Chapter XXI

PNEUMONIA

For many years, the x-ray treatment of pneumonic processes with delayed resolution has been recognized and used. Its value in unresolved pneumonia was first reported by Edsall and Pemberton²⁵ in 1907.

ACUTE PNEUMONIA

It was not until 1924 that Heidenhain and Fried²⁶ reported their success in the x-ray treatment of acute pneumonia. Among the first reports in this country were those by Powell²⁷ and McIntire and Smith.²⁸

We have had the opportunity to treat only a few pneumonia patients with x-rays, but we are convinced by their prompt response that x-ray treatment of this highly fatal disease produces excellent results. We believe with Powell that 100 to 140 kv. is necessary for adequate penetration. Powell recommends 135 kv., and this seems entirely reasonable. It has proved effective when dealing with a consolidated lung.

As in the other acute infections, starting treatment in the early stages of pneumonia is a distinct advantage, but one must be sure of the diagnosis. Treatment should never be given to an area of lung without having an x-ray film of the entire chest or without some consideration of the history and the present condition of the patient. When the film shows a consolidation of a lobe or of the entire lung on one side, the character of the density and whether or not there has been any shift of the mediastinal shadow should be considered.

Some of the commonest causes of consolidation of a lobe or the entire lung are: (1) acute pneumococcic pneumonia, areas of unresolved pneumonia or delayed resolution; (2) massive collapse secondary to an obstructed bronchus, occasionally seen postoperatively; (3) atelectasis and massive collapse in an area of lung to which the main bronchus is closed by neoplasm; (4) occasionally, presence of a foreign body, opaque or non-opaque, in a large bronchus; (5) infarct or an embolism and the secondary changes or a patch of bronchopneumonia on an
infectious basis causing partial consolidation with irregular borders; (6) postoperative atelectasis and deficient aeration or early bronchopneumonia causing irregular areas of consolidation at the bases; (7) tuberculosis and other conditions less often found; (8) collections of fluid or pus in the pleural space or between the lobes or in the abscess cavities. Lateral chest films are often essential for diagnosis.

This is not the proper place to discuss the differential diagnosis of the aforementioned conditions, but the necessity for correct diagnosis is apparent to anyone who appreciates the wide variations of the pathologic processes and consequently the variations in therapeutic requirements.

The conditions which are primarily due to infection may be treated by radiation. Also, any patient with a secondary infection, but whose condition is not primarily infectious, should receive some x-ray treatment in addition to whatever other measures are indicated. The only instance in which the low voltage therapy recommended as beneficial in an infection should not be used is the case in which the full skin tolerance of any given port must be preserved for necessary deep therapy which is to follow. Therefore low voltage therapy should not be used to treat an infection when a more stubborn type of lesion, such as a malignant tumor, may be present.

Low voltage therapy may or may not be indicated for the patient who has a massive collapse postoperatively. If the usual thump on the back after the patient is turned on the good side does not suffice and bronchoscopy for direct attack on the obstructing mucus is impracticable or is not available, x-ray treatment after 24 to 48 hours may produce some shrinkage or liquefaction of the obstruction and aid in its release. One such experience is related in detail in the following reports. The response in that case was gratifying, but consistent repetition should not be expected. It may even have been a coincidence that x-ray treatment was started just before the mucus was released. The fact that the patient recovered entirely without permanent lung damage is worth noting.

An area showing increased density due to infarcts, such as one sees occasionally post partum, may well be treated with a daily dose of x-rays to minimize or prevent, if possible, a secondary infection. Such a procedure can certainly do no harm and might
do some good, but it is not recommended as a specific measure.

The lesson learned in treating an ordinary boil on the back of the neck should be applied to conditions in the lung, where suppuration may occur if the organisms are allowed to develop their usual termination. Just as one aborts an early boil by x-ray treatment, so one should use x-ray treatment at the first sign of a localizing infection in the lung with the hope that through early treatment, early resolution of the process may be obtained and suppuration with its probable cavitation avoided.

