Medical Management of Acute Lung Abscess
Report of 12 Cases*

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Within the past decade, the medical regimen for lung abscess has included postural drainage, bronchoscopic aspiration and irrigation, artificial pneumothorax, intravenous injections of arsphenamine and guaiacol, rectal instillations of ether in oil, and the oral administration of potassium iodide and sulfonamides. The data reported by Rosenblatt (1940) indicate the hazards and ineffectiveness of such treatment. Of 72 patients with putrid lung abscess treated medically, only 9 per cent were improved or cured, and 91 per cent were either unimproved or dead.

Allen and Blackman in 1936 collected 2,114 cases of pulmonary abscess from the American literature and found the mortality with medical treatment was 34.4 per cent, and with both medical and surgical treatment was 34.2 per cent. In 1948, Smith published a statistical analysis of 2,166 cases compiled by representative hospitals throughout this country from 1936 to 1944 and concluded that no material change in the gross mortality (34.2 per cent) had occurred.

With the addition of penicillin an appreciable increase in the number of symptomatic cures of medically treated lung abscess has been reported. Potter, however, questions that the follow-up of these cases has been sufficiently long to determine whether spontaneous obliteration of abscess cavities has materially increased.

Material

During a 24 months period we have observed 28 cases of lung abscess (Table 1). Eleven cases are reported in which acute suppuration occurred in a previously healthy lung, as distinguished from suppuration secondary to malignancies, bronchiectasis and cystic lung disease. One additional case of acute abscess in a bronchiectatic lobe is included because complete healing of the abscess cavity resulted under medical management. One case of amebic lung abscess with bronchopleural fistula was successfully

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treated without surgical drainage. One fatality occurred, following spontaneous evacuation of a giant abscess into the pleural space, despite immediate surgical drainage.

Report of Cases

Case 1: W.B., a 49 year old laborer, was admitted on December 21, 1947 with a five weeks' history of chills and fever, productive cough, hemoptysis, dyspnea, and a 35 pound weight loss. He was orthopneic, hoarse, and seriously ill. The temperature was 102.4 degrees F. He coughed up large amounts of fetid, blood streaked pus. There were diminished reson-

![Large abscess cavity with fluid level in right upper lobe.](image1a.png)
![Complete clearing after 54 days of penicillin therapy and normal bronchogram 14 months later.](image1b.png)

**FIGURE 1a**
**FIGURE 1b**

*Fig. 1 (Case 1):* (a) Large abscess cavity with fluid level in right upper lobe. (b) Complete clearing after 54 days of penicillin therapy and normal bronchogram 14 months later.

<table>
<thead>
<tr>
<th>Types of Lung Abscess Observed</th>
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<tbody>
<tr>
<td><strong>Primary:</strong></td>
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<tr>
<td>Acute</td>
<td>10</td>
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<td>Chronic</td>
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<td><strong>Secondary:</strong></td>
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<tr>
<td>Bronchogenic Carcinoma</td>
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<td>Bronchiectasis</td>
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<td>Reticuloendotheliosis</td>
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<td>Cystic Lung Disease</td>
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<td><strong>TOTAL</strong></td>
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<td>Case No.</td>
<td>Age, Race</td>
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<tr>
<td>1</td>
<td>49 W</td>
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<td>2</td>
<td>49 W</td>
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<td>31 W</td>
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<td>28 N</td>
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<td>5</td>
<td>48 N</td>
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<tr>
<td>6</td>
<td>52 W</td>
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* D+ = Daily dosage
* T* = Total dosage

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**TABLE 2**

Summary of Penicillin Dosage and Results of Therapy

JEWETT AND DIMOND

Nov., 1950
<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age, Race</th>
<th>Location of Lesion</th>
<th>Penicillin Intramuscularly</th>
<th>Penicillin Aerosol</th>
<th>After Therapy Begun</th>
<th>Fever Subsided</th>
<th>Abscess Cavity Lost to View</th>
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<tr>
<td>7</td>
<td>44 W</td>
<td>RUL</td>
<td>240,000 17 300,000 37</td>
<td>400,000 14 200,000 37</td>
<td>7 days 41 days</td>
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<tr>
<td>8</td>
<td>58 W</td>
<td>LUL</td>
<td>400,000 40 300,000 24</td>
<td>300,000 64 150,000 25</td>
<td>5 days 30 days</td>
<td></td>
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<td>9</td>
<td>33 N</td>
<td>LLL</td>
<td>400,000 22 300,000 16</td>
<td>200,000 38</td>
<td>5 days 35 days</td>
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<tr>
<td>10</td>
<td>45 W</td>
<td>RUL</td>
<td>400,000 47</td>
<td>200,000 105</td>
<td>14 days 100 days</td>
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<tr>
<td>11</td>
<td>53 W</td>
<td>RUL</td>
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<tr>
<td>12</td>
<td>31 W</td>
<td>RLL</td>
<td>240,000 9 300,000 7 400,000 24</td>
<td>200,000 25</td>
<td>7 days 55 days</td>
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D* Daily dosage. T* Total dosage and days. Average 9 days 52 days
ance, bronchial breathing, and rales over the upper lobe of the right lung. Carious teeth and oral sepsis were noted.

