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# Radiologic Errors in Patients With Lung Cancer

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*Some 20 percent to 50 percent of detectable malignant lesions are missed or misdiagnosed at the time of their first radiologic appearance. These errors can result in delayed diagnosis and treatment, which may affect a patient's survival. Use of moderately high (130 to 150) kilovolt peak films, awareness of portions of the lung where lesions are often missed (such as lung apices and paramediastinal and hilar areas), careful comparison of current roentgenograms with those taken previously and the use of an independent second observer can help to minimize the rate of radiologic diagnostic errors in patients with lung cancer.*

A RATE OF radiologic diagnostic error of 20 percent to 50 percent has been well documented in previous years.[1-5] This study analyzes the factors that led to such errors in 27 cases of lung cancer. Reasons for these errors and methods to improve the detection rate are suggested.

## Patients and Methods

A retrospective series was collected of consecutively seen patients in whom lung cancer had been diagnosed. Of these, 78 patients had a radiologically apparent mass. Current and previous chest roentgenograms and reports on these patients were reviewed. In eight cases, radiologic errors in diagnosis had been made before confirmation of the disease.

Over a subsequent two years roentgenograms of the chest of all patients with newly or previously diagnosed lung cancer were checked for radiologic error. Of the 143 cases of lung cancer diagnosed, 19 errors were found.

The 27 cases of radiologic error were reviewed by a second radiologist. He concurred that in all cases there had been an error in detection or interpretation but that no case in which the diagnosis was possible only in retrospect had been included. Questionable cases were not classified as radiologic errors.

Medical records of the 27 patients in whom lung cancer had been missed radiologically were reviewed to determine the length of time between the error and accurate diagnosis. These records were also analyzed to establish if the radiologic error had an effect on eventual surgical management of the tumor.

## Results

The 27 radiologic errors involved 22 cases in which the abnormality had been missed, 4 in which radiologic findings were reported but misinterpreted and 1 case in which there were errors in both detection and interpretation at different times (Table 1). Therefore, in 23 cases there was a delay in diagnosis of lung cancer because of a failure to detect a significant radiologic finding.

The location of each radiologically apparent lesion on posteroanterior or lateral roentgenograms was plotted on a diagram of the chest for

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TABLE 1.—*Radiologic Errors in Lung Cancer Diagnosis*

| | |
|---|---|
| Missed observations | 22 |
| Misinterpreted findings | 4 |
| Both missed and misinterpreted (at different times) | 1 |
| TOTAL | 27 |

TABLE 2.—*Analysis of Consecutive Cases of Lung Cancer in Which There Was a Radiologically Apparent Mass*

| | |
|---|---|
| Total cases included | 78 |
| Previous films available for comparison | 20 |
| Observation missed | 7 |
| Finding misinterpreted | 1 |
| Rate of diagnostic error | 40% |

the 78 consecutive cases of lung cancer, group 1 (Figure 1), and for the 23 patients in whom there had been a radiologic error in diagnosis of lung cancer, group 2 (Figure 2).

Of the 78 patients in group 1, there were 20 for whom previous roentgenograms were available for comparison. Radiologic errors had been made in reading earlier films of eight patients in this group (Table 2).

When all previous roentgenograms were reviewed in the 23 patients in group 2 (failure of detection), multiple errors were discovered in most cases (Table 3).

The diagnosis of lung cancer was often delayed months to years after the first definite radiologic evidence of a mass had gone unrecognized (Table 4). This delay in diagnosis may have affected patients' chances for surgical cure (Table 5).

## Discussion

Error in diagnostic radiology has been studied by many authors, all of whom have concluded that a large number of significant abnormalities is

