CHEST

Commonly Missed Findings on Chest Radiographs

Causes and Consequences

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Chest radiography (CXR) continues to be the most frequently performed imaging examination worldwide, yet it remains prone to frequent errors in interpretation. These pose potential adverse consequences to patients and are a leading motivation for medical malpractice lawsuits. Commonly missed CXR findings and the principal causes of these errors are reviewed and illustrated. Perceptual errors are the predominant source of these missed findings. The medicolegal implications of such errors are explained. Awareness of commonly missed CXR findings, their causes, and their consequences are important in developing approaches to reduce and mitigate these errors.

CHEST 2023; 163(3):650-661

KEY WORDS: artificial intelligence; chest radiograph; errors; lawsuits; misses

To err is human . . . —Alexander Pope

Chest radiography (CXR) is the most frequently ordered and performed imaging examination worldwide,[1] despite its limitations and the availability of more advanced, cross-sectional chest imaging. The clinical usefulness of the CXR is based on its wide availability, cost-effectiveness, ability to depict a broad range of cardiopulmonary conditions,[2] and low radiation dose. It is performed frequently as the first imaging study in the evaluation of patients with pulmonary symptoms.

Despite its widespread clinical usefulness, CXR interpretation remains highly challenging. It is a two-dimensional projection of a three-dimensional volume, with consequent superimposition of structures. Abnormal lung findings often are subtle and nonspecific. The appearance of normal anatomic structures varies with patient age. Chest radiography interpretation thus is appreciably prone to errors. Some of these errors, such as missed lung nodules resulting from early stage lung cancer or a pneumothorax requiring urgent attention, may lead to patient harm. Errors of these types are a common cause of medical malpractice claims. Clinicians therefore must remain proficient in interpreting these studies.[3,4]

This special features article discusses and provides examples of commonly missed CXR findings of clinical significance. The incidence, principal causes, and potential adverse consequences of these errors are explained, including their medicolegal implications. Awareness of these missed

ABBREVIATIONS: CXR = chest radiography

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DOI: https://doi.org/10.1016/j.chest.2022.10.039

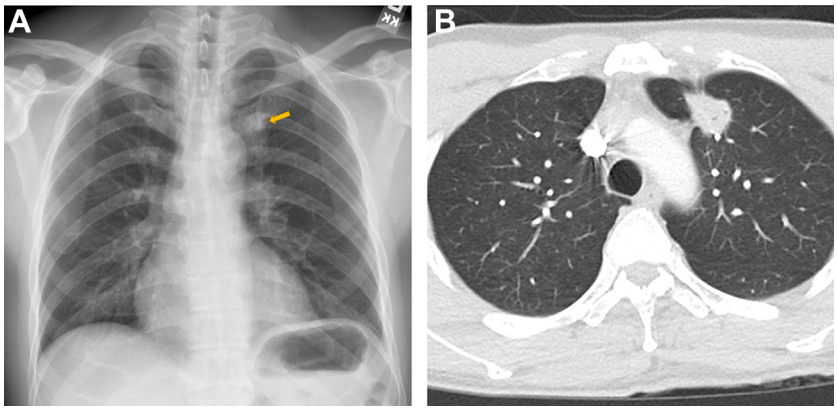

Figure 1 – *Images from a 53-y-old man with a left upper lobe nodule resulting from non-small cell lung cancer. A, On posteroanterior chest radiograph, note was made of an asymmetric opacity superimposed on the anterior aspect of the left first rib at its costochondral junction (arrow) . Detection was made difficult by superimposition of structures. B, Axial contrast-enhanced CT scan demonstrating the corresponding spiculated nodule with pleural indentations in the left upper lobe, consistent with the diagnosis of the non-small cell lung cancer.*

findings and their sources are important in developing approaches to avoiding them.

Commonly Missed Chest Radiography Findings

Incidence of Missed Lesions

Looking at radiologic error as a whole, approximately 1 billion radiologic imaging examinations are performed annually worldwide. The prevalence of radiologist errors has been estimated at 4% in a typical sample of cases encountered in practice, in which a substantial percentage of normal exists.[5,6] However, the incidence of errors may be as high as 30% when the test cases all show abnormalities.[6-8]

Garland's[6] seminal and prolific studies of radiologic error between the late 1940s and late 1950s showed that even experienced radiologists failed to note significant findings on 30% of CXR images showing positive results for disease.[5] He also found a false-positive rate of 2%. Many subsequent studies continue to confirm Garland's findings. The interobserver variability in CXR interpretations also is substantial,[9-11] generally reported to be 20% among patients with findings,[5] with radiologists' disagreement as high as 56%.[12] This further reflects the challenges of accurate detection of CXR abnormalities, even among experienced observers.

Published statistics on the frequency of specific missed CXR findings are limited and largely are based on malpractice data.[13] Missed nodules resulting from lung cancer are the predominant cause for malpractice claims involving chest imaging, accounting for 43%.[13] As detailed further herein, these errors overwhelmingly result from failure to detect the lesions on CXR. Among the most frequent CXR errors, in addition to missed lung nodules or lung cancer, are airspace opacities resulting from pneumonia, pneumothorax, pleural effusion, mediastinal and hilar masses, lymphadenopathy, thoracic fractures, and pneumoperitoneum.[13]

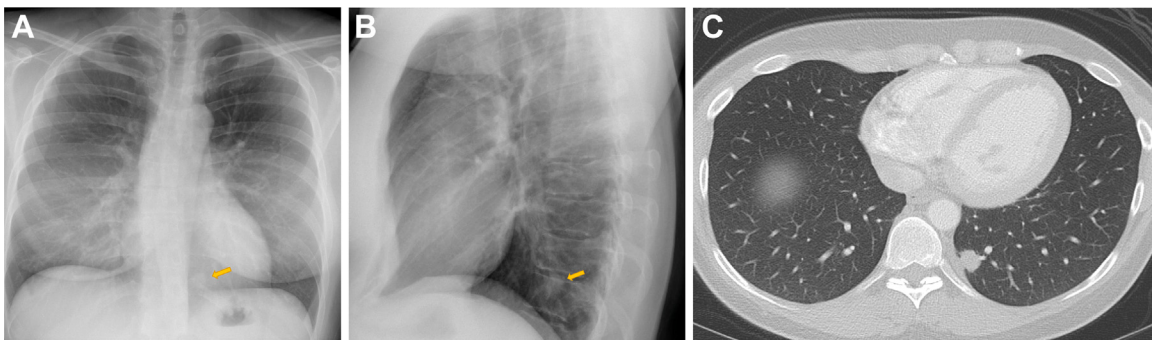

Figure 2 – *Images from a 34-y-old woman with a small pulmonary nodule in the left lower lobe. A, On posteroanterior chest radiograph, note was made of a nodular opacity superimposed on the inferior heart just above the medial left hemidiaphragm (arrow). The nodule is located within one of the blind spots where lung nodules commonly are missed (Fig 5). B, Lateral chest radiograph showing the nodule overlying the lower thoracic spine (arrow). C, Axial noncontrast CT scan demonstrating the corresponding lobulated nodule with pleural indentation in the left lower lobe.*