On the chest roentgenogram a large abscess cavity (8 cm. in diameter) with a moderately thick wall (1 cm.) was demonstrated in the right apex. The erythrocyte count was 2.7 million. The leukocyte count was 12,400. Streptococcus viridans predominated on aerobic cultures of the sputa.

Parenteral penicillin was begun immediately but was interrupted for 10 days because the process was mistakenly thought to be tuberculous. In the interval a fluid level developed in the abscess cavity (Fig. 1). On bronchoscopic examination pus was draining from a patent right upper lobe orifice. The vocal cords were edematous. Despite the subsidence of fever and amelioration of symptoms after three weeks of therapy, the lack of improvement by roentgenogram prompted his transfer to the surgical service for pneumonotomy. On a preoperative roentgenogram some decrease in the size of the cavity was first noted and surgery was deferred. Thereafter progressive clearing of the abscess was observed. After 54 days the cavity was no longer visible.

He was discharged April 23. (See Table 2 for a summary of penicillin dosage). A normal chest roentgenogram and bronchogram of the right lung were obtained 14 months later (Fig. 1). This patient has been followed 22 months and has remained well.

Comment: When cavitary pulmonary tuberculosis is suspected and the sputum is abundant, the inability to demonstrate tubercle bacilli on direct smear or in concentrates should suggest an early revision of the diagnosis. Penicillin therapy of suspected lung abscess should not be delayed while attempting to exclude tuberculosis. Valuable time was lost and this patient's lesion was in excess of two months duration before penicillin therapy was begun. Despite this delay and the thickened wall noted on the roentgenogram, complete resolution occurred.

Case 2: D.B., a 49 year old carpenter, expectorated a cupful of malodorous, thick, green pus following a paroxysm of coughing on February 15, 1948 and was hospitalized two days later. A weight loss of 20 pounds had occurred during the preceding six weeks. For five days prior to admission he had intermittent chills and fever, pain in the left side of chest, severe headaches and loss of appetite. He was irrational and seriously ill. The breath was fetid and his cough was profusely productive. The temperature was 101.2 degrees F., the pulse was 124 per minute, and the respirations were 32 per minute.

The chest roentgenogram (Fig. 2) disclosed an abscess with a fluid level in the superior segment of the left lower lobe. There was a leukocytosis (15,950 cells). Streptococcus viridans and streptococcus beta hemolyticus were cultured from the sputum. The spinal fluid was normal.

Parenteral penicillin therapy was begun on admission. The temperature returned to normal within 24 hours and the volume of sputum promptly decreased from 600 cc. to 50 cc. per 24 hour period. The only abnormality seen on bronchoscopic examination was hyperemia of the left main stem bronchus. After 42 days the abscess cavity was lost to view. He was discharged on April 16.

A follow-up chest roentgenogram and bronchogram of the left lower
lobe were within normal limits 14 months later (Fig. 2). It has been 21 months since complete resolution of the abscess cavity, without evidence of recurrence.

Comment: Metastatic brain abscess was considered at the time of admission but was not confirmed. Embolic brain abscess with fatal outcome is not an infrequent complication of pulmonary suppuration, and should be considered when headache or mental confusion are prominent symptoms. Seven of the 10 metastatic brain abscesses successfully treated by Rizzoli and co-workers were considered thoracogenic.

Case 3: J.F., a 31 year old metal grinder, was admitted on March 20, 1948 with a history of cough, profusely productive of foul smelling sputum, chills, fever, chest pain, anorexia, and profound prostration of one week's duration. The past history included bronchial asthma and two episodes of pneumonia in childhood. The breath was fetid. He coughed frequently and expectorated foul smelling, thick, blood streaked pus. The temperature was 101.4 degrees F., the pulse was 124 per minute, and the respirations were 28 per minute. The teeth were markedly carious.

The chest roentgenogram revealed an abscess cavity in the subapical segment of the left upper lobe with an air fluid level and extensive perifocal reaction (Fig. 3). The leukocyte count was 19,250. Hemolytic staphylococcus albus predominated on aerobic cultures of the sputa.

Penicillin was administered intramuscularly from the day of admission and on the second hospital day sulfonamides and penicillin aerosol were added. The aerosolized penicillin was preceded by one half cc. of nebulized "Vaponefrin" (2.25 per cent solution of racemic epinephrine) dur-
ing waking hours. The volume of sputum markedly diminished and he became afebrile on the fifth hospital day. After 31 days of therapy, the cavity was no longer visible. He was discharged April 22 asymptomatic and with a 20 pound weight gain.

Chest roentgenogram 21 months later was normal. A bronchogram revealed the bronchial radicals of the left upper lobe to be entirely normal, but far advanced cylindrical bronchiectasis was demonstrated in the basilar segments of the left lower lobe (Fig. 3).

Fig. 3 (Case 3): (a) Abscess cavity with marked perifocal reaction in subapical segment of the left upper lobe. (b) Complete clearing after 31 days of penicillin therapy, but bronchogram 21 months later shows bronchiectasis in the basilar segments of the left lower lobe.

