Abdominal ultrasound image acquisition and interpretation by novice practitioners after minimal training on a simulated patient model

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CLINICIAN'S CAPSULE

What is known about the topic?
Focused assessment with sonography (FAST) could be used by prehospital systems but the optimal training regimen has not been established.
What did this study ask?
Can paramedics interpret FAST in trauma as well as emergency physicians after a 1 hour didactic training session.
What did this study find?
FAST interpretation was comparable between the two groups with accuracy of 85.6% and 87.5% for paramedics and emergency physicians respectively.
Why does this study matter to clinicians?
Determination of effective, cost effective training programs is important when considering incorporating FAST examinations in prehospital systems.

ABSTRACT

Background: The Focused Assessment with Sonography in Trauma (FAST) exam is a rapid ultrasound test to identify evidence of hemorrhage within the abdomen. Few studies examine the accuracy of paramedic performed FAST examinations. The duration of an ultrasound training program remains controversial. This study's purpose was to assess the accuracy of paramedic FAST exam interpretation following a one hour didactic training session.
**Methods**: The interpretation of paramedic performed FAST exams was compared to the interpretation of physician performed FAST examinations on a mannequin model containing 300ml of free fluid following a one hour didactic training course. Results were compared using the Chi-square test. Differences in accuracy rate were deemed significant if p < 0.05.
Results: Fourteen critical care flight paramedics and four emergency physicians were voluntarily recruited. The critical care paramedics were mostly ultrasound-naive whereas the emergency physicians all had ultrasound training. The correct interpretation of FAST scans was comparable between the two groups with accuracy of 85.6% and 87.5% (∆1.79 95%CI -33.85 to 21.82, p = 0.90) for paramedics and emergency physicians respectively.
Conclusions: This study determined that critical care paramedics were able to use ultrasound to detect free fluid on a simulated mannequin model and interpret the FAST exam with a similar accuracy as experienced emergency physicians following a one hour training course. This suggests the potential use of prehospital ultrasound to aid in the triage and transport decisions of trauma patients while limiting the financial and logistical burden of ultrasound training.

RÉSUMÉ

Contexte: L'évaluation d'un trauma par échographie ciblée (acronyme anglais : FAST) est un examen rapide visant à mettre en évidence des signes d'hémorragie abdominale. Peu d'études portent sur l'exactitude de l'évaluation FAST, pratiquée par des ambulanciers paramédicaux, et ce qui suscite la controverse est la durée de la formation. L'étude avait donc pour but d'évaluer l'exactitude de l'interprétation de l'examen FAST pratiqué par des ambulanciers paramédicaux après une heure de formation théorique.
Méthode: Un examen FAST a été pratiqué sur un mannequin contenant 300 ml de liquide libre après une heure de formation théorique, puis les résultats de l'interprétation de l'examen pratiqué par des ambulanciers paramédicaux ont été comparés à ceux obtenus par des médecins. La comparaison reposait sur le test du chi carré, et l'écart entre les taux d'exactitude était jugé significatif si p < 0,05.
Résultats: Quatorze ambulanciers paramédicaux navigants, spécialisés en soins intensifs et 4 urgentologues, tous volontaires, ont participé à l'étude. Les ambulanciers paramédicaux spécialisés en soins intensifs étaient, pour la plupart, novices

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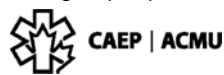
en échographie tandis que les médecins d'urgence avaient tous reçu une formation en la matière. L'interprétation exacte des examens FAST était comparable dans les deux groupes : le taux d'exactitude était respectivement de 85,6% et de 87,5% (Δ 1,79; IC à 95% : -33,85 à 21,82; p = 0,90) chez les ambulanciers paramédicaux et chez les médecins d'urgence.

Conclusion: Il ressort de l'étude que les ambulanciers paramédicaux spécialisés en soins intensifs étaient capables de pratiquer une échographie afin de détecter la présence de liquide libre sur un mannequin et d'interpréter les résultats de l'examen FAST avec une exactitude comparable à celle des médecins d'urgence expérimentés, et ce, après une heure de formation. Les résultats permettent donc de croire en l'utilisation possible de l'échographie en phase préhospitalière dans le but de faciliter le triage des blessés et les prises de décision quant à leur transport, dans un contexte de limitation du fardeau financier et logistique de la formation en échographie.