The chronic lung abscess is a distressing condition, occasionally meaning the social isolation of the patient; therefore the use of every reasonable means to prevent such a result is warranted. It is obvious from a comparison of the results of early and late treatment that early treatment is a great advantage.

One should avoid, if possible, suppuration of the involved area of a consolidated lung. Since several large doses of x-rays (250 to 300 r per dose) given at short intervals may be followed by suppuration in a superficial area of inflammation, the possibility that x-ray therapy is a factor in producing this suppuration should be kept in mind. Repeated small doses seem the method of choice, avoiding large doses except for the occasional initial large one, used when treatment is started late and the patient is extremely toxic. This should be followed by smaller doses at short intervals. Not over 100 r units per day should be given in 50 r unit doses; if one dose is given, 60 to 75 r units should suffice.

One should not depend entirely on x-ray therapy and delay more direct and appropriate measures of treatment of the massive collapse seen postoperatively, as after tonsillectomy in children. X-ray therapy is indicated for this condition only in conjunction with other measures. If the condition is slow in clearing up after the main obstruction is relieved, a small dose of x-rays given every day for two or three days may be helpful.

A collection of fluid or pus or a solid tumor in the chest should not be mistaken for an acute consolidation due to infection. These areas are sometimes best diagnosed by using an aspirating needle; if the underlying condition is such that x-ray treatment is indicated, for example, a neoplasm, as much fluid or pus as possible should be removed before x-ray treatments are given. A large pleural effusion or a greatly thickened pleura should
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not be mistaken for complete consolidation. Lateral views of the chest must be taken if there is any question about the diagnosis or the location of the consolidation. The laminagraph may furnish important information.

What has been said in a general way concerning x-ray treatment of infections and the effect of radiation on the various organs applies to the x-ray treatment of certain infections of the lungs. There is no reason why a patient with a streptococcal sore throat in whom bilateral bronchitis then develops should not have early x-ray treatment to both lung fields. Some streptococcal infections are exceedingly susceptible to radiation, and two treatments of 50 to 60 r per dose each day for such bronchitis, or bronchopneumonia (should it be that extensive), may control the condition and prevent it from developing to serious proportions. Staphylococcal infections in the same area do not respond as promptly. Thus, one cannot be too optimistic regarding what will happen in a given case; one must treat and watch the effects.

The chemotherapeutic group of drugs is used extensively for all chest infections; but if the complications and late sequela make their use seem hazardous, practitioners may well rely on x-rays without any fear of ill effects and may obtain just as low mortality and morbidity. In comparing morbidity following x-ray therapy with that after treatment with the chemotherapeutic group of drugs, one should use as a basis for proper calculation not the length of time needed to "break the fever" but the length of time required for the patient to regain his strength, feel well and return to work with a normal blood picture and normally functioning kidneys.

The x-ray technical factors in general correspond to Powell's recommendations, but the frequency of treatment has required that the dosage be divided into a smaller number of r units per treatment. The greater the toxicity, the closer together the treatments until the toxemia is under control.

The use of the mobile unit has minimized to a great extent the difficulties usually encountered in giving frequent treatments, since x-ray treatment no longer necessitates disturbing the patient.

Children and patients with postoperative involvement have often responded promptly to radiation. In one case, a youngster
had both mastoid and chest involvement; both areas were treated with prompt response. This youngster would have had a mastoid operation but for the fact that the chest involvement prevented the procedure. By the time the chest was clear, the mastoid infection was gone.

Several patients with peritonitis in whom intrathoracic complications developed received x-ray treatments over the chest and responded promptly, often when the condition seemed hopeless.

The details concerning the technic used in the cases reported below should be broad enough to serve as a general guide for the various types of cases encountered. One must always remember that heavier kilovoltage is needed to penetrate thicker areas of tissue, and when treating through fluid or through any mass of consolidated tissue adequate kilovoltage is essential. It should also be remembered that increased kilovoltage requires increased filter to protect the skin.

