

fit for military service. Those men who have given a history of having had subjective symptoms in civil life have all made complaints following these exercises. Those cases in which the irritable heart had as its basis pulmonary tuberculosis have usually responded poorest to the exercises.

In forty-one cases, we feel confident that the exercises brought out positive findings in the chest and caused a rise in temperature, so that we were justified in making the diagnosis of pulmonary tuberculosis. Thirteen of the patients under observation were discharged with the diagnosis of hyperthyroidism. The exercises in those cases brought out signs that previously were only suggestive.

#### SUMMARY

For the present, we feel safe in saying it is possible to detect the irritable heart before a man is inducted into service. This can be done, first, by taking a careful history, paying particular attention to previous attacks of dizziness or fainting, exhaustion, precordial pain, and pounding of the heart on *slight exertion*; second, by noting the unusual physical response to the hopping exercise and the increase in the pulse rate out of all proportion to the exercise.

### THE INFLUENZA EPIDEMIC AT CAMP DIX, N. J.

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The influenza epidemic began at Camp Dix, September 15, and ended, October 6. The number of daily admissions increased rapidly and reached the maximum, September 26, on which day 806 patients were received, making a total of 4,025 in the hospital on that date. The number then decreased daily, reaching the normal average of eighty admissions, October 7. During the twenty-two days of the epidemic, 6,500 patients were cared for. Approximately 6,000 of these men had influenza. There have been 800 deaths due to the epidemic. Four of our nurses and one dietitian died during the epidemic, contracting the disease while on duty. One medical officer was taken ill while on leave and died from bronchopneumonia a few days later at the Massachusetts General Hospital.

When the epidemic began to subside and the hospital discharges to increase, wards were consolidated as rapidly as possible. The emptied wards were renovated and disinfected thoroughly and all bedding sterilized in the steam autoclave before being used again for noninfluenza patients.

#### ADMINISTRATION

To take care of the large number of patients, all of the forty-eight wards of the hospital, except six, were turned over to the medical service; but in spite of this, it was found necessary to expand, and an annex was started in the camp. Through the cooperation of the headquarters authorities and the camp surgeon, a number of empty barracks were quickly equipped, a medical and nursing staff organized, and in this way eighteen additional wards with accommodations for

1,100 patients were provided. The annex was used for the most part for convalescent patients, and the patients were moved there from the base hospital as rapidly as safety permitted. Our rule was not to transfer patients until the temperature had been normal for forty-eight hours. They were kept in bed at the annex for another forty-eight hours and not discharged until the temperature had been normal for ten days.

By this plan overcrowding was avoided and, as soon as possible, arrangements were made by which each influenza and pneumonia patient in the hospital was given 100 square feet of floor space. All patients, including those on the porches, were placed in cubicles. Nurses, medical officers and orderlies wore gauze mouth and nose coverings while on duty. Nasal discharges and sputum of patients were disinfected. A 2 per cent. solution of tincture of iodine in physiologic sodium chlorid solution was used for oral and nasal hygiene. Floors of all wards were gone over daily with a cloth wet in disinfectant. Individual drinking cups were provided. Particular care was given to the disinfection of thermometers and other utensils as they passed from patient to patient. Enlisted attendants in wards wore white-cotton coats and trousers. Medical officers and nurses were instructed to disinfect carefully their hands before and after the handling or examining of patients and before leaving the ward, or passing from one class of patients to another. Pails containing a disinfecting solution were provided at convenient places in every ward.

Blankets, mattresses, mattress covers and pillows were disinfected by steam before being used for another patient. Soiled linen was immersed in a 2 per cent. dilution of liquor formaldehydi before being sent to the laundry. The clothing of patients was disinfected by steam or formaldehyd before discharge.

For patients too ill to use covered sputum cups, paper napkins were provided for the reception of sputum and nasal secretions. At the head or side of each bed a paper bag was fastened with a pin or adhesive plaster. These bags were used for napkins, gauze, swabs and other infected refuse and burned when full.

The medical service was directed by the medical chief and an assistant. There were ten ward supervisors, admitting officers and consultants. These men met with the chief for a conference at 8 a. m. daily, when the work of the day was outlined and discussed. There was a daily conference of all medical officers attached to the medical service (about eighty-five officers at the time of maximum stress) at 1:15 p. m. when matters requiring advice, questions of discipline, treatment, etc., were gone into fully.

