Roentgenographic Patterns of 
*Pneumocystis carinii* Pneumonia in 104 Patients with AIDS*

Lawrence J. DeLorenzo, M.D., F.C.C.P.;
Chin Tang Huang, M.D., F.C.C.P.; George P. Maguire, M.D., F.C.C.P.; and Daniel J. Stone, M.D., F.C.C.P.

We reviewed the initial and follow-up chest roentgenograms (CXR) of 104 patients with the acquired immune deficiency syndrome (AIDS) and *Pneumocystis carinii* pneumonia (PCP) diagnosed between 1981 and 1985 in order to determine the relative frequencies of its various roentgenographic patterns. Although a diffuse bilateral interstitial infiltrate is most common, it was concluded that unusual and atypical roentgenographic manifestations of PCP occur in AIDS. These include localized infiltrate, cystic or honeycomb lesions, hilar enlargement and spontaneous pneumothorax.

*Pneumocystis carinii* pneumonia (PCP) is the most common and serious opportunistic pulmonary infection occurring in patients with the acquired immune deficiency syndrome (AIDS). It is estimated to occur in approximately 60 percent of patients with AIDS and contributes significantly to the overall morbidity and mortality of those patients.1-4

The roentgenographic appearance of PCP in both AIDS and non-AIDS patients is most commonly described as a bilateral interstitial or alveolar pattern. This frequently evolves from a primarily perihilar location into a more extensive and diffuse process.2,3,4 Unusual roentgenographic manifestations of PCP have been reported, but these reports pre-date observations made during the recent "epidemic" of AIDS. These atypical patterns include lobar distribution, pleural effusion, sparing of previously irradiated areas of lung, atelectatic changes, hilar adenopathy, and "abscess formation."5,6,9,11

In an effort to better characterize the roentgenographic manifestations of Pneumocystis disease of the lung, we reviewed all chest roentgenograms available to us of those patients with AIDS and PCP only, seen at Lincoln Medical and Mental Health Center and Westchester County Medical Center. This report is a summary of these observations.

---

*From the Pulmonary Division, Department of Medicine, New York Medical College, Valhalla, New York: Lincoln Medical and Mental Health Center, Bronx, and Westchester County Medical Center, Valhalla, New York.
†Assistant Professor of Medicine.
‡Professor of Medicine.
§Associate Professor of Clinical Medicine.
Manuscript received May 16; revision accepted September 19.
Reprint requests: Dr. Huang, Lincoln Hospital, 245 East 149th Street, Bronx 10451

METHODS

The radiology folders of 104 patients with only PCP and AIDS were available for review. These patients were carefully observed between 1981 and 1985, and they fulfilled the Centers for Disease Control criteria for AIDS.10 Intravenous drug abuse (IVDA) was the predisposing risk factor to the development of AIDS in almost all cases. All of the patients at either institution were known to the pulmonary division at that hospital. The diagnosis of PCP was made by fiberoptic bronchoscopy with transbronchial lung biopsy and/or bronchoalveolar lavage (BAL) in all except 19 patients, who underwent open lung biopsy. Appropriate specimens (lung tissue, bronchial brushings, bronchial washings, BAL) were routinely examined for histopathology, acid-fast, Giemsa, and methenamine silver stains. Bronchial washings and BAL fluid were sent for routine bacterial, mycobacterial, fungal, and viral cultures. The dates of diagnostic procedures and complete histologic and microbiologic results were known. Patients with other complications in addition to PCP were excluded from the study. Patients whose disease progressed despite anti-Pneumocystis therapy underwent additional diagnostic studies including repeated fiberoptic bronchoscopy on one or more occasions when necessary.