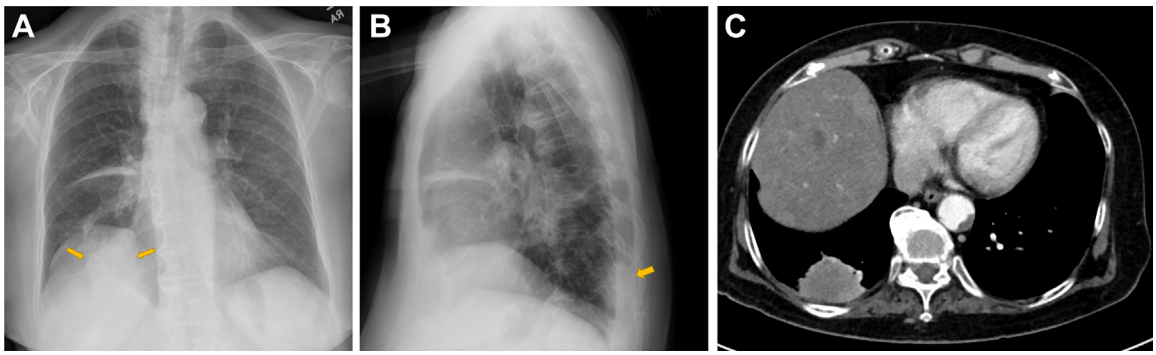

Figure 3 – *Images from an 82-y-old woman with right lower lobe non-small cell lung cancer. A, On posteroanterior chest radiograph, note was made of a round opacity at the right lung base, superimposed on the right hemidiaphragm (arrows). The lesion may be missed easily without attention to the blind spots in the lungs. B, Lateral chest radiograph showing the opacity overlying the mid to lower thoracic spine (arrow). C, Axial CT scan with contrast enhancement demonstrating the corresponding mass in the right lower lobe abutting the pleura. Multiple liver metastases also are seen.*

Types of Errors

As discussed in detail herein, radiologic error can be broken down into two fairly broad categories: perceptual error and cognitive error.[14] Briefly, perceptual error refers to an abnormality being seen retrospectively after having been missed during the initial interpretation of imaging. Cognitive error, however, refers to an abnormality that is detected, but is not understood or is diagnosed incorrectly. Perceptual error is a much more common occurrence, accounting for 60% to 80% of all radiologic errors.[3,5] It is this perceptual error, or observer error, that seems to account for the high frequency of missed abnormalities on CXR images, specifically.

The image interpretation process is based on a complex interplay of psychophysiological and cognitive processes.[5] It is important to note that overall evidence indicates that radiologists' errors are not the result of carelessness or negligence, but rather are the result of the very complex processes involved in CXR interpretation.[13,15-19]

Classically, three fundamental steps in the CXR interpretation process have been recognized: search and detect, recognition, and decision.[20] Seminal studies by Kundel et al[20] using eye tracking pointed to three categories of visual misses: (1) search error, in which the eyes never fixate on a lesion, and thus it is not seen; (2) error of recognition, in which the observer fixates on a lesion, but for less than the threshold time required to recognize it as an abnormality; and (3) decision error, in which fixation on a lesion is longer than the time required for recognition, but the observer fails to recognize it as an abnormality or actively disregards it.

The key component of the perceptual phase of CXR interpretation is that of visual search. A systematic,

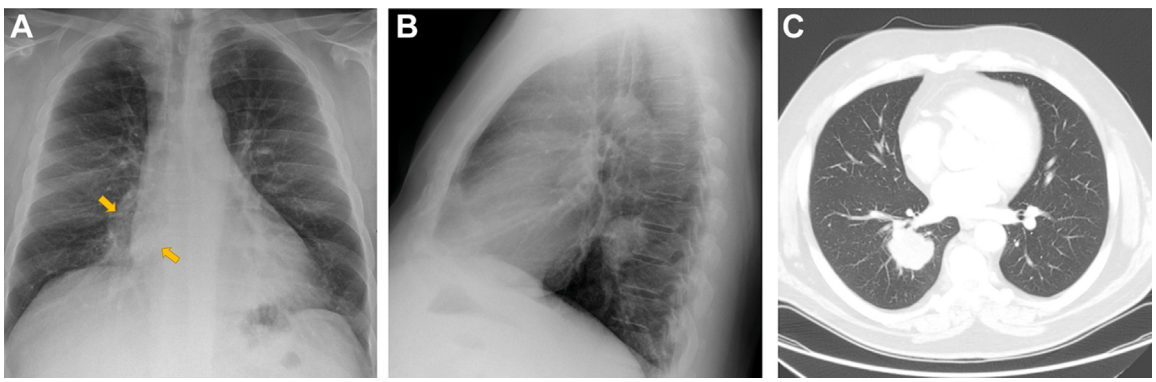

Figure 4 – *Images from a 56-y-old man with right lower lobe non-small cell lung cancer. A, On posteroanterior chest radiograph, note was made of an opacity at the medial right lung base, superimposed on the right heart and the right descending pulmonary artery (arrows). B, Lateral chest radiograph more clearly visualizing this opacity anterior to the lower thoracic spine. C, Axial CT scan demonstrating the corresponding mass in the right lower lobe.*

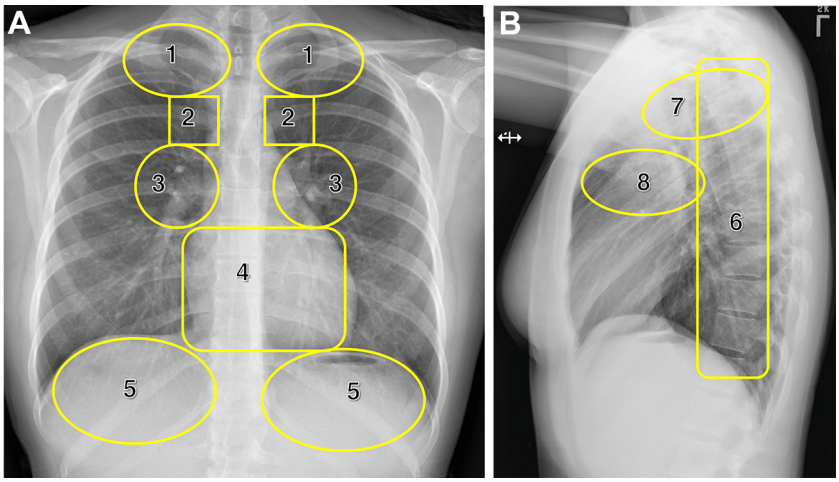

Figure 5 – *Be aware of the common locations of missed pulmonary nodules, the so-called blind spots. A, Posteroanterior chest radiograph showing that these include: (1) lung apices, in areas surrounded by the first ribs; (2) juxtamediastinal regions between the apices and hila; (3) hilar regions; (4) retrocardiac areas; and (5) lung areas projected beneath the diaphragms. B, Lateral chest radiograph showing that these include: (6) lung overlying the lateral spine, (7) posterior and apical upper lobes, and (8) lung superimposed on the superior heart. (Courtesy of Dr Mizuki Nishino at Brigham and Women's Hospital, Boston. Modified from RSNA 2004 Educational Exhibit "Hide and Seek: Subtle pulmonary nodules on chest radiograph. Mizuki Nishino, MD and Hiroto Hatabu, MD, PhD)*[35]