Comment: The abscess in the subapical segment of the left upper lobe was considered incident to gravity spillage from a long standing lower lobe bronchiectasis. Because of the known bronchodilator effect of epinephrine-like substances administered by nebulization in asthmatics, these should facilitate the transmission of aerosolized penicillin through the terminal bronchioles.

Case 4: J.S., a 28 year old college student, following a mild infection of the upper respiratory tract in April of 1948, had a sudden onset of chills and fever to 103 degrees F., pain in the right side of the chest, and a cough productive of foul, bloody sputum. The third week of his illness a chest roentgenogram obtained elsewhere was interpreted as lung abscess of the right upper lobe. His family physician had administered 300,000 units of penicillin in oil and wax in a single intramuscular injection daily for approximately one month prior to his admission here on June 22. Subsidence of fever and clinical improvement had been noted after one week of therapy. When first seen here he was chronically ill, but was afebrile. There had been a 25 pound weight loss. There were rhonchi over the right upper hemithorax. Oral sepsis was present.
The chest roentgenogram showed an area of infiltration containing several small cavities in the subapical segment of the right upper lobe. Beta hemolytic streptococci predominated on aerobic cultures of the sputa. Penicillin was administered intramuscularly and by aerosolization from the day of admission. Serial roentgenograms showed progressive clearing of the lesion and after 82 days only minimal fibrosis remained. A bronchogram showed no evidence of dilatation or obstruction of the bronchial radicals. Medication was discontinued on August 31, and he was discharged asymptomatic. The chest roentgenogram one year later was read as negative. Over 17 months have now elapsed with no evidence of recurrence.

Comment: This patient received over 50 million units of penicillin in a course extending over a period of 101 days. Although he became afebrile at the end of one week, complete clearing of the lesion did not result until after 82 days of therapy.

Case 5: A.W., a 48 year old Negro was transferred to the medical chest service on July 29, 1948 for the treatment of an acute putrid abscess of the upper lobe of the left lung, resulting from suppuration in a bland pulmonary infarction. He was admitted on December 26, 1947 to the cardiac service with a history of progressive exertional dyspnea, angina pectoris, and high blood pressure since 1940. The occupational history included coal mining for a number of years. The chest roentgenogram on admission was consistent with pneumoconiosis. The electrocardiogram was diagnostic of a recent anteroseptal myocardial infarction. In February lateral extension of the myocardial infarction was demonstrated on the electrocardiogram.

In April there was a sudden onset of pleural pain in the right side of

![FIGURE 4a](image1) ![FIGURE 4b](image2)

**FIGURE 4a**  **FIGURE 4b**

*Fig. 4 (Case 5): Abscess in (a) right lower lobe and (b) pectoral segment of left upper lobe incident to pulmonary infarction. Both cleared completely with penicillin therapy.*
the chest, followed by fever and cough markedly productive of foul, blood streaked, coal black sputum. A rounded density was noted on the roentgenogram in the base of the right lung (Fig. 4). A clinical diagnosis of pulmonary infarction with suppurative breakdown was entertained. Penicillin was administered intramuscularly, with prompt subsidence of fever in the ensuing week, and was then discontinued. He was given supportive treatment with gradual clinical and roentgenologic improvement until July 2, when he again spiked a fever to 101 degrees F. and complained of severe pain in the left side of the chest. The cough became increasingly productive of foul, blood streaked, black, tenacious sputum. Penicillin therapy was reintroduced on July 6. On July 16, the chest roentgenogram showed elevation of the left leaf of the diaphragm and a large abscess cavity with fluid level in the pectoral segment of the left upper lobe (Fig. 4). The leukocyte count was 13,500. On bronchoscopic examination pus was seen in the left upper lobe bronchus. Following his transfer to the chest ward, penicillin aerosol and sulfonamides were added to the regimen. The fever subsided after 25 days. The abscess was no longer visible by August 25.

At the time of discharge on September 29, the only abnormality noted on the chest roentgenogram was extensive interstitial nodular infiltration throughout both lungs, such as described on the initial film.

Comment: Chester and Krause7 have emphasized that pulmonary infarction should be considered as a possible underlying cause in every case of lung abscess, especially if cardiac failure is present. An antemortem diagnosis of abscess secondary to bland pulmonary infarction was definitely established in only three of 23 cases collected by Levin et al8 among 550 necropsies in which infarcts were found. Of the 23 cases in which suppurative breakdown occurred in a bland pulmonary infarction, 15 were nonoperative pulmonary infarctions, and of the latter cardiac decompensation was present in 13. It is suggested by Levin that abscess formation should be suspected in any case of pulmonary infarction in which leukocytosis, unremitting fever, and possibly a productive cough subsequently develop.

Case 6: O.K., a 52 year old alcoholic addict, was admitted to the isolation section on August 12, 1948 with a three weeks' history of productive cough, fetid breath, hemoptysis, 20 pound weight loss, and prostration. Chills, fever, and chest pain were denied. He appeared malnourished, anemic, and chronically ill. Fever was notably absent. There were physical signs of consolidation extending from the second to the sixth rib posteriorly on the right. The liver was enlarged and tender. Finger clubbing was noted.

