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PATIENT SAFETY NETWORK

The Dropped Lung

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The Case

A 79-year-old woman was admitted for hypoxia and shortness of breath. Two weeks prior she had been hospitalized for dyspnea and was found to have multiple bilateral pulmonary nodules on chest x-ray and a small left-sided pleural effusion felt to be consistent with widely metastatic cancer. The patient refused a work-up and was discharged to a skilled nursing facility (SNF). Increasing dyspnea and oxygen desaturations at the SNF prompted her return to the hospital. In the Emergency Department, the patient was moderately dyspneic with a respiratory rate of 25 and an oxygen saturation of 85% on room air and 97% on 6-Liter nasal canula. Chest x-ray again demonstrated nodules on the right side, but her entire left lung field was now completely “whited out.”

The residents caring for the patient interpreted the white-out as a large pleural effusion, and diagnostic thoracentesis was attempted with return of only 25 cc of yellow fluid. A repeat chest X-ray showed a small lucency at the apex, which they interpreted as improved aeration after removal of fluid. On hospital day two, the initial chest x-ray was read out by the radiologists as left lung collapse (not effusion) with mild leftward deviation of the trachea. The post-procedure film was interpreted as persistent collapse, now accompanied by a small apical pneumothorax.

The patient’s pneumothorax ultimately resolved with conservative treatment, and she received palliative care for her cancer.

The Commentary

The image of harried on-call residents huddled around a dyspneic patient as they perform a thoracentesis evokes images of medicine’s finest therapeutic traditions, but also increasing concerns about patient safety and supervision of trainees. This elderly woman with terminal cancer was transported to an acute care hospital where admitting residents considered the radio-opaque hemithorax to be the source of her symptoms. Having previously seen similar appearing radio-opaque hemithoraces as a manifestation of malignant pleural effusions in patients with cancer, the residents mistakenly assumed this diagnosis and attempted thoracentesis. Their attempts, however, caused a pneumothorax, failed to drain any significant

volume of fluid, and did not relieve the patient's dyspnea.

Of greatest concern is the needlessness of the procedure. The chest x-ray demonstrated a mediastinum shifted toward the affected side.(Figure 1) This radiographic sign suggests airway obstruction with whole-lung atelectasis, rather than pleural fluid, as the cause of the opaque hemithorax. Thus, thoracentesis was not indicated and was dangerous.

How did this error occur? The residents did not notice the mediastinal shift because they had not yet learned this radiographic sign--a misperception error. They performed the wrong procedure because they oversimplified this patient's complex presentation by focusing on familiar findings, which guided them to the wrong diagnosis--an intention error. Their heuristic for a dyspneic cancer patient equated an opaque hemithorax with malignant pleural effusion. In the minds of trainees, such rules often demonstrate how "bits and pieces of knowledge…interact with each other to create large-scale and robust misconceptions."(1) These residents also demonstrated poor "knowledge calibration," (2) in that they "didn't know what they didn't know," which diminished opportunities to call for help.

The absence of a supervising attending physician in this situation should be considered. Thoracentesis is the third leading cause of iatrogenic pneumothorax in inpatients.(3) Even when performed under the direct supervision of certified pulmonary physicians using pre-procedure ultrasound, 5% of thoracenteses result in pneumothorax.(4) For these reasons, some training programs designate thoracentesis an attending-level procedure. Others have concluded that direct oversight for all such procedures is unfeasible, particularly since residents perform many other unsupervised procedures with risks comparable to thoracentesis.

Patients and their families might assume residents always receive formal training and certification of competency before they perform high-risk, invasive procedures independently. However, this assumption is often incorrect. One study demonstrated high variability in requirements for documenting procedural skill among family medicine residency programs.(5) Internal medicine programs have lagged behind emergency medicine and surgery training programs in teaching and documenting procedural competency.(6) The adage "see one, do one, teach one" describes a decades-old and ongoing patient safety vulnerability in our teaching institutions. In a recent survey, residents stated that it took more than the minimum number of procedures recommended by the ABIM before they felt comfortable performing thoracentesis (and other procedures).(7)

The Accreditation Council for Graduate Medical Education (ACGME) now requires residents to achieve six "Core Competencies".(8) (Table) In implementing new JCAHO and ACGME standards, educators face considerable challenges in validating tools to ensure that programs' certification of competency identifies residents who can perform procedures independently.(7,8) For procedural skills, greater attention will be paid to simulation and scenario modeling using cadavers, computer programs, and hands-on workshops.(9) In implementing these new standards, it will be crucial to focus on the cognitive aspects of determining the appropriateness of procedures, not just the technical skills.

In this case, the residents misinterpreted this patient's chest radiograph, which is a common problem among junior doctors.(10) Studies demonstrate high concordance between the initial radiographic interpretations of residents in radiology and emergency medicine and the later interpretations of staff radiologists.(11) Because we lack similar studies of ward resident skills, it might be prudent to require

residents to review radiographs with credentialed physicians (either on-site or via teleradiology) before performing invasive procedures based on those radiographs. This strategy may also promote teamwork and communication, in addition to improving procedural safety.