**Unresolved Pneumonia**

Although many clinicians remain unconvinced about the value of x-ray treatment of acute pneumonia, practically everyone concedes that it is helpful in treating pneumonia which shows a delayed resolution.

Incidentally, it is easy for the radiologist to demonstrate on the film the area of unresolved pneumonia and then, after radiation therapy, to show that this area of consolidation has disappeared. However, in the acute disease which has a tendency to terminate by crisis, it is obviously difficult to be sure in a small series of cases that the crisis, though it does appear early in the course, is the result of x-ray therapy. This is particularly difficult because the time of appearance of the crisis in untreated patients is quite variable. The problem of evaluating the effect of x-rays in pneumonia—a self-limited disease—can be contrasted to the ease of evaluating the results of x-ray therapy of gas bacillus infection—which is practically never a self-limited disease.

The lessened toxemia in pneumonia following x-ray therapy is, in our opinion, due in part at least to the x-ray therapy. The present tendency to use chemotherapy for pneumonia is result-
ing in much improvement in the results, but following chemo-
thrapy we have seen areas of delayed resolution which were
benefited by x-ray therapy. In this group of patients and in
patients who react unfavorably to chemotherapy or who offer
some contraindication to the use of chemotherapy, x-ray therapy
should be used.

Chemotherapy and x-ray therapy should not be used simul-
taneously, but chemotherapy may follow x-ray therapy or x-ray
therapy may follow chemotherapy, after the drugs have been
excreted from the blood. When the use of chemotherapy has
become more stabilized, there may possibly remain a large group
of patients with pneumonia for whom x-ray therapy is the
method of choice.

The radiation dosage used for treatment of unresolved pneu-
monia should be about 100 r per day given in one treatment, with
110 to 130 kv. and 2 to 3 mm. Al filter, depending on the density
of the consolidation as judged from the x-ray film. Three to five
days’ treatment should be sufficient.
CASE 80.—D. T., a boy aged 6, was admitted to the hospital January 16, 1938, with a diagnosis of acute appendicitis and hernia. The appendix was removed and the hernia repaired on the day of admission. A blood transfusion was given. January 18 a clinical diagnosis of pneumonia was made. The temperature was 105 F., but an x-ray film taken the same day failed to disclose evidence of consolidation (Fig. 94). Respiratory rate was 60. At the clinician's request, x-ray treatment was started over the chest and was continued once daily for five successive days, 60 r per day, total 300 r. The laboratory reported type III pneumonia. On January 19, a film of the chest disclosed a consolidation in the upper right lobe (Fig. 95). An x-ray film taken January 24 showed the pulmonary consolidation in the upper right lung field to have completely disappeared (Fig. 96). The patient was discharged from the hospital the day the last film was taken (Fig. 97).

The patient received no sulfanilamide. He was in an oxygen tent and received some liver extract.
Fig. 94.—Case 80. Film taken January 18, before there was any evidence of pneumonia on the film. The clinician, however, insisted that the child had pneumonia and instituted x-ray therapy.
Fig. 95 (left).—Same case as preceding. Film taken January 19. Definite area of consolidation in upper right lung field. X-ray therapy was continued.