The chest roentgenogram (Fig. 5) showed a rather homogeneous density obscuring the right upper lobe. Several cavities were noted in this area, at least one of which contained an air fluid level. The trachea was deviated to the side of the lesion, and emphysematous changes were present throughout the aerated lung. The erythrocyte count was 3.4 million with 10.5 grams of hemoglobin. The leukocyte count and differential formula were normal. The 5 mg. per kg. bromsulphthalein test showed a 30 per cent retention of the dye at 45 minutes. The sputa were examined
for tubercle bacilli but none were found. No intrinsic lesion of the bronchus was demonstrated on bronchoscopic examination. No neoplastic cells were identified in bronchial aspirations.

General supportive therapy was given during a three weeks period of observation without improvement. Following his transfer to the medical chest service, penicillin was administered intramuscularly and by aerosolization. The sputum decreased after one week. Serial roentgenograms showed progressive clearing of the infiltration, but the cystic changes persisted. These cyst-like cavities in the right upper lobe, filled with iodized oil on a bronchogram October 21 (Fig. 5). He was discharged December 17, asymptomatic. The erythrocyte count and hemoglobin, as well as liver function tests were all within normal limits. He has remained well for over one year.

Comment: As in Case 1, penicillin therapy was needlessly delayed during a three weeks' period of observation for tuberculosis. It is assumed that the bronchiectasis represents a complication of the abscess, rather than the converse. Because of the pulmonary emphysema the thoracic surgeons elected to defer lobectomy as long as he remained asymptomatic. The lack of chills, fever, and chest pain are unusual.

Case 7: H.C., a 44 year old steamfitter, was admitted on January 22, 1949 with a history of chills, fever, pain in the right side of the chest, cough productive of bloody, purulent sputum, and prostration of two days' duration. His temperature was 104 degrees F. There were oral sepsis, and physical signs of consolidation of the upper lobe of the right lung. An infiltration with an area of rarefaction 2 cm. in diameter was noted.
on the chest roentgenogram in the pectoral segment of the right upper lobe. An examination three days later showed an extension of the lesion at which time the rarefaction measured 4 cm. in diameter.

Penicillin was administered intramuscularly from the day of admission and three days later penicillin aerosol was added. On the fifth hospital day he was still spiking a fever to 103 degrees F. At this juncture, because of the apparent lack of response to penicillin, sulfadiazine was added. Two days later the temperature fell to normal, and there was striking clinical improvement. No significant abnormalities were noted on bronchoscopic examination. The abscess cavity was no longer visible after 6 weeks. On March 8, the right lung was mapped with iodized oil. No defects in the bronchi were demonstrated.

He was discharged asymptomatic on March 17, and advised to continue on penicillin aerosol for a period of one month at home. In July 1948, the chest roentgenogram revealed minimal scarring in the right mid-lung field, but was otherwise within normal limits. Ten months following discharge there has been no evidence of recurrence.

Comment: This patient received penicillin for five days with no apparent response. Two days after sulfadiazine was added his temperature fell to normal with striking clinical improvement. Although one is tempted to give sulfadiazine a share of the credit, we have observed a similar course where sulfonamides were not employed; i.e., a clinical response to penicillin did not occur in less than one week.

Case 8: J.T., a 58 year old foundry worker, had an onset of harassing, non-productive cough in November, 1948, which became progressively worse. In January, 1949 a severe aching pain developed in the left side of the chest. Chills and fever recurred daily. The cough became productive of large amounts of foul purulent sputum. There was a precipitous weight loss of 65 pounds. He was admitted on January 31, 1949, moribund. Cachexia was extreme. His height was 71 inches (180.3 cm.) and he weighed 90 pounds (40.8 kg.). The temperature was 101 degrees F., the pulse was 100 per minute, and the respirations were 24 per minute. There was obvious pulmonary emphysema. Crepitant rales were heard over the left lower anterior aspect of the chest.

A large, irregularly outlined, rounded density 8.0 cm. in diameter was present on the roentgenogram in the lingula of the left upper lobe (Fig. 6). Several small cystic or cavernous areas were noted within this density. There was a leukocytosis (15,850 cells) and a left shift of the differential formula. The hemoglobin was 12.5 grams. Preparations of the sputa, using Papanicolaou’s technique, were negative, Class 1. Two bronchoscopic examinations were essentially normal except for the presence of pus in the left main stem bronchus.

Penicillin therapy was begun on the second hospital day, administered both intramuscularly and by aerosolization. The temperature fell to normal on the fifth day of therapy, and marked clinical improvement occurred. After 30 days only a stellate scar remained. A bronchogram March 8, showed no evidence of obstruction or dilatation of the major bronchi (Fig. 6).

He was discharged on May 2, asymptomatic, having gained 44 pounds,
in weight. He was advised to continue the aerosol penicillin at home for an additional month. There has been no evidence of recurrence nine months since discharge.

Comment: On admission this patient presented the picture of a far advanced bronchogenic carcinoma with suppuration behind an obstructed bronchus. In spite of his rapid deterioration prior to therapy complete recovery resulted.

