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Selected Topics: Aeromedical Emergencies

PROSPECTIVE EVALUATION OF PREHOSPITAL TRAUMA ULTRASOUND DURING AEROMEDICAL TRANSPORT

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☐ **Abstract—Background: Ultrasound is widely considered the initial diagnostic imaging modality for trauma. Preliminary studies have explored the use of trauma ultrasound in the prehospital setting, but the accuracy and potential utility is not well understood. Objective: We sought to determine the accuracy of trauma ultrasound performed by helicopter emergency medical service (HEMS) providers. Methods: Trauma ultrasound was performed in flight on adult patients during a 7-month period. Accuracy of the abdominal, cardiac, and lung components was determined by comparison to the presence of injury, primarily determined by computed tomography, and to required interventions. Results: HEMS providers performed ultrasound on 293 patients during a 7-month period, completing 211 full extended Focused Assessment with Sonography for Trauma (EFAST) studies. HEMS providers interpreted 11% of studies as indeterminate. Sensitivity and specificity for hemoperitoneum was 46% (95% confidence interval [CI] 27.1%–94.1%) and 94.1% (95% CI 89.2%–97%), and for laparotomy 64.7% (95% CI 38.6%–84.7%) and 94% (95% CI 89.2%–96.8%), respectively. Sensitivity and specificity for pneumothorax were 18.7% (95% CI 8.9%–33.9%) and 99.5% (95% CI 98.2%–99.9%), and for thoracostomy were 50% (95% CI 22.3%–58.7%) and 99.8% (98.6%–100%), respectively. The positive likelihood ratio for laparotomy was 10.7 (95% CI 5.5–21) and for thoracostomy 235 (95% CI 31−1758), and the negative likelihood ratios were 0.4 (95% CI 0.2–0.7) and 0.5 (95% CI 0.3–0.8), respectively. Of 240 cardiac studies, there was one false-positive and three false-negative interpretations (none requiring intervention). Conclusions: HEMS providers performed EFAST with moderate accuracy. Specificity was high and positive interpretations raised the probability of injury requiring intervention. Negative interpretations were predictive, but sensitivity was not sufficient for ruling out injury.** © 2014 Elsevier Inc.

☐ **Keywords—trauma ultrasound; FAST; EFAST; prehospital; aeromedical**

INTRODUCTION

For more than 3 decades, physicians and surgeons have successfully utilized ultrasound for the injured patient (1). The Focused Assessment with Sonography for Trauma (FAST) is a goal-directed sonographic assessment of the intraperitoneal and pericardial spaces for blood, and the extended version (EFAST) also includes an evaluation of the pleural spaces (2). FAST decreases time to operative care and reduces exposure to the ionizing radiation of computed tomography (CT) (3–5).

Institutional Review Board approval was obtained.
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Lung ultrasound has been shown to be more accurate than chest radiography for the diagnosis of pneumothorax (2).

The improved portability of ultrasound has expanded its use beyond the traditional hospital setting. Handheld ultrasound has been introduced into prehospital settings around the world (6–9). Potential advantages to EFAST in the prehospital setting include improved triage of patients, guidance of prehospital management, and expediting time to definitive care (9). Ultrasound may allow helicopter emergency medical services (HEMS) crews to discern the etiology of undifferentiated hypotension in the trauma patient (i.e., intraperitoneal hemorrhage, tension pneumothorax, hemopericardium). Ultrasound has been used in a decision tool to initiate blood product transfusion in the field (10). Pneumothorax is frequently misdiagnosed by clinical examination, resulting in a rate of unnecessary needle decompression as high as 26% (11). Prehospital providers may be able to use ultrasound to more accurately diagnose life-threatening conditions and to more appropriately manage them.

Several European studies report success with prehospital ultrasound protocols, however, prehospital providers in Europe differ from their American counterparts in that most are physicians, often with advanced ultrasound training (12). In the United States, a small number of studies describe the use of FAST in ground ambulances and, to an even lesser extent, during aeromedical transport (13–17). These helicopter studies were conducted a decade ago and evaluated small samples of in-flight FAST with varying success (14–18).

We evaluated a large-scale HEMS trauma sonography program. The goal was to assess prehospital provider accuracy in performing the abdominal, cardiac, and lung components of EFAST.

METHODS

Study Design

This was a prospective observational study of the accuracy of EFAST performed by HEMS flight nurses and paramedics. HEMS providers performed in-flight EFAST on a sample of trauma patients if time allowed after patient stabilization. This study was approved by the Committee for the Protection of Human Subjects and the Institutional Review Board (HSC-MS-08-0085). Informed consent was obtained from the HEMS providers participating in the study. Patient data were used via waiver of consent. SonoSite, Inc. (Bothell, WA) provided funding and the ultrasound machines used for this study.

Setting

HEMS is a hospital-based, accredited, critical care, air-medical transport service, operating within a 150-mile radius of a large urban medical center. At the time of the study, the service included 4 helicopters (EC145, American Eurocopter, Grand Prairie, TX), 17 flight nurses, 16 paramedics, and 13 pilots. Typical flights consisted of a flight nurse, paramedic, and pilot. The emergency department (ED) is an urban academic Level I trauma center with an annual patient census of nearly 70,000 and > 6000 trauma admissions.

Selection of Participants

Participation in the study for HEMS providers was voluntary. HEMS providers were trained to perform EFAST during a 2-month period. The training curriculum has been described in a previous study; it included a 1-day didactic and hands-on course, six weekly internet-based training modules, proctored scanning sessions in the ED, pocket flashcards, a review session, pre- and post-testing, and remedial training for those that need it (18). Three weeks before the start of the study, the helicopters were equipped with the ultrasound machines and providers performed several practice scans. Portable ultrasound machines with phased-array cardiac probes were used for all helicopter imaging (M-Turbo and P-21x transducer; SonoSite).

Protocol

Study protocol instructed HEMS providers to perform EFAST on adult trauma patients (18 years or older) transferred directly from scene if time allowed after standard stabilization. In this observational study, HEMS providers were instructed not to alter management based on ultrasound findings. Timing the ultrasound after stabilization was to preclude management alterations, as most of our prehospital interventions (such as needle thoracostomy, intubation, and blood transfusion) are only performed on unstable patients.

HEMS providers performed EFAST using the following views: hepatorenal, splenorenal, suprapubic, cardiac (subcostal or parasternal long-axis), right lung, and left lung. All views were standard and in accordance with imaging described by the American College of Emergency Physicians and American Institute of Ultrasound in Medicine (19). Abdominal and cardiac examinations were performed to evaluate for intraperitoneal and pericardial fluid, respectively. Lung ultrasound was performed to evaluate for lung slide to exclude or diagnose pneumothorax. Abdominal views were saved as still images, and cardiac and lung views as 4-s video clips.

HEMS providers documented interpretations before patient delivery to the ED and were blinded to ED diagnostics and management. Receiving teams were blinded to HEMS EFAST, unless providers felt it essential to

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