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Impact of Portable Pre-Hospital Ultrasound on Patients' Outcomes: A Narrative Review

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Abstract

Introduction: Training of emergency staff to use portable prehospital ultrasound machines is not a potential barrier for adoption of the technique. Moreover, being general doctor or paramedics was not a significant barrier for training of ambulant or emergency health staff on prehospital ultrasound. This review aimed to evaluate the use of prehospital ultrasound among nurses and emergency medical services providers.

Methods: An electronic search in PubMed and Embase was conducted to identify relevant studies. The title and abstract of the relevant study were screened for eligibility criteria. The eligible articles were referred for two reviewers for in-depth reading. A total of 9 studies were included in this review aiming at providing an evidence for the use of prehospital ultrasound.

Results: As the progression of bedside ultrasound utilization from radiologists to non-radiologists continues, we have seen penetration of ultrasound use by non-physicians as well. As cost, machine size, and ease of use continue to improve, the applications of field ultrasound may continue to increase. Ultrasound may provide additional diagnostic information to guide therapy. The utility of this information will depend on the transport time as well as the training level of the provider in the ambulance.

Conclusions: Several types of practitioners (physicians, emergency medical technicians, nurses and flight crews) have used portable ultrasound in a variety of practice environments including air and ground deployment.

Keywords: Emergency, Radiology, Ultrasound, Prehospital, Trauma.

Introduction

Improvement of ultrasound machines have made them smaller, similar to a laptop computer size, with improved image quality and good resistance to environmental hazards. Thus, portable ultrasound machine became more feasible and efficient in the diagnosis of trauma, cardiovascular and abdominal conditions as shown by many studies in the literature [1-3]. Portable ultrasound imaging was associated with increased outside-hospital use of the machines in military and emergency care to assess heart, peritoneal, and vascular conditions [4, 5].

Durability and validity of ultrasound machine during emergency care have been tested by many investigators [5, 6]. In regards to emergency care, the enhanced portability of ultrasound machines led to very fast increase in prehospital use during rapid patients' transport, particularly in high-income countries [7]. In the developed countries such as Germany, 20 years ago, the German Air Rescue Organization have included ultrasound imaging to the field management protocol with training focusing on emergency care staff [8]. In France, prehospital use of ultrasound d has been reported since 1998, particularly for Focused Assessment with Sonography in Trauma (FAST) exam, pericardial effusion, and aorta evaluation [4].

The adoption of prehospital ultrasound by emergency care departments was slower in the United States than that in Europe due to some obstacles. First, emergency algorithms in the US focusing more in rapid transport and reducing on-scene time. Second, American staff in ground ambulant care had low experience in the routine use of ultrasound [4]. Training of emergency staff to use portable prehospital ultrasound machines is not a potential barrier for adoption of the technique, as health staff required only short training with an average time of 8 – 100 hours based on the modality [9, 10]. Moreover, being doctor or paramedics was not a significant barrier for training of ambulant or emergency health staff on prehospital ultrasound. A study found 100% success rate in the course of ultrasound scanning with observed structured clinical encounter (OSCE) among paramedical staff [11]. In Saudi Arabia, several obstacles facing the use of prehospital portable ultrasound [12]. This review aims to evaluate the use of prehospital ultrasound among nurses and emergency medical services providers.

Methods

An electronic search in PubMed and Embase was conducted to identify relevant studies. We used the keywords: "ultrasound", "POCUS", "Radiology", "point of care ultrasound", "echocardiography", "emergency medicine", and "FAST" to search the databases. The title and abstract of the relevant study were screened for eligibility criteria. The eligible articles were referred for two reviewers for in-depth reading. A total of 9 studies were included in this review aiming at providing an evidence for the use of prehospital ultrasound.

Results and discussion

Many studies with Descriptive Cross-Sectional Design (DCSD), which was used to assess the reading perception of medical staff about the use of prehospital ultrasound as the researchers adopted convenience sampling so they took sample size from King Abdulaziz Hospital, which was nurses (25) doctors (25) EMS Emergency Medical Training (EMT) EMS intern students EMS fourth years, and EMS third years [13]. In addition, approximately 60% of emergency physicians suggested that the possible presence of ultrasound in private ambulances was valuable, while 20% were against this idea. The majority of practicing physicians who supported the presence of ultrasound in ambulances reported that they could create a treatment plan before critical cases reach the emergency department, which in turn will improve patient outcomes [8]. A North American survey of emergency medical services (EMS) medical directors found that ultrasound was only used in 4.1% of services but a further 21% of services were considering implementing it. Abbas et al., 2020.