BACKGROUND

The Focused Assessment with Sonography in Trauma (FAST) exam is a rapid test that uses ultrasound to survey the pericardial and abdominal regions sequentially for sonographic signs of hemorrhage.[1,2] The FAST exam is particularly useful to medical practitioners as a quick clinical adjunct for determining the most appropriate procedure (laparotomy or thoracotomy) to obtain definitive hemorrhage control in the unstable trauma patient.[2,3] In the prehospital setting, the information from a FAST examination can help triage patients, direct patients to the most appropriate facilities, assist with management strategies, and potentially expedite time to definitive intervention.[3,4]

Despite significant literature to support the use of FAST in both hospital and prehospital settings by physicians, the utility of paramedic-performed FAST exams in the Canadian prehospital system is unclear.[5] Current literature supports the use of prehospital FAST exams in prehospital systems where the prehospital team consists of physicians and paramedics. In these studies, FAST exams were performed or supervised by physicians.[6] There are few studies that examine the accuracy of paramedic-only-performed FAST examinations.[7,8] In these studies, the accuracy of paramedic-performed FAST examinations and the optimal duration of a suitable paramedic ultrasound training program remain controversial.[9,10]

It can be assumed that paramedics with significantly less training may require more robust training regimens than physicians to achieve the same level of competency in ultrasound assessments such as the FAST exam. However, despite the potential benefits to the Canadian prehospital system, a potential barrier to implementation is the tremendous financial and operational burden, if paramedics require prolonged ultrasound training courses. In this study, we conducted a double-blinded observational study comparing the accuracy of paramedic-performed FAST with that of physician-performed tests on a sonographic Phantom, after a one-hour didactic training session.

METHODS

Study design

A prospective observational study was conducted in which Canadian aeromedical critical care paramedics were compared with emergency medicine staff with regards to their ability to accurately perform and interpret FAST examinations on a FAST phantom (CAE FAST Exam Real Time Ultrasound Training Model – model #BP-FAST1800), after a one-hour didactic training course. The trial used one ultrasound system (Philips lumify S4-1 broadband phased array 4-1 MHz transducer) for all scans performed in this study.

Study setting

The training sessions and evaluation of accuracy for performing FAST examinations took place at the Middlesex-London Paramedic Services Headquarters in London, Ontario, Canada.

Population

A letter asking for volunteers from the critical care paramedic contingent at two Ornge air ambulance bases (London and Toronto) was circulated through Ornge management. Only travel expenses were covered. Emergency medicine physicians were recruited from a major

academic health sciences centre (London Health Sciences Centre). One day of training and evaluation was selected on May 21, 2019.

Intervention

A standardized one-hour didactic training course was taught to all paramedics and emergency physicians. The training course consisted of an introduction to the ultrasound system, including how to turn on the system and how to position the probe and change gain and depth setting on the ultrasound device. The training then focused on identifying anatomic and ultrasono-graphic landmarks necessary for performing an appro-priate abdominal FAST exam. The three areas of focus were the hepatorenal space, splenorenal space, and retro-vesicular/retrouterine pouch in the pelvis. Participants were taught to identify anechoic stripes in the appropri-ate anatomic locations as a sign of potential hemorrhage. Pericardial examination was not taught or performed.

Outcome measures

After the one-hour didactic session, participants were asked to complete a survey with questions pertaining to baseline demographic information, prior ultrasound training, and years of experience in their field. Each par-ticipant was then asked to perform two distinct scans on a specialized mannequin designed for FAST ultrasound training techniques. The mannequin utilized in this study was a realistic model of a human torso in which fluid could be injected into the abdomen to create a real-istic ultrasound image of abdominal free fluid. Partici-pants were required to scan the mannequin twice, once with 300 mL of fluid instilled and once with the abdo-men free of fluid. Participants were blinded to the status of hemoperitoneum. The primary outcome of the study was the accuracy rate of FAST examination by parame-dics compared with emergency room physicians. The accuracy of the FAST exam was reported as:

(number of true positives and true negatives)/(total number of scans performed).

Data analysis

Demographics, previous ultrasound experience, and FAST interpretation were analysed in a descriptive fash-ion using proportions with percentages. Time to

complete each scan was summed across all scans for each participant to create a total scan time. Total scan time was reported using means, standard deviations, and 95% confidence intervals (CI) and was compared between groups using a standard t-test.

We compared the accuracy of paramedic-performed FAST exams with the accuracy of physician-performed FAST examinations, using a chi-square test. Differences in accuracy rate were deemed significant if $p < 0.05$.

RESULTS

Fourteen critical care paramedics and four emergency department (ED) physicians (two staff physicians and two residents) were voluntarily recruited. The critical care paramedics were mostly ultrasound-naive whereas the emergency physicians all had ultrasound training.

