

INFLUENZA AND BRONCHOPNEUMONIA

A STUDY OF THE EPIDEMIC FROM A ROENTGENOLOGICAL POINT OF VIEW

BY MAJ. J. A. HONEIJ

U. S. Army General Hospital No. 16

NEW HAVEN, CONN.

THE opportunity to study influenza from a roentgenological point of view has been exceptional. The conditions under which the study was undertaken were most favorable on account of the interest of the Commanding Officer, the cooperation of the Staff and Ward Surgeons, the absolute control of the patients, the close relations with the Pathological and Bacteriological Department, and the reliability of the staff of the X-Ray Department.

Introduction.—This study was undertaken in a modern hospital thoroughly equipped with a really practical system for taking care of patients and their records. The roentgenological examination of the patients was possible because of a U. S. Army bedside roentgen ray apparatus which enabled the Department, as a matter of routine, to examine the patients with very little disturbance, from the beginning of the attack until recovery or until the patient succumbed to complications. The very earliest cases were roentgenographed in the Department in the upright position and later in bed in the prone and upright positions. Those cases that had a final examination were, of course, taken after the patient had been returned to duty, and were taken in the Department in the upright position again. This study therefore covers a number of cases from the earliest onset of influenza to the full development of the disease and the later period from the time when the patient developed a bronchopneumonia to recovery or to autopsy, every case coming to autopsy having a post-mortem roentgenological examination. Consequently the

three types of pulmonary changes to be studied are those produced by influenza, bronchitis, pneumonia and other associated processes. As this institution is primarily for tuberculosis cases, the after effects of influenza and pneumonia on the tuberculous processes had to be borne in mind.

Review of the Literature.—As far as could be determined, this shows no reference to a study having been made of the epidemic from a roentgenological standpoint. A clinical and pathological study of previous epidemics, last spring and early fall of this year, in military camps in the United States and at naval hospitals abroad gives evidence of considerable value for the present study. I should especially like to call attention to the abstracts of foreign literature on influenza compiled by the British Medical Research Committee concerning the pathology of the disease. It was found that the same short period of incubation, the rapid and sudden onset and the general trend of symptoms were the same. It was found that it was a common occurrence to have a remission the second or third day; that after this a coryza occurred with bronchial cough; that approximately one week later the patient became normal; also that bronchopneumonias developed most frequently after the second remission. The occurrence of bronchopneumonia in these epidemics was approximately 5 to 10 per cent with a mortality of approximately 60 to 70 per cent. Empyema or purulent processes occurred very seldom, but in the terminal stages of the disease a sero-fibrinous effusion into the pleural cavity, which was

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usually unilateral and most often on the right, occurred quite frequently.

What is of specific interest to this particular study is that clinically the process of bronchopneumonia appeared as a continuation of the bronchitis which was present in a large percentage of cases, and that in cases of progressive or extensive involvement, the patient rarely recovered.

Consolidation occurred most often in the right lower lobe just medial to the inferior angle of the scapula, next affecting the left lower lobe, then the right upper and middle lobes, and finally the left upper lobe.

MacCullum, reporting on the pathology of the epidemic *Streptococcal Bronchopneumonia in the Army Camps*, gives a very clear description of these processes. This must be thoroughly understood to appreciate the changes brought about as seen on a roentgenogram. He states that the most characteristic lesions appeared; that at necropsy there was found most intense congestion of the whole respiratory tract; a nodular consolidation could be felt throughout but especially in the posterior parts of the lungs. On section the bronchi contained a gray purulent exudate. They were markedly dilated toward the periphery. The mucosa was a deep, purplish gray. All showed thickening of the walls and the terminal bronchioles were especially thickened so that with the adjacent alveoli they projected in cross section in the form of small firm nodules. Such dense peribronchial nodules were nearly always surrounded by hemorrhage. Often in these very fresh cases there were occasionally small areas of more homogeneous consolidation. Microscopically the lumen was found to be filled with an inflammatory exudate of leucocytes, blood and bacteria and in the infiltration and thickening of the walls of the bronchioles were mononuclear wandering cells. Great hyperemia and edema of the bronchial walls was seen accompanied by a less evident new formation of connective tissue cells. The adjacent alveoli, so

far as they were not filled with red blood corpuscles, were compacted with mononuclear cells and dense fibrin. The alveolar walls were infiltrated with mononuclear cells and were widened.

Keegen, reporting on the prevailing pandemic of influenza, states that on autopsy these cases showed a massive bronchopneumonia simulating lobar pneumonia, from which a large quantity of blood exudated from the cut surfaces. He also states that the heart in only one case out of thirty-five was acutely dilated.

The British Committee abstract states that: "In the initial stage of the affection of the lungs, namely, when only small foci without any great reaction in the immediate neighborhood were observed, the most striking findings were small, bean-sized hemorrhages projecting into the lung tissue. As a next step there followed a firmer infiltration of the parenchyma, the nodules sitting subpleurally and raising the pleura in consequence. A whole scale of intermediate formations lay between these small nodules and large hemorrhagic tuberos infiltrations; all possible gradations were observed from simple blood extravasations into the lung tissue, still containing air, to firm, almost dry, infarct-like hemorrhages of a bluish-black tinge. These extensive infiltrations were of the same shape as the usual pulmonary hemorrhagic infarcts, namely, they had the form of a wedge with its base resting on the pleura, thus clearly indicating an intimate relationship with the vascular system of the lungs.