Case 9: P. P., a 33 year old lathe operator, was admitted on May 11, 1949, complaining of a productive cough, associated with fever, chills, night-sweats, weakness, and a 15 pound weight loss over the preceding three weeks. The day preceding admission the cough suddenly became productive of large quantities of green sputum. Significant in the past history were an episode of hemoptysis in 1943 and chronic productive cough in the intervening years. On admission the temperature was 104 degrees F., the pulse was 110 per minute, and the respirations were 20 per minute. Crackling rales were heard at the base of the left lung.

A chest roentgenogram showed a cavity 5 cm. in diameter with an air fluid level in the lateral basilar segment of the left lower lobe (Fig. 7). The leukocyte count was 21,550. The hemoglobin was 11 grams. Beta hemolytic streptococci and pneumococci predominated on aerobic culture of the sputum.

Penicillin was administered from the day of admission both intramuscularly and by aerosol. He became afebrile the fifth hospital day. The abscess cavity was lost to view on the 35th day of therapy. On July 7, bronchial mapping of both lungs revealed evidence of advanced cylindrical bronchiectasis and contraction of the left lower lobe (Fig. 7). On August 17, 1949, left lower lobectomy was performed. The inferior lateral
aspect of the lobe on cut section showed an area of increased fibrosis, but no abscess cavity could be identified. His postoperative course was uneventful. He was discharged on September 13.

\[ \text{FIGURE 7a} \]
\[ \text{FIGURE 7b} \]

*Fig. 7 (Case 9):* (a) Abscess cavity with fluid level in lateral basilar segment of left lower lobe. (b) Complete clearing after 35 days of penicillin therapy, but bronchogram shows far advanced cylindrical bronchiectasis and contraction of the left lower lobe.

*Comment:* The history would indicate that bronchiectasis unquestionably antedated the abscess. It is of interest that complete healing of the lung abscess was demonstrated in the surgical specimen.

*Case 10:* E.V.V., a 45 year old truck driver, had an acute onset of fever, productive cough, sharp pleuritic chest pain, accompanied by anorexia and severe prostration 10 days preceding admission on May 23, 1949. For two years he had had a cough and had noted weakness, ease of fatigue and a decrement in weight of 30 pounds. He was pallid and emaciated, weighing 100 pounds (45.4 kg). The temperature was 101.6 degrees F., the pulse was 120, and respirations were 20 per minute. The chest was emphysematous. There were an inspiratory lag on the right and physical signs of consolidation of the upper lobe of the right lung.

The chest roentgenogram showed a dense infiltration with “honey combing” of the right upper lobe (Fig. 8). There was extensive emphysema of the remaining lung fields. The leukocyte count was 32,000, with 81 per cent neutrophils. The hemoglobin was 9 grams, with 2.9 million erythrocytes. The sputum cultures grew the usual mouth organisms. Slight retraction of the trachea to the right, but without fixation, was noted on bronchoscopic examination. Bronchial secretions for cytologic examination were obtained from the right upper lobe bronchial orifice, and were interpreted as negative, Class 1.
Penicillin was administered intramuscularly from the day of admission. By the fifth hospital day he continued to spike a fever to 102 degrees F. daily and aerosol penicillin was added. A high caloric, high vitamin alimentation was given together with whole blood transfusions. On the ninth hospital day the fever began to fall by lysis and he became afebrile five days later. There was a 15 pounds weight gain within one month. After 100 days only a slight density remained in the apex. A bronchogram revealed some crowding of the more terminal radicals of the apical and subapical branches of the right upper lobe bronchus (Fig. 8). These changes were considered incident to pulmonary fibrosis.

He was discharged asymptomatic after 109 hospital days, having gained 27 pounds in weight. He was advised to continue penicillin aerosol therapy at home for 30 days.

Comment: The history and the character of the sputum were considered more in keeping with pulmonary tuberculosis, or bronchogenic carcinoma than lung abscess. The leukocytosis of 32,000 and the failure to demonstrate tubercle bacilli in the sputum, however, did not support that impression. The clinical course confirmed the diagnosis of lung abscess. The abnormalities noted on the bronchogram may remain stationary, but bronchectasis may eventuate.

Case 11: E.C., a 53 year old Italian laborer, was struck in the chest with a 100 pound sack of potatoes while working at a produce market and was admitted three weeks later on September 27, 1949. During the week preceding admission his illness was characterized by chills and fever, dyspnea, copious expectoration of foul, bloody sputum and marked prostra-
tion. His lips were cyanotic, the breath was fetid, and respirations were noisy and rapid. The temperature was 101.6 degrees F., the respirations were 36 per minute, and the pulse was 100 per minute. There were an inspiratory lag, diminished expansion and impaired resonance of the right hemithorax. The abdomen was distended and tympanitic. The liver was enlarged.

The chest roentgenogram revealed a large cavity with an air fluid level in the upper lobe of the right lung, with a moderate collection of pleural fluid at the right base (Fig. 9). The leukocyte count was 23,500 with a left shift of the differential formula.