Fig. 96 (right).—Same case as preceding. Film taken January 24. All signs of consolidation have disappeared. Type III pneumonia is difficult to manage with serum, but in this case the entire course of the disease was over in about one week. The child left for home one hour after this film was taken.
FIG. 97.—Same case as preceding. The steady drop in temperature and pulse is common when x-ray therapy is used early in such acute toxic infections. The rapid pulse and respiratory rates early in the course are probably the finding on which early clinical diagnosis of pneumonia was based. These were present before consolidation was evident on the film.
CASE 81.—J. B., a girl aged 8, was admitted to the hospital January 30, 1938, at 4:30 p. m., complaining of severe pain in the abdomen and shortness of breath. The temperature was 104.6 F., pulse rate 110 and white blood cell count 20,500. The diagnosis of lobar pneumonia was confirmed by an X-ray film, which showed consolidation in the upper right lobe (Fig. 98). X-ray treatment was started the third day after admission. The temperature dropped the fourth day. She was given a total of six treatments (Fig. 99). She received no sulfanilamide, no transfusions and no oxygen. She was on a high calorie, soft diet, had turpentine stupes and colonic irrigations. The patient was discharged February 12 (Fig. 100).
FIG. 98.—Case 81. Consolidation of upper right lobe. Diagnosis of pneumonia.
FIG. 99.—Same case as preceding, after six x-ray treatments in six days. Consolidation has almost entirely disappeared.
Fig. 100.—Same case as preceding. Temperature dropped after the second day of treatment, but treatment was continued to prevent, if possible, any pleural or other complications. Technical factors were: 110 kv.; 5 mm.; 50 cm. distance; 3 mm. Al filter; anterior chest as port. Result was excellent.
Case 82.—J. A., a man aged 22, was admitted to the hospital January 20, 1939, with a history of fever and chills for four days. The white blood cell count was 14,450, temperature 101 F., pulse rate 134 and respiratory rate 50. A film of the chest showed extensive bilateral consolidations (Fig. 101). Diagnosis was type I pneumonia. He received one x-ray treatment the day of admission, two daily for the next two days, one the next day and one two days later. The patient was in an oxygen tent, but received no serum nor sulfanilamide. He had extensive lung involvement, but recovered without complications (Fig. 102). Two safe therapeutic measures were used, x-rays and oxygen.
FIG. 101 (left).—Case 82. Right lung is opaque and lower half of left lung is slightly clouded.

FIG. 102 (right).—Same case as preceding. Film made 10 days later. The lung is much clearer. X-ray therapy and oxygen tent were the principal therapeutic measures. Recovery was complete.
CASE 83.—E. L., a boy aged 16, entered the hospital January 18, 1939, with a history of pain in the left side of the chest for three days and chills and fever for one day. He had had a cold for two or three weeks. On admission the white blood cell count was 20,300, with 93 per cent polymorphonuclear leukocytes. The temperature was 102.4°F., pulse rate 150 and respiratory rate 36. An x-ray film of the chest showed partial consolidation at the left base and some consolidation around the right hilus. X-ray therapy was started immediately, with one treatment on the day of admission, two on the second hospital day and one on each of the following two days. Temperature reached normal the third hospital day and remained normal until dismissal the seventh hospital day (Fig. 103). Supplementary therapy consisted of cough syrup, sedatives, mustard plasters and steam inhalations.
Fig. 103.—Case 83. Indefinite history of acute respiratory infection; rest in bed, x-ray therapy and general measures effected prompt response. Five x-ray treatments in four days is a good procedure to terminate an illness which has been active too long. Technical factors were: 110 kv.; 5 ma.; 50 cm. distance; 3 mm. Al filter; anterior chest as port. Result was good.
CASE 84.—W. C., a boy aged 6, was admitted to the hospital April 5, 1938, with a diagnosis of lobar pneumonia. He received one x-ray treatment April 10, but treatment was not given the next day because the x-ray film showed the entire right lung field to be opaque (Fig. 104). It looked like consolidation with pleural involvement, probably some fluid or pus. Thoracentesis was done and 60 cc. of serosanguineous fluid obtained. On April 12, when the needle revealed but a small amount of nonpurulent fluid, x-ray treatments were resumed, and the patient received one x-ray treatment daily for the following eight days (Figs. 105 and 106).