"The second stage was characterized by exudative pneumonic processes combined with hemorrhages. There may be a true croupous hepatization of lobular, or even lobar, extent, both red and gray. These pneumonic infiltrations usually embraced in their center circumscribed hemorrhages.

"The bronchi were filled with pus already in the first stage, the smaller branches containing thin fluid, though at times dried-up exudates formed firm plugs occluding the lumen of the bronchioles.

"The pleura participated in the process. The first signs consisted in punctiform hemorrhages, or ecchymoses; serous exudations followed next, and, as often as not, empyemas completed the picture. As a rule, one side only was affected. Pericarditis was a natural consequence of pleuritis. There were no gross changes in the heart save for some thickening of the arteries of the lung hilum.

"The larynx and the upper third of the trachea showed no involvement in the process. The lower portion, however, was the seat of an intense mucopurulent exudation, which in many cases assumed a fibrinous character, with the consequent formation of extensive pseudomembranes in the lower trachea and down into the bronchi. Sometimes edema of the epiglottis was observed. Marked lymphatic changes were also observed with enlargement of the cervical and axillary glands.

"The foci of inflammation in the lungs showed a leukocytic infiltration around the alveoli, bronchi, and the walls of small arteries. It did not involve the whole vessels, which were dotted with isolated spots of infiltration. There were also hemorrhages into the heart valves, with a consequent displacement of the fibers and damage to the endothelium; thus no definite endocarditis, but lesions, which facilitated the development of a secondary mycotic endocarditis."

It is evident from the review of the literature that limited information from a pathological point of view was obtained as to the direct results on the parenchyma tissue due to influenza alone. The changes usually described invariably mean changes seen in bronchitis with development of a broncho- or lobar pneumonia and after results. Although the study of clinical and pathological reports of past epidemics is interesting, there appears to be a distinct difference as compared with the last epidemic and these differences as they affect the roentgenological diagnosis will be pointed out later.

As far as the causative factors are con-

cerned, there apparently is still discussion; but in this investigation it is assumed that the bronchopneumonias were due to the pneumococcus and the changes expected would be no different from bronchopneumonias seen roentgenologically under ordinary conditions.

The Present Problem.—It became apparent that roentgenological examination would only be of value in the very earliest cases of beginning bronchopneumonia and also in determining the extension of the process from one lung to the other or from one lobe to another. The study, therefore, was undertaken with these points in view, namely: (1) What the appearance of influenza was; what changes were brought about, whether consistent, and how these changes progressed; as well as what the associated changes were in adjacent tissues or organs. (2) How early, if possible, could a bronchopneumonia be detected; what its progress was; what part of the lung was most actively affected; associated tissue changes, cardiac changes, diaphragm changes; and whether progressive improvement was noticed in the lung not affected by a pneumonic process but previously affected by influenza. (3) Whether the marked bronchial changes noted due to influenza would determine the type of pneumonia, that is, whether the bronchial changes would be sufficiently early to show when the bronchioles became affected and whether these changes would determine the changes characteristic of a broncho- or a lobar pneumonia.

Class of Cases Studied.—This consisted of corps men, patients, and staff. From September 24 to November 4, 260 cases of influenza occurred. Of these 118 were corps men, 37 Students' Army Training Corps men, 67 patients, 17 nurses, 13 medical officers and 8 miscellaneous. Of these 260 cases, 91 cases were studied roentgenologically. In the 260 cases there occurred 66 cases of pneumonia. Of these 91 cases, there were 52 cases of bronchopneumonia and 4 cases of probable bronchopneumonia. These occurred among the

following classes: Of the 55 corps men, 36 had bronchopneumonia; 2 had probable bronchopneumonia; one had probable lobar pneumonia; and the remaining 16 had influenza and congestion.

Of the 8 nurses studied, 6 developed bronchopneumonia; 2 recovered as influenza and congestion.

Eleven medical officers were examined and of these, 2 developed bronchopneumonia; 2 had questionable bronchopneumonia; 1 had a probable lobar pneumonia; 6 had congestion and influenza.

Of the 15 tuberculous patients, 7 had bronchopneumonia; 3 had pneumonia (type undetermined) and one had a probable bronchopneumonia; 4 continued as influenza with congestion.

The cases studied depended largely on the clinical signs and symptoms presented whether suitable for serial roentgenological study, questionable clinical diagnosis, or whether atypical in type. It will be seen from these numbers that 28 cases of influenza and congestion were studied. The rest actually became cases for the study of pneumonic processes. The examinations varied in number from one to ten. In the case of influenzas and congestions, these examinations often were taken every day while the bronchial changes progressed, until the patient recovered, or until a pneumonic process developed, examination being less frequent after a definite diagnosis of the process was made. In the case of a pneumonia being diagnosed on first examination, repeated examinations were then made to determine the progress of the disease until the final stage had been reached. In only one case did an empyema develop. Several cases developed fluid in the chest, probably of pleural origin, and most rapidly in the serious cases that finally came to autopsy.

A full report was made each day after original description of the roentgenogram, and the clinical evidence was carefully considered and discussed so that both the medical officer, staff and student officers

and department staff could get the most value from these discussions. Very ideal conditions, therefore, prevailed for the study of influenza and its complications and there was extremely close cooperation between the clinical and roentgenological staff.