The chest roentgenograms were reviewed independently and placed in preassigned roentgenographic categories by three of the authors (C.T.H., L.J.D., G.P.M.). Differences among the three reviewers were discussed and final decision required agreement of at least two of the three reviewers. Five categories of roentgenographic abnormality were defined. The *interstitial pattern* was recognized as one with a granular, nodular, reticular, or reticulonodular appearance. The *alveolar pattern* was characterized by air-space filling, the presence of air bronchograms, or confluent acinar infiltrate. The *interstitial-alveolar pattern* included characteristics of both interstitial and alveolar categories. A *honeycomb pattern* was defined by the presence of air-containing cystic spaces up to 1 cm in diameter and separated by a coarse reticular network. A *pulmonary cyst* was defined as a thin-walled air-containing space 1 cm or greater in diameter.11

Follow-up observations were made at three weeks after the initial observation, and also by review of the last available roentgenograms. These observations were categorized as to change, favorable or unfavorable, and as to the development of new or unusual manifestations.
Table 1—Initial Roentgenographic Abnormalities

<table>
<thead>
<tr>
<th>Initial CXR finding of PCP</th>
<th>Cysts</th>
<th>Honeycomb</th>
<th>Hilar Enlargement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstitial pattern</td>
<td>78 (75.0)*</td>
<td>5 (4.8)</td>
<td>3 (2.9)</td>
</tr>
<tr>
<td>Alveolar pattern</td>
<td>13 (12.5)</td>
<td>2 (1.9)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Interstitial-alveolar pattern</td>
<td>13 (12.5)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>7 (6.7)</td>
<td>4 (3.8)</td>
</tr>
</tbody>
</table>

*Parentheses indicate percent.

RESULTS

A summary of the abnormalities on the initial chest roentgenograms is shown in Table 1. An interstitial pattern was observed in 78 patients (75 percent), an alveolar pattern in 13 patients, and a combined interstitial-alveolar pattern in 13 patients. In addition to these findings, four patients had bilateral hilar enlargement, seven patients had thin-walled cysts, and four patients showed honeycomb lesions (Fig 1).

The roentgenographic infiltrations involved both peripheral and central distributions in 87 patients (84 percent), a peripheral distribution in 15 patients, and a central distribution in only two patients. Bilateral disease was present in 99 patients (95 percent). Only five patients had a unilateral infiltration.

The predominant location of infiltration on the initial chest roentgenograms involved the entire lung in 50 patients (48 percent). However, localized infiltrates...
were observed in the lower lung field in 35 patients (33.7 percent), in the upper in six patients, and in the middle in another six patients. Seven patients showed infiltrates in both middle and lower lung fields.

Short-term roentgenographic follow-up is shown in Figure 2, and final roentgenographic outcome in Figure 3. Approximately one-third of the patients showed no change in the status of the film over the first three weeks. Forty-six percent of the patients showed deterioration in the chest roentgenogram at one week. Over the next two weeks, this number decreased. Only 17 percent of the patients showed regression (improvement) in the roentgenographic abnormality in the first week, but this number almost doubled over the subsequent two weeks.

Roentgenographic outcome, in most instances, is established within two months after the initial observation (Fig 3). Forty-five of 104 patients (43 percent) had complete roentgenographic resolution of their abnormality. This was observed within two months in 37 patients, two to five months in four patients, and over five months in four patients. An additional 17 patients (16 percent) had partial improvement. Nineteen patients (18 percent) had worsening of their roentgenographic abnormalities, and this was manifested within the first month. Sixteen patients (15 percent) had unchanged findings at one month and another five patients at two months.

In the group of seven patients who presented with cysts on the initial chest roentgenogram, three showed complete resolution at one and one-half, four, and five months. Three patients had residual cysts on the last available chest roentgenograms at three, four, and four weeks. One patient died after only two weeks of hospitalization. Six additional patients developed cystic lesions during their hospital course. Five of these six had residual cysts from one to four months after the cysts were identified, while one patient died three weeks after the cyst was first seen.

Honeycomb abnormalities, which were seen in four patients initially, showed complete resolution in two patients and partial resolution in one patient at two months. The honeycomb lesions were unchanged in one patient at five weeks.

