Perioperative Point-of-Care Ultrasonography

The Past and the Future Are in Anesthesiologists' Hands

IN this issue of ANESTHESIOLOGY, Ueda *et al.* report two cases in which point-of-care ultrasonography led to the rapid intraoperative diagnosis of pneumothorax.[1] In recent years there has been a dramatic increase in the utilization of ultrasound for real-time guidance of clinical decision-making and procedures. A growing body of evidence demonstrates the benefits of this change in practice. The scenarios described in this issue's case report highlight anesthesiologists' application of an improved method for diagnosis of intraoperative pneumothorax. Furthermore, they prompt the question: "What role should anesthesiologists play in the burgeoning field of point-of-care perioperative ultrasonography?" To answer that question about the future, we must delve into the past.

"Numerous studies have shown that ultrasound is more sensitive than chest x-ray for pneumothorax detection . . ."

Anesthesiologists have been instrumental in the development of perioperative ultrasound over the last 30 yr. Notable success stories include intraoperative transesophageal echocardiography, ultrasound-guided vascular access, and ultrasound-guided regional anesthesia. Cardiologists initially developed transesophageal echocardiography in the early 1980s for imaging of cardiac structures not well visualized on transthoracic echocardiography.[2] By the late 1980s, cardiac anesthesiologists recognized the potential effect of intraoperative echocardiography on cardiac surgery. Initially anesthesiologists depended on cardiologists for transesophageal echocardiography image acquisition and interpretation, but subsequently gained the skills to perform and interpret intraoperative transesophageal echocardiography independently. Much advancement in transesophageal echocardiography is attributable to the ingenuity of anesthesiologists who sought to improve the care of cardiac surgical patients. More recently, critical care anesthesiologists have helped lead the development of point-of-care transthoracic echocardiography in the perioperative period.[3] Focused transthoracic echocardiography allows clinicians to rapidly and noninvasively answer important questions about cardiac function and pathology.

Ultrasound-guided vascular access was first described in the late 1970s and has evolved into a widely recommended method for improving patient safety.* In 1978, Ullman and Stoelting described the use of a Doppler device for localization of the internal jugular vein.[4] Legler and Nugent published a small series in 1984 that showed an increased likelihood of first-pass success during internal jugular cannulation using Doppler technology.[5] By the 1990s, anesthesiologists were using ultrasound for imaging of neck anatomy during the placement of internal jugular lines.[6] Anesthesiologists' use of ultrasound guidance for vascular access increased tremendously in the past decade and in 2011 it is a common component of anesthesiology residency training. Clinicians who use ultrasound for central venous access also successfully apply similar techniques to aid in the placement of difficult arterial or peripheral venous lines.[7,8]

Anesthesiologists followed a similar time course in the development of ultrasound guidance for regional anesthesia.[9] A 1978 article by la Grange *et al.* described Doppler localization of the subclavian artery before performance of a supraclavicular brachial plexus block.[10] Eleven years later, Ting and Sivagnanaratnam reported real-time imaging of local anesthetic spread around the axillary brachial plexus during 10 nerve blocks.[11] In the 22 yr since that report, ultrasound guidance for regional anesthesia has developed into a major component of routine anesthesia practice, thanks in large part to a group of dedicated pioneer anesthesiologists who have fostered the field and ensured its success.

◆ This Editorial View accompanies the following article: Ueda K, Ahmed W, Ross A: Intraoperative pneumothorax identified with transthoracic ultrasound. ANESTHESIOLOGY 2011; 115:653–5.

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* Making Health Care Safer: A Critical Analysis of Patient Safety Practices. 2001. Available at: http://www/ahrq.gov/clinic/ptsafety/. Accessed November 8, 2011.

 Anesthesiology 2011; 115:460–2

If transesophageal echocardiography, vascular access, and regional anesthesia represent established "mainstream" applications of perioperative ultrasound, chest ultrasound and other modalities have emerged more recently among anesthesiologists. Two recent articles in ANESTHESIOLOGY describe the use of ultrasound for evaluation of gastric content and volume, the preoperative implications of which are obvious.[12,13] Anesthesiologists have developed methods for the sonographic evaluation of the upper airway before, during, and after tracheal intubation.[14–16] Intraoperative transcranial Doppler has been used by anesthesiologists to monitor cerebral blood flow during prolonged Trendelenburg positioning.[17]

Sonographic demonstration of "lung sliding" to rule out pneumothorax has been well described in the critical care literature.[18,19,20] What makes this case report noteworthy is that anesthesiologists used this technique while the patient was having surgery. The authors' actions demonstrate the fundamental advantage of point-of-care testing of any kind: the clinician at the bedside can obtain, interpret, and use diagnostic data in real time. This eliminates the inefficiencies associated with consulting other services for imaging studies. When used properly, point-of-care ultrasound gives the clinician essential data without unnecessary delays.

Traditionally, chest x-ray is the study of choice for diagnosis of pneumothorax. Numerous studies have shown that ultrasound is more sensitive than chest x-ray for pneumothorax detection, making it a superior screening test.[19,21,22] Although the absence of lung sliding is highly sensitive for detection of pneumothorax, it is not highly specific.[23] Any condition that prevents the visceral and parietal pleura from sliding against each other will result in the absence of lung sliding. Such processes include acute respiratory distress syndrome, atelectasis, pleural disease, or contralateral mainstem intubation. When evaluation of lung sliding is combined with evaluation of other sonographic signs such as B-lines, lung pulse, and lung point, the specificity of ultrasound for pneumothorax is greatly increased.[23] The high specificity of chest x-ray for pneumothorax makes it a reasonable confirmatory test if the patient's condition allows the time necessary for obtaining a radiograph. Alternatively, in the setting of high clinical suspicion for pneumothorax and deteriorating respiratory or hemodynamic status, the absence of lung sliding is sufficient to make the diagnosis and proceed with thoracostomy without waiting for a chest x-ray.

The second case is an excellent example of the use of point-of-care ultrasound of the pleura and lung. In the setting of a clinical suspicion of pneumothorax, ultrasound aided in the diagnosis and allowed the clinicians to use lifesaving therapy without waiting for additional imaging studies. One could argue that in a trauma patient with known intrathoracic injuries and reduced breath sounds on the left, pneumothorax could be diagnosed without ultrasound. However, with ultrasound readily available, examination for lung sliding requires minimal time and reduces the risk of an unnecessary thoracostomy tube placement.

The application and scope of point-of-care ultrasound performed by anesthesiologists are not without controversy. It is worthwhile to recall that a few years ago, intraoperative transesophageal echocardiography, ultrasound for vascular access, and ultrasound for regional anesthesia were considered controversial modalities in anesthesiology. Our field's careful development of these applications has made them standard practice in many centers. With appropriate training and development, point-of-care ultrasound of the chest, including evaluation for pneumothorax and other techniques, may be standard practice among anesthesiologists 10 yr from now.

A key component of anesthesiologists' apprehension toward point-of-care ultrasonography is the potential for image misinterpretation resulting in incorrect assessment and treatment. Critical to the safe and effective use of this modality is proper training. We encourage readers to obtain training in ultrasound and seek instruction from colleagues familiar with chest ultrasound and other applications, including focused echocardiography and abdominal sonography in trauma.[24] Recent anesthesia history has shown us that we are capable of making point-of-care ultrasonography an important component of the high quality care that we provide. In the past, anesthesiologists have succeeded in developing ultrasound modalities that improved patient care. The impetus is on today's anesthesiologists to guide perioperative point-of-care ultrasound into the future.

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