Influenza — Roentgenographic Appearance.—On examination of the roentgenograms there is seen to be a general increase of density throughout the lungs. This density may be described as being of a hazy or smoky nature which decreases the contrast between the normal lung transparency and the bronchial tree outline. This generalized density is somewhat greater from apex to the base, inner half, and especially adjacent to the mediastinal border, thus obscuring to some extent the mediastinum and cardiac outline. The most marked changes are seen in the bronchial structures themselves. A greater number of vessels are seen than is usual in any other disease. They are more definite although diffuse in outline. This peribronchial thickening, however, is seen most markedly around the hilus, extending outward in "sunburst" type and rapidly diminishing in size from the hilus to about the outer one-third of the lung. The peribronchial thickening extends upward parallel to the mediastinum and helps to obscure the mediastinal outline. The greatest thickening and greatest diffuse bronchial density is seen at the base, extending downward from the hilus, reaching the diaphragm outline and extending to just beyond the mid-clavicular line. This is more marked on the right than on the left, largely because the left is obscured by the heart, but probably also because the larger number of cases of marked bronchitis or bronchopneumonia occurred at the right base, and partly because of the anatomical difference between the right and left bronchial structures. The diffuse density of the bronchial outline, although becoming most marked in some cases, never showed a "pussy-willow" effect unless a bronchopneumonia was develop-

ing. The distribution of the bronchi could be fairly well traced out but the difference between the bronchi and parenchyma is most often diminished.

In cases where influenza progressed as influenza towards recovery there is a gradual diminution, first, in the hazy generalized density and then in the diffuse density of the bronchial structure. The density around the hilus, due partly to peribronchial thickening, remains considerably longer. The hilus becomes affected very early. There are an immediate enlargement of the hilus and a marked increase of density with irregular outline, so much so that in no case is there any question of the reaction of the hilus. The irregular outline is due to peribronchial thickening.

In a few cases there is definite enlargement of glands at the same time in the hilus region.

The mediastinum in some cases is somewhat increased in width and, as previously described, the outline is shown to be increased in density.

The diaphragm is, if anything, more dome-shaped; that is, the convexity is increased and the cardio-diaphragmatic angles become more acute. Also there is some obliteration of the costo-diaphragmatic sinuses.

The heart shows a slight dilatation of the right auricle and, to a less extent, a slight dilatation of the pulmonic area. The heart as a whole is not enlarged.

The appearances as described are typical and consistent—so much so that a diagnosis of influenza and congestion could be made in almost every case, and a diagnosis of influenza and congestion was made in several cases before there were any clinical signs to warrant such a diagnosis; and in two cases of tuberculosis a diagnosis of influenza and congestion was made a week after onset of the disease and when tuberculosis was the only clinical diagnosis. In a few cases the changes were very light and these invariably were cases that led to a speedy recovery. Unilateral congestion

was seen in a few cases and these invariably recovered within a few days. In one case, an influenza suspect, a diagnosis of bronchitis was made and later clinically verified; and in another, a diagnosis of transitory congestion was made and within forty-eight hours verified. This proved to be a case of serum reaction. These cases are quoted to emphasize the specific value of the roentgenological changes in influenza.

The appearances, therefore, of the lungs and bronchi show a very early and marked congestion of the parenchyma and bronchial tissues. It is an active congestion as the bases in none of the cases show a greater congestion than the middle or upper portions. It also shows that the lower bronchial structures and the bronchi of large diameter are earlier and more markedly affected than the smaller and terminal branches. It shows also a marked lymphatic and glandular congestion and reaction as demonstrated by changes in the hilus area and a diminution in pulmonary function as evidenced by the height and shape of the diaphragm. The cardiac changes also bear out the early congestion of the lungs. The changes in the bronchi in early bronchopneumonias will be taken up under the study of bronchopneumonias.

Bronchopneumonia, the Appearance of.—As previously stated, there were 91 cases of influenza, and of this number 52 were cases of bronchopneumonia and 4 cases of probable bronchopneumonia. Of the 4 probable bronchopneumonias, 2 resembled true lobar pneumonia. In the most typical cases, those developing gradually, the first changes seen, after those described under influenza, are apparently bronchial in nature. There is a greater irregular diffuse peribronchial thickening so that the individual outline of the bronchi can be made out with difficulty. Then there occur small, more or less localized areas, most visible in the middle of the lung, 6 to 8 cm. distant from the hilus, but in very early cases occurring nearer

the hilus and most often in the lower part of the lung. These localized areas superimposed and adjacent to the bronchial outline resemble somewhat the "pussy-willow" stage in the budding of the willow branch seen in spring.

The next distinct stage is a spreading out of these areas to a confluent, more or less localized area, varying in size from approximately 3 to 6 cm. in diameter. If this occurs in the full pulmonary field, the localized congestion appears light and hazy, not unlike a "powder-puff" in appearance, with an irregular, soft, diffuse outline. In a few cases resolution begins in this stage; but in the majority of cases the process progresses, the density increasing and detailed structures becoming obscured. The bronchial outline is no longer visible and pulmonary changes become more extensive and definite. In short, a pseudo-lobar pneumonic appearance is seen. If this occurs at the base, the heart and diaphragm outlines are obscured, the sinuses are obliterated and the density from apex to base becomes gradually greater. It frequently occurs that, after one portion of the lung has become consolidated and the process progresses, the next earliest changes are seen on the opposite side, extending outward from the hilus after primary hilus changes, in the same manner as previously described. Associated with the early bronchial changes there are marked changes in the hilus on the side where these bronchial and pulmonary changes begin. The hilus becomes more dense and more definite in outline, as well as increasing in size. In comparison there is a distinct difference in the hilus on the opposite side, if the process involves that lung. When the process becomes extensive, the hilus outline becomes obliterated.

