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An evaluation of echo in life support (ELS): is it feasible? What does it add?

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ABSTRACT

Background Emergency physicians were trained to perform echo in life support (ELS)—that is, limited transthoracic echocardiography during advanced life support (ALS) management of cardiac arrest.

Methods Data were collected on the adequacy of views obtained and timing of the scan, as well as the clinical findings of pericardial effusion and ventricular wall motion. Any intervention performed as a result of the scan was also noted. ELS was performed on 50 patients during cardiac arrest.

Results Adequate views were obtained in 47 (94%) scans, and 45 (90%) were obtained within the 10 s rhythm check. Twenty patients (40%) had ventricular wall motion (VWM), three (6%) had pericardial effusions and six patients (12%) had an intervention performed as a direct result of the scan. These included pericardiocentesis, thrombolysis and insertion of a chest drain. The presence of VWM had a positive predictive value of 55%. The absence of VWM resulted in a negative predictive value of 97% for predicting return of spontaneous circulation (ROSC).

Conclusion It is concluded that ELS is feasible and that the scan findings may guide further interventions.

INTRODUCTION

Ultrasound has become a vital diagnostic tool in the emergency department (ED) for managing patients with trauma and hypotension. Limited transthoracic echo during a cardiac arrest or peri-arrest setting is a Level 1 skill recognised by the Royal College of Radiologists and the College of Emergency Medicine.[1 2] The use of ELS (echo in life support) has become integrated in the everyday practice of many EDs. Managing pulseless electrical activity (PEA) in cardiac arrest involves looking for underlying causes (the 'H's and 'T's).[3] In particular cardiac tamponade and thromboembolic events are difficult to diagnose during resuscitation. It has been shown in many small studies that transthoracic echocardiography can identify pericardial effusions[4] and right ventricular (RV) dilatation,[5 6] suggesting a pulmonary embolus (PE) in arrest and periarrest states. It is also possible to see the presence or absence of ventricular wall motion (VWM) in PEA arrests.[4 6 7] We assessed the ability of emergency physicians to perform echocardiography during advance life support (ALS) management of cardiac arrest.

METHODS

We collected data from a convenience sample of 56 adult patients in cardiac arrest over 2 years and 5 months in two centres as part of a service evaluation.

Normal ALS procedures were followed, and scanning was only permitted during the 10 s rhythm check by either the team leader or a doctor not directly involved in delivery of ALS. ELS did not contribute to any decisions regarding cessation of ALS.

Data collection forms were completed by scanning physicians for all adult cardiac arrests when an appropriately trained ELS provider was available. The primary ultrasound view was subxiphoid, using a curvilinear probe (figure 1), with an option to proceed to another window using either the curvilinear or phased array (cardiac) probe. Forms recorded the type of arrest and initial rhythm, as well as the ultrasound views obtained, the adequacy of the scan and whether it was obtained within 10 s. The clinical findings documented were presence or absence of VWM or pericardial effusion and any intervention performed as a result of ELS. Return of spontaneous circulation (ROSC) was documented, as well as whether the patient survived to leave the ED or to hospital discharge. A signature from the lead nurse involved in the resuscitation was required to confirm that ALS care was not compromised.

Doctors performing ELS scanning were emergency physicians or specialist trainees who already held Level 1 competency in emergency ultrasound, working in a teaching hospital (TH) and a district general hospital (DGH). In both these hospitals ELS was already established practice. Extra teaching sessions were held to provide revision of three cardiac windows for ELS: subxiphoid, parasternal and apical. Each physician was then assessed obtaining an adequate picture within 10 s. Care was taken to emphasise that scanning should not interfere with normal ALS management.

This study was a service evaluation referencing practice guidelines issued by the Royal College of Radiologists,[1] College of Emergency Medicine[2] and the Resuscitation Council (UK),[3] with formal ethics approval waived by the Chairman of the local ethics committee and by the audit department.