The patients were grouped as rapidly as possible, all uncomplicated influenza cases being kept together, and the cases complicated by pneumonia gathered in separate wards.

The following laboratory tests were ordered for all pneumonia patients:

1. Routine urine examination.
2. Urine precipitin test, for type of pneumococcus.
3. Blood examination: white corpuscle and differential blood count.
4. Blood culture (only in serious cases).
5. Sputum: Collected in sterile Petri dish, after patient had rinsed mouth and throat with physiologic sodium chlorid solution, to eliminate contaminating organisms as much as possible; for smear and white mouse necropsy to determine the type of pneumococcus.

The following rules are laid down for the guidance of ward surgeons in the general management of convalescent pneumonia patients:

1. It is advisable that in all serious or severely toxic cases of pneumonia, the patient shall remain in bed for at least two weeks after temperature is normal.
2. Convalescent patients are to be transferred to the convalescent ward, as soon as this can be safely done.
3. No patient will be transferred without the approval of the consultant. Patients so transferred will be carried on litters, not wheel chairs.
4. Before discharge from the hospital, all pneumonia patients are to be sent to the roentgen-ray laboratory for fluoroscopic heart examination and cardiac measurement.
5. Generally speaking, no patient is to be discharged until the heart is normal in size, as determined by fluoroscopic measurement.
6. No influenza patient is to be returned to duty until the temperature has been normal for ten days.

All ward surgeons were repeatedly warned to be on the alert for the early detection of empyema and were given these instructions:

1. Consult your supervisor as to advisability of exploration.
2. *Technic of Exploration:* A 10 to 20 c.c. Lürer syringe and appropriate needle. One per cent. cocaine anesthesia by infiltration at site of puncture. Send fluid to laboratory (in syringe in which fluid is obtained) for smear and culture labeled "Chest fluid for smear and culture."
3. Roentgen ray to be requested as indicated.
4. *Aspiration:* If exploration has been advised and if fluid is sterile, do not remove by aspiration until after consultation and unless something in clinical condition warrants it, i. e., exacerbation of fever, pressure symptoms, respiratory distress, etc.
5. Repeated explorations are to be avoided on account of danger of conveying fresh infection from lung to pleura incident to puncture of lung by exploring needle. The pleural fluid may be sterile. Avoid infecting it.
6. If fluid is thin enough to run through a Potain aspirating outfit, it should be removed in this way, as often as symptoms indicate. If after consultation a case is considered to be one requiring thoracotomy, the sick soldier will be transferred to the surgical ward for operation.

In addition to the large stationary outfit in the roentgen-ray laboratory, we have two portable bedside machines. These were kept almost constantly in use during the epidemic.

#### CLINICAL FEATURES

The usual history was one of gradual onset with prodromes for four or five days prior to admission—consisting of headache, malaise, backache, myalgia, fever and chills or chilly sensations, and marked prostration. There was a history of anorexia, and of aggravation of symptoms, after drill or exercise. Occasionally the onset was sudden, sharp and severe. On admission there was cough, often with rusty sputum, a temperature of 103 F., occasionally hyperpyrexia, respirations of 28 or 30, the pulse between 80 and 120. A low temperature in a severe case was an unfavorable sign. The blood count showed usually leukopenia. The urine contained albumin and casts. The patients looked very ill, but often did not feel so. Few complained of sore throat or the early sticking pains in the chest, aggravated by coughing, so commonly observed in beginning pneumonia.

One third of our cases presented frank signs of pneumonia. Every patient who had fever, prostration, rapid pulse, increased respirations, cough and bloody sputum was at once put down as a pneumonia suspect,

which diagnosis could usually be confirmed later by physical signs and roentgen examination.

Frequently no physical signs of pneumonia were apparent on the initial examination. A day or two later bronchopneumonia was discovered, the lobules subsequently tending to become confluent. This condition sometimes gave the physical signs of a lobar pneumonia, but the real condition was repeatedly demonstrated at necropsy. The roentgen ray was an invaluable aid in the diagnosis of such cases.