Progressive changes in the lungs in advanced cases are of less interest. As consolidation increases, the density naturally also increases and the outlines and details of structure disappear.

In the marked changes of bilateral pneumonias where the greater portion of both lungs is affected, the bases become so dense that a differential diagnosis between an extensive edema, pleural effusion and pneumonia, as such, cannot be made.

Two associated changes occur very early in the onset of pneumonia which are of great interest and importance. Invariably as early as the changes occur in the hilus there is seen in the heart a marked and acute dilatation of the right auricle and also dilatation of the pulmonic area. In a number of cases dilatation of the aorta also occurred. In a few cases in the later stages, dilatation of the left ventricle was also seen. Reference to the tables will show the number and type of cases in which these changes were observed.

The second associated change has to do with the position and shape of the diaphragm. In the majority of cases the diaphragm on the side affected becomes more dome-shaped and its position is from one to two interspaces higher than normal. This was so marked and occurred so frequently that emphasis was made of this in the diagnosis of cases. In massive types of pneumonia the diaphragm was often lower than usual.

The changes described therefore show the bronchial congestion first with associated hilus changes; then localized congestion of the bronchioles; and lastly the congestion of the true parenchyma. The early dilatation of the heart accentuates the acute and rapid congestion of the lungs and the marked changes in the diaphragm also indicate the early impairment of respiratory function on the side affected. In a few difficult cases there was some difficulty in differentiating true bronchopneumonias from the lobar type and it was only possible to make a differential diagnosis after resolution began, as it is well known resolution in lobar pneumonias begins near the hilus and retrogresses towards the periphery, whereas in bronchopneumonias this is reversed.

What is of special significance and of aid to the clinician is the verification of



CASE 512. First Examination.

suspected bronchopneumonias based on very slight changes in breathing over localized areas with occasional râles. In a number of cases roentgenological examination showed areas of congestion as described before clinical evidence was presented. The consistency of the changes stated

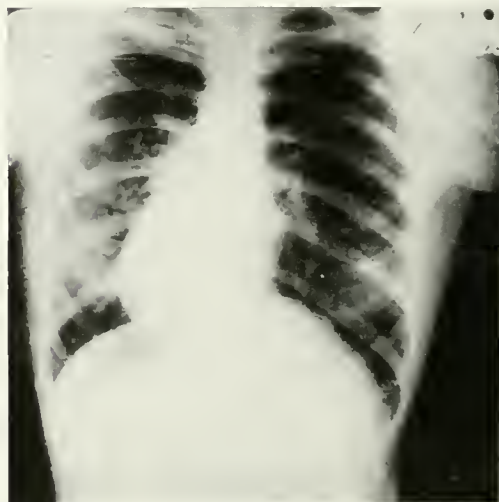
become also of considerable prognostic value. It is found that if these small diffuse areas of congestion occur widely distributed around the hilus of a more irregular and faint type, these cases invariably progress to massive types of pneumonia rapidly and more intensively.

It is equally true in cases where the bronchial changes are less evident and the parenchyma changes greater. The prognostic value of the changes in the lung and hilus as well as in the diaphragm are also seen during resolution. The return to normal of the right auricle and the pulmonic area after dilatation seen during the acute pulmonary changes is exceedingly slow. It was of extreme interest to consult the clinician as to the changes found from day to day and to determine the accuracy of the physical signs with the consistency of the changes as shown by the roentgenogram. The consistency of these changes and their frequency can be seen by referring to the tables.

Lobar Pneumonia.—In the four cases presented in which a diagnosis of bronchopneumonia could not be made, a definite lobar type of density occurred, more or less demarcated, localized to a lobe, limited by the interlobar fissure, and with the greatest density occurring at the



CASE 512. Second Examination.



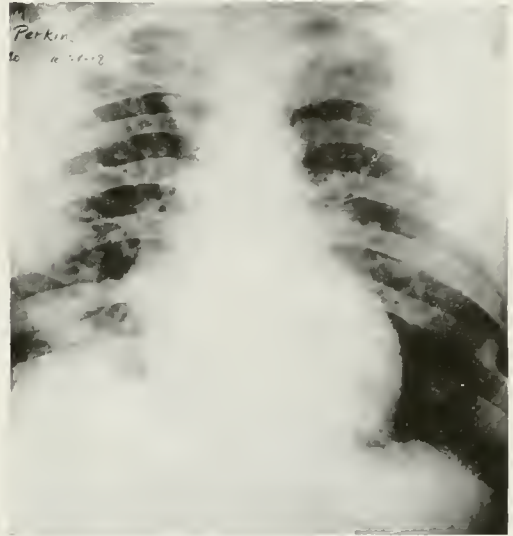
CASE 512. Third Examination.

periphery and gradually less toward the hilus. In two of these cases the diagnosis of bronchopneumonia was made only after resolution had begun. In the remaining

parenchyma changes and before these small areas of density become confluent and the congestion so great as to simulate a lobar pneumonia.



CASE 540. First Examination.