Penicillin was administered from the day of admission intramuscularly and by aerosolization. A sulfadiazine-sulfathiazole mixture was also employed, but, because of the early appearance of heavy crystalluria, was discontinued after three days. On the seventh hospital day he became psychotic and delirious. A brain abscess was suspected but there were no localizing signs. The spinal fluid dynamics and constituents were within normal limits. The leukocyte count markedly increased (40,950 cells with 90 per cent polymorphonuclears). Roentgenogram showed the abscess had evacuated and a considerable increase in the pleural collection of fluid at the right base had occurred (Fig. 9). An emergency thoracotomy was performed under local anesthesia, and a large amount of foul pus was evacuated. A No. 32 Pezzar catheter was inserted through the thoracotomy wound and attached to a water-seal, gravity drainage. Immediately postoperative he became cyanotic, comatose and moribund. General supportive treatment was given with temporary improvement. His course was one of progressive deterioration with the subsequent appearance of jaundice, anasarca, ascites and ileus. The treatment included penicillin, digitalization, mercurial diuretics, gastric intubation for de-
compression, multiple transfusions and repeated bronchoscopic aspirations. A sulfathiazole-sulfadiazine mixture was again administered as well as streptomycin. He remained febrile and expired the 38th hospital day. Permission for necropsy was not granted.

Comment: This patient received both medical and surgical therapy and was the only case in which spontaneous rupture of an abscess into the pleural space occurred. Such a catastrophe might have been prevented by early pneumonotomy. In spite of emergency thoracotomy and adequate evacuation of the pyothorax his course was one of gradual deterioration. The history of chest trauma two weeks preceding onset of symptoms suggests that a contusion of the lung may have occurred which ultimately went on to suppuration and abscess formation.

Case 12: C.B., a 31 year old World War II veteran of the South Pacific Theater, was hospitalized here initially in September 1946, at which time an amebic abscess of the liver was drained and he received a course of emetine totaling 11½ grains. He remained well until the spring of 1948 when he again observed transient pain in the right side of the chest and progressive fatigue. Four months prior to his second admission, December 11, 1948, his appetite began to fail and he lost weight. Chills and fever reoccurred daily. Chest pain and prostration were progressive. Cough with abundant expectoration of foul bloody sputum developed. For a few weeks prior to admission dyspnea had been distressing on slight exertion. The temperature was 102 degrees F., the pulse was 120 per minute, and respirations were 36 per minute. The cough was profusely productive of "tomato catsup-like" sputum. There was moderate pallor and weight loss.

Fig. 10 (Case 12): (a) Large abscess cavity in right lower lobe with bronchopleural fistula. (b) Abscess cavity no longer visible, but residual tenting of diaphragm and pleural reaction are present.
The right hemithorax was splinted and breath sounds were diminished. Moist rales were heard at the inferior tip of the right scapula.

On the chest roentgenogram a large cavity with an air fluid level was seen in the right lower lung field. A second density was noted in the right costophrenic angle with an air fluid level suggesting a bronchopleural fistula (Fig. 10). The leukocyte count was 28,100 and hemoglobin was 8.2 grams. The albumin-globulin ratio was reversed. Endamoeba histolytica cysts were recovered in the stool. The complement fixation titer for amebiasis was positive in a dilution of 1:128. The sputum was repeatedly examined for ameba on direct smear with saline and iodine but none were seen. Aerobic and anaerobic cultures of the sputum for ameba were likewise negative. On thoracentesis a reddish-brown material identical to the material expectorated was recovered.

A diagnosis of amebic lung abscess with bronchopleural fistula and pyopneumothorax secondary to a recurrence of liver abscess was made. Therapy consisted of repeated pleural aspirations, penicillin and amebicides, together with general supportive measures. Penicillin was administered intramuscularly from the day of admission, and later by aerosolization. He received two courses of emetine hydrochloride 1 gr. daily for 10 days and two courses of diodoquin 9.6 gr. t.i.d., for 21 days with suitable intervening rest periods. Multiple whole blood transfusions were given. He became afebrile on the seventh hospital day. The final roentgenogram the day of discharge, February 4, showed some residual pleural thickening and tenting of the right leaf of the diaphragm. The abscess cavity was no longer visible (Fig. 10). He has been asymptomatic for a period of one year.

Comment: Ochsner and DeBakey9 have estimated that about 15 per cent of patients having amebic hepatitis (or abscess) have pleuropulmonary complications. Kossalka10 considers wide thoracotomy mandatory if a liver abscess ruptures through the diaphragm. This patient was seen in consultation by the thoracic surgeons, and it was agreed to defer thoracotomy as long as clinical improvement continued under repeated thoracentesis. It is well recognized that several courses of systemic and intestinal amebicides are frequently necessary to eradicate the infection. Had such a course been followed during this patient's first admission, a recurrence might have been avoided.

Discussion

The management of acute uncomplicated lung abscess has been modified in the past few years. With the knowledge that rapid healing can occur with penicillin, the pendulum has swung away from early pneumonotomy in favor of antibiotic therapy. Adequate drainage is axiomatic in the treatment of any localized collection of pus, but due to the bronchial communication of pulmonary abscess, internal drainage may suffice.

A needless controversy still exists between the proponents of early intensive medical management and those favoring early
surgical intervention precluding a trial of medical therapy. There need be no competition between medicine and surgery. Samson\textsuperscript{11} has emphasized that pulmonary abscess is a serious and unpredictable disease with ever present surgical potentialities, and has urged frequent consultations between the internist and his thoracic surgical consultant.