The outstanding feature of the disease was the extreme toxemia noted in the serious cases. We could predict almost from the first inspection the outcome of each case. There has been a sharp line of demarcation between the serious and mild cases. In the former, many patients developed a cyanosis early in the disease and died promptly, after periods varying from a few hours to three days after admission.

The cyanosis appeared early and was progressive. It was a fairly constant and characteristic symptom in the severe cases. This intense cyanosis was a striking phenomenon. The lips, ears, nose, cheeks, tongue, conjunctivae, fingers and sometimes the entire body partook of a dusky, leaden hue. Frequently this cyanosis was apparent before there were any demonstrable physical signs of pneumonia. The cause could not be ascertained, a few spectroscopic readings failing to show absorption bands of methemoglobin. As necropsy revealed marked so-called compensatory emphysema in these cases, and as cyanosis is a common accompaniment of emphysema, possibly this was in some way accountable for the condition. Otherwise a purely mechanical conception of the mode of production of the cyanosis seems untenable. Lividity, occurring early in the disease proved to be an ill omen.

Very often this cyanosis came on suddenly in patients who had been doing well. It was not due to cardiac dilatation. The pulse was often slow, full and regular in such cases, and remained so, with a rate under 100, almost until death.

The disparity between temperature and pulse was striking. Patients with temperature between 104 and 106 not infrequently had a pulse rate below 80. This we regard as a strong point in differential diagnosis between these influenzal pneumonias and those of pure pneumococcal origin.

The disease was a veritable plague. The extraordinary toxicity, the marked prostration, the extreme cyanosis and the rapidity of development stamp this disease as a distinct clinical entity heretofore not fully described.

It is entirely different from our previous pneumonia epidemics. It is fair to state that it is primarily a profound, rapidly progressing septicemia and toxemia in which pneumonia is an important but somewhat secondary factor.

There was noted in many instances a distinct tendency to relapse. In several of our mild cases, after a day or two of nearly normal temperature, exacerbations occurred and the infection changed to the severe, toxic type.

Herpes labialis was relatively infrequent, but became more common as the disease advanced. It was seemingly of little help in prognosis, as many with herpes died, contrary to the teachings of the older clinicians.

The sputum showed varying characteristics. It was mucoid, mucopurulent, blood streaked, frothy and bloody, the blood pure as in infarct.

In one of our cases it was thin, brown, without froth and homogeneous (prune juice variety). At times it was rusty but lacking tenaciousness and of the consistency of typically pneumonic sputum; it was odorless. In one case the patient coughed up a large quantity of homogeneous, thick, purulent, greenish sputum at one time.

Necropsy in this instance revealed multiple bronchopleural fistulas leading to an encapsulated empyema on the right side.

Tachypnea was constant and variable in rate. The expiratory grunt was uncommon.

The cough differed materially from that of lobar pneumonia, being free, often painless, sometimes paroxysmal, resembling the cough of pertussis. One may reason from this that pleurisy was relatively uncommon as an initial feature. Pleuritic rubs were occasionally heard, however, while diaphragmatic pleurisy with its referred pain was not uncommon, often simulating a condition suggestive of appendicitis.

Flushing of the face was common. An early generalized erythema resembling that of scarlatina, most noticeable on the chest and back, was often observed. Miliaria (sudamina) was common later in the disease, especially in lethal cases in which sweating was frequent and excessive.

The throat was usually injected, but not painful; the tonsils were not swollen as a rule; there was marked conjunctival congestion at the outset of the disease. The tongue was variable: usually coated, moist in milder cases, dry, cracked and occasionally bleeding in severe cases. Sordes appeared frequently on the teeth.

Hoarseness was frequent, due either to the trauma of coughing or to superficial laryngeal ulceration or edema, as demonstrated at necropsy.