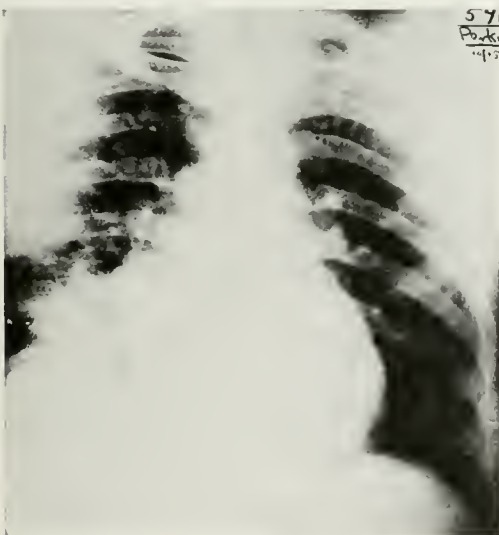


CASE 540, Second Examination.

two cases the diagnosis of lobar pneumonia stood.

It is well to point out here the importance of an early roentgenological examination to determine the type of pneumonia, that is, to determine the bronchial changes before

Pleural Changes.—In a few cases a pleural reaction was demonstrable. This can, of course, only be demonstrated in the interlobar fissure where any congestion or thickening of the pleural surfaces can be detected, and it is largely due to the fact



CASE 540. Third Examination.



CASE 540. Fourth Examination.

that the position of the interlobar fissure gives depth to the pleura, and depth with congestion is necessary to give a shadow on the roentgenogram.

pneumothorax without adhesions became affected with influenza and was examined roentgenologically. This was a case in which a previous roentgenogram had been made



CASE 540. Fifth Examination.



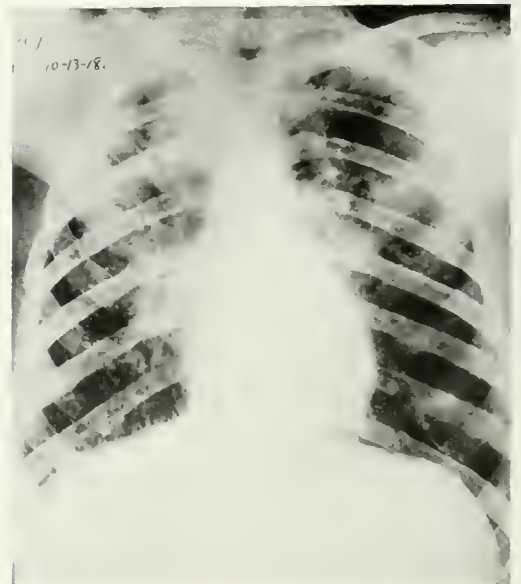
CASE 540. Sixth Examination.

An unusual opportunity was presented, however, to demonstrate the early congestion of the pleura in influenza. A case of tuberculosis with a complete unilateral

before the attack of influenza so that a comparison between the roentgenograms could be made. There was a marked congestion of the pleura throughout, which on con-



CASE 430. First Examination.



CASE 489. First Examination.

secutive examinations grew greater and then gradually receded. This was associated with a congestion of the opposite lung and acted as a control in the study of the pleural congestion. Reference to the autopsy findings in the later part of this report will show how frequently pleural affections occurred.

Sequelæ.—Under this heading two conditions may be considered, mediastinal

fifty per cent of all cases examined. The second condition is the possibility of tuberculosis occurring after the disappearance of acute pulmonary processes.

Tuberculosis with Influenza and Bronchopneumonia.—At the outset a diagnosis of influenza or bronchopneumonia is extremely difficult to make unless the tuberculous lesion is an apical one and not of recent activity. In cases of fairly advanced



CASE 362. First Examination.



CASE 436. First Examination.

and pulmonary changes. It has been pointed out in the preceding pages what marked changes occur in the hilus and mediastinum and from the pathological abstracts quoted the changes in lymphatic tissue and glands have been significant. From observation of the cases recovering, the attention of the medical staff was called to the slow improvement and gradual changes in the lungs, and the persistency of the congestion of hilus and mediastinum. A suggestion was made, therefore, to the clinician that the presence of d'Espine's sign would be an indication of this condition and a sign of some prognostic value. This suggestion has been followed and although a complete report cannot now be made, d'Espine's sign has been found to be present in approximately

tuberculosis or tuberculosis showing active processes with congestion the interpretation of a roentgenogram to differentiate these lesions from those produced by influenza or bronchopneumonia is well-nigh impossible. In the cases of tuberculosis that had roentgenograms previous to the attack of influenza a comparison, of course, can be made and in the majority of cases a diagnosis of a more acute condition is possible. In all the cases developing into a lobar form of bronchopneumonia a definite diagnosis can be made. In the cases which have led to recovery there have been observed differences in density and structural changes at the site of old tuberculous lesions, mainly apical, which suggest a field of work which will be of considerable value.

From the evidence already obtained concerning pulmonary apical changes, two conclusions may be drawn—either that there is renewed activity of an old tuberculous process due to the superadded acute infection; or that a congestion exists at the site of a tuberculous lesion which is more permanent in character than the influenza congestion and which may lead to active tuberculosis in case the patient is not placed under observation and care. A study of these cases and those coming to autopsy will be made later. It has been likewise difficult to determine the effect of the acute process on the hilus and diaphragm, as part of these changes may possibly be due to the tuberculous process. Dilatation of the right auricle and pulmonic area, however, was noted in all the cases.

