; beginning in the supraclavicular region or over the anterior chest wall, and becoming more or less generalized over the surface of the body. It appeared to be of no significance as to the outcome of the case. A postmortem study of several such cases by Lieut. David M. Nyquist revealed *B. welchii* in a very few instances but failed to reveal bacteria in the majority of the cases. Mechanical obstruction of small bronchi by plugs of muco-pus

and subsequent solution of continuity in the structure of the lung is the probable explanation of it.

Rectus Abdominalis.—In a very few instances lesions of the rectus muscles have been found. In some cases a necrosis resembling Zenker's necrosis, in other cases hemorrhages into the muscle were present.

Cranial Sinuses.—The first wave of the epidemic in May and June did not have any recognized cases of sinus or aural complications, and as there were few if any deaths from influenza at this time no opportunity presented itself to prove the absence of sinus involvement by necropsy. Clinical evidence of such involvement was entirely lacking. In the later phases of the epidemic, sinus and aural complications were occasionally met with.

Other Organs.—The changes in other organs have been those of acute toxemia, manifested particularly in the kidneys, liver and spleen. Icterus, apparently of hemolytic origin, was observed in a few instances.

Pathology of Particular Cases.—Clinical histories are available in some instances so as to permit a determination of the exact duration of the disease before death occurred. Significant features of a few necropsies on such cases will be presented.

NECROPSY 5002: Patient had a slight cold on Saturday, October 5, but took dinner with friends on that date. He was admitted to American Red Cross Military Hospital 1 from the Hotel Meurice at 6 p. m. on October 7 in a dying condition; died October 8 at 8:30 a. m. Duration of illness was therefore about 60 hours. Pleural cavities contain a few cubic centimeters of cloudy fluid. There are no adhesions. Lungs are both of the size of full inspiration. There is practically no exudate on either pleural surface. The right lung shows the upper two thirds of the upper lobe, the apex of the middle lobe and scattered patches throughout the lower lobe containing solid bluish-red areas, which have ill-defined margins. On section these areas are dark red in color and comparatively airless, the surfaces being bathed with a very large amount of bloody fluid. The remaining portions of the lungs are heavy with congestion and edema, except for a few of the anterior portions, which are dilated and feathery. The outer middle portion of the upper lobe and the outer half of the lower lobe of the left lung are in a similar condition; otherwise it resembles the right. The bronchi of both lungs are deep red in color, bathed with abundant blood-stained frothy mucus and covered with a thin, closely adherent, grayish-yellow, fibrinous pseudomembrane. The peribronchial lymph nodes are not markedly swollen. The sinuses at the base of the skull show some thickening of the mucosa and a small amount of mucoid fluid in the left sphenoid and left frontal. Smears and cultures from the lungs show streptococci and gram-negative bacilli (*B. influenzae?*). Smears from frontal sinus show staphylococci, gram-negative bacilli (*B. influenzae?*) and a short gram-positive bacillus; cultures from the same place show staphylococci. Prosector Major H. E. Robertson.

NECROPSY 3456: Patient was admitted to Evacuation Hospital 2 Oct. 16, 1918, with a diagnosis of acute influenza; temperature, 103 F.; pulse, 116; respiration, 24. October 17, the temperature rose to 104 F.; pulse, 104; respiration, 30.

The temperature remained above 104 F., at times reaching 105 F.; respirations increased to 50, but the pulse rate did not rise above 104 until the day of his death, when it reached 120. Death occurred Oct. 20, 1918, at 11:30 p. m., four days after admission. The pleural cavities each contain about 10 c.c. of clear serum. The parietal pleura is speckled thinly with petechial hemorrhages on both sides, and small tags of fibrin hang from it. The areolar tissues of the anterior mediastinum are moderately infiltrated with glistening, gelatinous material. The posterior and apical portions of the right pleural cavity are obliterated by very firm fibrous adhesions. The apical and posterior surfaces of the right lung are covered with fibrous tags and the pleura is thickened and rough. At the apex of the right upper lobe the pleura is puckered and thickened, and on section the thickened pleura at this point measures 4 mm.; it is whitish in color, very dense and resistant and fibrous in character. Beneath this, the cut surface of the apical portion of the right upper lobe is made up of irregular grayish-yellow areas, all coalescing, and separated here and there by fibrous strands. The middle and lower lobes are large, heavy and dark; their pleural surface has the appearance of pavement, the lines being formed by distended lymph channels. The cut surface is very dark, moist and compact; the lobes are entirely consolidated, but the consolidation is peculiar in that it is made up of coalescing patches of bronchopneumonia massed together. From the atypical appearance one is led to think of a mixed infection. The left lung is in the same condition, except the anterior portion of the upper lobe, the cut surface of which is markedly hyperemic and has, scattered in it, some dark red patches similar in appearance but much larger than the patches ordinarily seen in typical bronchopneumonia. The mucosa of the trachea and bronchi is very hyperemic and bathed in an abundance of thin, frothy fluid. The tracheobronchial lymph nodes are moderately enlarged, unusually moist and slightly bloody. The tissues of the posterior mediastinum are slightly infiltrated with glistening jelly-like material. Prosector, Capt. Arthur U. Desjardins.

Necropsy 2920: Patient entered Base Hospital 17 Sept. 12, 1918, having been in France one week. He had been sick since landing and had been riding in a baggage car for several days. He died September 12 at 11:50 p. m. The necropsy was performed at 3:25 p. m., September 13. The mediastinum is well covered with fat, the right visceral pleura hemorrhagic and injected and covered with fibrinous deposits. The pericardial cavity contains about 70 c.c. of a straw-colored fluid. The left lung weighs 1 pound 13½ ounces and shows irregular consolidated areas. The right lung weighs 2 pounds 12½ ounces. The left lung floats in water; on section it shows irregular consolidated areas from which frothy mucus exudes. The lobular type is more evident to the sense of touch than of sight. The entire right lung floats in waer as do portions from the most nearly consolidated portions. Bronchi are red and inflamed. Cultures from the brain and from the heart blood are negative; cultures from the right lung show *B. influenzae* and *Streptococcus viridans*. Prosector, Capt. Henry W. Cattell.

Necropsy 3958: Patient entered Base Hospital 8, Oct. 8, 1918, from a newly arrived transport. He died at 4 a. m. October 15. Necropsy was performed at 9:30 a. m., October 15. Pericardial cavity contains about 10 c.c. of a clear yellow fluid. There are numerous hemorrhages on the left side of the pericardium. The right lung is adherent posteriorly and the right pleural cavity contains about 300 c.c. of a cloudy yellow fluid. The lower half of the pleura is covered with a thick layer of yellow fibrinous exudate. The left pleura is slightly adherent at the base posteriorly and is also covered with fibrinous exudate. The right lung has four lobes, the fourth being a very small one at the apex. This is firm and on section is gray and consolidated throughout. The main upper lobe is collapsed and contains some nodules. Its surface is dull, granular and varying in color from light pink to bluish red. Centrally located there is a nodule of gray consolidation the size of a hen's egg. Around the periphery the lung is well aerated and for the most part of a light pink color.

The cut bronchi exude thick yellow pus. The middle lobe is well aerated, light pink in color and shows a few hemorrhagic areas. Pus exudes from the cut bronchi in this lobe also. The lower lobe is a gray consolidated mass of friable tissue and on pressure exudes thick pus. In the left lung the upper, middle and anterior portions of the lower lobe are aerated. Surfaces of the upper and middle lobes are of a dark red color; on palpation small nodules are felt throughout. The posterior half of the lower lobe is consolidated and nodules may be felt. The larger nodules in the upper lobe are gray and exude pus everywhere when squeezed. For the most part, the tissue is spongy, light pink to deep red and quite friable. At the periphery and at the base there is a dark red consolidation from which a considerable amount of pus exudes. Bacteriology: *B. influenzae,* pneumococcus and a gram-positive bacillus. Prosector, Lieut. William L. Aycock.