comprehensive approach to reading CXR images is important to assure all portions of the CXR image are inspected and analyzed.[21] This is particularly essential during training and for more novice readers. Studies using eye tracking have demonstrated that experienced radiologists use a more efficient, free, and global search, rather than scanning the CXR image with a preconceived orderly pattern.[21] Evidence has shown that experienced radiologists perceive most abnormalities within the first few seconds of viewing. In fact, < 300 ms may suffice to identify major features of lesions. This rapid identification of abnormalities increases with experience.[22] After this rapid phase is a slower, more deliberate, confirmatory and discovery phase to assure more difficult so-called blind-spot lesions are not overlooked and to take a second look in response to clinical indication. Analogous to the "thinking fast and slow" principle of Kahneman[23] is "perceiving fast and slow."[24,25] Such an approach requires extensive experience and is not advisable for less experienced readers, who should maintain a consistent, systematic approach to avoid missing important findings.

Among the multiple causes of perceptual errors are: (1) poor conspicuity of target lesions resulting from suboptimal technical factors, which include image acquisition, processing, and display parameters; (2) poor conspicuity of abnormalities resulting from intrinsic low contrast (eg, ground-glass lung nodules and opacities) or subtle contour alterations (eg, mediastinal or hilar lesions); (3) overlapping structures and blind spots, described herein; (4) incomplete visual search, including satisfaction of search, in which visual scanning of the image is terminated after an initial abnormality is detected; (5) inattentional blindness, a psychological phenomenon in which a seemingly obvious finding is

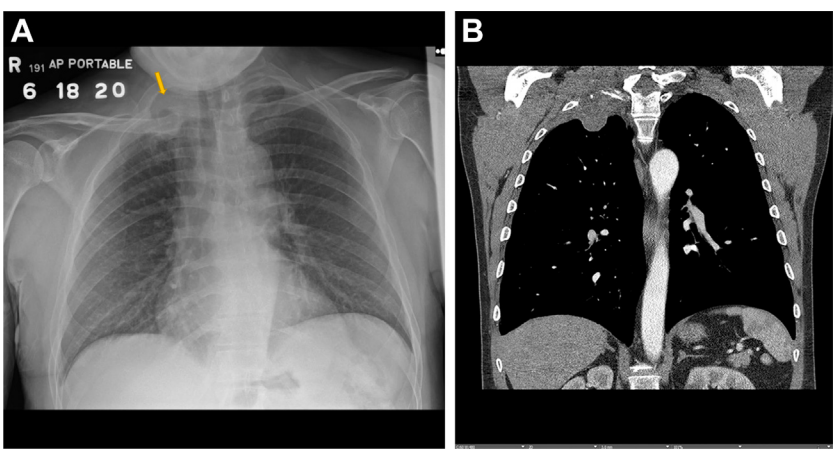

Figure 6 – *Images from a 49-y-old man with a superior sulcus tumor in the right apex with destruction of the right second rib (arrow). A, posteroanterior chest radiograph showing asymmetry is a clue to identify the abnormality. B, Coronal reformatted CT scan with contrast-enhancement demonstrating the right apical mass with chest wall invasion and destruction of the rib.*

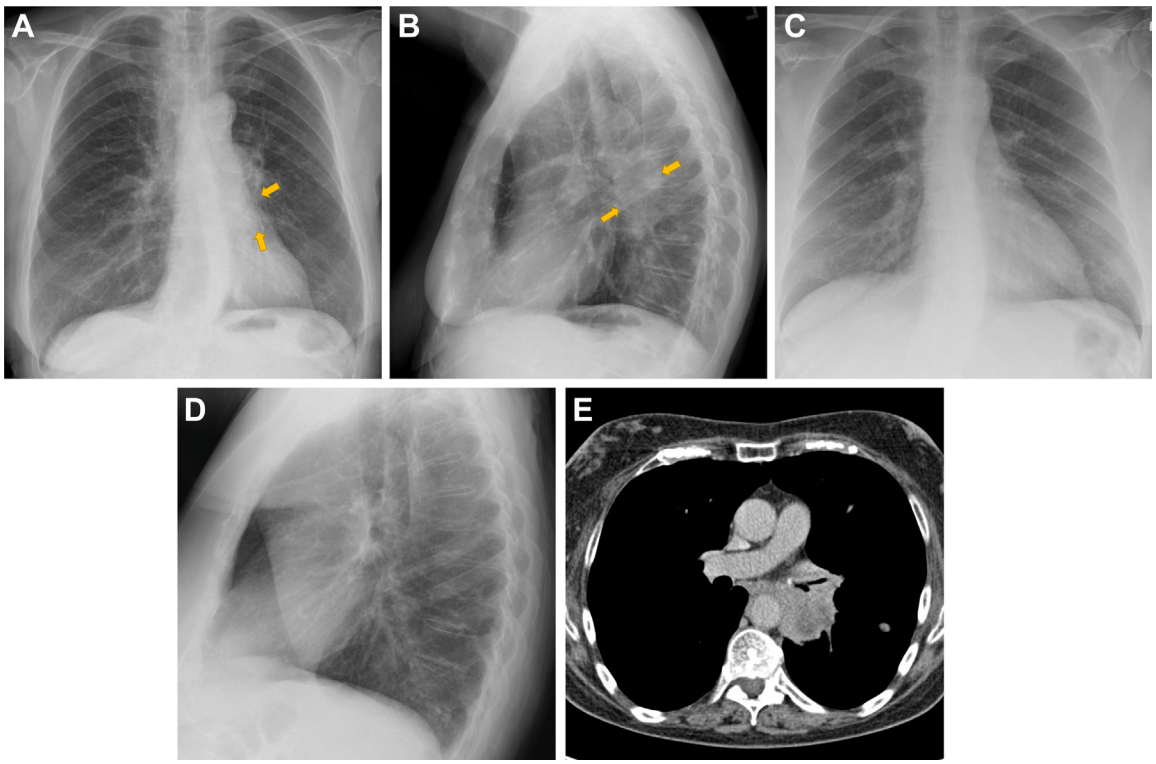

Figure 7 – *Images from a 58-y-old woman with left lower lobe non-small cell lung cancer. A, On posteroanterior chest radiograph, note was made of subtle increased opacity in the left infrahilar area (arrows). B, Lateral chest radiograph showing the corresponding opacity anterior to the mid thoracic spine (arrows). C, D, Prior posteroanterior (C) and lateral (D) chest radiographs showing that the abnormality is more easily identified by comparison. E, Axial contrast-enhanced CT scan demonstrating the corresponding hilar mass with heterogenous enhancement in the left lower lobe. This case illustrates the importance of comparison with prior radiographs and that even large masses in the hilar region may be difficult to detect. Knowledge of normal hilar anatomic features is essential.*

not noticed because attention is being focused on a different search task[26]; (6) suboptimal viewing conditions, including ambient lighting, distractions, and fatigue; and (7) overly rapid image interpretation speed. Many perceptual errors remain unexplained.