The mental condition was either apathetic or there was an active delirium. Cerebration was slow at the onset; the sensorium was numb; a noticeable incident in attempting to elicit history was the frequent apparent disregard of one's question or a response with an interrogatory and blank "What?" or "Sir?" Possibly this was due to a defect of ratiocination, rather than a faulty sense perception (tubotympanic catarrh with retracted membrana tympani or straight lethargy). The patient's assurances and statements as to the condition in many instances were unreliable, a moribund patient stating that he felt very well, requesting permission to get out of bed, reading the daily newspaper in some instances audibly and intelligently, or laying plans optimistically for the future. In other cases, apprehensiveness was most striking, the patient fearing for the future, predicting in a gruesome way the time of death, and making requests to be carried out posthumously. In moribund patients, motor and psychic restlessness was remarkable. In some cases the typical typhoid state existed: stupor, low muttering delirium, subsultus, tendinum, carphology, incontinence of urine and feces; one patient lay for several days stupid with the eyes wide open following imaginary objects about the ward (coma vigil).

In the lungs, the physical signs varied from impairment of resonance, especially over the lower lobes, with diminution of the vesicular murmur; with showers of crepitant and later subcrepitant râles to straightforward signs of consolidation, namely, dullness, bronchial breath and voice, increased fremitus and whisper with a few consonating râles. Often the only evidences of early pneumonia were the signs first

enumerated and these confined to a small area or a number of small areas, most commonly at the upper part of the right lower lobe or in either axilla, high up.

In the abdomen, meteorism occurred in some cases; in certain lethal cases it was excessive. Abdominal pain and tenderness were frequent, possibly not entirely due to pleurisy, but in the light of necropsy findings, to infection and hemorrhages in the rectus muscles. In one case necropsy revealed the presence of bilateral abscess in the lower rectus (Zenger's hyaline degeneration). The liver percussed large but was not often felt, owing to abdominal resistance. The spleen could be felt at or just below the costal margin in about one third of our cases. This finding was of little value, however, as many of these subjects were of the status lymphaticus type, in which cases splenomegaly is often observed.

Weakness and tremulousness of the extremities were noticeable manifestations in many cases.

Among accidents of the disease may be noted one case of death shortly after admission with no forewarning, and one case of sudden death many days after febrile period when the patient was regarded on the high road to convalescence.

#### EMPHYEMA

There have been fewer cases of empyema in this epidemic than might be expected, owing to the fact of the extreme toxicity of the disease with the result that death has occurred early. Most of the cases examined postmortem showed lesions in the pleura which would undoubtedly have resulted in empyema had the patients lived longer. Twenty cases of frank empyema have been discovered up to the present time.

Our experience here has taught us that early operation is not advisable in empyema. Aspiration with the Potain apparatus is resorted to when fluid is demonstrated to be present in the pleural cavity, unless the fluid is found to be sterile, in which event it is not removed. Aspiration may be repeated at two to four day intervals. Many patients do well under this plan of treatment; and if a costectomy is later deemed advisable, the patient's chances of recovery are very much enhanced if this operation is delayed until the acute stage of the disease has been passed, and the patient has begun to immunize himself.

The following type case illustrates the wisdom of this procedure:

Col. F. D. L., taken ill while in New York, Sept. 21, 1918, had a severe chill the next day at 3 a. m. He traveled back to Mount Holly in the afternoon. He complained of fever, chilliness and drowsiness. Signs of a diffuse bronchopneumonia with involvement of all lobes quickly developed. On the fourth day there was a remission in temperature and the patient felt better, but on the fifth day he had an exacerbation and the condition rapidly became critical. His fever was continuously high and expectoration was bloody. There were several attacks of hematemesis and one rather severe hemoptysis. The patient became delirious, September 28. This condition persisted one week. He was cyanosed and toxic, with signs of dilatation of the right ventricle and myocardial failure. The pulse rate ranged between 140 and 150, with respirations between 44 and 50 a minute. A pronounced jaundice, due probably to a hemolytic infectious process, developed about this time. On the fifteenth day, signs of fluid developed at the base of the right chest. Exploration in the eighth interspace at the posterior axillary line revealed a cloudy serofibrinous exudate, which on smear and culture showed the staphylococcus. Next day, 250 c.c. were removed by aspiration. On the eighteenth day, 400 c.c. of slightly

cloudy serous fluid were removed, and on the twentieth day 600 c.c. of frankly purulent fluid were obtained. On the twenty-third day, 1,120 c.c. of similar fluid were removed by aspiration. After this aspiration the patient's condition began to improve at once, and at present writing his temperature is normal, and the prognosis for recovery is excellent. The sputum on white mouse necropsy showed the Type IV pneumococcus. The urine contained albumin and casts. Cultures of the blood were made twice but were negative on each occasion. All aspirated fluid has shown a pure culture of *Staphylococcus aureus*.