Hilar enlargement underwent complete resolution within one month in two patients and was unchanged in two other patients after one and three months.

Additional roentgenographic abnormalities observed at various points after the initial roentgenograms included spontaneous pneumothorax in six patients, and pneumomediastinum in three patients. Fifteen more patients developed pneumothoraces which were related to either diagnostic procedures and/or the use of mechanical ventilation.

**DISCUSSION**

The routine chest roentgenogram is of value in the diagnostic and follow-up evaluation of patients with AIDS. Knowledge of the variety of roentgenographic patterns of PCP in AIDS may be helpful in the early diagnosis and management of these patients. However, review of the pulmonary manifestations of AIDS have
not focused in detail on the roentgenographic manifestations of PCP in AIDS.

Gamsu et al. described the roentgenographic findings of 12 AIDS patients with PCP. Eight presented with a "ground glass" roentgenographic appearance, two had intrathoracic lymphadenopathy, and two had normal chest roentgenograms. In one patient, roentgenographic progression was manifested by multiple 1 to 2 cm cystic spaces during or after prolonged intubation. Bilateral diffuse interstitial infiltrate has been recognized as the most common roentgenographic manifestation of PCP in patients with AIDS.

The frequent occurrence of these "cyst-like" structures within areas of infiltrate was an unexpected finding of our study. The mechanism of the development of these "cysts" is unknown. These radiolucencies are unlike the cavities of necrotizing pneumonia in that they are thin-walled and do not appear to be filled with fluid or debris. We have not seen air-fluid levels or suppurative pulmonary syndromes in any of our cases. The explanation for their development may have to do with the response of the pulmonary parenchyma to the Pneumocystis carinii infection in an immunocompromised host. Lung biopsies performed before, during, and after treatment frequently reveal "alveolar-interstitial pneumonitis and fibrosis" of varying degree. This may result in transient or permanent remodeling of pulmonary architecture and a cystic or honeycomb appearance. Pulmonary interstitial emphysema has been observed in the setting of acute lung injury syndrome and has a roentgenographic appearance not unlike the cysts encountered in our patients. Therefore, pulmonary barotrauma may have been an additional stimulus to the formation of these air spaces in some patients. However, in seven of our 13 patients, the cyst-like structures were present on the initial chest roentgenogram before the patient was exposed to any positive airway pressure. Moreover, only four of six patients who developed cystic lesions during their hospitalization were receiving mechanical ventilation.

It is conceivable that necrotizing infection of the lung due to opportunistic organisms, other than Pneumocystis carinii, may produce localized areas of emphysema. Bacterial, mycobacterial, fungal, and viral infections must be considered in the context of AIDS. These agents could potentially be responsible for the chest roentgenographic abnormalities noted in this study, as noted above, serial laboratory studies did not reveal the presence of any infection other than that due to Pneumocystis carinii, and therefore, make this a much less likely explanation for the described roentgenographic abnormalities. Although it must remain speculative, it is possible that these areas of localized emphysema are a result of cell-mediated lung injury.

The 104 AIDS patients reported here all belonged to a high-risk group of intravenous drug abusers. Interstitial lung disease may result from intravenous drug abuse. All of our patients presented with acute symptoms and roentgenographic abnormalities. Almost 60 percent of them, however, showed improvement and 45 patients had complete resolution of the chest roentgenographic abnormalities. We, therefore, conclude that the described abnormalities were a result of PCP and not an underlying IVDA-related lung disorder.

Hilar adenopathy could not be explained by Kaposi's sarcoma or mycobacterial disease in the four patients in whom it was seen. None of these patients had any evidence of Kaposi's sarcoma, and as noted above, mycobacterial, fungal, and viral pathogens could not be found despite extensive work-up. In addition, hilar enlargement resolved completely in two of the cases after treatment for PCP only.