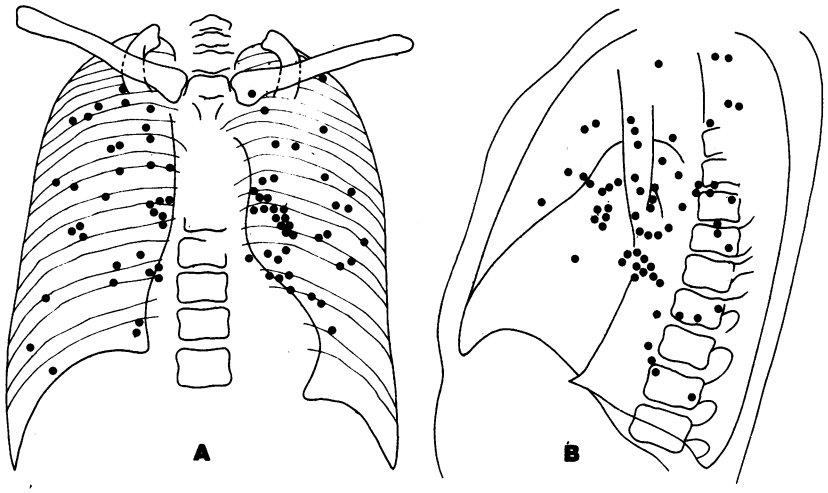


**Figure 1.—A,** Posteroanterior diagram of the chest with the locations of malignant lesions in 78 consecutively seen cases of lung cancer. (Reproduced by permission from Forrest and Sagel[20]; copyright 1979 by the Radiological Society of North America, Incorporated.) **B,** Lateral diagram of the chest with the locations of the lesions in 78 consecutively seen cases of lung cancer.

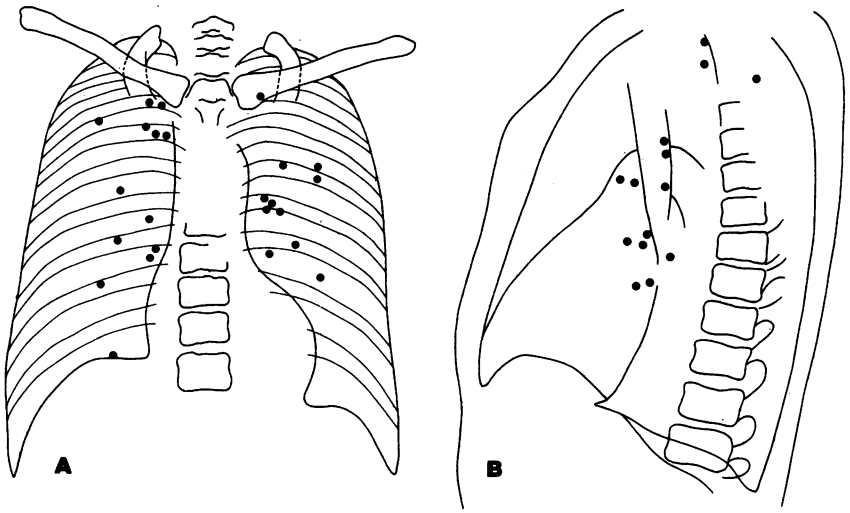


**Figure 2.—A,** Posteroanterior diagram of the chest with the locations of 23 missed lung cancer lesions. **B,** Lateral diagram of the chest with the locations of 23 missed cases of lung cancer. Note the predominance of central and apical lesions in both views.

TABLE 3.—*Missed Observations*

| | |
|---|---|
| On one radiologic study | 10 |
| On two radiologic studies | 5 |
| On three or more radiologic studies | 8 |
| TOTAL | 23 |

TABLE 4.—*Delay in Diagnosis Because of Error*

| *Delay (months)* | *No. of Cases* | *Delay (months)* | *No. of Cases* |
|---|---|---|---|
| 0-1 | 6 | 12-24 | 3 |
| 2-3 | 3 | 24-36 | 2 |
| 3-6 | 3 | 36-48 | 2 |
| 6-12 | 8 | | |
| | | TOTAL | 27 |

TABLE 5.—*Effect of Error on Patient Management*

| | |
|---|---|
| Number of patients | 27 |
| Delayed resection that was still possible later | 8 |
| Unresectable but might have been resectable at time of error | 3 |

either not detected, not reported or misinterpreted. Estimates of error rate have varied from 20 percent to 50 percent.[1-5] Among the 78 consecutive cases of lung cancer in which there was a radiologically apparent mass, 20 had previous films for comparison. In 8 of the 20 patients the mass was obviously present on review of earlier examinations but either had been missed (7 cases) or misinterpreted (1 case). The false-negative error rate of 40 percent in this small series is in line with the findings of others. It should be emphasized that only a clearly detectable lesion has been classified as a miss. Questionable or very small lesions visible only in retrospect were not considered errors for this report.