#### OTHER COMPLICATIONS

The complications other than empyema associated with the epidemic were those ordinarily encountered in an infectious disease of great virulence. Pulmonary edema was a comparatively frequent terminal condition. One of the most striking of the complications was hemorrhage from the mucous membranes, especially from the nose, stomach and intestine. Frequently pneumonia patients would have hemoptysis like the hemorrhage of tuberculosis. Bleeding from the ears, and petechial hemorrhages in the skin also occurred. Purpura was seen rather frequently. Other complications were phlebitis, thrombosis, or embolism of peripheral arteries (with gangrene of the foot in two cases), toxic erythema, vomiting, diarrhea, conjunctivitis, convulsions, purulent peritonitis, inflammation of the accessory sinuses and of the middle ear, and pericardial effusion. A pronounced jaundice, not obstructive, as the stools are not acholic and probably of infectious origin, was noted in many of our severe cases. Retention of urine was not uncommon.

In several instances the infection produced a pronounced hemolytic effect with rapidly progressive anemia. In one instance, that of a medical officer, the red cell count was reduced to 1,600,000, with 50 per cent. hemoglobin on the fifth day of his disease. This patient is recovering.

A report of our series of cases, twenty in all, showing subcutaneous emphysema of the tissues of the neck, face, upper portion of the chest and arm will be published elsewhere.

Other rarer complications were meningismus, fibrinous and serofibrinous pleurisy, rupture of an encapsulated empyema into the bronchus, thyroiditis, pneumothorax and cerebral thrombosis or embolism (one case showed hemiparesis, hemianesthesia, and probably hemianopia).

#### TREATMENT

Influenza cases were treated symptomatically. Codein or heroin was found useful in relieving the distressing cough. Medicated steam vapor inhalations were found useful in relieving laryngeal irritation.

In the pneumonia cases, digitalis is begun early and given in full dose for forty-eight hours. It is then discontinued or reduced to one or two doses daily, after the heart muscle is digitalized.

Abdominal distention is guarded against, and when symptoms of this condition develop, an enema is given or, if necessary, pituitary solution hypodermically is administered.

If the patient is toxic or unable to take fluid freely by mouth, water is given by proctoclysis, hypodermoclysis or intravenous administration.

In the pulmonary edema cases, postural treatment, the Trendelenburg position being employed, was found useful in a few instances; in others it seemed to add

to the distress. Atropin or belladonna did not prove of any value in these cases.

The diet that we have recommended for influenza and pneumonia cases is a nourishing one providing calories in excess of 3,000 a day. It includes such articles as gruels, broths, purées, eggs, and milk fortified with cream and lactose.

To lessen the danger of relapses and exacerbations, we believe it is of the utmost importance to keep all patients in bed until the temperature has been absolutely normal for at least forty-eight hours. The rule not to discharge patients until the temperature has been normal for ten days has been rigidly enforced.

#### SERUM THERAPY

Serum was administered in cases in which the laboratory reported the Type I pneumococcus. It was given only after desensitization and under the direction of the medical officer to whom the supervision of pneumonia patients had been entrusted. It was administered intravenously in doses of from 60 to 100 c.c. at twelve hour intervals until the temperature remained below 101 F.

#### SPINAL PUNCTURE

As many soldiers who died from pneumonia were shown at necropsy to have had an infection of the meninges with the pneumococcus organism, in a few instances of Type I, a lumbar puncture was advised in every case in which any symptoms of meningeal irritation developed. The spinal canal was drained, and the fluid withdrawn was sent to the laboratory for examination.

The precipitin test on the spinal fluid is rapidly done and the type thus easily determined. If the laboratory reported the Type I pneumococcus, serum was administered at once intraspinally (20 c.c.) and a desensitizing dose of 5 c.c. given subcutaneously. Five hours later, from 80 to 100 c.c. were given intravenously.