The principle causes of cognitive errors, in addition to lack of domain knowledge, are the consequence of cognitive biases, of which > 40 have been described.[5] Among the more common cognitive biases are anchoring (latching onto initial data), framing (being influenced by the way a case is presented), alliterative (being overly influenced by prior reports), and expectation bias (missing findings which are unexpected to be present or absent).

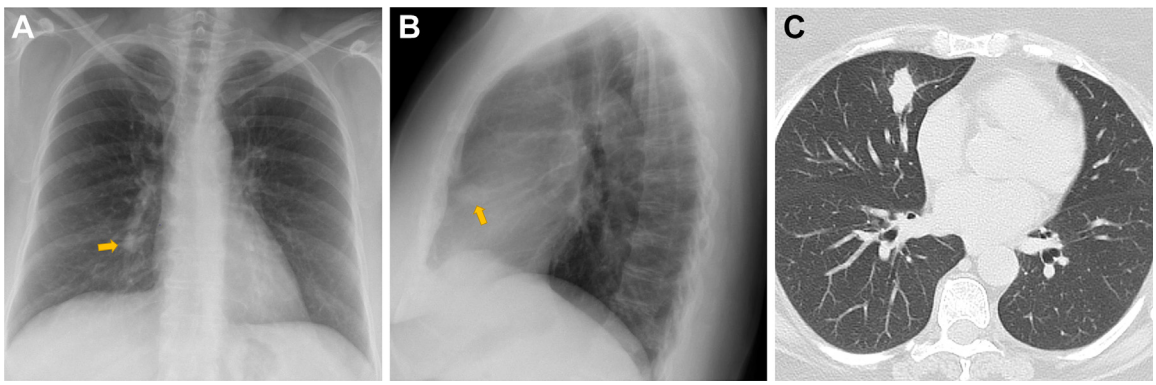

Figure 8 – *Images from a 62-y-old woman with carcinoid tumor in the right middle lobe. A, On posteroanterior chest radiograph, note was made of a subtle asymmetric opacity superimposed on the mid portion of the right descending pulmonary artery (arrow). B, Lateral chest radiograph showing the nodule to better advantage anteriorly in the right middle lobe (arrow). C, Axial noncontrast CT scan demonstrating the corresponding lobulated lesion in the right middle lobe.*

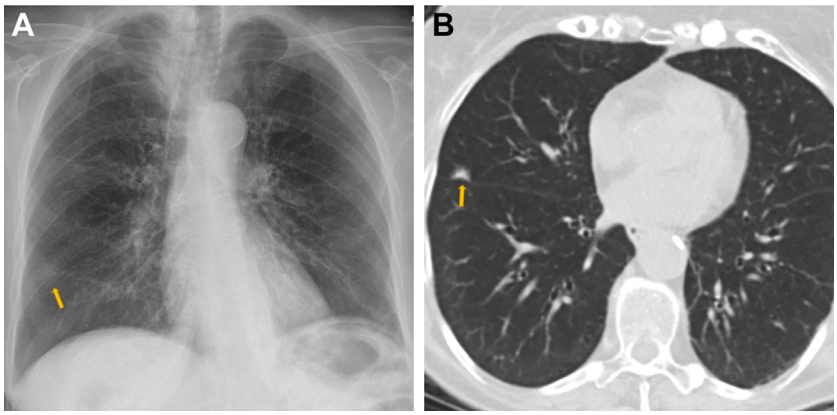

Figure 9 – *Images from an 89-y-old woman with a small, low-density nodule in the right middle lobe. A, On posteroanterior chest radiograph, note was made of a faint asymmetric opacity overlying the anterior aspect of the right fifth rib (arrow). B, Axial noncontrast CT scan demonstrating the corresponding small spiculated nodule in the right middle lobe with traction of the right major fissure (arrow). Lung cancers presenting as small, low-density nodules can be missed on chest radiography.*

Examples of Missed Lesions of Clinical Significance

Lung Nodules and Masses

In many patients, CXR provides the first opportunity to detect early lung cancer by the detection of incidental pulmonary nodules, despite the fact that screening is performed by low-dose CT scan imaging.[27] Unfortunately, these incidental nodules often are missed. The percentage of lung cancers missed on CXR that can be seen in retrospect ranges from 20% to 30%[28] to as high as 90%.[29-31] Countries other than the United States seem to be showing similar statistics.[32]

In 90% of cases in which a presumed mistake in lung cancer diagnosis has occurred, the error occurred on CXR.[13,33,34] As previously mentioned, the leading cause of these missed diagnoses is observer error. This often results from overlapping anatomic structures, including ribs and their costochondral junctions, clavicles, spine, mediastinum, heart, hila, pulmonary vessels, and diaphragms (Figs 1, 2, 3, 4). Common blind spots where lung nodules can be missed on the posteroanterior view, as illustrated in Figure 5, include the lung apices (Fig 6), extending along the paramediastinal areas (Fig 1) and the hilar regions (Fig 7). These areas have been referred to informally as "the legal zone." Additional blind spots are the areas of the lung superimposed on the heart (Fig 2) and projected below the domes of the diaphragm (Fig 3). The lateral radiograph plays an important role in allowing further evaluation of these blind-spot regions on the posteroanterior view (Figs 2, 3, 4, 8). However, it should be noted that relative blind spots also exist on the lateral radiograph, depicted in Figure 5. The most common of these are the posterior and apical portions of the upper lobes, overlying the spine, and over the superior heart.[35] Also contributing to missed lung nodules and lung cancers are tumor characteristics, including small size, low lesion attenuation (ground glass) (Fig 9), ill-defined margins,[3,22,34,36-40] and the presence of other lung opacities.[41]

Pneumonia

Opacities resulting from pneumonia may be subtle (Fig 10) and may occur within the blind-spot regions described herein. In particular, pneumonia frequently may be overlooked when at the lung bases and