Safe thoracentesis requires identification and localization of pleural fluid. Physical examination and standard chest radiographs with decubitus views may identify only 60% of effusions in patients with heart failure.(12) Complex pleural processes, such as loculations and entirely opaque hemithoraces, essentially negate the value of the physical examination and chest radiographs for fluid localization. Ultrasound, in contrast, identifies and localizes more than 90% of pleural effusions regardless of the complexity of the pleural process.(13) The enhanced safety of ultrasound-guided thoracentesis (Figure 2) has stimulated our pulmonary service to adopt it as the standard of practice. An alternative strategy of performing ultrasound only for patients at high risk of thoracentesis complications is faulty because no specific features reliably identify those at increased risk of pneumothorax.(4) The advent of low cost, small, and highly portable ultrasound equipment allows non-radiologists to perform ultrasound, ostensibly extending the physical examination and replacing the stethoscope for evaluating patients for thoracentesis.(14) Had the residents received training in thoracentesis with portable ultrasound or consulted a trained ultrasound operator, the absence of pleural fluid and the presence of consolidated lung would have been readily detected with a diagnostic accuracy comparable to chest CT.(15)

Take-Home Points

This patient's experience illustrates several key points about enhancing the safety of care provided by residents, particularly as it relates to invasive procedures:

- A certified competent physician should directly supervise resident procedures until outcome measures certify the resident as an independent competent operator.
- ACGME requirements will enhance patient safety by expanding the boundaries of resident education to include systems-based practice and communication.
- To ensure optimal outcomes from invasive procedures, residency programs should develop protocols, algorithms, and checklists. These would include appropriate safeguards, such as review of pre-procedure imaging studies by a competent physician, use of available resources that improve outcomes (eg, ultrasound for thoracentesis), and guided review of common indications and contraindications for the procedure.
- We believe clinical evidence supports performing thoracentesis by image guidance with ultrasound or CT for most patients with pleural effusions. Exceptions include patients with large, free-flowing effusions who have successfully undergone serial thoracenteses.

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Table

Table. Six Core Competencies and Resident Evaluation Requirements Defined by the Accreditation Council for Graduate Medical Education (ACGME).(8)

Competencies	Requirements
Patient Care	Compassionate, appropriate, and effective treatment of health problems and the promotion of health
Medical Knowledge	Established and evolving biomedical, clinical, and cognate (eg, epidemiological and social-behavioral) sciences and the application of this knowledge to patient care
Practice-Based Learning and Improvement	Effective information exchange and teaming with patients, their families, and other health professionals
Interpersonal and Communication Skills	Effective information exchange and teaming with patients, their families, and other health professionals
Professionalism	Commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population
Systems-Based Practice	Actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value

Figures

Figure 1. Patient’s radiograph showing complete opacification of the left hemithorax and shift of the mediastinum toward the left.

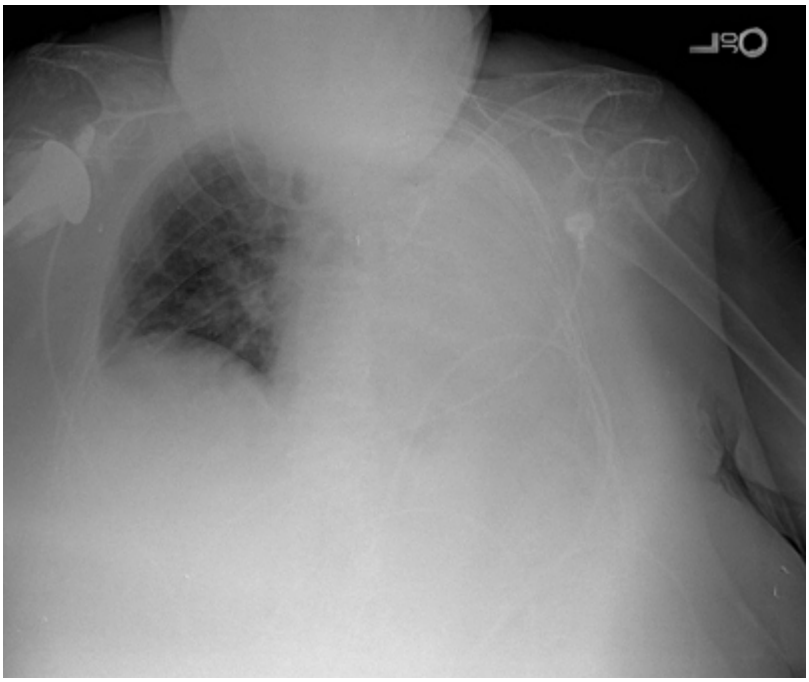
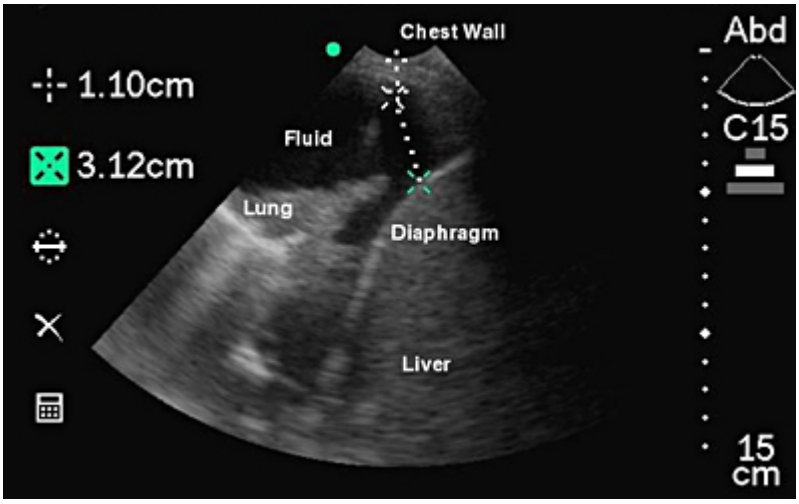


Figure 2. Ultrasound image directed from the right lower chest wall toward the lung. Pleural fluid is shown as a dark, anechoic region. Atelectatic lung is shown contrasted as a white density. The diaphragm (white curved structure) and liver are within reach of a thoracentesis needle (potential needle path shown by dotted line).



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