It is now clear that a high recovery rate cannot be anticipated if all acute lung abscesses be surgically drained. Touloff and Neu-hof,\textsuperscript{12} have found surgical intervention generally of no value in the management of acute uncomplicated nonputrid abscess, and they feel moreover that in many cases it may be absolutely harmful.

Maxwell\textsuperscript{13a} (1934) proposed six factors upon which he felt therapy depended:

1) The cause of the abscess.
2) The duration of the abscess.
3) The general condition of the patient.
4) The nature and virulence of the infecting organism.
5) The site and extent of the lesion.
6) The presence of complications in the lung and pleura.

These same criteria may be applied equally well today.

1) The Cause of the Abscess: The etiology and precipitating factors of lung abscess have been adequately discussed in the literature.\textsuperscript{3,13a,b,c,d} Bronchoscopic examination, early in the course of the disease, serves as a safeguard against an unnecessary delay in arriving at a diagnosis of neoplasm (present in 25 per cent of our series, Table 1) or rarely a foreign body. In addition, internal drainage may be facilitated. The examination should include aspiration of secretions for bacteriologic and cytologic study.

2) The Duration of the Abscess: It is now generally accepted that the onset should be figured from the first appearance of fever and signs of pulmonary infection, and need not coincide with the production of characteristic sputum and roentgenographic evidence of excavation. It has been emphasized by Smith\textsuperscript{3} and others that lung abscesses respond best to medical management when treatment is begun within six weeks of onset. Whereas Bailey\textsuperscript{14} considers abscesses acute if less than two months' duration, there is no disagreement with regard to the urgency for early recognition and treatment.

Only acute lung abscesses, those in which symptoms have been present for two months or less, are considered good subjects for medical management. There is now general agreement that no abscess is doing well that remains unchanged on the roentgenogram for two to three weeks at a time, even if there has been amelioration of symptoms. This is considered an indication for external drainage, or resection.
3) General Condition of the Patient: Supportive treatment differs in no essential respects from that of any severe pulmonary infection. The patient should be turned in bed so that coughing is induced, but heroic efforts at postural drainage are seldom justified. Narcotics should be used sparingly.

4) The Nature and Virulence of the Infecting Organisms: Potter\(^4\) has expressed the opinion that the clinical course is a more practical measure of bacterial sensitivity or resistance to penicillin than extensive bacteriologic studies. Recent emphasis on bacteriologic diagnosis and in vitro sensitivity has resulted from the introduction of a group of newer antibiotics.

5) The Site and Extent of the Lesion: The exact anatomical location of the lesion with reference to lobes and segments can best be determined by fluoroscopic inspection and by suitable roentgenograms. A knowledge of pulmonary topography and bronchopulmonary segmental anatomy is necessary for accurate localization. We have used Brock's\(^5\) terminology. If an interlobar empyema is mistaken for a lung abscess surgical drainage may be unnecessarily delayed. Brock states that fully 50 per cent of cases of lung abscess do not show convincing evidence of cavitation on radiograms. Among the 23 cases of lung abscess reviewed by Levin,\(^8\) there was roentgenologic evidence of abscess in only three.

6) The Presence of Complications in the Lungs and Pleura: In conclusion, the diagnosis must include any local or distant extension of the process. Rupture into the pleural space is an indication for prompt surgical intervention. Spreads to adjacent lobes and mediastinal structures, are accompanied by increased morbidity and mortality. Septicopyemia and brain abscess frequently terminate fatally.

Bronchographic follow-up of patients treated by both surgical and medical means reveals that a small but significant number are left with residual parenchymal and bronchiectatic changes. If symptoms persist as a result of these sequelae medical management should be supplemented with surgery. Kay and Meade\(^16\) have reported a mortality of 1 per cent in a series of 100 cases of chronic suppurative disease subjected to lobectomy.

Penicillin Therapy

Until penicillin was made generally available the mortality, regardless of the method of management, remained practically unchanged, as attested by several comprehensive surveys.\(^2\,^3\) It would seem therefore that penicillin has contributed more than any other single factor to the steady decline in mortality observed in the past few years, granted that earlier recognition, earlier
treatment, and improved operative technique, have also exerted a favorable influence.

The early reports of combined penicillin and sulfonamide therapy were discouraging. More recently, Stivelman and Kavee (1949) have reported a series of 21 cases of acute putrid lung abscess, with 19 cures and one death, as contrasted to a control group of 70 patients (treated with general supportive measures but without penicillin), in which spontaneous recovery occurred in only eight.

Numerous studies have been undertaken to evaluate the most efficient method of administering penicillin. Bryson and his associates (1944) are credited with the original report on penicillin aerosolization. Barach et al. were among the first to attempt a clinical evaluation of the effectiveness of penicillin aerosol in bronchopulmonary infections. Farfias and co-workers, have adopted a technique developed by them for mucosography of the respiratory tract to the treatment of pulmonary suppuration. This innovation would appear to hold little advantage over the conventional methods of penicillin aerosolization. Gaensler and associates have demonstrated that parenteral penicillin does not attain detectable concentrations in the sputum by the Rammelkamp dilution method. As might be expected, penicillin was recovered in the sputum following endotracheal instillation. Bryson has recently shown that the bacteriostatic effect of aerosolized penicillin can be enhanced by using a detergent as a solvent for the drug.