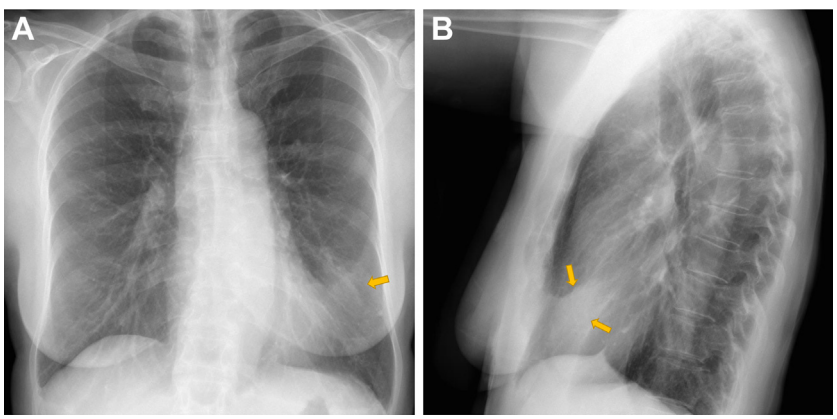

Figure 10 – *Chest radiographs from a 67-y-old woman with lingular pneumonia. A, Posteroanterior chest radiograph showing asymmetric increased opacity obscures the left lower heart boarder (arrow). B, Lateral chest radiograph showing corresponding opacity anteriorly (arrows).*

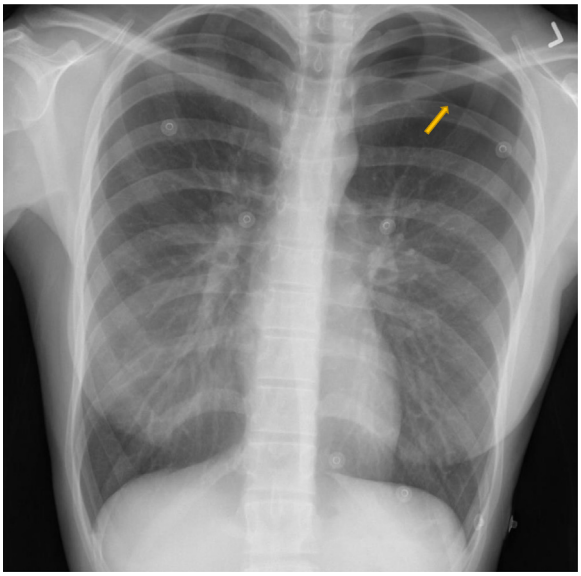

Figure 11 – *Posteroanterior chest radiograph from a 19-y-old woman with a left apical pneumothorax. Detection of this important finding requires observing the subtle asymmetric hyperlucency in the left upper hemithorax, the very thin curvilinear line of the visceral pleura, and lack of pulmonary vasculature beyond this line in the left apex (arrow).*

superimposed on the diaphragms. Therefore, it is important to use lateral radiography, in which pneumonias in the retrocardiac and diaphragmatic regions can be more apparent than on the posteroanterior view. Chest CT scans, including those obtained to evaluate for pulmonary embolism, not infrequently reveal a pneumonia overlooked on the CXR.

Pneumothorax

The findings of pneumothorax can be subtle and missed (Fig 11) because the very thin white line of the displaced visceral pleura can be overlooked, and the air in the pneumothorax space is not readily differentiated from that of the peripheral lung. The detection of a pneumothorax can be particularly challenging in the supine position, in which the pleural air predominates at the lung bases (the most nondependent region when supine), rather than the typical apical distribution. A supine pneumothorax can be recognized by the deep sulcus sign, along with basilar hyperlucency. Flattening of the ipsilateral hemidiaphragm and contralateral displacement of the mediastinum on inspiration are indicative of tension physiologic features.

Tight Lobar Atelectasis

Marked atelectasis of a lobe may be not be readily apparent because the opacity of the collapsed lobe may be relatively small, with compensatory hyperinflation of the remaining lung (Figs 12, 13). Detection relies on recognition of asymmetry between the lungs, often subtle, along with displacements of the hila and interlobar fissures. Familiarity with the characteristic appearances and displacements of lobar atelectasis (medial and anterior in the upper and middle lobes, medial and posterior in the lower lobes) is essential, because the finding may be the result of endobronchial tumor.

Tracheal Stenosis and Masses

The trachea long has been recognized as a blind spot for radiologists, with tracheal abnormalities (eg, postintubation or tracheostomy stenosis, primary tumors) frequently overlooked (Fig 14). However, this potentially can be avoided by making certain the trachea (and central bronchi) consistently and deliberately are included in the visual search of CXR images.

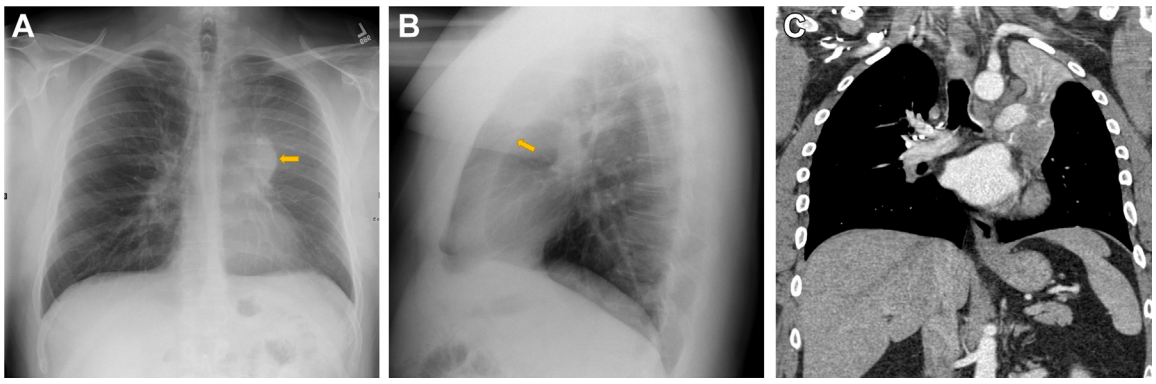

Figure 12 – *Images from a 42-y-old man with left upper lobe atelectasis resulting from a left hilar mass of non-small cell lung cancer. A, Posteroanterior chest radiograph showing that asymmetry is a clue to identify the abnormality, along with increased size and density of the left hilum (arrow). B, Lateral chest radiograph showing the atelectatic left upper lobe anteriorly (arrow). C, Coronal reformatted CT scan with contrast-enhancement demonstrating the left hilar mass with atelectasis.*