Variation Depending Upon Chronicity. — These four abbreviated protocols are fairly typical examples of the records of many hundreds of cases coming to necropsy in September, October and November, 1918, and indicate the diversity of picture observed within the thorax. These differences appear to have depended essentially on the rapidity with which the patient succumbed. The fulminant cases showed a picture of malignant coalescing bronchopneumonia which rapidly involved almost all the pulmonary tissue. The more chronic cases showed distinct foci of older gray consolidation; usually multiple with recent more extensive, even general, spread of the pneumonic process. Particular attention is directed to the presence of these nodules of older inflammation because they assume importance in the subsequent discussion of the epidemiology of the disease.

BACTERIOLOGY

Clinical. — The bacteriologic examinations made during life on sputum or material from the pharynx have shown various organisms, usually mixed together. The interest in many instances has centered on the question of Pfeiffer's bacillus and reports in regard to it have shown the very widest variations. Cultures made on blood-agar or on hemoglobin-agar have revealed, in the large majority of cases, pneumococci, streptococci, influenza bacilli, staphylococci and gram-negative cocci. Blood cultures taken during life have usually been negative, but in a moderate proportion of the cases have shown pneumococci or streptococci. Fluids obtained by puncture from the pleural cavity or from the lung tissue have shown the same organisms and at times the influenza bacillus. In certain localities, notably in Base Section 2 (Bordeaux and vicinity) and at Camp Coetquidan, enormous numbers of gram-negative cocci, identified as meningococci, have been found in the sputum during life and in the lungs at necropsy in a certain number of cases. It is probable that these were instances of the pulmonary form of cerebrospinal fever, either primarily such or possibly complicating influenza. Attempts to detect a filterable virus

have been reported, but experiments of this kind have not been carried out in the American Expeditionary Forces.

At Necropsy.—At necropsy, also, the bacteriologic findings have been variable and have usually shown a mixture of various species of microbes. Influenza bacilli, pneumococci of various types, hemolytic and non-hemolytic streptococci have occurred most frequently in the infiltrated lungs. Postmortem blood cultures have shown *B. influenzae* in a few instances, pneumococci and streptococci in a considerable number of cases. Cultures taken from the cut surface of the lung at necropsy in the series of necropsies at Base Hospital 17, made by the staff of the Central Medical Department Laboratory during September, 1918, showed influenza bacilli in 40 per cent. of the cases, hemolytic streptococci in 30 per cent. and pneumococci in 40 per cent., Group IV, Type I, Type II and Type III in order of frequency. In many cases, two or more of these organisms were isolated from the same tissue. More significant, perhaps, have been those necropsies in which a more thorough bacteriologic survey of the respiratory tree has been carried out by culturing in turn the mucous membranes of the trachea, large and small bronchi and alveolar tissue, such as have been reported by Capt. Richard M. Taylor and his co-workers in Base Section 1 (St. Nazaire and vicinity). In fulminant cases, large numbers of influenza bacilli were found, especially in the trachea and bronchi, sometimes apparently in pure culture. In most instances, however, the mucous membrane of the respiratory tract showed a mixture of organisms; in the trachea, influenza bacilli, streptococci, staphylococci, pneumococci, gram-negative cocci and occasionally larger gram-negative bacilli; farther down, influenza bacilli, pneumococci and streptococci; still lower, influenza bacilli, and one species of the cocci, and finally in the consolidated alveolar tissue, the pneumococcus or the streptococcus alone, as a rule, but sometimes mixed together or even associated with the influenza bacillus in this tissue. These findings suggest that the disease has been essentially due to an invasion of the respiratory tract by influenza bacilli, followed by and associated with other pharyngeal organisms, and that the fatal outcome, in most instances, has been brought about particularly by these secondary invaders, in some instances streptococci, in others pneumococci.

The reports from some hospitals indicate that the important secondary infections were due to pneumococci, but in those instances in which type determination was carried out, the strains usually fell into three or four type groups, a considerable proportion of them belonging to Group IV of the classification of the Rockefeller Institute. In other hospitals streptococci were found to be the important secondary invaders. The explanation of these results is not entirely clear. It is

possible that the distinction between pneumococcus and streptococcus has not always been accurately made, and that there has been a tendency in one place to call all these organisms pneumococci and in another to call them streptococci. These reports suggest, however, that the secondary invaders may also have spread from patient to patient, possibly within the hospital wards. In certain series of necropsies, where considerable attention seems to have been devoted to the identification of the cocci in the lungs, these invaders were found to be quite variable, even in bodies coming from the same hospital ward, indicating that their specific nature depended on the type of organisms which happened to be present in the upper respiratory tract of the man at the time of his illness, rather than on contagion.

ETIOLOGY

Infectious Nature.—The epidemic occurrence of the disease leaves no reason to doubt its infectious nature. As in all infectious diseases, contagion and susceptibility require consideration in the etiology.

Susceptibility.—The military population affords little contrast in respect to age and sex. However, it is certain that female nurses have been attacked by the disease with some deaths. In the series reported by Major Richard C. Cabot, there were sixty-three cases of influenza in the personnel of the Base Hospital 6, itself. Of these, forty-three were enlisted men, five were officers, and fifteen were nurses, representing 12 per cent. of the enlisted personnel, 10 per cent. of the officers and 15 per cent. of the nurses. The disease was distinctly milder in the nurses and officers than in the enlisted men. The relative care possibly explains this difference. Older men, particularly those beyond the age of 50, appear to have escaped to such an extent as to suggest a real immunity. Men of this age in the A. E. F. have been relatively few in number and have probably enjoyed better living conditions than most of the younger men, so that the evidence of their immunity should not be too readily accepted as conclusive. Young children of the civilian population appear to have suffered to a considerable extent, although accurate information has not been obtained. Of the soldiers a very large proportion has been found susceptible. In some companies as many as 90 per cent. have been stricken within a period of ten days, and occasionally from 30 to 50 per cent. of a company have reported sick within a period of two days. High incidence of the disease has been observed in organizations performing exhausting duties and in those exposed to cold and wet, and without proper nourishment, particularly in units arriving on crowded transports, making long journeys in troop trains and in those undergoing severe training. Fatigue evidently plays a part in increasing susceptibility,

and the influence of exposure to cold and wet is clearly indicated. During the summer the outbreaks seemed to be related to dust in the atmosphere, the disease becoming epidemic after a long, dusty march, or after a few days of dry, windy weather in camp. Inadequate ventilation has played an important part, probably by decreasing resistance as well as increasing exposure to contagion.

Contagion.—The malady is unquestionably highly contagious. Some of the epidemics have been explosive in character, suggesting that the virus had become generally distributed throughout the organization, and that the exact moment of onset of the disease had been subsequently determined by some general factor influencing susceptibility, such as a hard day's work, a dusty day or a cold, wet night. It is possible that general distribution of the virus at mess by infected food or utensils, infected by some member of the kitchen force, may have caused some of these explosive outbreaks. Members of the Medical Department attending cases of the disease have very frequently contracted it, and in many organizations the epidemic has progressed gradually, involving relatively few new victims each day, after the manner of a disease spread by contact. The virus undoubtedly exists in the secretions of the upper respiratory tract, from which region its dissemination by coughing, sneezing and talking, as well as by contact of hands or various utensils, readily occurs.

Relationship of the Summer and Fall Epidemics.—The identity of the summer epidemic with the disease prevailing after September 1 may be called into question, particularly because of the benign character of the earlier outbreaks and the high death rate observed later. In the later months bronchitis and bronchopneumonia have been very common, while such involvement was extremely rare in the summer. In favor of the essential identity may be mentioned the similar epidemic character of the outbreaks, the clinical resemblance between the milder autumn cases and those of the summer, the rather clear evidence indicating a gradual increase in malignancy as the weather has become colder, and the similar bacteriologic findings during life. Most convincing, perhaps, is the similar epidemic character, which alone almost suffices to prove the essential unity of causation for the disease in the two seasons. Those medical officers who have observed the disease in both seasons are inclined to the view that the primary disease is essentially the same, with the secondary complication of bronchopneumonia in the colder weather. The unfavorable influence of cold and exposure is universally recognized in relation to this disease.