This study confirms the impression that the initial chest roentgenographic abnormality of patients presenting with Pneumocystis infection and the AIDS most often is that of diffuse bilateral interstitial infiltrate involving the entire lung or the lower lung fields. A variety of less commonly occurring presentations can also be seen. "Cysts," a honeycomb appearance, localized infiltrates, and hilar enlargement are associated roentgenographic manifestations of PCP in approximately 10 percent of cases. Approximately 6 percent of the patients in our study group developed spontaneous pneumothoraces during the course of their illness. While most patients who attained complete roentgenographic resolution did so within a two-month period, abnormalities may persist for five or more months. In conclusion, the presence of atypical roentgenographic findings in immunocompromised patients warrants work-up for Pneumocystis infection.

ACKNOWLEDGMENT: The authors would like to thank Ms. Susan N. Kessler for her assistance in preparation of the manuscript, and Ms. Julie Rotta and Mr. Mel Zane for their assistance with the illustrations.

REFERENCES

7. Bragg DG, Burton J. The roentgenographic manifestations of...
pulmonary opportunistic infections. AJR 1973; 117:798-809
12 Centers for Disease Control. Update on Kaposi's sarcoma and opportunistic infections in previously healthy persons—United States. MMWR 1982; 31:294, 300, 301
13 Fraser RG, Fare JA. Diagnosis of diseases of the chest. Philadelphia: W.B. Saunders, 1977, Vol 1; 341-434

**CRITICAL CARE EXAMINATION REVIEW COURSE**

**Dates:**
June 7-10, 1987, San Diego, CA
September 14-17, 1987, Washington, DC

**Locations:**
Hotel Del Coronado, San Diego, CA
The Shoreham Hotel, Washington, DC

**Sponsor:**
American College of Chest Physicians

**Course Director:**
D. Robert McCaffree, M.D., FCCP

**Course Description:**
The Critical Care Examination Review Course is designed to help chest physicians to prepare for the Critical Care Medicine examination. Faculty members represent the range of specialties with clinical responsibilities in the delivery of critical care. Course registrants will be assumed to be chest physicians with basic knowledge of, and experience in critical care medicine. Registrants will receive a comprehensive syllabus at the course site. An annotated bibliography will be sent by mail prior to the course. Pre-testing, daily post-testing and computerized interactive sessions will be used to provide feedback to both registrants and faculty. Additional, optional evening sessions will feature presentation and discussion of cases by faculty members drawn from teaching hospitals in the local areas of San Diego or Washington, D.C.

Specialty areas covered in the course include neurology, pulmonology, cardiology, trauma management, pharmacology, hematology, nephrology and renal disease, gastroenterology, infectious disease, immunology, clinical nutrition and physiology. Topics also include such multidisciplinary emergencies as shock, poisonings and metabolic acid-base problems.

Pre-testing will be used by faculty to assess the knowledge level of registrants prior to course presentation, and to stress during the course those areas the pre-testing identifies as needing most emphasis. The same test questions will serve as a post-test at the end of each day.

During the course, maximum interaction between faculty and registrants will be provided by the computerized Audience Response System. This system permits registrants to use a five-button key pad to respond to the questions posed by the instructors; aggregated responses are displayed on a large screen, allowing both registrants and faculty members to focus immediately upon points for discussion and emphasis.

**Tuition:**
ACCP Members $500.00
Nonmembers $575.00

ACCP Affiliate Members $250.00
Physicians-in-training $300.00

COURSE ENROLLMENT IS LIMITED. PLEASE REGISTER EARLY.

Refunds for cancellation prior to two weeks before the starting date of each course will be made, less a $30.00 administrative fee.

**Credit:**
As an organization accredited for continuing medical education by the Accreditation Council for Continuing Medical Education (ACCME), the American College of Chest Physicians designates that this continuing medical education offering meets the criteria for 30 credit hours in Category 1 as outlined by the ACCME and by the American Medical Association for the Physician's Recognition Award.

For information, contact the Division of Education, American College of Chest Physicians, 911 Busse Highway, Park Ridge, IL 60068 (312-698-2200).