RESULTS

Data from 56 patients were collected from July 2006 to December 2008 from two hospitals. Six patients had scans performed outside the cardiac arrest period and so were excluded from further analysis, leaving 50 arrest cases; 32 from the TH and 18 from the DGH. Data were incomplete for one patient. Table 1 summarises the adequacy of

Figure 1 Position of the curvilinear probe to obtain a subxiphoid view of the heart.

the scans and views obtained. In 94% of cases, scans were sufficiently adequate to see the presence or absence of a pericardial effusion and VWM. The overall success rate for obtaining adequate views within a single 10 s time period was 90%.

The subxiphoid view was the most commonly used window (80%), followed by the parasternal view (40%). Some doctors chose to perform a second view at a subsequent pulse check. The highest success rate for the use of an individual window in obtaining adequate views within a single 10 s period was the subxiphoid window (95%), followed by the parasternal window (85%) and apical window (50%).

There were seven traumatic cardiac arrests; of these, five presented in asystole and two in PEA (see table 2). There were no pericardial effusions identified but one case had VWM that prompted further fluids and an inotrope infusion to be given. ELS in another traumatic arrest showed an underfilled heart and haemothorax, so intravenous fluids and blood were administered and a chest drain inserted.

There were 43 non-traumatic arrests. Table 2 shows the initial rhythm recorded. Of these 18 (42%) had sonographic evidence of VWM. Three pericardial effusions were identified in this group. Overall, seven further interventions were undertaken as a result of ultrasound findings, including pericardiocentesis, extra intravenous fluids and inotrope infusion administration, and thrombolysis.

VWM was seen in 20 cases, of which 11 had ROSC and four survived to ED discharge. One patient had absent VWM but had ROSC and survived to ED discharge (but not hospital discharge). Ultrasound detection of VWM had a positive predictive value of 55% for predicting ROSC. The absence of VWM on ultrasound had a negative predictive value of 97% for death.

DISCUSSION

Overall this study shows that limited echocardiography performed by ED physicians during ALS management of a cardiac arrest is feasible. There were no cases where ALS management was compromised. There were two cases where the scan took >10 s; however, it is not clear whether it took several rhythm checks to obtain an adequate scan or whether the doctor extended the rhythm check. It is vital that if a picture is not obtained within 10 s, scanning stops and CPR (cardiopulmonary resuscitation) recommences. The most commonly used view was the subxiphoid view (80%), followed by the parasternal (long axis) view (40%). This is likely to be due to the familiarity of the subxiphoid view from FAST (focused assessment with sonography for trauma) scanning. It is worth noting that the parasternal view was used in a large proportion of the cases. It is important that this view is taught as either a primary or secondary view in this clinical setting.

Table 1 Technical aspects of echo in life support

View	Number (% of total)	Adequate view (n)	Adequate view (%)	Number within single 10 s window	Success rate (adequate view and within 10 s)
Subxiphoid	40 (80%)	38	95%	38	95%
Parasternal	20 (40%)	19	95%	17	85%
Apical	4 (8%)	3	75%	2	50%
Combined	50	47	94%	45	90%

The revised ALS 2006 guidelines stress having as few interruptions to CPR as possible. CPR is stopped every 2 min for a brief rhythm check, and only if the rhythm is compatible with life should a pulse check be performed. So, in practice, in PEA, a pulse check may be needed every 2–3 min, providing opportunities to perform ELS.

Scan results led to seven additional interventions, none of which led to a change in outcome. Survival to hospital discharge for out-of-hospital arrests is still poor; studies report rates between 6.4% and 10.7%.[3 8] If ELS were to lead to interventions that improved survival by even a fraction of a per cent, a large study would be needed to show this.

The main motivation for performing ELS is the early diagnosis of a reversible cause, leading to improved survival. Performing an intervention early, such as pericardiocentesis or thrombolysis, could make ELS worthwhile as long as it did not compromise ALS management.