Specific Organism.—In its epidemiologic, clinical, bacteriologic and pathologic features, the disease is everywhere recognized as being

identical with influenza as it was observed in the pandemic of 1889-90. The bacterial findings are those of influenza. In the A. E. F. the bacillus of Pfeiffer has been demonstrated in a very large percentage of the cases properly examined; in several series it has been demonstrated in every case. The other bacteria isolated, namely, streptococci, pneumococci, gram-negative cocci, although undoubtedly the cause of death in many cases, can be excluded from consideration as the primary cause of the epidemic disease, because of the inconstancy with which any one specific type has been encountered. The possible causative relation of the bacillus of Pfeiffer cannot be similarly excluded. On the other hand, the causative relation of this organism cannot be accepted as proven. During this epidemic, as during previous epidemics of influenza, a considerable proportion of throats of persons not suffering from the disease have been found to harbor this organism or organisms indistinguishable from it by the methods employed.

A report by Major Kenneth Taylor under date of Nov. 5, 1918, of work done in the Base Laboratory, District of Paris, presents evidence on this question. In a series of thirty-five selected cases of epidemic influenza without signs of bronchopneumonia, cultures of swabs from the nasopharynx showed streptococcus in 57 per cent., pneumococcus in 74 per cent., and influenza bacillus in 46 per cent. In a second group of fifteen cases diagnosed clinically as bronchopneumonia, cultures of the sputum revealed hemolytic streptococcus in 33 per cent., pneumococcus in 87 per cent. and influenza bacillus in 87 per cent. Only one of these patients died and in his case pneumococcus and hemolytic streptococcus were present in the lung at necropsy. In four cases the sputum was inoculated into mice and pneumococcus of Group IV and the influenza bacillus were recovered from the animal's peritoneum and heart blood. In a third group of twenty-two meningitis contacts, nasopharyngeal cultures showed influenza bacilli in 48 per cent.

A report under date of Sept. 5, 1918, by Capt. Alan M. Chesney and Lieut. Marcus P. Neal, on the epidemic of influenza at the Valdahon Camp, contains the records of nasopharyngeal cultures from 106 cases of influenza, of which 46.2 per cent. showed the influenza bacillus and 20.7 per cent. showed streptococci. In a series of twelve normal individuals, direct contacts of these cases, the influenza bacillus was found in 41.6 per cent. and the streptococcus in 25.0 per cent. A series of forty-two normal individuals, not contacts, examined in the same way, showed influenza bacillus in 7.0 per cent., and streptococcus in 10.0 per cent.

In order to settle in a convincing fashion the relation of the bacillus of Pfeiffer to the disease it would be necessary to carry out a series

of very carefully controlled experiments on a group of thoroughly segregated men, preferably those confined in a prison which has entirely escaped the epidemic. It will not be sufficient to produce by the inoculation of pure cultures the clinical manifestations of influenza merely in the individual inoculated, but a critical demonstration should include the reproduction of the disease with its characteristic epidemic feature.

A limited number of experiments have been reported by various investigators suggesting that the causative organism may be a filterable virus. More detailed reports of experiments on a considerably larger scale will be required before the results can be accepted as conclusive. In addition to the numerous sources of error which require attention in all investigations of filterable viruses, there is here the special confusing element of the filterable virus of common colds,* a virus which appears to be capable of causing the signs and symptoms of influenza in the individual inoculated, but has not been proved to be connected with the genuine pandemic disease.

Until conclusive experiments have been carried out to decide the claims of the bacillus of Pfeiffer and of the filterable virus as the cause of influenza, one should keep an open mind in regard to the matter. It appears fruitless to attempt to settle the question by debate.

TREATMENT

Isolation. — Influenza patients should be segregated in a separate ward and the strictest precautions taken to prevent the spread of the disease to other patients in the hospital and to the hospital personnel. In addition, because of the serious nature of the secondary infections, individual isolation within the ward by means of cubicles, masks, thorough sterilization of every article after use in contact with each patient, individual personal equipment for each patient as far as possible and extraordinary cleanliness of person and clothing on the part of attendants and nurses are required. Gross defects in the program of isolation will usually be found unless the medical officer in charge has given close personal attention to the minute details. Elaborate material equipment and extravagant use of linen will not effectively compensate for lack of intelligence, skill and diligence in the personnel.

Therapeutics.—For the treatment of the individual patient, the most important and essential feature is to put him to bed promptly and keep him there until his temperature has become normal and his appetite has returned. The bowels should be opened at the outset. Abundant ventilation and adequate provision to keep the patient warm

* Foster, George B.: The Etiology of Common Colds, J. Infect. Dis. **21:** 451, 1917. This paper cites other literature on the subject.

are essentials. In this way the danger of bronchopneumonia and death are reduced to a minimum and the attack remains benign in character and short in duration. Promptness in the institution of these measures is of greater importance even than the most skillful subsequent medical treatment and the most careful nursing.

Complicating bronchopneumonia sometimes appears early, but, as a rule, only after the second day of the illness and in neglected cases, particularly in patients who have failed to report sick, have refused to go to bed or have been transported a considerable distance to a hospital after the onset of the influenza. For the bronchopneumonia, careful nursing and feeding are the chief elements in successful treatment. The patient should be encouraged to take plenty of food, especially milk, eggs and broth, and abundant fluid. Tepid sponging and attention to the comfort of the patient in little things are indicated, if the nursing personnel is sufficient to permit it. Various drugs have been employed, such as quinin to the physiologic limit, whisky, three ounces every four hours, tincture of digitalis in full doses. Opinion as to the value of these drugs varies considerably, and the death rates in those series, in which they have been employed, do not furnish convincing argument in their favor. One series of cases treated systematically with full doses of atropin showed a very high death rate. Pleural effusion should not be allowed to pass unnoticed.

Under field conditions the treatment has often been hampered because the medical officers, nurses and enlisted men of the Medical Department, already inadequate to care for the excessive numbers of patients, have had their own ranks decimated by the disease.

At least two weeks should be allowed for convalescence before returning to duty.

PREVENTIVE MEASURES

Hygienic measures have to be directed to prevent or diminish contact with the virus of the disease, to increase and retain at a high level the natural resistance to the infection and also to avoid the serious complications in those who have become ill.

Avoidance of Contagion.—For troops located in country districts quite apart from the civil population, a thorough segregation may prevent the entrance of the infection. This would entail the denial of all leave and the strict avoidance of contact and association with outsiders. Too much reliance should not be placed on the effectiveness of such measures, and during the time of a pandemic the advent of the disease should be expected and the measures to meet it prepared in advance. In many organizations the introduction of the disease will prove inevitable.

To diminish the danger of spread within the organization, increased floor space for sleeping quarters, cleanliness of quarters, thorough ventilation night and day, avoidance of all dust, separation of heads of adjacent sleepers in bunks by board, paper or shelter-half partitions between bunks, effective prohibition of spitting and of open coughing and sneezing, immediate segregation of all men with coughs and colds, sterilization of mess kits by boiling water after each meal; strict care in regard to individual use of personal equipment, such as pipes and towels; daily sunning of bedding and clothing, and thorough drying of clothes and shoes should be provided for.

As soon as cases of the disease are recognized the patients should be provided with face masks and be segregated promptly, preferably in a hospital. Early recognition of these cases is so important that it is well for the medical officer to examine his entire organization every afternoon, sending to the hospital every man with a temperature above 99.5 F. Early recognition makes possible early treatment and also the removal of a source of infection from the organization. If wounded and sick are transported together, all patients should be masked in transit.

