Critically Appraised Topic

By: Michael Brock

Title: The Use of Cardiac Ultrasound by Paramedics During Pre-hospital Cardiac Arrests

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PICO
Will pre-hospital EMS workers (EMTs, EMRs, paramedics, and EMS students), given basic instruction on the use of cardiac ultrasonography, be able to effectively use cardiac ultrasound during a cardiac arrest to identify cardiac movement/standstill, compared to EMS workers not running a cardiac arrest.

Search Strategy
(ems OR emt OR paramedic OR prehospital OR emergency medical technician) AND (ultrasound OR sonic imaging OR sonography OR ultrasonic OR ultrasonography OR echo OR echocardiography) AND (cardiac arrest OR cpr OR cardiopulmonary resuscitation OR vsa OR vital signs absent)
This search strategy was used to search Medline database via pubmed.org, and the CINAHL database

Limiters: Publication date 2011 – 2017, English language, Humans.

Search Outcome:
Search of Medline database on pubmed.gov resulted in 24 publications with limiters applied. 11 articles directly related to pre-hospital ultrasound use were considered for review. 2 papers were removed for not being related to cardiac ultrasound. 2 article were not available, 1 was removed for having a small sample size of only 2 case reports, and 1 was discarded because it was a qualitative survey of physicians on the topic, but was referenced in the clinical significance section of this appraisal. The remaining 5 articles were chosen for this CAT.

Search of CINAHL database resulted in 6 publication. 3 articles were directly related to cardiac ultrasound during cardiac arrest. 1 article was discarded because it was not related to pre-hospital ultrasound. The remaining 2 articles were already included in the 5 articles chosen from Medline database.

Relevant Papers: 5 articles were chosen for this topic appraisal.

Author	Design/LOE	Population	Intervention/Comparison	Outcomes Measured	Results
Reed et al. 2016	Prospective educational observation study	11 practicing Scottish paramedics	- 2 hour lecture + 4 hour practical session - Compared initial US scan with subsequent scans.	- Frequency of adequate US view of heart - % of scans contained within 10 sec pause for pulse check - Time hands were off chest for US scan - Frequency of	- 80% of 1st attempt scans had good/excellent view of heart - Of the 80% above, 100% had good/excellent views in subsequent scans

				cardiac movement - Frequency of ECG rhythm check during 10s window - Frequency of pulse check during 10s window	- 44% of scans contained within 10s pause - Median time off chest for scan was 17s, longer than acceptable for regional guidelines - 42% of patients had no cardiac movement on initial scan, 69% in subsequent scans - ECG rhythm was checked during 33% of scans - Pulse was checked for only 22% of scans
Bhat et al. 2015	Prospective educational observation study, utilizing non-randomized controlled tests.	57 pre-hospital care providers in California: 19 EMT-B students 16 paramedic students 18 EMT-Bs 4 paramedics	- Participants given a 16 question image/video pre-test on US identification, then given a 1 hour lecture, followed by a 16 question post-test. - EMS students were given an additional 16 question test 1 week later. - Compared pre, post and 1 week post test scores - Compared certified EMS workers to EMT students	- Pre, post, and 1 week post test scores (% mark) of certified EMS workers, which was broken down into recognition of pneumothorax, pericardial effusion, and cardiac standstill via US images and videos - Pre, post, and 1 week post test scores (% mark) of EMS students, broken down into recognition of	- Certified EMS workers improved test scores from pre to post lecture tests on average from 63.9% to 93.5% respectively ($p<0.001$) - EMS students improved test scores from pre, post, and 1 week post lecture tests from 65.8% to 90.5% to 93.1% respectively ($p<0.001$) - Participants' confidence in

			- Tested working ER physicians as a control	pneumothorax, pericardial effusion, and cardiac standstill via US images and videos - Surveyed participants confidence in US interpretation before and after 1 hour lecture	US interpretation improved from 4% some or high confidence to 85% some or high confidence.
Chin et al. 2013	Prospective educational intervention study.	20 fire-paramedics in California	In groups of 3-4, given a 1 hour lecture and 1 hour hands on session on US image acquisition and interpretation for heart and lungs, and information on PAUSE protocol (Pre-hospital Assessment with UltraSound for Emergencies), lead by emergency physicians. PAUSE protocol outlines US procedures limited to being able to identify pneumothorax, pericardial effusion, and cardiac standstill.	- Recorded scores from 10 question US video quiz testing abnormal US recognition immediately after 2 hour learning session - Recorded ability of paramedics to acquire an adequate view of the heart, and left and right pleural interfaces, with no assistance. Heart view was graded with Cardiac Ultrasound Structural Assessment Scale (CUSAS)	- On average paramedics scored 91% on the image recognition quiz. Half of the students scored 100% - 100% of paramedics were able to acquire images of the left and right pleural interfaces adequate to identify pneumothorax. - 11/20 paramedics were able to achieve images of the heart to a CUSAS rating of 6 (the maximum). 19/20 paramedics achieved a CUSAS score of 4 or more.
Ketelaars et al. 2012	Prospective observational study	13 pre-hospital emergency physicians working for Nijmegen	- Physicians were trained to perform rapid chest and abdomen US in	- Data was collected from every PREP assessment between	- 281 patients received chest US scans. 31 patients received these