Postmortem Findings.—Of the 11 cases that came to autopsy, 3 occurred among patients and 8 among corps men. The 3 tuberculosis cases developed bronchopneumonia. All three cases had postmortem examinations and the diagnosis of bronchopneumonia verified. Marked pleuritis and acute bronchitis occurred in all three. There was edema of the lungs in two cases. There was acute dilatation of the heart in two cases.

Of the 8 cases occurring among the corps men, 7 had post-mortem examination. In all eight a diagnosis of bronchopneumonia had been made and this diagnosis verified by autopsy. In 6 cases acute bronchitis was found and in 3 acute dilatation of the heart, and in 7 edema of the lungs or pleural effusion was found.

The condition of the lungs and bronchi found on roentgenological examination corresponds closely to the findings of MacCullum and Keegan and others. The protocols of the autopsies made here have omitted the position of the diaphragm, but in the majority of cases the extreme height of the position of the diaphragm was verified. The marked edema or pleural fluid corresponds to the roentgenographic density at the bases of the lungs. The extent of the pneumonic processes varies but slightly.

The large amount of bronchial exudate and thickening of the bronchial walls correspond well with the roentgenographic description given in the study of influenza. Dilatation of the right auricle was very perceptible on opening the thoracic cavity and this is a distinct point of difference from previous postmortem findings but it bears out the roentgenological findings. The pleural reaction as already described was evidenced by the amount of pleural secretion and pleural fibrin organization



CASE 473. First Examination.

especially between the lobes, although not nearly as marked as occurred in the previous bronchopneumonic epidemic seen. The enlargement of glands was found in one of the ten autopsies. In short, autopsy findings verify the conditions in detail as described by roentgenological examination.

Clinical and X-ray Diagnosis Compared with Final Diagnosis.—(Includes all groups.)

- | | |
|--|----|
| 1. Clinical diagnosis bronchopneumonia, with x-ray diagnosis agreeing and confirmed by final diagnosis | 16 |
| 2. Clinical diagnosis influenza, with x-ray diagnosis agreeing and confirmed by final diagnosis | 18 |
| 3. Clinical diagnosis lobar pneumonia, with x-ray diagnosis agreeing and confirmed by final diagnosis: | |
| Clinical diag.—Lobar pneumonia. | |
| X-ray diag.—Lobar pneumonia and fluid | |
| Final diag.—Lobar pneumonia and fluid | 1 |

4. Clinical diagnosis bronchopneumonia; x-ray diagnosis influenza, confirmed by final diagnosis	3
5. Clinical diagnosis influenza; x-ray diagnosis bronchopneumonia, confirmed by final diagnosis	15
6. Clinical diagnosis influenza; x-ray diagnosis lobar pneumonia, confirmed by final diagnosis	1
7. Clinical diagnosis not determined; x-ray diagnosis congestion, bronchitis; final diagnosis congestion, influenza	1
8. Clinical diagnosis influenza confirmed by final diagnosis; x-ray diagnosis negative	1
9. Clinical diagnosis bronchopneumonia confirmed by final diagnosis; x-ray diagnosis probable lobar pneumonia	1
10. Clinical and x-ray diagnosis influenza; final diagnosis bronchopneumonia	12
11. Clinical diagnosis influenza; x-ray diagnosis probable pulmonary tuberculosis; final diagnosis congestion, influenza, tuberculosis	1
12. Clinical diagnosis influenza; x-ray diagnosis fluid; final diagnosis pneumonia (probable bronchopneumonia)	1
13. Clinical diagnosis questionable; x-ray diagnosis positive; final diagnosis positive: Clinical diag.—Questionable pneumonia X-ray diag. bronchopneumonia, confirmed by final diagnosis X-ray diag. influenza, confirmed by final diagnosis X-ray diag. influenza; final diagnosis bronchopneumonia	3 1 1 1
14. X-ray diagnosis questionable bronchopneumonia, confirmed by final diagnosis; clinical diagnosis influenza	4
15. X-ray diagnosis questionable bronchopneumonia; clinical diagnosis bronchopneumonia; final diagnosis confirming	1
16. X-ray diagnosis questionable pneumonia; clinical diagnosis influenza; final diagnosis bronchopneumonia	1
17. X-ray diagnosis questionable influenza; clinical diagnosis influenza; final diagnosis influenza	1
Total	83

Radiological Changes (includes all groups).

Lung Density.

Right	18: br. pn. 12; infl. 6
Left	18: br. pn. 15; infl. 2; lobar pn. 1
Both	33: br. pn. 27; infl. 6
— 20	
Upper only	3: br. pn. 3
Middle only	8: br. pn. 7; infl. 1
Lower only	26: br. pn. 17; infl. 9
Upper and lower	3: br. pn. 3
Upper and middle	5: br. pn. 4; infl. 1
Middle and lower	15: br. pn. 15
Upper, middle and lower	8: br. pn. 6; infl. 1, lobar 1
— 21	

Congestion.