Increased Resistance.—There can be no doubt that depressing influences play an important part in determining the moment of onset of influenza and the severity of the attack. Overwork, overcrowding, exposure to cold and wet, breathing a dusty atmosphere, bodily discomfort, as well as loss of sleep and alcoholism, may be mentioned as important depressing influences. In office workers, the lack of sufficient exercise has evidently contributed to susceptibility. Resistance may be kept up to normal by avoiding these depressing influences, and may probably be increased considerably by proper daily calisthenic exercise and moderation in hours of labor. Many organizations in the A. E. F. have been attacked by the disease without it ever becoming sufficiently epidemic to disturb seriously their work, and have escaped without a single death. Others have been paralyzed by the epidemic, and in some the number of deaths has been considerable. The hygienic factors mentioned above seem to have played a decisive part in determining these differences.

Acquired Immunity.—There is very little reliable information bearing directly on the question of acquired immunity. The experience of Base Hospital 6 at Bordeaux, reported by Major Richard C. Cabot, is the most interesting. At that hospital, eighteen of the personnel had influenza (three day fever) during June and July, 1918. Between September 28 and October 12, there occurred sixty-three cases of influenza in the same hospital personnel, and not one of these sixty-three persons belonged to the group of eighteen who had had the

disease earlier. This observation suggests an immunity lasting more than two months. On the other hand, there is the personal experience of several officers who have devoted special attention to the study of this disease, who have themselves suffered two, three and even four attacks within a period of six months. On account of the uncertainty in regard to diagnosis, this evidence cannot be accepted as scientifically reliable.

The relatively few cases of the disease among the older men has been regarded as evidence of an immunity persisting since the epidemic of 1889. However, it has been possible to find a few very definite instances of persons who suffered from the disease in 1890 and again in 1918. On the whole, the evidence of a lasting immunity is not very convincing. Its critical investigation is a matter for the future.

Bacterial vaccines for the artificial immunization have not been generally employed in the A. E. F. They have been used to some extent in the United States. The latest available information indicates that their use is considered to be in the experimental stage.

EPIDEMIOLOGY

General Considerations.—The origin of the great pandemic of influenza of 1918 is involved in considerable obscurity, and it may never be possible to elucidate the question in a convincing manner. It seems certain that the epidemic outbreaks first appeared in Europe, apparently either in France, Italy or Spain, and that the disease subsequently spread northward to Belgium and England and across the sea in ships to America and Africa. It is known that the disease also prevailed in Germany and Austria during the summer and fall, and special meetings of the medical societies of Berlin and of Munich were devoted to it in July, 1918. In August and September the disease was carried across the sea to America and to South Africa, where it has spread extensively. The conditions for its incubation probably bear a relation to the great war and the altered living conditions dependent on it, but the relation is far from clear. Theoretical considerations must enter largely into the discussion of its origin because of the incompleteness of accurately recorded observations.

In searching for the origin of any pandemic disease it is necessary to recognize that such a disease does not arise entirely anew, each time; especially is this evident for a disease which has previously existed in pandemic form. It must have existed in one or more, probably in many localities, as an endemic disease for a long time. In general, epidemic diseases, such as bubonic plague, cholera and yellow fever, are known to have existed for long periods in certain endemic foci, from which they have suddenly spread and assumed epidemic or even

pandemic character. Again, after the subsidence of the general pandemic, the disease has often remained established in certain new localities, potential new endemic foci, from which it has gradually disappeared or subsequently remained endemic, or even again spread as an epidemic. In tracing the origin of an epidemic disease, therefore, it is required first to ascertain its endemic focus or foci and then to recognize the particular places where the endemic disease has first spread to such an unusual extent as to merit recognition as an epidemic disease, and third, to trace the subsequent extension. In the case of a pandemic this is often impossible, and one can only discover the port at which the disease was introduced from abroad and trace its spread from that point.

Epidemic in A. E. F.—The earliest reported outbreak of epidemic proportions in the A. E. F. was that which appeared about April 15, 1918, at Rest Camp 4 in Base Section 2, near Bordeaux, reached its height on April 22 and ceased on May 5. The Base Epidemiologist, Lieut. J. LaBruce Ward, in a report dated May 8, 1918, stated that the disease occurred simultaneously in camps widely separated with no communication between the men; whether the French civilians were similarly affected was not ascertained; clinically, the disease resembled influenza except for its short duration and absence of complications. In a later communication, under date of May 20, 1918, he says, "The symptoms were those of influenza. The patient was afebrile on the third or fourth day and able to work within a few days thereafter. There were no signs or symptoms of pulmonary involvement except a mild bronchitis in about 10 per cent. of the cases." Several hundred cases were observed; in one camp with a strength of 3,400 men, there occurred eighty cases in two days; in another camp of only 180 men, twenty cases occurred in one day. Both white and colored troops were attacked.

May 26, 1918, Capt. Clifford B. Farr reported an outbreak of influenza at the Quartier de Beaumont, Tours, beginning on May 1, 1918, and ending May 24, 1918, with a total of 117 cases. In a few patients there were present marked laryngitis, bronchitis, occasionally localized at one or the other base. Herpes was observed in a few cases. The height of the epidemic was reached on May 14, on which day there were eighteen new cases.

May 3, 1918, a sharp outbreak of the disease appeared in the personnel of Camp Hospital 23 at Langres, with twelve cases on the first day, ten among the enlisted men and two among the French civilian employees. This has been reported by Lieut. Alan C. Sutton. In all there were forty-four cases. The symptoms were severe headaches, usually occipital; severe backache and general muscular pains, a gen-

eral soreness in the chest, especially substernal, with moderate cough and a mild sore throat. Onset was abrupt with rapid rise in temperature to 103 F., but no distinct chill. Extreme prostration was characteristic of the disease. Some of the men fainted while on duty and had to be carried to bed. Recovery was rapid in practically every case, the average stay in hospital being two days. There were no complications.

May 22, 1918, Major A. S. Bowen, Commanding Officer of Base Hospital 101, St. Nazaire, reported a mild epidemic of influenza in the personnel of that hospital, beginning May 11 and ending May 19. In all, fifty-four patients were treated in the hospital. The cases arose in small nests of contacts working together. Only six cases developed among patients in the hospital. The cases were practically all of a mild respiratory type, and showed a high percentage of cultures of influenza bacillus.

May 11, 1918, a memorandum was issued by the French Service de Santé-Militaire to all its directors in France, calling for telegraphic reports of all outbreaks of grippe and describing the characters recently observed as follows: "Evolution breve ou benigne mais extension rapide et massive des groupes atteints." This is proof that reports of outbreaks of some importance had already reached the French authorities before May 11.

An outbreak which served to bring the disease into greater prominence in the A. E. F. occurred in the garrison at General Headquarters, Chaumont, from May 13 to May 24, twelve days, during which period 132 cases of the disease were recognized. In the Company of the Fifth Marines, which served as Headquarters Guard and as Municipal Police of Chaumont, fifty-four men were sick in a total strength of 172 men. In this Company, nineteen men fell sick on May 15, and twenty-two more on May 16, sufficient to interfere most seriously with the military duties required of this organization. The attending surgeon, Major Henry Beeuwkes, recognized the existence of an epidemic of respiratory infection, reported it to the Chief Surgeon and to the Director of Laboratories and Infectious Diseases, and asked for assistance to control it. This outbreak necessarily received wide attention in the A. E. F. and at once brought to light information in regard to other similar outbreaks. At Chaumont itself, the medical officers of Base Hospital 15 described a similar small epidemic, which ran through one entire ward of that hospital early in April, 1918. The French physicians practicing among the civilian population were perfectly familiar with the disease, designated it as grippe and stated that it had been extensively prevalent in the civilian population of Chaumont from March 15 to May 15, 1918.

At Bourbonne-les-Bains a sharp outbreak occurred among the officers of the Third U. S. Cavalry in the period May 20 to 24.