Survival after operations to remove small malignant nodules is high.[6] Resectability rates are higher in patients in whom lung cancer is found in a regular screening program.[7,8] Rigler and coworkers[4] have reemphasized that many peripheral neoplasms grow very slowly and are demonstrable on roentgenograms for a long time before they show evidence of unresectability because of local invasion or distant spread. Although most physicians dealing with patients with lung cancer have assumed that early diagnosis and surgical procedures lead to improved survival, the report of the Philadelphia Pulmonary Neoplasms Research Project did not support this premise.[9] It was found that radiologic screening for early detection of lung cancer did not significantly enhance average survival. However, the project relied on photofluorograms, on which small lesions are hard to detect.[9] Several other major studies have reached opposite conclusions.[6-8,10-12] Overall, the balance of evidence supports the position that early radiologic detection of lung cancer is useful in increasing both surgical resectability rates and survival.

The effects of diagnostic errors on ultimate outcome are hard to determine. In many of the patients the radiologic error led to a significant delay in establishing the diagnosis of lung cancer (Table 4). In 15 of the 27 patients the time from first radiologic appearance to diagnosis was longer than six months and in two instances it was more than three years. Many of the tumors would have been unresectable even when first seen on the roentgenograms because of their location or, more commonly, because of coexisting disease, particularly severe emphysema. Given these considerations, it was concluded that 11 of the 27 patients had reduced chances of surgical cure because of the delay in diagnosis (Table 5).

Factors contributing to radiologic error are complex and hard to isolate. An inexperienced observer has a higher error rate than a radiologist[1]; however, Herman and Hessel[13] found that residents with a year of training had approximately the same likelihood of detecting abnormalities as fully trained radiologists. Garland[1] suggested that radiologists who subspecialized were less apt to make significant errors in their field. Errors in radiologic detection are more frequent if the reader is busy or rushed,[3] but fatigue does not appear to have this effect.[14,15] The rate of missed findings by radiologists working late in the day or after hours does not appear to increase.[3,14]

Lack of clinical correlation is a cause of error, particularly in trauma radiology.[3] Failure to study old reports and previous films carefully will also lead to error.[3] There were previous films available showing no abnormalities in 17 of the 23 cases involving detection errors; comparison clearly showed interval changes or new appearance of a shadow (Figures 3 and 4).

Although an inadequate or suboptimal examination can certainly cause a lesion to be missed, this was not a factor in our study. Several patients for whom films were of poor quality had other studies which clearly showed the abnormality. We regularly use a moderately high kilovolt peak (kVp) (130 to 150) which precludes underpenetration as a problem. In several cases a lighter film would have

shown a missed lesion better, but in no instance was a bright light necessary to see the abnormality. Other investigators have also concluded that technique plays a relatively unimportant role in the high rate of radiologic errors.[3]

Changing the technical factors of a roentgenogram and manipulating the image have been attempted to enhance the visibility of small lesions, particularly pulmonary nodules, to decrease the error rate.[16] The success of these attempts was questionable at best. Rigler[17] worked extensively with manipulation of the image by a television system, but this technique has not yet been shown to be of practical value. The use of 350 kVp films can increase the perceptibility of nodules.[18] However, the cost or inconvenience of new equipment, the loss of other information on the film and unfamiliarity with this technique have not yet led to its general acceptance.

The use of a kVp in the 130 to 150 range increases the availability of information from the parts of the lung overlying the mediastinum, hila and bones. Adequate penetration of these normal obscuring structures enhances the detectability of lesions. However, these regions were still the sites of most of the lesions missed in this study. The difference in distribution of lesions between the 78 consecutive cases of lung cancer and the 23