General congestion in all but 6 cases—br. pn. 2; infl. 4. (All six cases showed local congestion)	
Local congestion in all but 17 cases—br. pn. 8; infl. 9 (All seventeen cases showed general congestion)	
Lobular. 41: br. pn. 36; infl. 5; questionable 15; br. pn. 7; infl. 6; lobar 1	
Lobar. 27: br. pn. 24; infl. 3; questionable 1; lobar bronchial. All but 13: br. pn. 9; infl. 3; questionable 1; lobar	

Hilus Density

Right	10: br. pn. 4; infl. 6
Left	1: br. pn. 1
Both	78: br. pn. 51; infl. 25; lobar 1
Middle and lower	22: br. pn. 16; infl. 6

Upper, middle, lower 66: br. pn. 40; infl. 25; lobar 1
Upper and lower 1: br. pn. 1

Enlarged in every case but 4. In these four cases only slight enlargement: br. pn. 2, infl. 2.

Congested in every case but 4. Congestion slight in these four cases: br. pn. 2, infl. 2.

Outline.

Well defined	18: br. pn. 8; infl. 10
Fair	38: br. pn. 23; infl. 14; lobar 1
Ill defined	34: br. pn. 28; infl. 6

Mediastinum.

Increased in density in every case.
Enlarged, broadened in all but three cases, where it was slightly enlarged: br. pn. 1; infl. 2

Diaphragm.

Dome-shaped in all but 14 cases. Of these 3 were slightly dome-shape: br. pn. 2; infl. 1

Dome-shape on rt. 2: br. pn. 1; infl. 1

Flat 9: br. 4; infl. 5

Flat 58: br. pn. 36; infl. 21; lobar 1.

Flat on the left only, 2: br. pn. 1; infl. 1.

Irregular 13: br. pn. 10; infl. 3.

Heart. Rt. auricle dilated in all but 23 cases, of which 2 were negative (infl. 2); 1 showed moderate enlargement (br. pn. 1); 19 showed slight enlargement (br. pn. 13; infl. 6) and 1 was questionable (br. pn. 1).

Left pulmonary area dilated in 66 cases: br. pn. 44; infl. 21; lobar 1.

Moderate dil. 2: br. pn. 2

Slight dil. 18: br. pn. 10; infl. 8

No dil. 3: br. pn. 1; infl. 2

Left ventricle dilated in 30 cases: br. pn. 25; infl. 5.

Moderate dil. 1: br. pn. 1

Slight dil. 14: br. pn. 10; infl. 4

No dil. 43: br. pn. 19; infl. 23; lobar 1

Questionable 1: infl. 1

Aorta dilated in 62 cases: br. pn. 41; infl. 20; lobar 1.

Moderate dil. 2: br. pn. 1; infl. 1

Slight dil. 17: br. pn. 9; infl. 8

No dil. 8: br. pn. 5; infl. 3

Progress of Disease Radiologically in Pneumonias and Bronchopneumonias (includes all groups).

Onset	Progress	
Both hila to both bases		9
left base		2
right base		1
both middle		3
left upper and middle and rt. lower		2
left middle		2
left middle and rt. lower		1
left middle and rt. upper		3
left lower and rt. middle		1
right base and left middle		1
right base and left middle and base		1
right middle and upper and left middle		1
No extension		1
Right hilus to base		5
middle and lower		1
middle		2
upper		2
left middle and upper		1
right upper and left middle		2
Left hilus to base		1
base and middle		3
middle, upper and lower		1
middle		4
Right base to right middle and upper		1
left hilus and middle		1
right middle and left lower		1
No extension		1

Right middle to right upper and lower	1
Right lung, base to apex to left base	1
Left lower to right lower and middle	1
Left upper and lower right and left upper, middle and lower	1
Left middle to left upper and right upper	1

Corps Men, Officers and Nurses. Physical and Radiological Signs Compared.

Average Age 32.

Clinical Signs.

Severe	8: br. pn. 5; infl. 3.
Moderate	31: br. pn. 25; infl. 5; lobar 1.
Mild	33: br. pn. 15; infl. 18.

Radiological Exam.

Marked changes	36: br. pn. 33; infl. 1; lob. 2.
Slight changes	38: br. pn. 14; infl. 24.

Clinical Changes.

Breathing, br.	17: br. pn. 15; infl. 1; lob. 1.
Bron. vasc.	13: br. pn. 19; infl. 2.
Harsh	14: br. pn. 10; infl. 3; lob. 1.
Feeble	7: br. pn. 7.
Dimin., distant	17: br. pn. 11; infl. 6.
Negative	18: br. pn. 6; infl. 12.

Râles.

Crep.	30: br. pn. 25; infl. 4; lob. 1.
Subcrep.	30: br. pn. 20; infl. 9; lob. 1.
Indetermin.	30: br. pn. 23; infl. 5; lob. 2.
All kinds	2: br. pn. 2.
Fine râles	2: br. pn. 2.
Coarse râles	1: br. pn. 1.
None	8: br. pn. 2; infl. 6.

Fremitus.

Increased	42: br. pn. 30; infl. 10; lob. 2.
Dimin., impaired	3: br. pn. 3.
Pectoriloquy	1: br. pn. 1.
Negative	28: br. pn. 14; infl. 14.

Dullness

57: br. pn. 42; infl. 13; lob. 2.
Negative 17: br. pn. 6; infl. 11.

Heart Dilated

5: br. pn. 4; infl. 1.

X-ray signs preceding clinical signs, 2 cases, 1 by 3 days; 1 by 6 days.

Corps Men, Officers and Nurses. Physical and Radiological Signs Compared.