In Base Section 2, Bordeaux, the hospital personnel developed fourteen cases between May 15 and May 30. At Camp Hospital 66, St. Sulpice, near Bordeaux, an increase in undiagnosed fevers was noticed in the week ending May 13, and in the following week a distinct epidemic of 100 cases was recognized. In June and July the disease appeared in many localities in this Base Section.

By June 1, 1918, the disease had become very widespread in all sections of the A. E. F. in France and in the French and British armies as well, and apparently also in the German and Austrian armies.

The evidence fails to indicate any definite single point at which the new disease penetrated the border of France as an epidemic. It suggests rather that outbreaks occurred at several separate places in April and May, and that the disease became practically generalized in June. There is also a distinct suggestion that the civilian population was afflicted with the disease in March and April before the military outbreaks were recognized.

Outbreaks in Italy and Spain.—A note in the report of the Commission Sanitaire des Pays Alliés, for April, May and June, indicates that the disease became epidemic in the Italian navy in the first two weeks of May. Alberto Lutraria, the health commissioner of Italy, states that the disease was brought from America, but the observations on which this statement rests are not known, although it is not improbable that some association with Americans has been traced by the author. The suggestion that the epidemic was introduced from America is supported by the fact that it appeared at a time when large numbers of Americans were arriving in Europe, which is indeed an outstanding feature correlated in time with the onset of the epidemic. This view was evidently shared by some of the medical officers who arrived in France from the United States in the latter part of 1918. However, this conception is distinctly opposed and probably completely disproved by the fact that the epidemic was subsequently introduced into America in August and September and found there a most fertile soil for its spread.

In Spain the disease appeared in epidemic form about the middle of May and this outbreak received great publicity, sufficient to lead to the popular appellation of Spanish influenza. The very rapid and extensive spread of the disease in Spain would indicate that it had been introduced from without rather than transformed from the endemic state in that country. This also appears to accord with the view of those who have studied the epidemic in Spain.

Endemicity in France.—A possible explanation of the origin of the

epidemic may be found by regarding the incoming Americans as new fuel furnished to a smoldering fire already existing in Europe. In other words, influenza may be regarded as endemic in France, but relatively mild in character, until the large number of susceptible Americans, unused to campaign, unaccustomed to the climate, the houses, customs and work demanded of them, were suddenly brought into contact with it. In particular, Americans have been accustomed to more adequate provision for heating their houses and for drying their clothing than have been available for them in France. In the winter of 1917-1918 the living conditions in the cantonment camps in the United States apparently presented difficulties in regard to heating and overcrowding similar to those in France, but there the disease observed was evidently essentially different from the influenza of 1918. On the other hand, the American troops in France in 1917 began to show, as early as October, 1917, a very considerable rise in the influenza morbidity. The data available in the office of the Chief Surgeon, A. E. F., show an influenza morbidity per 100,000 of 321 in July, 438 in August and 404 in September, rising to 1,050 in October, 1,980 in November and 2,480 in December, 1917, in which month the total number of new cases of influenza reported was 3,520. That a considerable proportion of these cases were actual infections with the bacillus of Pfeiffer is proven by the necropsy findings in fatal cases of bronchitis and bronchopneumonia, especially those performed by Major H. E. Robertson at Army Laboratory 1, Neufchateau, in November and December, 1917, and January, 1918. In these cases the bacillus of Pfeiffer was found in the scattered patches of lung involved in the bronchopneumonia and also with great frequency in the cranial sinuses. These necropsy findings were, at the time, recognized as essentially new for young adult Americans, and, in a discussion at Army Laboratory 1 during December, 1917, they were considered as being of possible important significance for the future morbidity of American soldiers in France. In the British Army in France there is definite evidence of epidemics showing the same pathologic condition, during the winter of 1916-17,[2] and at Aldershot[3] in September, 1917. There can be little, if any, doubt that this disease was essentially the same as that which attacked the American soldiers late in 1917.

The essential similarity in the anatomic changes observed in the later epidemic and in these earlier cases warrants the quotation of the important parts of a few of these early protocols.

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2. Hammond, J. A. B.; Rolland, W., and Shore, P. H. G.: Purulent Bronchitis, Lancet **2**:41, 1917.

3. Hallows, F. N.; Eyre, J. W. H., and French, H.: Purulent Bronchitis: Its Influenzal and Pneumococcal Bacteriology, Lancet **2**:377, 1917.

NECROPSY 2. The patient enlisted August 12, 1917. He has had a cold for the past few weeks but was not admitted to Camp Hospital 4, Neufchateau, until Oct. 24, 1917, with symptoms of prostation, dyspnea, fever, cough and marked evidence of general sepsis. Pneumococcus (Group IV) was isolated from the sputum by mouse inoculation. The man died October 26 at 11:55 p. m. At the necropsy the left lung was found expanded to full inspiration; the surfaces were smooth; at the inner anterior margin of the upper lobe were several firm areas, the largest about the size of a walnut, grayish to bluish in color, with distinct puckering of the surrounding pleural surfaces. A few similar areas were located at the outer posterior margin of the lower lobe. Scattered throughout the pulp were smaller foci of increased consistence. Remaining portions of the lung were light, feathery, particularly the lingula. On section the firm areas had moist grayish surfaces and were comparatively airless. From the cut bronchioles purulent fluid escaped on pressure. The bronchial mucosa was bathed by a mucopurulent frothy liquid and was distinctly reddened and swollen. Peribronchial lymph nodes were markedly swollen, soft and red. There was no evidence of tuberculosis. The larynx and trachea showed the mucosa congested, especially near the bifurcation of the trachea, and covered by a frothy, mucopurulent exudate; the lymph nodes at the bifurcation were very greatly swollen, reddened and friable. The middle ears and mastoids were normal; the sphenoidal air cells were full of thick, yellow fluid and the mucosa was swollen and congested. The posterior ethmoidal cells contained some thin yellowish fluid, while the anterior cells were apparently free; the mucosa in both groups was distinctly thickened. Bacteriologic examination showed *B. influenzae* and gram-positive diplococci in sphenoidal sinus, in the lungs and in the liver. Prosector Major H. E. Robertson.

No less than six of the first nine necropsies recorded at Army Laboratory 1 were essentially identical with this one, and a large proportion of those performed in the training area during November, December, 1917, and January, 1918, were similar.

NECROPSY 87: The patient was admitted to Base Hospital 66, Neufchateau, February 7, 1918, complaining of severe cold, with cough, which began three days before; also pains in his joints and sore throat. February 13 a fine papular eruption appeared, especially over the chest and abdomen. At this time his temperature was 102 F., pulse and respiration rapid. Harsh râles were heard at the base of the right lung and fine moist râles in the lower lobe of the left lung. Death occurred February 13, 1918, 11:35 p. m. Necropsy, February 14 at 9:30 a. m.: The pleural cavities were free from abnormal fluid; the left visceral and parietal pleura were bound together by fresh fibrinous adhesions, uniformly distributed over the lower lobe. The right pleural cavity presented numerous firm fibrous adhesions over the surface of the middle and lower lobes, especially at the base. The left lung was rather voluminous; the upper lobe was grayish in color and air-containing; the lower lobe was of darker hue, mottled with reddish purple. The pleura here and there was covered with a yellowish shaggy friable exudate. Beneath these areas and also scattered in the deeper areas of the lung tissue were rather firm airless areas. The bronchial mucous membrane was intensely swollen and covered with mucopurulent secretion; this condition was likewise seen in the bronchioles. The pulmonary vessels showed no thrombi; the bronchial lymph nodes were swollen and friable. On section there were found, scattered throughout the lower lobe, corresponding for the most part with the bronchioles, areas varying in size from a pea to a walnut. In color they varied from gray to purple; were firm and quite friable. The lung tissue in the immediate neighborhood showed intense congestion. In the right lung, the upper lobe was grayish in color and air-containing; the middle and lower lobes were voluminous, dark red in color. The pleura was rough and showed numerous fibrous

tags. In all other respects it resembled the left lung. The tracheal mucosa was intensely swollen and covered with an abundant mucopurulent exudate. The middle ears were normal; the mucosa of the posterior and anterior ethmoids was slightly swollen and moist; no purulent exudate was present; the frontal sinuses were normal. Bacteriologic examination of the ethmoidal sinuses by both smear and culture was negative. Prosector, Lieutenant Hugh R. Spencer.