#### PROPHYLACTIC IMMUNIZATION

In the course of the epidemic the War Department offered prophylactic immunization to the camp, and several thousand inoculations have been given. These are given only to volunteers, but all medical officers, nurses, orderlies and soldiers in good health are strongly advised to take it. The vaccine consists of 10,000 million of each of the three types I, II and III of the pneumococcus. The dead organisms are suspended in cottonseed oil, making thus a lipovaccine. One dose is administered. The advantage claimed for oil over saline is that the vaccine is more slowly absorbed and hence the period of "negative phase," with lowered resistance, is avoided. Our experience at this camp substantiates this claim. All reactions have been light.

Observations following the use of this vaccine at Camp Upton indicate not only successful immunization against pneumococci of Types I, II and III, but also a very low incidence of streptococcus cases among the vaccinated. The vaccine is given subcutaneously.

Pneumonia is the most serious complication, and if this can be avoided, influenza will be robbed of most of its terrors.

#### PATHOLOGY AND BACTERIOLOGY

The pathology of the cases of influenzal pneumonia coming to necropsy at Camp Dix have presented very diverse pictures. In the cases that we have seen at

necropsy the lesions were confined for the most part to the chest cavity. This is especially true of the cases which ran a rapidly fatal course. In the latter, the greater part of the visible pathologic changes consisted of very much congested and hemorrhagic, water-logged lungs. Some of the patients who had been in the hospital two weeks or longer presented a pathologic picture more or less like those bronchopneumonia patients coming to necropsy here last spring and those described by MacCallum for the pneumonia epidemic at Fort Sam Houston, Texas, during the winter of 1917-1918. Between these two extremes there have been many intermediate stages.

A notable feature of the cases in which death occurred early in the disease has been the extreme water-logged appearance of the lungs—lungs that are more or less completely filled and distended with a watery, bloody and frothy fluid, with petechial and larger hemorrhagic areas in the pleura. The right lung in one of our cases weighed just short of  $4\frac{1}{2}$  pounds and was absolutely devoid of air except for a small area at the apex of the upper lobe and small areas here and there along the anterior margin. The latter areas appeared to contain air under pressure. The remainder of the lung was tightly filled with fluid, was soft at all points, and did not contain any nodules or firmly consolidated areas. When the lung was held up, large quantities of fluid ran out. A slice cut from the lung lost about half its weight in fluid squeezed out by pressure with the hand. From this lung there was grown a nonhemolytic streptococcus and the influenza bacillus. Pronounced inflammation of the trachea and bronchi was noted in all cases in which death occurred early in the disease.

While only one case of well marked empyema has come to necropsy, several showed evidence of beginning empyema.

The heart showed nothing beyond dilatation of the right ventricle in the more acute cases. Early pericarditis has been seen in cases of longer duration.

The spleen as a rule showed no evident change.

The liver has weighed on the average approximately 2,000 gm. and has been more or less congested and yellowish.

The kidneys have shown a markedly congested and yellowish cortex.

The intestinal tract has shown in the majority of cases only slight congestion, and petechial hemorrhages in the gastric mucosa.

Blood examination in more than 700 cases has revealed in most instances an absence of leukocytosis in the more severe cases and during the acute stage of those running a more favorable course. The average has been about 5,000 white cells per cubic millimeter during the acute stage. The lowest recorded was 1,200.

The lymphocytes experienced a relative percentage increase. The red cell count has as a rule shown no decrease and frequently a high count during the acute stage. After two or three weeks in the hospital the picture changes in most of the serious cases. The red cell count decreases, sometimes to 1,600,000, and a leukocytosis develops ranging from 12,000 to 30,000 white cells, with polymorphonuclear leukocytes running as high as 95 per cent. So far as we have seen, the hemoglobin varies directly with the red cell count.

The urine in practically all seriously ill patients has shown a liberal amount of albumin with frequent casts.

#### BACTERIOLOGY

A large variety of organisms has been encountered in cultures and smears from the lung substance, from the bronchial mucous membrane and from the sputum. Streptococci and pneumococci have been most frequently found. The influenza bacillus (Pfeiffer's) has been encountered in sputum, bronchi and lungs, but we have made no particular effort to study it or to determine its frequency. It has, however, been encountered in the majority of cases when looked for. It has been recovered from the lung substance, from the bronchi, from the trachea and from the sputum, but in none of our large series (over 300) of blood cultures.