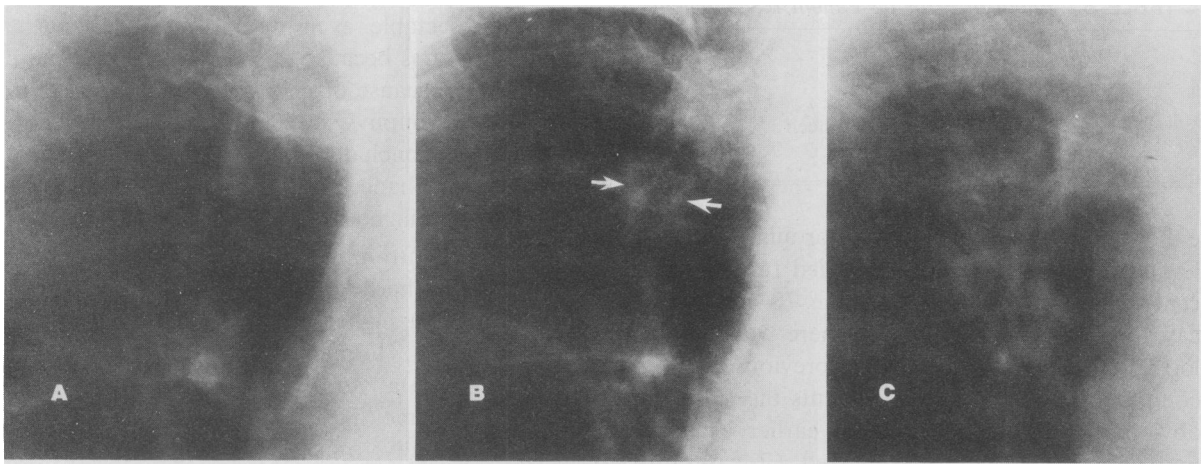


**Figure 3.—A,** Posteroanterior roentgenogram of right upper lung field. **B,** Growing mass **(arrows)** 16 months later, not reported. **C,** A year later, the mass is larger. Squamous cell carcinoma was found on needle aspiration of the lung.

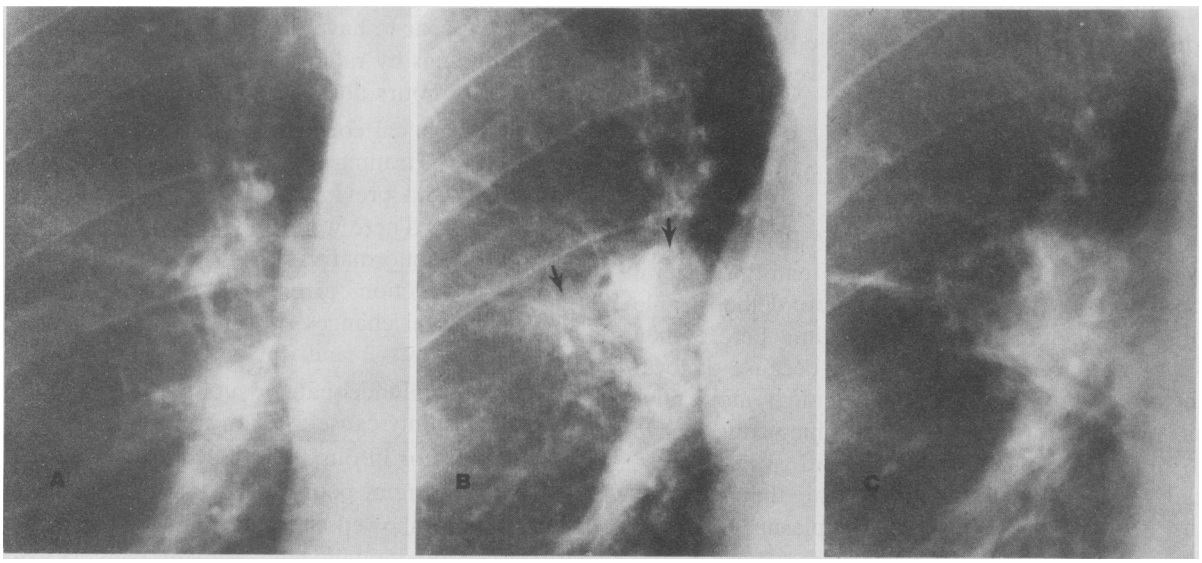


**Figure 4.—A,** Posteroanterior roentgenogram of right hilar area. **B,** Growing mass 14 months later lateral to and in superior pole of hilum **(arrows)** was missed. **C,** Larger mass five months later proved to be adenocarcinoma by bronchoscopic biopsy.

cases of missed lung cancer is striking (Figures 1 and 2). Most of the missed tumors occurred in the apices (especially the right) (Figure 3) and paramediastinal and hilar areas (Figure 4). Difficulty in separating normal structures from early lung cancer was the apparent cause of these errors.

