Feature

PARAMEDIC ULTRASOUND:

Just another fancy toy?

BY AIDAN BARON

BParaPrac., BSc Hons, GradCertClinUS paramedicultrasound@gmail.com @aLittleMedic

IN THE early 1970's Professor Douglas Chamberlain, largely considered the father of paramedicine in Europe, started teaching 'ambulancemen' how to read ECG's [1] [2].

Likely every paramedic today has come across Chamberlains 10 rules of ECG interpretation (rate, regularity, rhythm ..etc). In those early days, many were horrified at the idea that an ambulance officer could use such advanced technology. The phrases "reckless", "too difficult", "requires too much training" and "too costly" were thrown about, and our paramedic predecessors faced much resistance.

Yet today paramedics are expected to autonomously interpret 12 lead ECG's and diagnose acute myocardial infarctions, pre-alert and activate pPCI labs, and even thrombolyse patients in remote areas. Paramedic point of care ultrasound is facing today what the ECG in paramedicine faced over 40 years ago. As the evidence and research supporting its use creeps slowly forwards, we are almost at the point where we can see a viable future.

That is to say, paramedic-performed Point of Care Ultrasound is in its gestational period, not quite ready for birth, and not yet fully formed; but its delivery is soon to be expected.

So, what indeed IS Point of Care Ultrasound? POCUS (pronounced like hocus) as it is commonly referred, was the solution to a turf war between critical care physicians and radiologists some two decades ago. Faced with a battle over who was permitted to use the ultrasound machine, the radiologists conceded that critical care and emergency physicians could use the machines as long as they didn't claim to be performing formal diagnostic scans; only quick, focussed, and very specific scans looking for obvious and serious problems that would soon cause death.

The first of these scans was the FAST Exam – the Focussed Assessment with Sonography in Trauma [3].

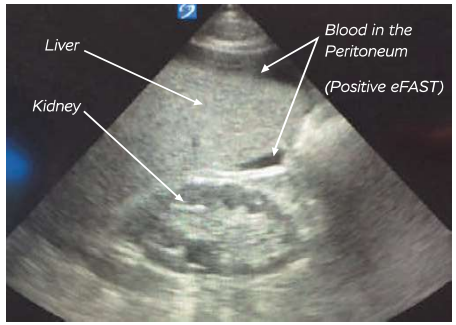
Pioneered in Europe in the late 1970's and then adopted and protocolised in America, the FAST used ultrasound (literally soundwave technology with no harmful radiation) to search for large amounts of free fluid (fluid sitting randomly outside of a specific organ structure; like the stomach, or gallbladder) in the abdomen [3]. The FAST arose because at the time, CT scans were not available and so the diagnosis of intra-abdominal bleeding relied on physical exam or a DPL (diagnostic peritoneal lavage).

The DPL involved placing a thin catheter into the peritoneum and infusing a litre of saline, then draining that saline out and examining its colour; clear meant no bleeding, red and bloody meant there was a bleed. For obvious reasons, this wasn't an ideal test; so the possibility of scanning a patient with an ultrasound machine became quite attractive.

As time went by, it became apparent that the cause of early death in trauma patients wasn't solely internal haemorrhage in the abdomen, but also due to obstructive shock in the thorax. By the early 2000's, the FAST had become the eFAST (extended FAST) and now, physicians and some nurses were also scanning the heart to detect cardiac tamponade, and the lungs for tension pneumothorax [3], [4].

POCUS has since exploded in emergency medicine, critical care, acute medicine, and a plethora of other subspecialties; let alone that cardiac ultrasound (known as echocardiography) is a core skill of modern cardiology. The list of diseases and organ system for which ultrasound is being used is ever expanding.

Despite lacking concrete scientific evidence showing its benefit in prehospital care (this is slowly being researched all over the world and the evidence is growing stronger), the emergency medicine and critical care sphere is pushing forwards. >>



Feature

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What differentiates POCUS from the rest of the shiny new toys that have promised so much and delivered so little? How will POCUS actually benefit patients and improve the care we can offer?

If all we do is transport every patient to the major tertiary hospital 10 minutes away, then POCUS won't help us. (And arguably, in that scenario, pre-hospital ECG's aren't of much benefit either). However, if we work in a large area where there are different hospital specialty services, varying community referral services, we regularly refer patients to alternative care solutions rather than transporting them to hospital, or occasionally need to make use of advanced critical care or aeromedical retrieval services; it's quite possible that POCUS adds significant value.

