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Original Research

Teaching Flight Nurses Ultrasonographic Evaluation of Esophageal Intubation and Pneumothorax

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A B S T R A C T

Aeromedical prehospital care has seen an increase in the use of point-of-care-ultrasound (POCUS) in recent years. Prior research has focused on abdominal trauma exams by physician or advanced practice providers. In this study, we describe the implementation of an ultrasound curriculum designed for Flight Nurse assessment of pneumothorax and esophageal intubation.

The study team conducted three one-hour training sessions over two months. The training curriculum included didactic and hands-on components. We enrolled twelve flight nurses with no prior ultrasound experience. A pre- and post-test was administered consisting of fifteen questions.

The median pre-test score was seven correct for an average of 45.0%. After the training session, the median post-test score was fourteen correct for an average of 90.6%. The training intervention resulted in an average improvement in score of 45.6%.

While not examining skill acquisition, we are encouraged by the implementation of this curriculum for future ultrasound education in esophageal intubation and pneumothorax.

Ultrasound is a common diagnostic modality in many emergency departments (EDs) for a wide range of conditions.[1] Ultrasound is unique in that it allows clinicians with little training to directly assess internal structures and answer crucial clinical questions. It empowers the bedside provider to make diagnoses amenable to immediate interventions such as tension pneumothorax, abdominal free fluid, pericardial tamponade, qualitative assessment of cardiac function, location, and patency of prominent vasculature. Like many ED technologies, ultrasound has also begun to diffuse into the prehospital air medical setting.

As early as 2000, the feasibility of prehospital ultrasound in air transport was explored in Europe.[2,3] Early uses of ultrasound in-flight were directed toward trauma using the focused assessment with sonography in trauma examination.[4] Like ground-based technologies, further studies showed that during flight the focused assessment with sonography in trauma examination could be expanded to include detection of pneumothorax.[5]

Flight nurses in the Airlift Northwest (ALNW) system frequently need to rule out esophageal intubations and pneumothoraxes before transport. Often, the transport locations cannot provide a chest x-ray in a timely fashion. Pneumothorax has been shown to be easily identifiable by new learners with ultrasound, both in the ED and prehospital settings.[5,6] More recently, in hospital settings, research has shown that ultrasound can quickly rule out esophageal intubation.[7-9] Thus, point-of-care ultrasound examination for esophageal intubation or pneumothorax by flight nurses could be a valuable tool in the field.

In this study, we describe the implementation of an ultrasound curriculum for the identification of pneumothorax and esophageal intubation for flight registered nurses (RNs). Previous ultrasound training curricula have investigated training advanced practice providers in extended focused assessment with sonography in trauma examinations.[10] In our air medical system, medical teams consist of RN-RN pairs without any formal ultrasound training. Thus, an ultrasound curriculum designed exclusively for flight RNs is a novel area of research.

Methods

The goal of this study was to describe the implementation of an ultrasound curriculum designed specifically for nonphysician air medical clinicians. We developed the curriculum in collaboration with flight nurses, emergency medicine ultrasound fellowship–

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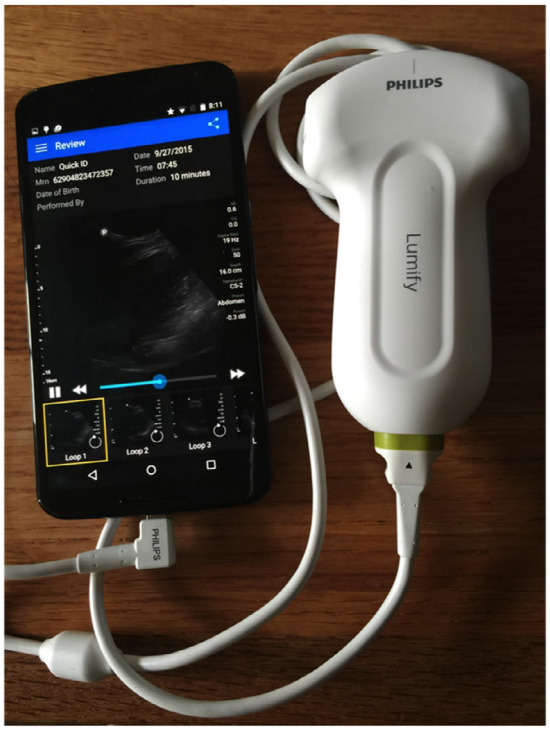

Figure 1. Philips Sonosite & Lumify Device

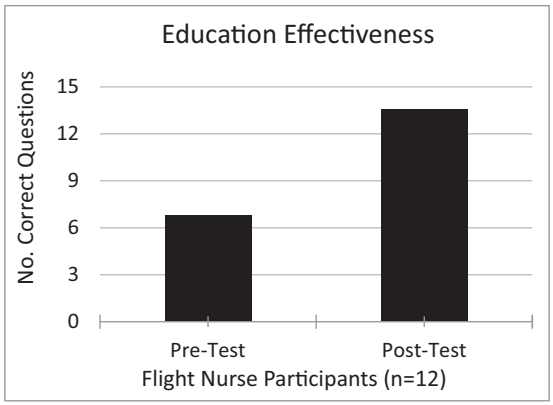

Figure 2. Pre- and Posttest Comparison

trained physicians, and emergency medicine emergency medical service fellowship–trained physicians. The curriculum is available in Appendix 1. (The videos within this curriculum can be obtained by contacting the corresponding author.)