Although the added value of ultrasound in ALS has been suggested, the question remains how it affects patient care and decision-making in the specific setting

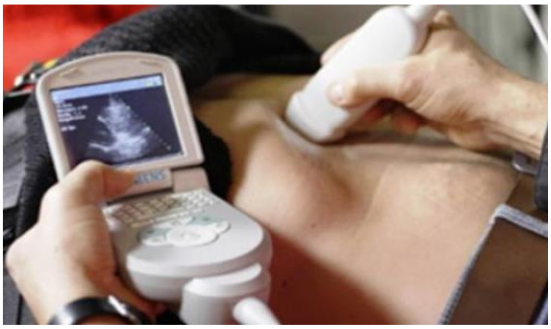
of a helicopter emergency medical service (HEMS). The authors sought to evaluate the use of prehospital ultrasound during traumatic and non-traumatic CPR and determine its impact on patient treatment in a Dutch HEMS [14]. O'dochartaigh et al., 2017.

Scharonow and Weilbach included one third of patients, changes were made in response to prehospital ultrasound findings with regard to the destination and/or priority of patient transport or the monitoring requirements (e.g. rescue physician does not need to accompany patient during transport) or the procedures in the emergency department of the hospital (e.g. no shock room alarm). The ultrasound images at the site of emergency were not stored for a subsequent analysis [15]. Another study aimed to identify the range of emergency situations in which prehospital ultrasound was used while excluding "confounders" (except potential investigator subjectiveness). In prehospital emergency medicine, the ideal situation of a rescue team achieving expert standard in both emergency treatment and emergency ultrasound is not always given. However, during rescue physician missions the average 3-min emergency ultrasound examination time is not exceeded. In the prehospital situation, emergency ultrasound should be used to answer questions that improve the quality of care and the choice of the patient transport destination. The reason for the slow introduction of prehospital emergency ultrasound is the significant time and logistic effort required to train all rescue physicians at a rescue service base in emergency ultrasound to a level of proficiency where meaningful findings are obtained in less than 60 s or 120 s (FAST and FEEL, respectively) [16].

During a study period of 18 months, prehospital emergency ultrasound scans were performed in 99 (18.1%) of the 546 patients treated by rescue physicians, either at the emergency site or during patient transport. More than half of the patients assessed with emergency ultrasound (n = 99) were medical cases (n = 68/68,7%) and about one quarter were trauma surgery cases (n = 31/ 31,3%). Among the patients assessed with emergency ultrasound (n = 99), 90.0% were categorized as NACA III to VI. In the category NACA VII (death confirmed after unsuccessful resuscitation), 9 patients underwent emergency ultrasound scans during resuscitation. The prehospital emergency ultrasound was most often used in patients with dyspnoea prior to cardiac arrest as well as fall, followed by high-speed trauma, hypotension and polytrauma. A FAST emergency ultrasound examination was performed in all trauma patients, while the majority of patients with the most common principal symptom "dyspnoea" underwent a PLUS examination. Among the altogether 99 patients assessed with emergency ultrasound, the combinations of the various protocols were as follows: 36 patients (36.4%) underwent FEEL and PLUS examinations, 21 (21.2%) FEEL alone, 19 patients (19.2%) FAST FEEL and PLUS examinations, 11 (11.1%) FAST and PLUS examinations, 6 (6.1%) PLUS alone and 5 (5%) FAST alone [15].

Considering the combined prehospital findings (clinical examination, emergency ultrasound) the prehospital. The correctness of the prehospital diagnosis in patients who underwent an ultrasound examination at the emergency site was confirmed in 90.8% of cases. The emergency ultrasound findings triggered changes in altogether 66 invasive and non-invasive treatments in 49 (49.5%) of 99 patients. After ultrasound examination, patient transport destination, patient transport priority or monitoring requirements (e.g. patient does not need to be accompanied by a physician), changed in 33 of 99 cases (16 of 31 trauma cases; 17 of 68 non-trauma patients); the differences between the groups were statically significant ($p = 0.009$). For example, based on the prehospital ultrasound findings at the emergency site, 'shock room' management in the destination hospital (shock room alarm) was avoided in 8 cases, while 9 patients were transported to a more distant specialist hospital after ruling out free abdominal fluid, or in one case a stable patient with perisplenic free fluid was directly (not via the emergency rooms) transferred to the CT and from there to the operating room [16].