It is worthy of note that *Bacillus influenzae* has in no single instance been the sole invading organism. It has occurred, as stated, in the sputum and in secretions taken directly from the trachea and bronchi and from the lung, but it has never been in pure culture. It has been always associated with one or more pathogenic organisms. We have found it associated with *Micrococcus catharrhalis*, with the pneumococcus of various types, with *Streptococcus hemolyticus* or *viridans*, with pneumococci and streptococci, and in one or more of these combinations plus various other undetermined organisms. Of the latter class there have been observed; spirilla, gram-negative cocci and bacilli and frequently a pleomorphic gram-positive coccus. It would thus appear that, whatever rôle *Bacillus influenzae* plays in the present epidemic, it does not invade the blood and in all probability cannot solely be responsible for the fatal termination.

The sputum in more than 500 cases has been examined as to organisms and subjected to test for pneumococcus type by the white mouse necropsy method. The organisms mentioned above have been recovered, namely, pneumococci of various types, *Streptococcus viridans* and *hemolyticus*, *Micrococcus catharrhalis*, *Bacillus influenzae*, a gram-positive pleomorphic coccus, and gram-negative bacilli and cocci in the associations already noted. During the early phase of the epidemic when the pneumococcus was encountered, it as a rule failed to give any type reaction by either the precipitin or the agglutinin test. More recently Type III and to a less extent Type II pneumococci became more and more frequent.

Three hundred and fifty urines and 120 spinal fluids from seriously ill patients were subjected to the precipitin test. The results are comparable to those from the sputum examination, Types III and II became more frequent during the later phase of the epidemic. It would thus appear that neither pathologically nor bacteriologically are we dealing with a definite disease. There is a variety of conditions found at necropsy and a multiplicity of organisms in the various cases. The epidemic has, however, shown phases, the later of which tend to resemble the bronchopneumonia of streptococcus and pneumococcus origin.

#### CONCLUSIONS

We are of the opinion that the infection begins in the upper respiratory tract and is characterized by an intense exudative inflammation. A tracheitis and intense general bronchitis follow. The exudate in the severe cases is so thin and voluminous that neither coughing nor the ciliated epithelia suffice to throw it off. The lungs soon become water-logged. This exudate carries with it into the lungs the organisms ordinarily found in the nose, nasopharynx and throat,

namely, streptococcus, Type IV pneumococcus, *M. catarrhalis*, Pfeiffer's bacillus, etc. A confluent lobular pneumonia ensues, caused by one or more of these organisms. In other words, we consider this a type of aspiration pneumonia.

However, it is by no means certain that *Bacillus influenzae* of Pfeiffer is the original infecting organism. We have not found it in pure culture in any of our cases examined postmortem. The disease may eventually be shown to be caused by some filterable virus or ultramicroscopic organism.

## LOBAR PNEUMONIA AT A BASE HOSPITAL

### LABORATORY AND CLINICAL STUDY OF FIFTY CASES \*

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Early in March, 1918, it was suggested by one of us (L. S. M.) that a more careful study be made on the lobar pneumonia cases that appeared at this camp. The chief of the medical service was therefore requested to continue Lieutenant Schiff on duty as ward surgeon in charge of the pneumonia wards. It was felt that a comparative study of the cases clinically could best be made if the same man were continued on duty.

This article is a report on two series of cases. In the first, thirty cases were followed up in a routine way. Polyvalent antipneumococcus serum was administered in each case without regard to the outcome of the type determination. The second series is a study of twenty cases in which more complete laboratory methods were done, such as blood cultures, daily leukocyte counts, type determination, and the use therapeutically of Type I serum only in those cases that were found to be due to the Type I pneumococcus.