Participants were recruited through e-mail solicitation of ALNW, an affiliate of the University of Washington. ALNW operates out of 7 bases serving 4 northwestern states with an annual flight volume of approximately 3,000. ALNW flies with a nurse-nurse configuration; consequently, the pool of volunteers were all trained RNs. Participation in the study was voluntary, and no compensation was provided.

The study group conducted 3 one-hour training sessions over 2 months based on the availability of the investigators and busy flight nurses. Before the training, participants filled out a 15-question pretest. The training involved a lecture followed by hands-on training with the Philips (Amsterdam, Netherlands) Sonosite & Lumify device (Fig. 1). An emergency medicine ultrasound fellowship–trained and ultrasound faculty member conducted the training sessions assisted by a senior emergency medicine resident physician.

After the training, participants completed a posttest consisting of the same 15 questions. We used a numeric signifier to maintain anonymity while associating the pre- and posttest scores. Pre- and posttests can be found in Appendix 2. (The videos within the tests can be obtained by contacting the corresponding author.)

This project was approved by the University of Washington Institutional Review Board. Phillips Corporation (Hanover, MD) loaned us the ultrasound machine. This loan was approved by the University of Washington governing boards and Institutional Review Board. Phillips was not involved with the curriculum design, training sessions, data collection, data interpretation, or manuscript production.

Results

A total of 12 flight nurses participated in the study. Out of 15 questions, the average and median pretest scores were 6.8 and 7, respectively. For the same 15 questions, the average and median posttest scores were 13.6 and 14, respectively.

The pretest average percent correct was 45.0%, whereas the posttest was 90.6%. The training intervention resulted in an average percentage improvement of 45.6%, or 6.8 questions (Fig. 2).

Discussion

Over the last decade, improvements in the size, weight, and battery life of ultrasound technologies has made air medical ultrasound more practical but not yet widely implemented. A 2014 survey showed less than 5% of emergency medical services in North America use prehospital ultrasound citing barriers including costs, portability, training, and limited evidence.[11] Air medical transport services are particularly sensitive to cost and size constraints. However, with the pace of technology, newer ultrasound devices are becoming less expensive and more portable. Thus, there is increasing research activity in air medical ultrasound.

Previous studies have investigated the education of nonphysicians in air medical ultrasound. Most notably, Press et al[10] designed a curriculum to teach the extended focused assessment with sonography in trauma to flight advanced practice providers. They incorporated a robust 2-month curriculum with significant improvement in pre- and posttest scores.[10] In contrast, our study had a much shorter and less involved curriculum. Although our results showed improvement in pre- and posttest scores, we can only conclude a likely transient improvement in the subjects' general ultrasound knowledge. Improvement in practical ultrasound skills remains to be seen but could be the subject of further investigations. Despite these limitations, we were encouraged by the minimal time commitment required to obtain even these modest gains in ultrasound knowledge.

One novel aspect of this study was the inclusion of the esophageal examination using ultrasound to confirm endotracheal tube placement. This has been studied in the hospital setting by Das et al[12] but, to our knowledge, never in a prehospital setting. Although endotracheal tube placement can be confirmed by other means such as qualitative or quantitative capnography, some experts are hesitant about relying solely on capnography for placement, arguing instead that "multiple methods of tube placement confirmation are superior to any single method because no single method has perfect accuracy."[13] Although unlikely to replace capnography, our study suggests that with proper education ultrasound could be another tool for endotracheal confirmation in the air medical setting.

Our study had several weaknesses that limit the generalizability and implications of the data. The study's small sample size may preclude predictions of the effectiveness and implementation of ultrasound training with flight staff. Additionally, our study only involves clinicians trained at the level of RN; thus, the effectiveness of the training remains unclear for flight crews that employ emergency medical technicians, paramedics, respiratory therapists, or other

professions. However, this has been explored by other authors as noted previously.

Furthermore, the measured improvement in test scores is a poor predictor of the effectiveness of the training sessions for skill acquisition. First, the improvement in test scores is likely bolstered by the immediate posttest administration. Second, the actual training time is minimal when compared with other curricula and has no ongoing skill sessions; thus, skill degradation can be assumed to be quite high. Third, the testing methods focused on recognition without requiring subjects to obtain images themselves—a crucial skill in the use of ultrasound. In sum, teaching clinicians to perform well on a test about ultrasound is hardly equivalent to performing ultrasound in the back of a dark aircraft on a critical patient. Thus, more practical studies investigating the performance of flight clinicians' ultrasound abilities are needed.

We conclude that our brief training session improved the ability of flight nurses to answer targeted clinical questions using ultrasound. Although we can make no conclusions regarding practical ultrasound skills or long-term effectiveness of education, we are encouraged by the low barriers required for the implementation of ultrasound curriculum for air medical clinicians. Accordingly, we believe further research should be pursued regarding the implementation of ultrasound in the American air medical system.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.amj.2018.11.007.

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