		helicopter EMS service in the Netherlands.	trauma victims, according to the Polytrauma Rapid Echo Evaluation Program standards (PREP). 5 US windows are scaned to look for abnormalities: 1. right lun, liver and kidney 2. Left lung, spleen and kidney 3. uterus and bladder 4. heart and pericardium 5. abdominal aorta	January 2007 and July 2010 - Recorded timing of US relative to arrival, US duration, quality of images obtained, physician diagnosis based on US, its impact on treatment, and impact on hospital destination.	during CPR - Timing of US performed was 37% during transport, 21% on arrival, 21% during treatment, 18% just before departure, 2% on hospital arrival - Average duration of US exam was 2.77 minutes, however decreased to 2.26 and 2.37 minutes in 2009 and 2010 respectively. - Image quality was “good” 55% of the time, “moderate” 25% of the time, “poor” 4% of the time, the rest were not evaluated. - Physicians stated that treatment was altered due to US findings in 21% of cases - in 5% of all cases, treatment was stopped due to US scan of the heart - In 10 cases, hospital destination changed due to US findings, usually to a lower level

					hospital than intended.
Aichinger et al. 2012	Prospective observational study	42 adult patients (<18 years old) in non-traumatic cardiac arrest with no pulse, in Austria.	Patients were treated by paramedics with CPR and medications/defibrillation if local protocols required it. Attending physicians had been trained for 2 hours on emergency echocardiography. Physicians performed at least 1 cardiac US examination on each patient.	- Time from dispatch to initiation of CPR by paramedics. - Time from CPR initiation to US examination. - Ultrasound findings relating to heart movement - Patient outcome	- Average time from CPR initiation to first cardiac ultrasound was 17.4 minutes (SE = 1.8). - Average time from dispatch to CPR initiation was 11.8 minutes (SE = 1.7), 9.8 for surviving patients and 12.1 for non-survivors. - 11.9% of patients survived and were admitted to hospital - Cardiac standstill was found on initial US in 32 patients, of which only 3.1% (1 patient) survived. - Cardiac movement was found on US scan in 10 patients, of which 40% survived - Cardiac standstill on initial ultrasound predicted death 96.9% of the time, where cardiac

					movement predicted survival 40% of the time

Comments: In 2 of these studies (Aichinger et al. 2012, and Ketelaars et al. 2012), physicians were performing and interpreting cardiac ultrasound in the pre-hospital setting, while paramedics managed the cardiac arrest. Thus, these 2 studies may not directly apply to paramedics or EMTs, although they do apply to the use of US in the pre-hospital setting. This must be considered when making conclusions on these studies. The nature of the majority of these studies was strictly observational, with no comparison between the test subjects and another group of health care providers or another group of EMS workers in a controlled environment. Most of the studies also did not have a control group.

Clinical Significance: The articles outlined show evidence supporting the ability of paramedics and other EMS workers to obtain good views of the chest and heart using ultrasound technology, and the ability to recognize basic life threatening conditions like cardiac standstill, pneumothorax, and pericardial effusion. Studies also show that pre-hospital emergency physicians are able to successfully implement the use of US on real patients in the field and almost a quarter of the time this lead to a change in treatment or destination, however this was their only task on scene while other emergency workers managed all other tasks. Paramedics often respond in pairs and are thus required to prioritize and perform multiple tasks in a short period of time, especially during the management of a cardiac arrest, potentially making obtaining ultrasonography difficult. Reed 2016 showed that paramedics in the field were able to use ultrasound during cardiac arrest and successfully obtain and interpret images gathered, however, this lengthened the pulse check window, reduced time on the chest, and distracted paramedics from checking for a pulse and the ECG monitor during this time.

We can see that paramedics are capable of using ultrasound in a stable and controlled environment on stable patients, but more research needs to be performed to assess if they are capable of performing this in the field on critical patients, without lowering their level of care. A survey performed by Taylor, 2015, of EMS medical directors in North America, found that the biggest hesitation that these physicians had around EMS use of ultrasound, was the lack of studies and lack of evidence showing that pre-hospital US use by EMS improves mortality and outcomes of the patients. More studies need to answer these questions before ultrasound will be introduced into the scope of practice of EMS providers.

Finally, it should also be noted that this appraisal is looking at the use of ultrasound during cardiac arrest, which are notoriously hectic and hard to manage situations. There are other studies focused on ultrasound use for identifying other conditions, such as pericardial effusion, pneumothorax, and massive abdominal bleeding. These uses of ultrasound by paramedics may be more feasible.

References

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