Temperature

Lowest Point	96° 21	Highest Point	106° 1
	97° 36		105° 5
	98° 4		104° 24
Above	99° 9		103° 21
Unknown	4	Below	102° 20
		Unknown	3

Pulse

Lowest Point	42 1	Highest Point	160 2
	48 1		152 3
	50 2		136 1
	52 6		132 1
	54 2		128 2
	56 6		124 1
Above	60 to 96 50	Below	120 to 96 53

Respiration

Lowest Point	14 3	Highest Point	80 1
	16 11		64 3
	18 43		60 1
Above	20 to 26 14		58 1
			56 3
		Below	52 to 26 62

Tuberculosis Cases. Physical and Radiological Signs Compared

Average Age 25.

Clinical Signs.

Severe	3: br. pn. 3.
Moderate	7: br. pn. 4; infl. 1; lob. 2.
Mild	5: br. pn. 2; infl. 2; lob. 1.

Radiological Exam.

Marked changes	9: br. pn. 7; lob. 2.
Slight changes	6: br. pn. 2; infl. 3; lob. 1.

Clinical Changes.

Bron. breathing	3: br. pn. 3.
Bron. vasc. breathing	2: br. pn. 1; pn. 1.
Harsh breathing	2: br. pn. 2.
All kinds	1: lob. 1.

Râles.

Crepitant	4: br. pn. 3; pn. 1.
Subcrepitant	3: br. pn. 3.
Bubbling	2: br. pn. 2.
Indeterminate	1: infl. 1.
All kinds	3: br. pn. 1; pn. 2.
None	2: infl. 2.

Fremitus.

Increased	3: br. pn. 2; lob. 1.
Dullness	10: br. pn. 7; lob. 3.

Temperature

Lowest Point	96° 2	Highest Point	100° 7
	97° 2		103° 5
	98° 5		102° 2
	99° 4		100° 1
	101° 1		

Respiration

Lowest Point	14 1	Highest Point	60 1
	16 2		48 1
	18 5	Below	40 to 24 13
	20 6		
	22 1		

Pulse

Lowest Point	45 1	Highest Point	146 1
	56 1		140 1
Above	60 to 100 13		126 1
		Below	120 to 100 11

Number of cases in which radiological diagnosis of bronchopneumonia was made upon first examination 6
 Lobar pneumonia 4
 Influenza 5
 Final radiological diagnosis of bronchopneumonia 9
 Lobar pneumonia 3
 Influenza 3

Radiological Signs

The author takes this opportunity to acknowledge his indebtedness to Lieutenant Edward I. Liss for his very valuable assistance and to express his thanks for the efforts of the x-ray staff.

COMPLICATIONS OF INFLUENZA FROM THE ROENTGENOLOGICAL STANDPOINT*

BY RUSSELL H. BOGGS, P. A. SURG., U. S. N.

PITTSBURGH, PA.

THE complications of influenza were studied by the roentgen rays at the United States Naval Hospital, Philadelphia, all the plates being taken stereoscopically with a few exceptions when the patients were too sick to be moved. The plates were studied in conjunction with the various staff officers, and the shadows shown were accounted for clinically, by operation or autopsy. Many of the patients were examined repeatedly, which made the series of cases examined extremely interesting. The picture of the pneumonic process was a lobular bronchopneumonia and appeared anatomically usually in a disseminated form. The foci were very near together and confluent in certain parts of the lungs, and in others obscure and far apart. The stereoscopic picture showed the image to be made up of a series of distinct shadows more or less confluent, and in most cases separated one from another by clear spaces. In some cases the appearance of certain forms of chronic tuberculosis was simulated.

It is evident that an influenza bronchopneumonia may give a stereoscopic picture analogous to certain forms of tuberculosis, and that it is only by care and by knowing the clinical side of the case that the true nature of the pulmonary process may be ascertained. When examined by a single roentgenogram in these influenza pneumonias one would be impressed that the lung cast a rather dense shadow in certain regions; but when a stereoscopic pair of plates were examined the apparent densities seen on a single plate were shown to be caused by added shadows throughout the lung tissue, and this was the reason that in so many cases so little was obtained by percussion. After studying a series of cases by the roentgen rays it was interesting to note the accuracy with which we could

tell the kind of breathing the lung densities would produce, namely, bronchial, bronchovesicular, etc.

The influenza chest of a very sick patient would usually give a rather characteristic picture. The glands varied in size from a grain of shot to a pea or even larger, and had a clear cut edge, as though each was injected with a rather dense material. This, together with prominent hilus shadows and increased linear markings of the lung fields, was called an influenza chest. If the glands were very prominent with some confluent areas of consolidation, the patient was always found to be very sick. The differences in the linear markings from those found in the tuberculous lung were that they were more general, and usually found in both lungs. These lines continue plus for some time after influenza, and a differential diagnosis from tuberculosis is going to be extremely difficult. This is bound to be a source of error during the next two or three months. Some of these influenza chests, having prominent linear markings, have been examined repeatedly since their recovery, and the plates showed that these markings were slow in disappearing. Influenza frequently caused the so-called fan-shaped markings described by Dunham, which are supposed to be diagnostic of tuberculosis. Influenza seemed to make a tuberculous process more active, this being particularly true in latent cases. Thickened pleura or effusions are clearly shown roentgenologically. The layers of the pleura are only visible in the pathological state when inflammation has produced a thickened pleura or a serofibrinous deposit on its walls.

During the recent influenza epidemic large pleural effusions were not very common, but small collections of circumscribed effusions or thickened pleura were frequently

* Read at the Midwinter Meeting of the American Roentgen Ray Society.