Emergency Ultrasound at the Bedside: Not Just FAST

A Cost-Effective Technology to Reduce Medical Errors and Improve Safety

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For critically injured trauma patients, "there is a golden hour between life and death," observed R. Adams Cowley, MD, who pioneered the United States' first statewide Emergency Medicine Service, in Maryland, in 1973. Also the founder of the nation's first shock trauma center, Cowley is widely credited with being the first physician to recognize the supreme importance of combining skill, speed, and use of state-of-the-art medical technology to diagnose and initiate treatment of trauma patients during the first 60 minutes after an injury. His "golden hour" paradigm has revolutionized emergency care worldwide by highlighting the ideal strategy to optimize trauma patients' survival (University of Maryland).

Since the 1980s, emergency ultrasound performed by emergency physicians at the point of care has been recognized as a valuable technology to improve emergency department (ED) care (Jehle et al., 1989). A large body of compelling clinical evidence has demonstrated that use of ultrasound at the point of care can safely aid time-critical decisions and procedures in the ED (Jain, Stead & Decker, 2008). Employing ultrasound at the bedside can also reduce medical errors, provide more efficient real-time diagnosis, and in certain clinical scenarios, can supplement or replace more expensive imaging modalities, such as computed tomography (CT), sparing patients exposure to ionizing radiation (Moore & Copel, 2011).

FAST, Accurate, and Cost-Efficient

Focused Assessment with Sonography in Trauma, or the FAST exam, is now well-established as the imaging modality of choice to evaluate trauma patients for potentially life-threatening injuries, by detecting free fluid in the peritoneal, pleural, pelvic, or pericardial spaces—typically an indication of hemorrhage in trauma patients. The FAST exam has been found to have a sensitivity of 73 to 99%, with overall accuracy of 90 to 98% for detecting clinically significant intra-abdominal injury in trauma patients (Moore & Copel, 2011). An extended version of the exam, e-FAST, also evaluates the chest for pneumothorax, the patient's volume status, and other focused indications.

The FAST exam, a term first coined in 1996, has become an enormously important tool in emergency medicine. More than 39 million patients a year are assessed in EDs for trauma, which ranks as the leading cause of death in people under age 45. Torso trauma alone accounts for more than 5 million cases annually, resulting in upwards of 500,000 operations and 50,000 deaths (Melniker et al., 2006).

Assessing trauma patients with ultrasound at the bedside has been shown to speed up care and improve outcomes while significantly reducing costs. For example, a clinical trial at two level 1 trauma centers analyzed the effect of evaluating torso trauma patients with point-of-care ultrasonography (PLUS). The average time from arrival at the ED to transfer to operative care was 57 minutes—achieving the goal of treatment within the "golden hour"—for PLUS patients, while the average time for a control group of torso trauma patients who didn't get PLUS was more than twice as long: 116 minutes (Melniker et al., 2006).

What's more, the PLUS group had fewer CT scans, a lower rate of complications, and shorter hospital stays, averaging 6.2 days versus 10.2 days for the control group. Total charges for PLUS patients who underwent surgery averaged $28,400, while charges for control patients averaged $47,600, vividly demonstrating the cost-effectiveness of ultrasound assessment of torso trauma patients.

Increased focus on improving patient safety has put the spotlight on efficient diagnosis of emergent disorders with ultrasound at the bedside and error reduction through ultrasound-guidance of needle procedures.

Improving Procedural Success and Safety

Use of ultrasound at the point of care can also significantly improve the safety of such invasive procedures as regional nerve block injections, central venous catheter (CVC) placement, and fluid drainage, compared to "blind" insertions based on anatomical landmarks. When thoracentesis for pleural effusions—a condition that affects about 1.5 million American patients a year—is performed under ultrasound needle guidance, the rate of iatrogenic pneumothorax, dropped to 0% from about 29% in one study and from 18% to 3% in another (Feller-Kopman, 2006).