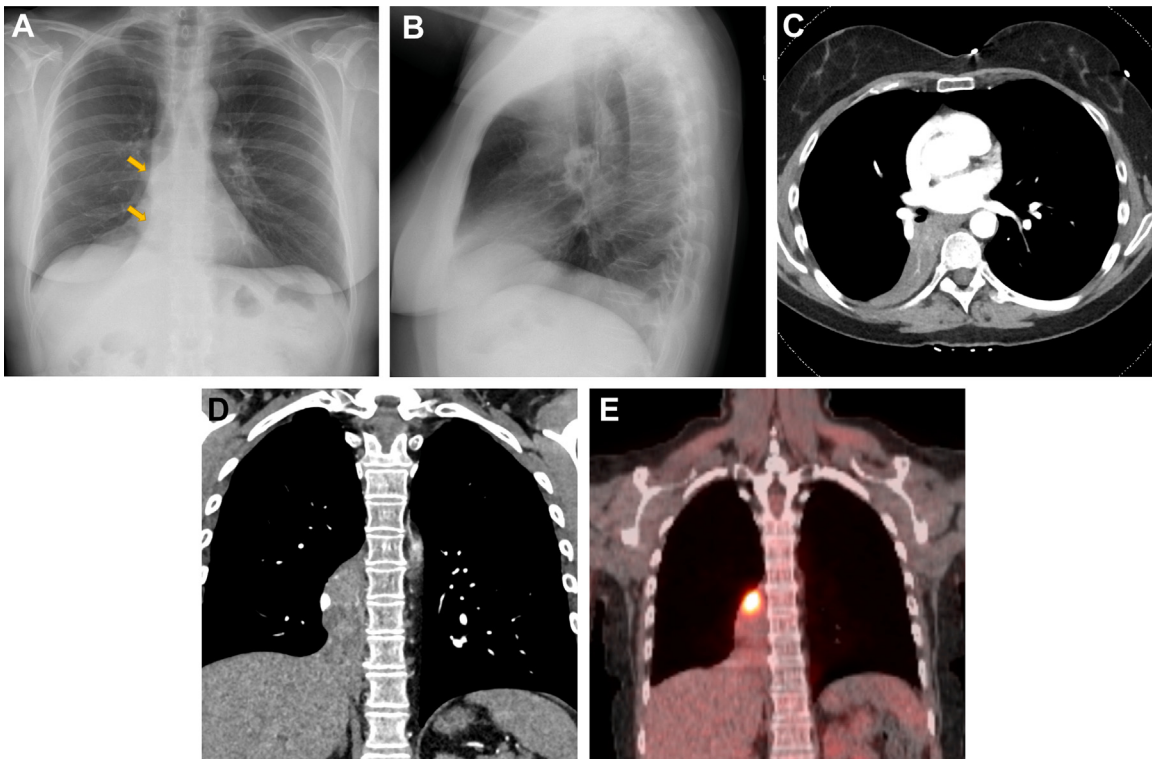

Figure 13 – *Images from a 56-y-old woman with right lower lobe tight atelectasis resulting from a right lower lobe mass of non-small cell lung cancer. A, On posteroanterior chest radiograph, note was made of asymmetric opacity and the sigmoid-shaped additional line in the medial aspect of the right lower lung (arrows), indicating the right lower lobe tight atelectasis. Also note the small, hypovascular right hilum and hypovascularity of the right lung resulting from compensatory hyperinflation of the right upper and middle lobes. Tight lobar atelectasis is an important finding that may be overlooked without careful observation. B, Lateral chest radiograph not showing the corresponding opacity clearly except for blunting of the posterior costophrenic angle of the right lung. C, Axial CT scan with contrast-enhancement demonstrating the corresponding atelectasis in the right lower lobe. D, Coronal reformatted CT scan with contrast-enhancement demonstrating the infrahilar mass with right lower lobe atelectasis. E, Coronal PET scan showing fluorine-18 fluorodeoxyglucose avidity in the tumor in the proximal portion of the right lower lobe.*

Hilar Masses and Lymphadenopathy

Recognition of hilar masses and hilar lymphadenopathy is one of the more challenging detection tasks in CXR interpretation. This requires familiarity with the range of normal appearances of the hila and knowledge of hilar anatomic features (relationship of hilar vessels, bronchi, and lymph nodes) on both the posteroanterior and lateral views. Evaluation of hilar size, configuration, and density allows for detection of hilar masses and lymphadenopathy (Figs 7, 12). Comparison with earlier CXR images facilitates the recognition of hilar lesions (Fig 7).

Mediastinal Lesions

Mediastinal lesions, including lymphadenopathy, masses, aneurysm, dilatation of the thoracic aorta, and mediastinal hematoma, generally manifest on CXR images as contour abnormalities of the mediastinum (Fig 15). They also may cause alterations of the normal mediastinal lines, that is, the interfaces between mediastinal structures and the adjacent air-filled lungs. The findings may be subtle and overlooked, requiring both a thorough visual search and knowledge of normal mediastinal anatomic features on both the posteroanterior and lateral CXR views. Likewise, abnormal gas collections in the mediastinum, as are present with pneumomediastinum (Fig 16), may be overlooked easily without a complete visual examination of the mediastinum from the thoracic inlet to the diaphragms.

Pneumoperitoneum

The upright CXR image is more sensitive than abdominal radiographs for the detection of free intraperitoneal air (Fig 17). Thus, it is important that the routine systematic visual search of the CXR image extends into the upper abdomen, both on the posteroanterior as well as lateral view if obtained, so as not to miss this potentially critical finding.