NECROPSY 139: The patient was admitted to Base Hospital 66, Neufchateau, March 13, 1918, having had a cough since March 6. On admission, he had severe headache, shortness of breath, pain in the right side, with temperature of 102.4 F., pulse 120, dulness over both lower lobes and moist râles everywhere. Pneumococcus, Type II, was isolated from the sputum. Death occurred March 20, 1918, at 3 a. m. Necropsy at 9 a. m. same date: Pleural surfaces were everywhere smooth and there was no abnormal fluid. In the lower lobes of both lungs, there were numerous small, grayish, consolidated areas, corresponding with the terminal bronchioles, which were considerably swollen. The lung tissue elsewhere was intensely congested and of a deep red color. The lymph nodes at the bifurcation were swollen, soft and red. Culture from the heart was sterile; cultures from the lung showed pneumococci and influenza bacilli. Prosector, Major F. H. Foucar.

NECROPSY 194: The patient was admitted to Camp Hospital 15, Camp Coetquidan, April 5, 1918, with a diagnosis of measles. April 8, he developed signs of diffuse bronchitis, with marked dyspnea and cyanosis; the white blood cells numbered 8,400; the sputum showed chiefly *B. influenzae*. Death occurred April 13, 1918, at 1:30 p. m. Necropsy April 13, at 4 p. m.: The pleural cavities were free, without exudate or adhesions; the fluid was not increased. The right lung weighed 660 grams. Externally all three lobes were irregularly mottled, with raised, grayish margins and depressed dark brownish centers. On section the same characteristic mottling was seen throughout all lobes. Interspersed between the grayish aerated tissue, from which a bloody froth exuded, were dark red firm areas of consolidation, the latter being found especially near the hilum. The bronchi were filled with a greenish purulent material. The left lung weighed 630 grams, and was identical in appearance with the right. Bacteriologic examination of pus from the right and left bronchi showed pure culture of *B. inflenzae*. Prosector, Lieutenant Edward H. Mason.

The records of these necropsies, especially those from Neufchateau, the laboratory center of the advanced training area in 1917, indicate very clearly the prevalence of influenzal bronchopneumonia from October, 1917. The almost epidemic character of the disease is indicated by the data presented in Table 1. The influenza rates per 100,000 of 1,050 in October, 1,980 in November and 2,480 in December, 1917, really indicate a greater relative prevalence of influenza at that time in the A. E. F. than occurred in the fall of 1918, when the respective influenza morbidity rates were 826 in September, 2,176 in October and 1,356 in November. The total number of American troops in France was relatively small during that winter — 141,995 effective mean strength in December — so that the prevalence of influenza did not lead to the recognition of an actual epidemic. Furthermore, the overcrowding in quarters, which seems to have had a definite relation to many of the later explosive outbreaks, had not become such a distinct feature at that time. In addition, the cold, wet weather,

exposure and unusual living conditions furnished explanations for the morbidity which were no longer adequate during the hot weather of May and June, 1918. Until May, 1918, therefore, the prevalence was that of an endemic disease, with perhaps an occasional outbreak suggesting epidemic character.

TABLE 1.—DATA IN REGARD TO INFLUENZA AND PNEUMONIA, ESTIMATED FROM RECORDS IN THE OFFICE OF THE CHIEF SURGEON, A. E. F. BY MONTHS

	Mean Strength A. E. F.	Influenza Cases	Influenza, Rate per 100,000	Pneumonia Cases	Pneumonia, Rate per 100,000	Pneumonia Deaths	
						Number	Case Ratio
1917:							
June	14,861	5	35	.....	.....	.....	.....
July	15,555	50	321	18	116	.....	.....
August	26,703	117	438	15	56	.....	.....
September	44,744	180	403	28	63	.....	.....
October	70,079	735	1,050	98	140	.....	.....
November	106,990	2,120	1,980	192	178	.....	.....
December	141,995	3,520	2,480	508	358	.....	.....
1918:							
January	188,652	3,660	1,940	980	520	.....	.....
February	229,316	2,195	958	480	210	.....	.....
March	286,521	2,420	844	625	218	.....	.....
April	437,063	1,850*	423*	252*	58*	.....	.....
May	503,265	.....	....	456*	73*	.....	.....
June	739,042	4,520	748	660	89	.....	.....
July	988,015	3,983	403	478	48	64	13.4
August	1,275,595	6,393	501	792	62	142	17.9
September	1,545,812	12,769	826	1,683	109	422	25.1
October	1,741,593	37,904	2,176	5,353	307	3,129	58.5
November	1,865,343	25,287	1,356	4,077	219	1,935	47.5

* These figures are regarded as quite inaccurate because of incomplete tabulation.

Origin of the Epidemic.—From the preceding discussion it is evident that the possibility that the epidemic actually originated in France has to be considered. The alternative possibility is that the disease first became epidemic elsewhere and was introduced into France in the epidemic form in the spring of 1918. The problem is made more complex because of lack of absolute certainty in regard to the nature of the disease and the identity of the epidemic disease with the influenza which was endemic in France in previous years. The endemic disease has lacked the clinical feature of sudden onset and the epidemiologic feature of rapid spread. However, the exact time and place at which these features became sufficiently prominent to justify the recognition of an epidemic in France cannot be specified. On the whole, the evidence favors the conception of a gradual transition of influenza in France itself from the endemic to the epidemic form. Since 1890, influenza has remained endemic in many places and in nearly every country, and small epidemic outbreaks have been recognized from time to time. Given the essential conditions, the disease might have assumed epidemic proportions in any one of many different places and might have extended as a pandemic from such a point. The special condition favoring influenza in France, in addition to the ordinary