Ultrasound guidance also increases the effectiveness of paracentesis, a challenging procedure to perform in a blind fashion. In a randomized prospective clinical trial at University of Texas Southwestern Medical Center in Dallas, emergency physicians successfully performed this procedure under ultrasound guidance at bedside in 95% of patients, while only 61% of patients were successfully aspirated using the traditional technique (Nazeer, 2005).

For central line placements, the evidence is so robust that the Agency for Healthcare Research and Quality (AHRQ) has classified ultrasound guidance as one of the 11 most important safety practices to prevent procedural errors and adverse events. The AHRQ has concluded that the use of ultrasound visualization reduces the number of failed venipuncture attempts prior to successful placement and substantially lowers the risk of complications, including pneumothorax, corresponding to a relative risk reduction of 78% (AHRQ, 2001).

Preventing Costly Errors

Iatrogenic lung puncture during central line placement can be an expensive error, since AHRQ has reported that the marginal costs of treatment range from $17,000 to $45,000 (Zhan et al., 2004). Medical errors associated with blind techniques can also trigger costly litigation. An analysis of 7,328 closed malpractice claims, conducted by American Society of Anesthesiologists researchers, found that those related to central catheters "had a high severity of injury," leading to large settlements. For pneumothorax, the median payment was $143,250. Payments of up to $1,076,653 were reported for air embolism and up to $6,912,000 for cardiac tamponade. When all central catheter-related malpractice claims were combined, the median payment was $105,500 (Domino et al., 2004).

To reduce mechanical complications, such as pneumothorax and bleeding, during central line placement, in February of this year, the Centers for Disease Control designated ultrasound guidance for central line placement as category 1B (strongly recommended for implementation) in its 2011 Guidelines for the Prevention of Intravascular Catheter-Related Infections (O'Grady et al., 2011). In an era of growing concern about hospital-acquired infections, ultrasound-guided catheterization of the internal jugular vein has been shown to reduce the rate of catheter-related infections by 35% (Karakitsos et al., 2006).

This finding highlights an important opportunity to save both lives and dollars by adopting ultrasound guidance at the point of care as a best practice for central venous access. According the CDC, about 250,000 catheter-related bloodstream infections occur annually, with attributable mortality estimated at 12 to 25%, and the attributable cost per infection estimated to range from $34,508 to $56,000 (O'Grady et al., 2002).

Locally we use ultrasound to guide all elective central-line insertions into the internal jugular vein, a practice that is now the recommended standard of care in the United Kingdom, under evidence-based guidelines issued by that nation's National Institute of Clinical Excellence (NICE) in 2002. Based on an analysis of seven randomized clinical trials, NICE reported that central venous catheterization under ultrasound lowers relative risk of failed placements by 86% (NICE, 2002). Not only are patients spared the stress, discomfort, and increased risk of complications from multiple jabs in the neck during failed central line insertion attempts, but the increased first-pass success associated with ultrasound-guided placement helps emergency physicians commence treatment more rapidly in an environment where time truly is of the essence.

The Future of Emergency Ultrasound

In the decade since the American College of Emergency Physicians (ACEP) published its first specialty-specific ultrasound guidelines, use of this technology in the ED has grown. Increased focus on improving patient safety, while simultaneously providing cost-effective care, has put the spotlight on efficient diagnosis of emergent disorders with ultrasound at the bedside and error reduction through ultrasound-guidance of needle procedures. In a 2008 update of the guidelines, ACEP has identified 11 core or primary-focused emergency ultrasound applications, including novel soft tissue, thoracic, and ocular applications in the ED (ACEP, 2008).

However, even these advances are only the beginning of emergency ultrasound's potential to improve the safety and quality ED care. Emergency physicians have become the leading non-traditional specialty to integrate this powerful tool into their clinical practice and are blazing a path for allied specialties, such as critical care and anesthesiology. Competency in use of ultrasound at the bedside is now mandated as a core skill for graduates of emergency medicine training programs, ensuring that tomorrow's emergency physicians will be well-equipped to help critically ill and injured patients achieve optimal outcomes in that golden hour between life and death. These patients will need care; the portable ultrasound equipment will be at the bedside. PSQH

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