The principle objections to the use of aerosolized penicillin are the increased incidence of sensitivity induced by contact of the drug with mucous membranes and the rather dubious concentration of penicillin which results in the diseased portion of the lung. May and Floyer and Drinker and Hardenbergh have pointed out that aerosolized penicillin may not attain any higher concentration than parenteral penicillin in deep supplicative foci, since there would appear to be little stimulus for minute aerosol particles to enter a rigid motionless cavity. Such cavities could conceivably be reached by a gravitational flow of penicillin via endobronchial instillation.

The European literature contains several reports of pulmonary suppuration successfully treated by endobronchial instillation of penicillin in combination with parenteral administration. Bénard and co-workers treated nine patients with acute or subacute bronchopulmonary abscess by this method, and reported complete clinical and anatomical recovery in eight. Complete recovery resulted from this treatment in 36 of an additional 40 cases of bronchopulmonary abscess cited in the literature. This
treatment should probably be reserved for those cases where other routes of administration appear to have failed. The undesirable side effects of this procedure include suppression of the cough reflex, irritation and edema of the vocal cords from repeated manipulation, and the ever present danger of reaction to anesthesia.

There is experimental evidence to show that in laboratory animals topical penicillin in high concentrations may be injurious to the mucous membrane of the upper respiratory tract. Furthermore Eagle has recently shown that bacteriostasis of certain strains of streptococci and staphylococci in vitro does not parallel increasing concentration of penicillin beyond a certain optimum level, at which point a paradoxical zone appears and bacteriostasis tends to decline.

A discussion of antibiotic therapy of lung abscess should rightfully include the newer compounds that have been derived from the genus Streptomyces which include dihydrostreptomycin, aureomycin, and chloramphenicol. Tentative recommendations regarding the antibiotic of choice in various infections and dosage schedules have appeared in the recent literature. Long believes combined therapy may be the treatment of choice in severe infections; however, this is not to be construed as an endorsement of "shot gun" treatment. A penicillin reaction might be of sufficient magnitude to interdict its use and recourse to another antibiotic would be gratifying. Successful desensitization to penicillin, however, has been reported.

Addendum: As a result of a recent survey, we have extended the observation period of the cases for an additional six months. In none was there evidence of a recurrence.

SUMMARY

1) The data in the literature suggest that penicillin therapy has significantly reduced the mortality of acute lung abscess. The present trend of opinion seems to favor combined parenteral and topical administration.

2) Twelve cases of acute lung abscess are reported, of these all but one were considered primary. Eleven responded to parenteral and aerosolized penicillin (in conjunction with amebacides in a single case), and of these radiographic cure resulted in 10. Residual bronchectasis was demonstrated in but one case. One patient, treated by both medical and surgical measures, died. It was felt that the surgical procedure in no way contributed to the fatal outcome.

3) Whereas it has been emphasized that medical management is not offered in competition to surgical intervention, penicillin
therapy would appear to offer an entirely satisfactory means of treating acute uncomplicated lung abscess. Early pneumonotomy is no longer necessary as long as an abscess remains uncomplicated and uninterrupted roentgenographic regression results.

4) Penicillin therapy should be continued until complete healing has been demonstrated by roentgenologic analysis. The latter should include a bronchial mapping in every case, since a significant number of patients with symptomatic cure may have residual bronchopulmonary pathology.

5) Our experience has impressed upon us the need for thoroughly investigating every case of lung abscess for bronchogenic carcinoma, as well as bronchlectasis.

**RESUMEN**

1) La literatura médica sugiere que la penicilina, ha reducido considerablemente la mortalidad del absceso de pulmón agudo. La tendencia en el presente, parece favorecer la administración local y parenteral.

2) Se presenten doce casos de absceso agudo de pulmón, todos menos uno, fueron considerados primarios. Once casos respondieron a la penicilina por vía parenteral y aerosol (junto con amebiacios en un caso) y con curas radiográficos en diez casos. La bronquitectasia residual fue demostrada solamente en un caso. Un caso que fue tratado médicamente y quirúrgicamente falleció. Se creyó que el tratamiento quirúrgico, no fue responsable por esa muerte.

3) Se ha argumentado que el tratamiento médico no se ofrece en competencia con el quirúrgico; la penicilina parece que ofrece un medio de tratamiento satisfactorio no es necesaria ya, siempre que el absceso permanezca sin complicaciones, la regresión se hace evidente en radiografías periódicas.

4) El tratamiento con penicilina debe de ser continuado hasta que la lesión está curada radiológicamente. La broncografía debe ser hecha en cada caso, desde el momento que algunos enfermos son completamente asintomáticos y sin embargo se puede demostrar patología broncopulmonar residual.

5) Muestra experiencia en abcesos de pulmón, nos ha demostrado la necesidad de una prolífica investigación para el cancer broncogénico y la bronchectasia.

**REFERENCIAS**