At the right apex, posterior and anterior ribs (particularly the first costochondral junction), the clavicle, manubrium, innominate artery, lung vessels, apical capping and scars of previous granulomatous disease create a conglomeration of shadows that can readily obscure a small lesion. Variations in hilar and mediastinal density and contour are endless and allow early abnormalities to be overlooked. Experience and knowledge of normal anatomy should help in the search for these lesions, although many were missed by senior radiologists (and presumably by the senior clinicians at our medical center who often look at their patients' films). Knowledge of recent studies of normal radiologic mediastinal and hilar anatomy should help in the search for subtle abnormalities.[19]

Although the use of lateral chest films is critical for confirmation and localization of lung cancer, it was not a major factor in early diagnosis or error in our series. Two of the missed lesions (of those listed in Table 1) could be seen better in the lateral view. And in only two of the 78 consecutive cases of lung cancer could the lesions be seen better in the lateral films. However, no lesion in either group was visible only on the lateral roentgenogram. The lateral view complements the frontal film, especially for visualization of the lung bases and retrosternal space; however, very few of the cases of lung cancer developed in these regions (Figure 4). In a previous exensive evaluation of the value of lateral roentgenograms, no cases of cancer were discovered that could be seen only from this view.[20] On the other hand, in the group of missed lesions, 9 of 23 were visible only in the frontal projection.

In 5 of the 27 undiagnosed malignant lesions of the lungs, the error was due to misinterpretation of an observed abnormality. In one instance a large mediastinal mass was thought to be an aortic aneurysm. Another instance of lung cancer was interpreted as an enlarging left pulmonary artery. The other three cases involved slowly growing, poorly defined peripheral lesions, which were interpreted as chronic pneumonia. Misinterpretation due to slow tumor growth is significant because it delays treatment of the lesions most likely to be successfully managed surgically. In this series alveolar cell carcinoma was likely to be a misdiagnosed, slowly growing peripheral lesion.

Past studies have shown that an excellent way to reduce error is double reading.[2,3,21,22] Approximately half of significant errors can be avoided by this procedure.[2,3] Most of our roentgenograms were seen by a resident and a staff radiologist before being reported. In addition, many films were reviewed by specialists on the clinical services. Nevertheless, 13 of 23 cases of lung cancer were undetected on two or more studies (Table 3). Independent double reading by radiologists is impractical in many departments. A more immediate solution would be to teach technologists to screen films. Technologists were successfully trained to pick out lung cancer in the New York Early Lung Cancer Detection Program.[23] Sheft and his associates[24] also showed that specially trained technologists could accurately screen chest roentgenograms.

An error rate of about 30 percent appears to be an unavoidable aspect of chest radiology as it is currently practiced. With the recent rise in malpractice suits, many radiologists and nonradiologists are being sued for missing or misinterpreting a shadow caused by lung cancer. This legal challenge is inconsistent with the known limitations of accuracy of interpretation of chest films, as illustrated once again in this series. If a substantial rate of error in detection is a customary aspect of radiology, then such an error cannot be a justification for a liability action.

Another significant cause of mismanagement of patients with lung cancer occurs despite correct radiologic interpretation. In our review of records of patients with lung cancer, we found several instances in which a report suggesting the diagnosis was not read or was ignored by the referring physician. Even more frequently, patients missed follow-up appointments or refused further evaluation.

## Conclusions

This retrospective study supports the observation that many detectable malignant lesions of the lung are missed at the time of their first radiologic presentation. Because all published studies confirm the high rate of error, it is suggested that such errors in diagnosis should not result in legal liabil-

ity. Unfortunately, these errors often result in a significant delay in diagnosis and treatment, which may affect resectability and, thereby, decrease the survival rate.

Use of moderately high (130 to 150) kVp is a practical technique which can increase the detection of lung cancer in several regions in which it is missed; these are the lung apices and paramediastinal and hilar areas. Awareness of the likelihood of error and careful checking of these problem areas on roentgenograms should help radiologists improve the detection rate of lung cancer.

The one proved method of reducing the error rate in the diagnosis of lung cancer is the use of a second independent observer. A trained radiologic technologist or the referring physician may be the most appropriate person for this role, in cooperation with the responsible radiologist. However, over 90 percent of our errors involved cases in which roentgenograms were reviewed by more than one radiologist; therefore, merely having a second trained observer does not eliminate many instances of missed lesions. Current radiologic techniques and practice still result in a high rate of error in the early diagnosis of lung cancer.

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