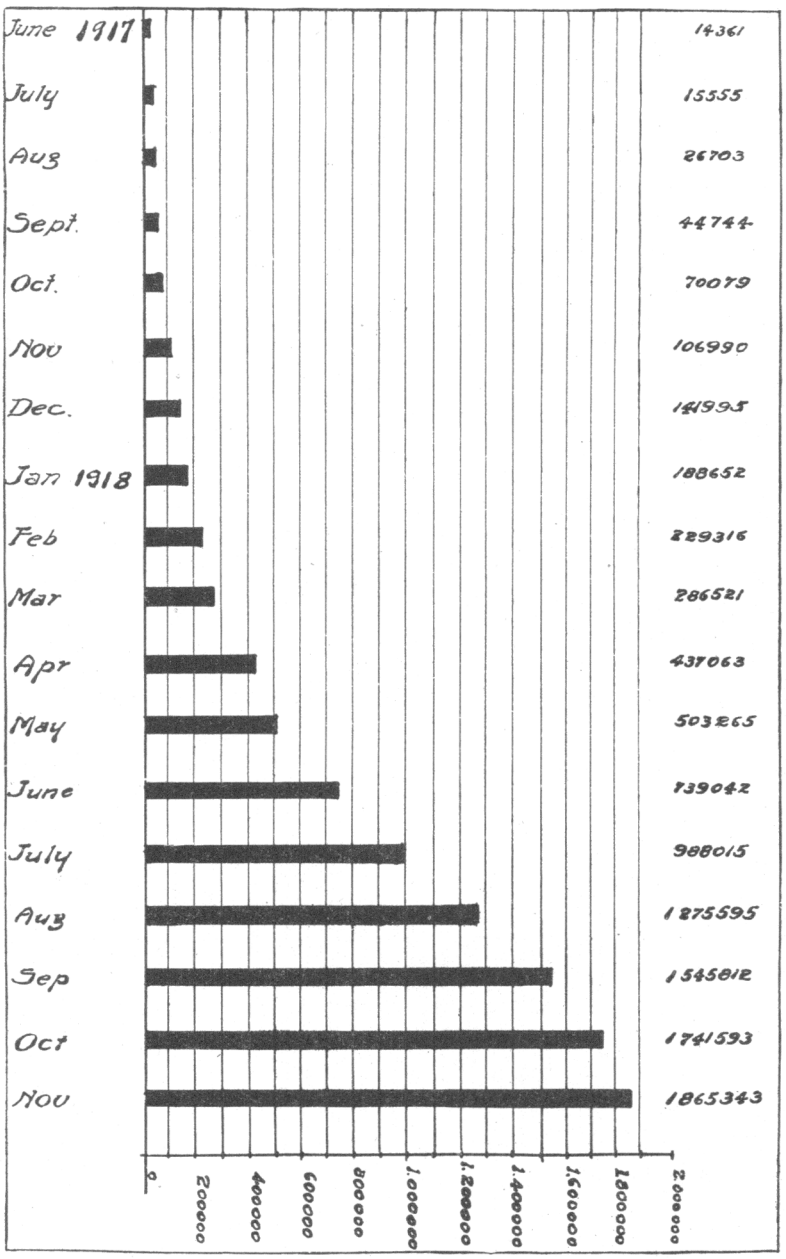

CHART 1.—The mean monthly strength of the American Expeditionary Forces. Taken from the records in the office of the Chief Surgeon. Note the sudden relative increase from March to April, 1918.

hardships of a country at war and the large amount of cold, damp weather, has been the fuel shortage, which has been peculiarly severe in France during the war. The evidence indicates that influenza has been very prevalent and that small epidemic outbreaks of it were recognized in the British Army in France in 1916 and in 1917. The arrival of American troops in France has been a factor of possible importance in relation to this disease. Their relative numbers are indicated in Tables 1 and 2 and Chart 1, the data of which apparently indicate line troops only, rather than the total forces. However, they are sufficient to give an idea of the relative increases. Attention may be directed to the sudden increase in mean strength from March to

TABLE 2.—DATA IN REGARD TO INFLUENZA AND PNEUMONIA. BY WEEKS

1918	Mean Strength A. E. F.	Influenza Cases	Influenza, Rate per 100,000	Pneumonia Cases	Pneumonia, Rate per 100,000	Pneumonia Deaths	
						Number	Case Ratio
Week ending—							
July 5	893,910	1,103	123	157	18	9	0.6
12	929,714	1,247	134	116	13	21	18.1
19	1,025,028	917	90	105	10	12	11.4
26	1,103,409	716	65	100	9	22	22.0
August 2	1,162,486	937	81	137	12	22	16.0
9	1,214,581	1,260	104	160	13	16	10.0
16	1,285,402	1,285	100	150	12	23	15.3
23	1,315,822	1,073	82	131	8	29	22.1
30	1,399,682	1,838	131	214	16	52	24.3
September 6	1,469,885	1,503	102	166	11	38	23.5
13	1,520,890	3,066	202	479	32	68	14.2
20	1,567,771	4,279	273	477	30	137	28.7
27	1,624,762	3,921	241	561	35	179	31.9
October 4	1,679,126	9,285	552	1,035	63	363	35.1
11	1,725,748	8,555	496	1,035	60	514	49.7
18	1,761,578	9,081	515	1,323	75	782	59.1
25	1,799,919	10,983	610	1,960	109	1,470	75.0
November 1	1,823,469	9,110	500	1,478	81	803	54.3
8	1,842,663	5,972	324	1,062	58	196	18.5
15	1,868,000	4,862	261	793	43	476	60.0
22	1,883,959	2,972	157	488	27	297	60.9
27	1,908,626	2,371	124	256	13	163	63.7

April, 1918, when 150,000 men were added to the 287,000 already in France. This increase of more than 50 per cent. required, in many places, the crowding of three or even four men into the quarters previously occupied by two, thus increasing enormously the opportunity for the rapid transmission of respiratory infection. Furthermore, it furnished a large group of newly arrived susceptible individuals and brought them into close association with the influenza already endemic among the American soldiers who had preceded them. One is tempted, therefore, to account for the origin of the epidemic by assuming an increase in virulence of endemic influenza, depending, first, on war conditions in France, especially the lack of fuel, second, on the introduction of Americans in 1917 and the spread of the disease among them during the following fall and winter, and third, the greater influx of susceptible American troops, beginning in the latter part of March,

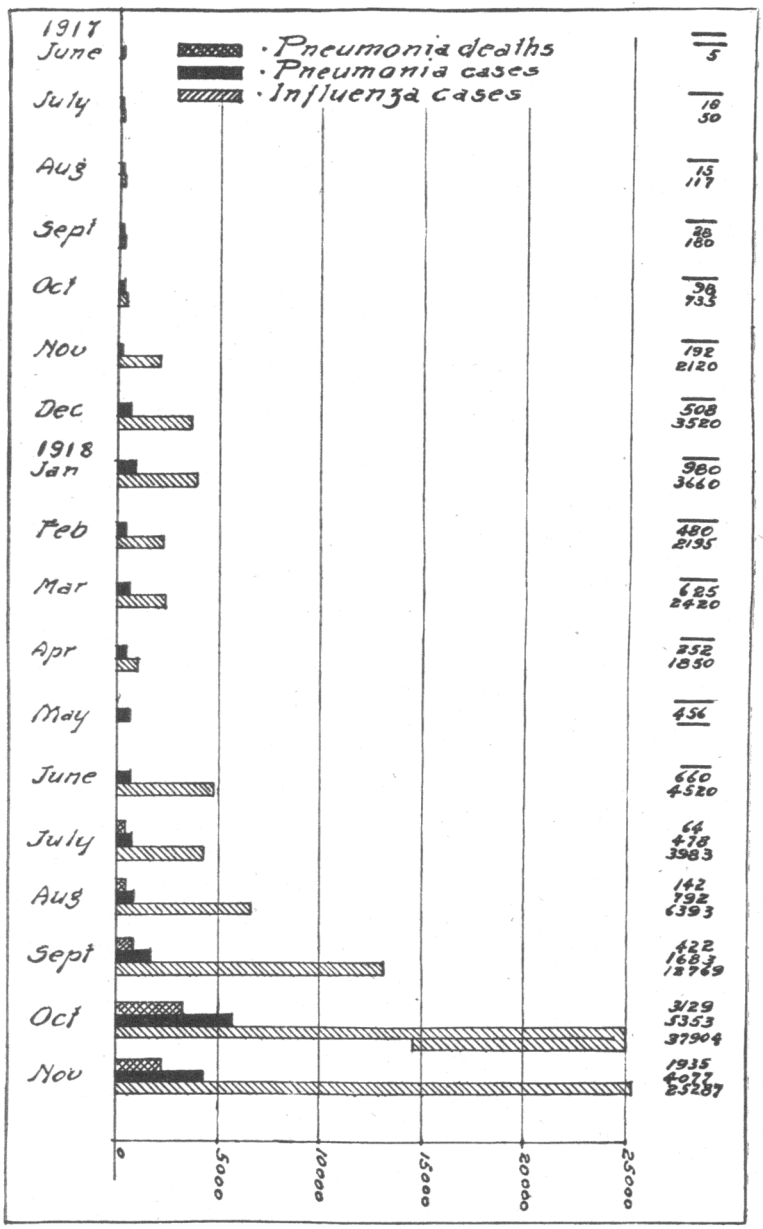

CHART 2.—Influenza cases, pneumonia cases and pneumonia deaths by months. The data for April and May are believed to be quite inaccurate because of incomplete tabulation of the statistics.

following which the disease assumed epidemic proportions. The evidence in favor of this conception appears strong, but a final decision should be withheld until reliable reports from the other European countries are at hand.