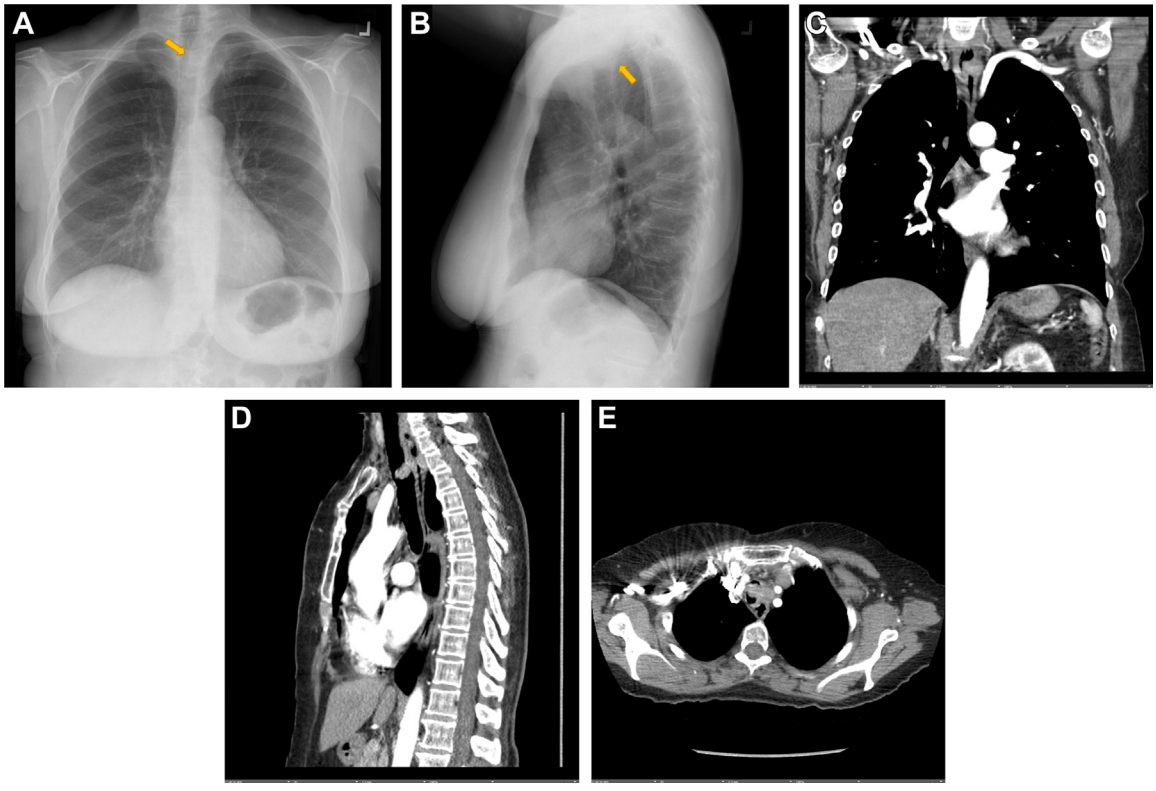

Figure 14 – *Images from a 60-y-old woman with tracheal tumor. A, On posteroanterior chest radiograph, note was made of the increased opacity on the left side of the mid portion of the trachea (arrow). B, Lateral chest radiograph only vaguely showing the opacity overlying the mid portion of the trachea (arrow). C, D, Coronal reformatted (C) and sagittal reformatted (D) CT scans clearly visualizing the corresponding tumor, which was not detected easily on the posteroanterior or lateral chest radiographs. E, Axial CT scan with contrast-enhancement demonstrating the corresponding mass in the trachea with invasion of the surrounding tissue and abutting to the left common carotid and left subclavian arteries. The trachea long has been considered a blind spot for radiologists, requiring routine inspection on chest radiography.*

Osseous Fractures and Metastases

As discussed herein, missed fractures are the second most common cause of malpractice claims against radiologists.[42] Thus, evaluation of the CXR image requires a dedicated, systematic search of the thoracic osseous structures so as not to miss the presence of fractures, as well as metastases and other lesions of the bones. This requires specific attention to the ribs, clavicles, scapulae, proximal humeri, and spine on the posteroanterior view, as well as the thoracic spine and sternum on the lateral view.

Malpositioned Lines and Tubes and Retained Foreign Bodies

A very large number of CXR images are obtained to check the position of support lines and tubes,

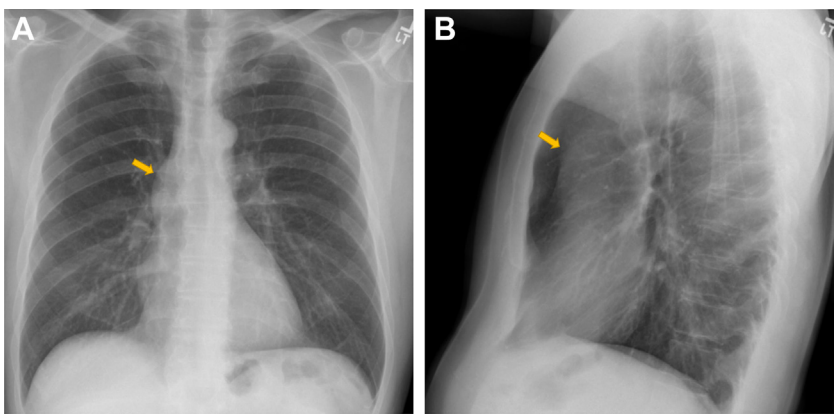

Figure 15 – *A, B, Chest radiographs from a 54-y-old male renal donor with markedly dilated ascending aorta (arrow) on the frontal (A) and lateral (B) views.*

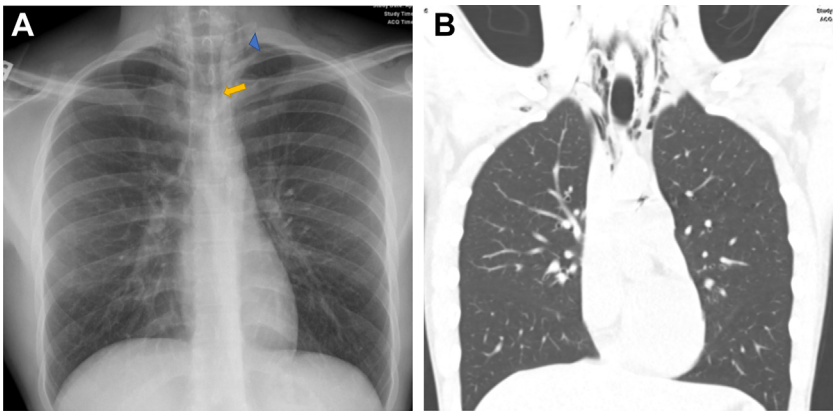

Figure 16 – *Images from a 38-y-old man with pneumomediastinum. A, Frontal chest radiograph showing streaks of air in the superior mediastinum (arrow) extending into the neck (arrowhead). B, Coronal reformatted CT scan confirming the findings.*

particularly in the ICU setting.[43] American College of Radiology appropriateness criteria support obtaining CXR images after placement of an endotracheal tube, central venous line, Swan-Ganz catheter, nasogastric tube, feeding tube, or chest tube.[44] Malpositioned lines, tubes, and other hardware can pose significant potential harm to patients (Fig 18). One study of newly placed catheters or tubes found that 27% were positioned improperly, and in 6%, complications were detected radiographically.[45] Therefore, a dedicated check of support apparatus is necessary. This also should include the detection of radiopaque foreign bodies, particularly when clinical concern for the latter is present.

Potential Adverse Consequences of Missed Chest Radiography Findings

Although many CXR errors may not be consequential, some may have significant adverse impact on patients, such as failure to recognize a critical finding—for example, pneumothorax (Fig 11), acutely widened mediastinum, and pneumoperitoneum (Fig 17)—or a missed opportunity for early diagnosis of cancer (Figs 1, 2, 3, 4, 6, 8, 9) or recognition of an early pneumonia (Fig 10). Beyond their impact on patients, these errors may cause physicians to experience appreciable stress, even in the absence of malpractice claims.[46] Missed findings on CXR, for example, a basilar pneumonia projected below the dome of the diaphragm, in some cases may lead to unnecessary additional imaging, such as a CT scan pulmonary embolism study.