This youngster was desperately ill, and when x-ray treatment was started, slight hope was held for his recovery. He left the hospital 10 days later, apparently in excellent condition. He received no sulfanilamide. The pneumonia was not typed. If thoracentesis had revealed pus, treatment would have been discontinued until drainage was established.
FIG. 104.—Case 84. Complete consolidation of entire right lung. Diagnosis was pneumonia. No pus was obtained on aspiration.
FIG. 105.—Same case as preceding. Right lung field almost clear after 10 days of x-ray therapy.
FIG. 106.—Same case as preceding. X-ray therapy was interrupted on the second day to await the result of aspiration, because empyema was suspected. Aspiration failed to reveal any pus in the pleural space. X-ray therapy was renewed. Recovery was without complications. Technical factors were: 110 kv.; 5 mm.; 50 cm. distance; 3 mm. Al filter; anterior chest as port. Result was excellent.
CASE 85.—R. S., a boy aged 17 months, was admitted to the hospital November 26, 1939, with a history of a cold for 10 days and fever, cough and dyspnea. A film made immediately showed no consolidation, but the temperature was 105.2 F., respiratory rate 44 and pulse rate 140. The white blood cell count was 21,800, with 64 per cent polymorphonuclear leukocytes. X-ray therapy was started the second hospital day, with two treatments given daily for three days and one treatment daily for three additional days. A film on the third hospital day showed bronchopneumonia in the left lower lung (Fig. 107).

Temperature varied from 101 to 104 F. rectally, and reached normal for the first time on the sixth hospital day. Convalescence thereafter was uneventful. The patient was dismissed the ninth hospital day (Figs. 108 and 109).
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Fig. 107.—Case 85. Bronchopneumonia in the lower left lung.
Fig. 108.—Same case as preceding, three days later. Disappearance of the area of partial consolidation in the left lower lung field.
FIG. 109.—Same case as preceding. The irregular temperature and the roentgen examination suggested bronchopneumonia; the condition cleared up much more rapidly, however, than it usually does in children of this age. Technical factors were: 100 kv.; 5 ma.; 40 cm. distance; 2 mm. Al filter; entire chest as port. Result was excellent.
CASE 86.—T. M., a boy aged 6, had his tonsils removed November 6, 1939. About 12 days later, he had a fever and a cough. He was hospitalized on November 22, at which time the temperature was 103.6 F., pulse rate 160, respiratory rate 70, and white blood cell count 20,350. X-ray films showed increased density in the middle third of the left lung (Fig. 110). X-ray therapy was started the second hospital day, and the next morning the patient expectorated a large amount of dark-brown, foul-smelling sputum (Fig. 111). One treatment daily was continued until the fifth hospital day. The cough gradually subsided, and the temperature reached normal the fourth hospital day and remained normal thereafter (Fig. 112). He was clinically well two weeks later.
Fig. 110.—Case 86. Area of increased density lateral to the left heart border. History of recent tonsillectomy led to diagnosis of an obstruction of a large bronchus.
Fig. 111.—Same case as preceding. The day after x-ray therapy was recommended, a prolonged paroxysm of coughing resulted in raising a large amount of material; improvement was rapid from then on. Absence of density noted three days before.
Fig. 112.—Same case as preceding. Improvement obviously began with use of x-ray therapy, but this might have been coincidental. Nevertheless, x-ray therapy is recommended in similar cases, since some good might be obtained and no harm is likely. Technical factors were: 100 kv.; 5 ma.; 40 cm. distance; 2 mm. Al filter; entire chest as port. Result was excellent.
The bronchopneumonia seen occasionally after tonsillectomy in children may be effectively treated with x-rays. The tendency of lymphatic tissue to shrink following irradiation is well known, and the fact that lung complications may follow a tonsillectomy is also well known. There is no reason why x-ray therapy should not be tried under the circumstances. The moderate dose effective for the condition could not possibly do any harm. Excessively large doses, 400 or 500 r at one exposure, are not recommended lest lessened resistance be established in the adjacent tissue.

BIBLIOGRAPHY FOR PART V