The number of cases of influenza and pneumonia reported in the A. E. F. are indicated in Chart 2, except for the month of May, for which the influenza figures are not available. In Chart 3 the rate for 100,000 mean strength is indicated for influenza and pneumonia. The remarkable feature is the high rate for influenza in November, December, 1917, and January, 1918, that of December being higher than in October, 1918, at the peak of the fall epidemic. Obviously, figures based on the reports of such a disease as influenza are only approximately accurate, but they have a relative value, nevertheless.

Pandemic Extension.—The spread of the epidemic from France to the United States by ships can hardly be questioned, although exact information in regard to this may better be obtained in America. Doubtless many of the transports carried the infection. A written report has been rendered in regard to one boat which had an outbreak of forty-two cases of influenza among the crew during the voyage to the United States in August, 1918. On its return to France this ship brought a part of the 64th Infantry. An epidemic of about 100 cases of influenza broke out on this boat again two days before reaching France, about September 1. The disease evidently spread rather rapidly in the United States, so that after September 15, nearly every transport arriving in France or in England, came in with a serious epidemic of influenza on board, which could be traced back to cases existing in the military organizations before embarkation in the United States. Reports from the United States indicate very clearly that the disease spread westward from the Atlantic seaboard.[4] Although the disease must be regarded as identical in essential nature with influenza, which has been endemic in many parts of the United States since 1890, it is necessary to recognize that the virus brought over from France had acquired an epidemic quality to a degree which that previously existent in America no longer possessed.

An interesting example of transmission of the disease has been reported by Colonel M. A. Delaney from England. On August 26 and 27 the British vessel *Mantua,* which had influenza on board, stopped at Sierra Leone for consultation with two other British ships, *Chepstow Castle* and *Tahiti,* the former carrying New Zealand troops and the latter carrying naval ratings from East Africa. Influenza broke out

4. For further data as to influenza in the United States reference should be made to the article by Vaughan and Palmer in the Military Surgeon, October, 1918.

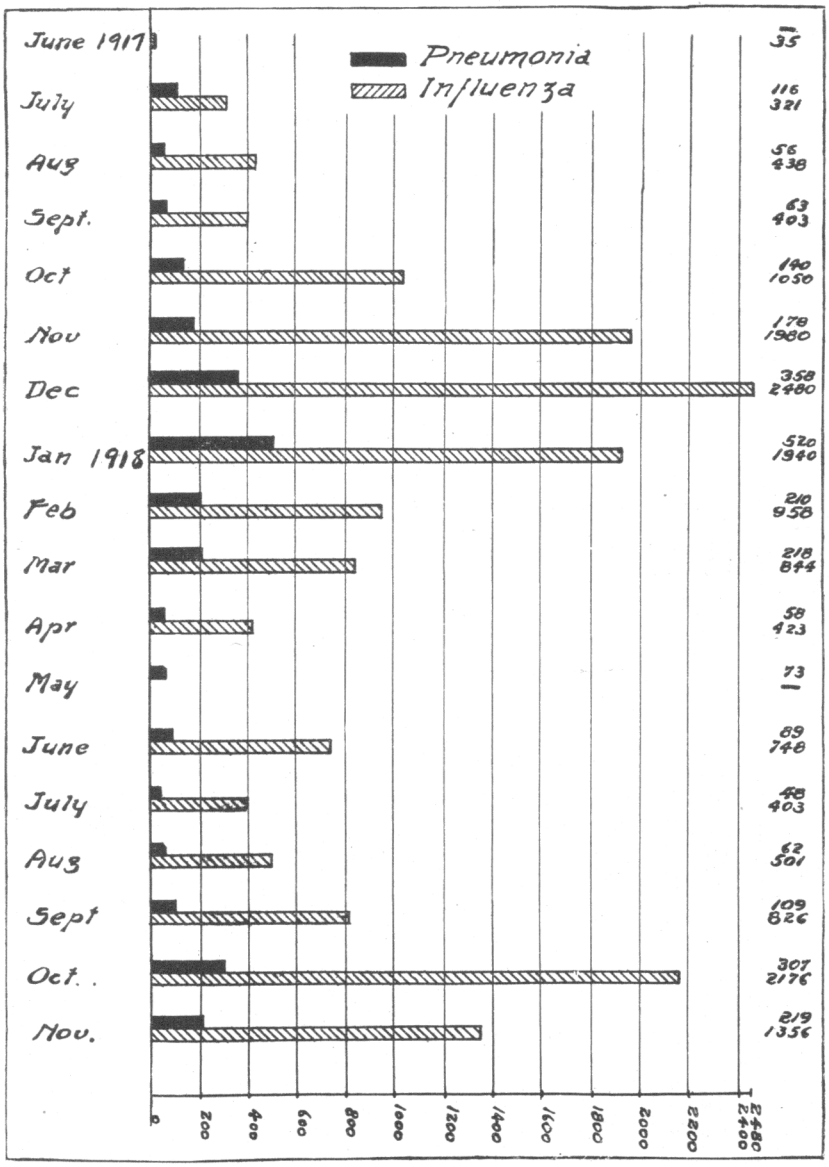

CHART 3.—Morbidity rate per 100,000 troops for influenza and pneumonia. Note that these diseases were relatively more prevalent in December, 1917, than at any time up to November, 1918.

on both the *Tahiti* and the *Chepstow Castle* within forty-eight hours after this call, and before arrival in England the *Tahiti* had sixty-eight deaths and the *Chepstow Castle* had thirty-eight. It is evident that New Zealand and East Africa had not been reached by the epidemic at the time of departure of these boats. On Oct. 23, 1918, the steamship *Mozambique* arrived at Lisbon from Cape Town, South Africa, having 200 deaths during the voyage and reporting an epidemic of influenza raging at Cape Town at the time of her departure.

SUMMARY

1. A disease, clinically recognized as influenza, became epidemic in the A. E. F. in France in May, 1918.

2. Since August, 1918, the epidemic, previously mild, has assumed a more malignant character, often leading to a fatal bronchopneumonia.

3. In the fatal cases the lungs have presented a picture of malignant coalescing bronchopneumonia, frequently with hemorrhagic tracheobronchitis. The changes have varied considerably according to chronicity of the disease and the nature of the secondary infections.

4. Influenza bacilli in large numbers have been found in the bronchi in fulminant cases. At most of the necropsies a mixture of bacteria was found in the respiratory tract, including pneumococci of various types, streptococci and sometimes staphylococci.

5. Blood cultures during life were usually negative, but showed pneumococci or streptococci in some cases.

6. Overwork, exposure to cold and wet, inadequate nourishment, poor ventilation, inhalation of dust and general physical discomfort have diminished the natural resistance to the disease.

7. The contagion spreads rapidly by distribution in the secretions of the nose and mouth, not only of the sick, but of many other infected persons not suffering from the disease.

8. The primary epidemic disease of the autumn is considered identical with that of the early summer, with the added complication of bronchopneumonia in the colder weather.

9. The bacillus of Pfeiffer is the apparent cause of the epidemic disease, but its causal relationship is not proved conclusively.

10. Rest in bed, warmth and bodily comfort, promptly enforced at the outset are the most important elements in the treatment.

11. Prophylaxis includes avoidance of contagion and general hygienic measures to enhance natural resistance and retain it at a high level. Vaccines are of questionable value.

12. Influenza has been endemic in France for many years, and during the war this infection appears to have assumed a more virulent type in this country, small epidemics having been recognized in the British army in the winter of 1916-17, and in the fall of 1917.

13. American troops in France suffered very much from influenza, especially in the winter of 1917-18, the disease apparently being the same as that which became epidemic in 1918.

14. The evidence suggests that the epidemic of influenza originated in France from the endemic influenza widely prevalent here. It is probable that the large numbers of American soldiers in France, subjected to strange environmental conditions, furnished a fertile soil for the propagation of the disease.

15. The epidemic was evidently carried by ships from Europe to the United States and to South Africa.

CONCLUSIONS

1. The epidemic of 1918 has been influenza.

2. It appears to have developed by transition from a widespread and serious endemic influenza in France.

303 East Twentieth Street.