In another study a total of 99 (18.1%) emergency ultrasound examinations were performed during 546 callouts. The most frequent indications for the performance of prehospital emergency ultrasound were dyspnoea (n = 38; 38.4%), during cardiac arrest (n = 17/17.2%), fall (n = 12/ 12.1%) and high-speed trauma (n = 11/11.1%). The emergency ultrasound



findings were confirmed in 90.8% of cases in the hospital. The significantly higher mean NACA score in patients assessed with emergency ultrasound could be explained by the fact that in the most seriously ill or injured patients the most extensive diagnostic workup was undertaken. For example, ultrasound examinations were only performed at the emergency site on patients categorized as NACA III to VII with only one exception. Consequently, the mean mission time in the emergency ultrasound group (NACA 4.5) is longer compared with the mean mission time in the total (NACA 3.7) patient population (40 min 26 s and 34 min 12 s, respectively). The use of emergency ultrasound in 15 (88.2%) of 17 cardiac arrest patients (NACA VI and VII) was considered almost "obligatory". A "change in management" in response to the prehospital emergency ultrasound findings occurred in 49 (49.5%) of 99 patients [15].

Physicians changed in-patients diagnosed with acute coronary syndrome, heart failure and COPD the management in 25% of cases after prehospital ultrasound examinations of the lungs (FEEL PLUS) and in 68% of patients the prehospital emergency ultrasound was rated as helpful. In this study, the most common indication for prehospital emergency ultrasound was dyspnoea (38.4%). Emergency ultrasound was frequently performed in the prehospital setting and the physicians seemed to combine protocols based on the individual patient [17].

A study, conducted by that aimed to use of ultrasound in prehospital emergency care to improve diagnostic accuracy and facilitate rapid treatment decisions has attracted significant interest in recent years. Since then, a new generation of portable ultrasound devices have emerged that are small and lightweight enough to qualify as "handheld" devices which can be easily used in the prehospital emergency care field. A 2015 systematic review of paramedic ultrasound curricula found that most studies centered on paramedic-performed Focused Assessment with Sonography for Trauma (FAST) exams. Rapid assessment protocols that combine different ultrasound exams to rapidly rule in or out life-threatening causes of hypotension or respiratory distress, such as the Rapid Ultrasound in SHock (RUSH) and Bilateral Lung Ultrasound in Emergency (BLUE) protocols and their modifications, are of particular interest for prehospital use. These findings were identified For this topical review, the team of authors included a critical care paramedic with training in point-of-care ultrasound (POCUS), an emergency medical technician-basic with formal training in literature analysis and a prehospital physician medical director with training and certification in emergency medicine, critical care medicine, emergency medical services (EMS), and clinical ultrasonography [18].

Amaral et al., 2020 conducted an assessment of the emergency physician responsibility to decide when and where to use ultrasound. They recruited Ultrasound equipment was available during the management of 971 consecutive emergency patients [19].

Ketelaars et al., aimed for assessment of the performance of portable units has been investigated in many applications, including the focused assessment with sonography in trauma (FAST) , echocardiography , and aorta evaluations among others [20]. Increased portability and ease of use of modern ultrasound machines initially led to non-radiologists adopting the technology in a host of environments, including obstetrics, surgery, emergency medicine, and others [20]. Physicians, military medics, and emergency medical services (EMS) personnel have used portable ultrasound machines in the field to diagnose conditions such as pleural, peritoneal, and pericardial effusion and deep venous thrombosis. Prehospital ultrasound is employed in this setting to differentiate reversible causes of pulseless electrical activity (PEA), assess for pericardial, intraperitoneal, and pleural fluid in trauma, and to differentiate between pulmonary edema

and emphysema. Several types of practitioners (physicians, emergency medical technicians, and flight crews) have used portable ultrasound in a variety of practice environments including air and ground deployment. The performance of portable units has been investigated in many applications, including the focused assessment with sonography in trauma (FAST), echocardiography , and aorta evaluations among others. Increased portability and ease of use of modern ultrasound machines initially led to non-radiologists adopting the technology in a host of environments, including obstetrics, surgery, emergency medicine, and others [20].

Conclusions

Physicians, military medics, and emergency medical services (EMS) personnel have used portable ultrasound machines in the field to diagnose conditions such as pleural, peritoneal, and pericardial effusion and deep venous thrombosis. Prehospital ultrasound is employed in this setting to differentiate reversible causes of pulseless electrical activity (PEA), assess for pericardial, intraperitoneal, and pleural fluid in trauma, and to differentiate between pulmonary edema and emphysema. Several types of practitioners (physicians, emergency medical technicians, and flight crews) have used portable ultrasound in a variety of practice environments including air and ground deployment.

Conflict of interests

The authors declared no conflict of interests.

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