We found pericardial effusions in 6% of our patients. The incidence of pericardial effusions in patients who have arrested is not accurately known. A study by Tayal and Kline found eight pericardial effusions in 20 arrested patients in the ED.[4] Mayron scanned 58 ED patients with cardiac arrest and found no effusions; this was confirmed by postmortem.[9]

PE causing arrest is a more difficult diagnosis to make on the basis of ultrasound. RV dilatation is usually seen in massive PE. We did not ask physicians to comment directly on RV size, but ELS findings prompted thrombolysis in two of our case series. The TROICA study[10] showed no benefit to giving thrombolysis to all cardiac arrest patients. However, there are case reports of thrombolysis being given to patients with cardiac arrest due to PE and the patient surviving to hospital discharge.[5 11] Further

Table 2 Initial rhythm, clinical findings and number of interventions performed as a result of ultrasound

	Initial rhythm				Findings			
	Asystole	PEA	VF/VT	Data missing	VWM	Pericardial effusion	Data missing	Further intervention as a result of ELS
Traumatic arrests (n=7)	5 (71%)	2 (29%)	0	0	2 (29%)	0	1 (14%)	2 (29%)
Non-traumatic arrests (n=43)	15 (35%)	21 (49%)	6 (14%)	1 (2%)	18 (42%)	3 (7%)	0	5 (12%)
Total (n=50)	20 (41%)	23 (45%)	6 (12%)	1 (2%)	20 (40%)	3 (6%)	1 (2%)	7 (14%)

ELS, echo in life support; PEA, pulseless electrical activity; VF/VT, ventricular fibrillation/tachycardia; VWM, ventricular wall motion detected on ultrasound.

Key points

- Echo in life support
  - —Is feasible
  - —Can be performed within ALS guidelines
  - —Does not compromise ALS delivery
  - —Provides evidence of potentially reversible causes
- The absence of ventricular wall motion on a single ultrasound scan alone is not sufficient to direct stopping resuscitation; this remains a clinical decision.

training could enable those able to do basic ELS to identify RV dilatation.

One controversial use of ELS is using the absence of VWM to back up a decision to stop resuscitation. Three small studies [4 7 12] have showed a lack of VWM on ultrasound while in cardiac arrest to be uniformly associated with death. However, another study on inpatient arrests showed initial lack of VWM in 18 out of 20 patients.[6] Wall motion returned in four of these patients, of whom two survived. In our study, one patient with an arrest secondary to myocardial infarction arrived in asystole; ELS initially showed an absence of VWM but the patient recovered and survived for a further month. This evidence indicates that lack of VWM on one 10 s evaluation alone is not a reliable indication to stop CPR. It is, however, important to consider the absence of VWM in the clinical setting, as the decision to stop CPR after prolonged efforts will differ from the decision during the early stages of resuscitation, or whether an arrest is witnessed or unwitnessed. Perhaps repeated views showing an absence of VWM may provide a more reliable indicator for stopping CPR. On the other hand, the presence of vigorous VWM is a powerful reason to continue resuscitation.

There were some limitations to our study. This was a convenience sample, as not all senior ED doctors were trained in ELS. Cardiac arrests are relatively infrequent in our EDs and it would be useful to repeat the study in a hospital that receives several arrests per day. Also, we did not assess the strength of ventricular contraction. A vigorously beating hyperdynamic heart is likely to indicate a better prognosis than one where only occasional weak contractions are seen.

In conclusion, ELS is feasible during adult cardiac arrests in the ED setting and can identify pericardial effusions and VWM. In our study this led to interventions beyond ALS management. The presence of VWM may assist in making a decision to continue CPR; however, any decision to stop should not be based solely on ultrasound findings. Much larger studies would be needed to see if ELS affects outcome from cardiac arrest.

Competing interests PA, RK and DL regularly teach on courses sponsored by Toshiba and Sonosite, and also run the educational website http://www.emergencyultrasound.org.uk.

Ethics approval This study was conducted with the approval of the Cambridgeshire (1) Ethics Committee—approved as a clinical audit.

Contributors All authors contributed towards the audit design, data collection, review and final review of the manuscript.

Provenance and peer review Not commissioned; externally peer reviewed.

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