The correct interpretation of FAST scans was com-parable between the paramedic and emergency physician groups, with an accuracy of 85.6% and 87.5%, respect-ively ($\Delta 1.79$, 95% CI -33.85 to 21.82, $p = 0.90$). Average time per scan differed between groups but did not reach statistical significance; paramedics took longer to com-plete the FAST examination with a mean (standard devi-ation [SD]) time per scan of 5.18 (1.72) minutes, as compared with 3.67 (1.37) minutes for physicians ($\Delta 1.51$ minutes, 95% CI -0.48 to 3.50, $p = 0.128$).

DISCUSSION

In this study, we found that ultrasound-naive critical care flight paramedics could accurately determine the pres-ence or absence of simulated hemoperitoneum on abdominal FAST examination of an ultrasound phan-tom, after a one-hour training session. They accurately identified the presence or absence of free fluid on the FAST examination 85.6% of the time, compared with a control group of ED physicians, who were accurate 87.5% of the time.

The original papers describing the FAST examination focused on identifying free intraperitoneal or pericardial fluid in blunt trauma patients.[11] Originally, the clinical utility of the FAST examination was to identify trauma patients quickly who would benefit from emergent surgi-cal management of either large volume hemoperitoneum or cardiac tamponade.[11] Ultrasound has now been expanded to include an examination of a variety of

other clinically significant injuries in trauma that include: hemoperitoneum; pneumothorax; hemothorax; hemopericardium with or without tamponade; traumatic hypovolemia; and even rib, nose, and other fractures.[11,12] Despite the increased utility of the extended FAST examination in trauma for a variety of conditions, there is disagreement regarding appropriate management strategies given particular positive findings. In this study, we chose to use 300 cc of fluid to simulate a clinically significant volume of hemoperitoneum. As such, our study suggests that a brief training program might be able to teach paramedics to interpret abdominal FAST examinations reliably only for large volume hemoperitoneum that would alter facility choice and/or triage priority.

Our study adds to the minimal literature concerning the optimal training duration and accuracy of FAST exams performed by paramedics.[7,8] Previous studies suggest that with a combination of didactic and practical education modalities, FAST can be effectively taught to paramedics in as little as a one-day course to reach a high degree of diagnostic accuracy. Unluer et al. trained four paramedics on FAST examinations for eight hours and reported a sensitivity of 84.6% for hemoperitoneum and specificity of 97.4%.[13] Walcher et al. trained a mixed group of five physicians and four paramedics on prehospital FAST exam, using healthy volunteers and patients with peritoneal dialysis for a full day. These nine study participants performed a total of 39 FAST examinations in the field, with both sensitivity and specificity of 100%.[9] Press et al. trained 33 paramedics and nurses to perform extended FAST exams (FAST and pleural assessments) on consenting in-flight trauma patients. Training consisted of a three-hour didactic and eight-hour practical over a two-month period.[14] Our study is the first to suggest that FAST can be taught using a shorter duration course if the goal is only to detect a significant amount of free intra-abdominal blood.

In the past, shorter duration courses were associated with lower accuracy. Kim et al. trained six level 1 emergency medical technicians (EMTs) on FAST in a two-hour didactic and two-hour practical training program performed on EMT volunteers.[15] Sensitivity was 61.3%, and specificity was 96.3% for the detection of peritoneal cavity fluid. West studied 10 paramedics and their accuracy in diagnosing free fluid in the abdomen in a cohort of patients requiring peritoneal dialysis. The paramedic success rate was only 60% for diagnosing free fluid, after a training duration of four hours. However, as discussed, the amount of fluid in the abdomen was significantly

associated with increased sensitivity of paramedic-performed FAST.[16] Kim and colleagues found that paramedic FAST performed in the hospital showed low sensitivity for any hemoperitoneum, as compared with computed tomography (CT) scan findings. However, sensitivity increased to over 86%, as compared with CT findings of significant or moderate amounts of hemoperitoneum.[15]

LIMITATIONS

The major limitation of our study was the use of a mannequin and not human volunteers. Mannequin images simulate anatomic and ultrasonographic landmarks; however, they do not simulate anatomic variants, and images generated are evidently different, as compared with live volunteers. Another limitation of our study is that the overall number of paramedics and controls was relatively small, limiting the ability to apply these data to larger groups.

CONCLUSION

This study determined that critical care paramedics were able to detect large volumes of free fluid on a simulated abdomen after a short one-hour training course. Overall, this study is hypothesis generating. This suggests the potential use in prehospital programs to determine the most appropriate transport destination and aid in the triage of trauma patients while limiting the financial and logistical burden of ultrasound training. Further studies need to be performed to determine the optimal training time and effective training regimens for both small volume hemoperitoneum and extended FAST exams.

Competing interests: None. This study was approved by the Western Health Science Research Ethics Board.

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