Regardless of the cause, errors in the interpretation of CXR images continue to be a leading motivation for medical malpractice lawsuits that allege a failure to diagnose CXR abnormalities. This is a worldwide issue that continues to impact the frequency of medical malpractice lawsuits brought against radiologists and other physicians in all areas of medicine.

Missed lung cancer on CXR, detailed previously herein, carries major medicolegal risk. Missed lung cancer is the third most common cause overall for malpractice litigation against radiologists, following breast cancer and fractures.[42] It is the leading cause of malpractice claims specifically related to chest imaging, accounting for 43%. Ninety percent of these malpractice suits have been the result of errors in CXR interpretation.[34] Lesions with high conspicuity are more likely to be associated with adverse legal outcome.[13,34]

With respect to litigation, medical malpractice lawsuits are brought against physicians, nurses, and other healthcare professionals in all areas of medicine, no specialty going untouched. Research has found that 70% of medical malpractice lawsuits pertain to allegations that a diagnostic error was committed.[47] This puts radiologists in a particularly vulnerable position when it comes to

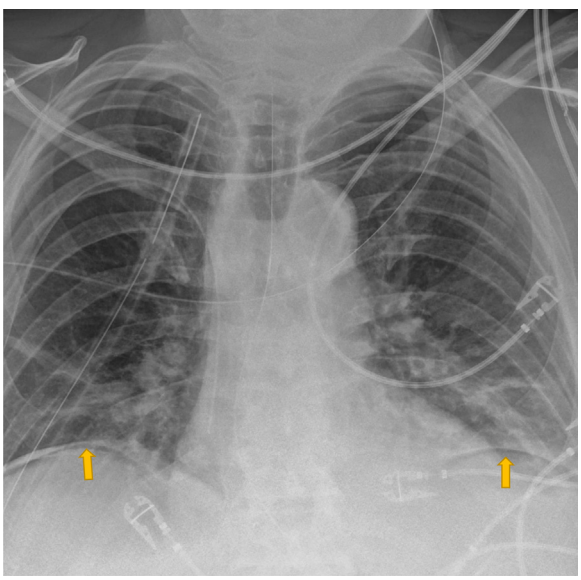

Figure 17 – *Chest radiograph from 58-y-old man with pneumoperitoneum (arrows) after undergoing esophagectomy with gastric pull-through.*

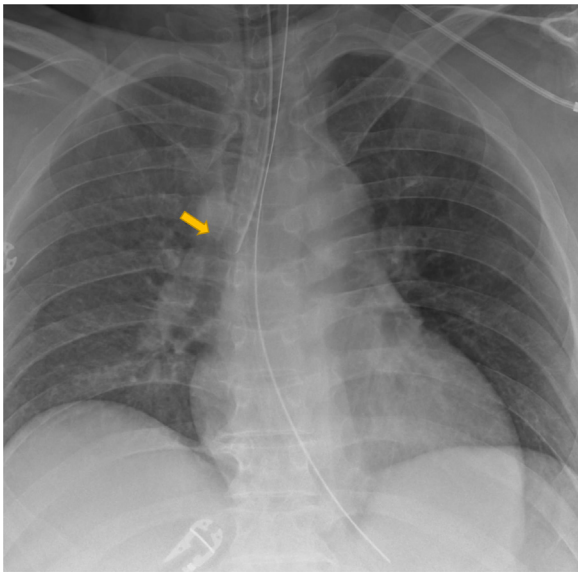

Figure 18 – *Chest radiograph from 42-y-old man with malpositioned endotracheal tube in the right main bronchus (arrow).*

the risk of legal action being taken against them, because imaging is among the most significant and most frequently used diagnostic tools in modern medicine. Moreover, radiologists are especially vulnerable because they typically do not have the opportunity to develop a longstanding relationship with a patient or to build good will. In the face of time constraints and the sheer increase in imaging workload, this unfortunately is a trend that likely will continue.

Despite the prevalence of alleged radiologic errors and lawsuits alleging medical malpractice, approaches are available that can be used to minimize the effects of alleged errors and to help to defend physicians in these lawsuits successfully. First, virtually every lawsuit must be assessed from the standpoint of both the allegation of negligence and the allegation of causation. Before damages can be recovered, the plaintiff typically must prove a violation of the standard of care.

In addition to assessing whether a violation of the standard of care occurred, all cases must be assessed as to whether any alleged violation of the standard of care was a proximate cause of any harm. Often, the interval from the time of misdiagnosis to the time of the correct diagnosis is important. The shorter the period, the less chance of proximate causation. In addition, in cases of missed cancers, the specific type of cancer must be assessed in determining whether proximate causation can be proven. A pathologic analysis often is required.

In short, plaintiffs bear the burden of proving both negligence and causation before any recovery of damages can occur. Nevertheless, with a meticulous analysis of both the negligence and causation aspects of any given case, lawsuits against radiologists and other clinicians interpreting CXR images often can be defended vigorously.

Conclusions

Given the frequency with which CXR is performed and its susceptibility to interpretation errors with missed findings, it behooves clinicians interpreting these studies to understand the sources of these errors. Examples of commonly missed, clinically significant abnormalities have been described. Perceptual errors are the primary cause of missed CXR findings. An important approach to avoiding these errors is a consistent, systematic, and comprehensive visual search pattern, with attention to known blind spots. In consideration of the potential adverse consequences of missed CXR findings, including risks of lawsuits alleging malpractice, the medicolegal implications of missed CXR findings have been explained. Awareness of the most commonly missed CXR findings and understanding the causes of these CXR errors offer opportunities to develop practical strategies to avoid them.[48]

Funding/Support

H. H. is supported by the National Institutes of Health [Grants R01CA203636, 5U01CA209414, and R01HL135142] and the National Heart, Lung, and Blood Institute [Grants 2R01HL111024 and 1R01HL130974].

Financial/Nonfinancial Disclosures

The authors have reported to *CHEST* the following: W. B. G. receives research support from Siemens Healthineers outside the submitted work. W. B. G. serves as a consultant for Siemens Healthineers, related to work. H. H. reports grants from Canon Medical Systems, Inc., grants from Konica-Minolta, Inc., personal fees from Mitsubishi Chemical Co., and personal fees from Canon Medical Systems, Inc., outside the submitted work. None declared (B. A. P.).

Acknowledgments

Author contributions: W. B. G. developed and implemented the search strategy and performed the literature search. H. H. provided the cases. W. B. G. created the first draft of the review with section contributions by B. A. P. and H. H. All authors critically reviewed the manuscript and approved the final version, taking accountability for the work.

Other contributions: This article is dedicated to the memory of Wallace T. Miller Sr., MD. "Wally Sr." was a master chest radiologist, clinician, teacher, and role model. He showed us that the chest radiograph is not simply an image, but a portal through which one can gain deep clinical insights into a patient. The authors thank Marlene Gefter and Lyndsay Tipton for their devoted assistance in the preparation of the manuscript and beyond.

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