TABLE 1.—FREQUENCY OF POSITIVE BLOOD CULTURES IN  
PNEUMONIA AND ITS PROGNOSTIC SIGNIFICANCE  
(SECOND SERIES)

Type	No.	Cases Examined Per Cent.	Blood Cultures		Mortality in Cases with	
			Positive No. Per Cent.	Negative No. Per Cent.	Positive Blood Cul. No. Per Cent.	Negative Blood Cul. No. Per Cent.
I	3	15	1	33	2	66
II	9	45	4	44	5	56
III	—	—	—	—	—	—
IV	8	40	3	38	5	63

### PNEUMOCOCCUS SEPTICEMIA AND ITS PROGNOSTIC SIGNIFICANCE

The incidence of positive blood cultures in lobar pneumonia has been variously stated as ranging from 20 to 50 per cent. The findings at the Rockefeller Institute<sup>1</sup> were 30 per cent. Our findings, as will be seen in Table 1, are 40 per cent., thus distributed: Type I, 33 per cent.; Type II, 44 per cent., and Type IV, 38 per cent. The two deaths that occurred were both among those with the positive blood findings, one in Type II and the other in Type IV. The mortality

of those with positive blood findings according to this table is 20 per cent., as compared with no mortality in the negative cases.

The technic followed was to obtain about 20 c.c. of blood from a vein at the elbow under aseptic precautions; plant 10 c.c. of the blood in a bottle containing 80 c.c. of meat infusion broth, and from 2 to 3 c.c. in each of a tube containing plain agar melted and brought down to 45 C., and plated. The cultures were kept under observation for from five to seven days and examined daily before a definite negative report was made. The typing was done mostly by Avery's cultural method. Both the agglutination and precipitin

TABLE 2.—COMPLICATIONS AND MORTALITY \*

Type	No. Cases		Empyema		Otitis		Died		Recovered	
	1st	2d	1st	2d	1st	2d	1st	2d	1st	2d
	Series	Series	Series	Series	Series	Series	Series	Series	Series	Series
I.....	3	3	0	1	0	0	0	0	3	3
II.....	4	9	0	2	0	3	0	1	4	8
III.....	0	0	0	0	0	0	0	0	0	0
IV.....	11	8	0	1	1	0	0	1	11	7
Undeter- mined...	12	0	0	0	0	0	0	0	12	0

\* Comparison between Series 1, cases treated at random with polyvalent serum, and Series 2, those treated with Type I serum only when found due to Type I pneumococcus infection.

tests (the routine method was the agglutination test) were done in a number of cases. The mouse method was not used, owing to the impossibility of obtaining white mice.

The pneumococcus obtained from the blood was in all cases found to correspond to the type obtained in the sputum.

The blood cultures were taken from two to nine days following the first initial symptoms, and in most cases from two to five days prior to the occurrence of the crisis.

It is significant that in the fifty cases here reported there was not a single case of Type III. It would be of interest to know whether the infection with this type of pneumococcus was as rare in other camps. In the thirty-one cases of lobar pneumonia reported by Cole and MacCallum<sup>2</sup> at Fort Sam Houston, Texas, they found only one case with Type III, or 3 per cent., as against 13 per cent. at the Rockefeller Institute.<sup>1</sup>

In a recent article by A. A. Small<sup>3</sup> in a report on the pneumonia cases at Camp Pike, the type determination findings were: Type I, 21 per cent.; Type II, 34 per cent.; Type IV, 45 per cent.—no Type III in the whole series. Our findings of those fifty cases that were typed were: Type I, 16 per cent.; Type II, 34 per cent.; Type IV, 50 per cent.—none of Type III in this series.

### COMPARISON OF COMPLICATIONS AND MORTALITY BETWEEN THE TWO SERIES

In comparing the complications and mortality between the two series in Table 2, one cannot help but recognize the marked difference between them. One would expect the course of the disease to be much more severe and the mortality much higher in the first series of the thirty cases, which extended through the months of January, February and March, the coldest months of the year, as compared with the second series of cases, which extended through the last week of March, April and May, the wards and general treatment being the same and carried out by the same ward surgeon.

\*From the Clinical and Pathological Laboratory, Base Hospital, Camp MacArthur, Waco, Texas.

1. Avery, Chickering, Cole and Dochez; Monographs of the Rockefeller Institute for Medical Research, No. 7, Oct. 16, 1917.

2. Cole, Rufus, and MacCallum, W. G.: Pneumonia at a Base Hospital, THE JOURNAL A. M. A., April 20, 1918, pp. 1146-1156.

3. Small, A. A.: Pneumonia at a Base Hospital, THE JOURNAL A. M. A., Aug. 31, 1918, pp. 700-702.