Trauma

As a non-metropolitan-based paramedic, deciding the disposition of trauma patients is often difficult. There lies a grey area between the acutely shocked polytrauma patient, and the completely stable isolated limb injury. Being able to rule-in an intra-abdominal bleed (perhaps a splenic or liver laceration) and justify an extra 30 minutes' drive with a stable patient to a higher care facility is potentially valuable.

This is a weak destination-dispositional advantage, not a clinical use per se. In understanding clinical implications, one might ask, what do we do with a patient who has multiple left sided rib fractures and shortness of breath? The hypothetical patient appears dyspnoeic and hypotensive.

Common practice dictates that we decompress the left side of the chest to relieve a likely tensioning pneumothorax. But common practice is not necessarily correct practice. Lung ultrasound is extremely accurate for the detection of pnemothoracies. Almost 99% accurate in some cases [5].

As such, we might find that there is in fact no pneumothorax at all, but rather a large amount of lung with pulmonary contusion (able to be seen using ultrasound). This information can prevent us performing an unnecessary and invasive procedure (decompression) for a patient who requires a protective lung ventilation, not a hole in their chest. Alternatively, if there is a pneumothorax, ultrasound provides us with a clear and definitive finding; especially useful in intubated or unconscious patients who are unable to communicate their mounting respiratory distress. Often the only signs of tension pneumothorax in these patients are increasingly poor vital signs [6].

Medical

Trauma is exciting; however, it is also thankfully becoming less common due to improved public health and safety interventions. Medical emergencies on the other hand, remain a significant proportion of the clinical caseload of paramedicine. The undifferentiated unwell patient can be a conundrum. Even the undifferentiated dyspnoeic patient is a diagnostic difficulty. A 2016 retrospective review of patient charts treated by both paramedics and emergency department teams for shortness of breath found that the diagnostic accuracy of paramedics in determining the cause of shortness of breath was poor [7].

Christie and colleagues in Auckland found that although paramedics demonstrated almost 100% accuracy for the diagnosis of anaphylaxis as the cause of shortness of breath, and 86% accuracy for acute asthma and COPD; paramedics were only 46% accurate for diagnosing acute pulmonary oedema as the cause of dyspnoea [7].

Indeed, a similar study from Western Australia showed that paramedic diagnosis of acute pulmonary oedema only had a 52% chance of being correct, and that paramedics missed two thirds of all patients who ended up being diagnosed with pulmonary oedema on discharge[8]. That is not to suggest that paramedics are poor diagnosticians, rather it reflects the difficulty of accurate diagnosis in the out-of-hospital environment where there is no access to advanced imaging or accurate testing... yet.

Ultrasound can change this. POCUS is an accurate tool to differentiate between wet lungs (pulmonary oedema) and dry lungs (asthma and COPD), and more so, in combination with basic cardiac ultrasound, it can even differentiate between normal wet lung (pulmonary oedema) versus infected wet lung (pneumonia)[9] [10]. POCUS doesn't just have the ability to improve our diagnostic acumen, it can actually prevent us from doing harm. By formulating a more accurate diagnosis we can stop treating pneumo-sepsis patients with nitrates and CPAP, and avoid giving fluids and antibiotics to acute pulmonary oedema patients.

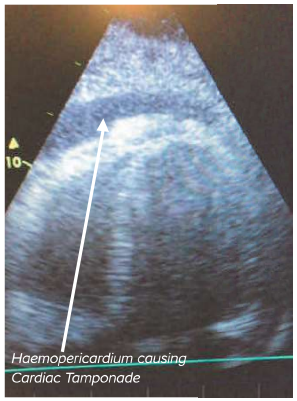
The future

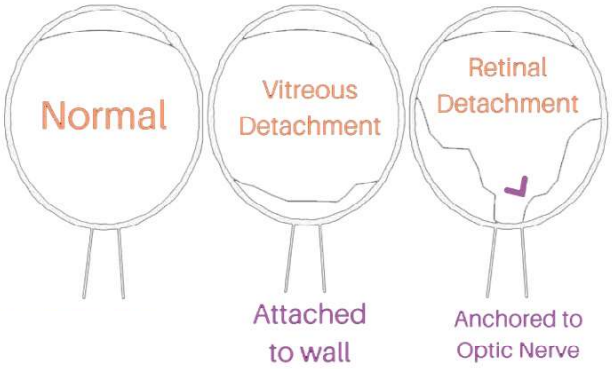
Imagine if there were a way to find an aortic dissection, or abdominal aortic aneurysm and immediately ready a vascular interventional team, not give the patient anti-platelets (that they would routinely receive in ACS-chest pain) and expedite their transfer to an appropriate centre?

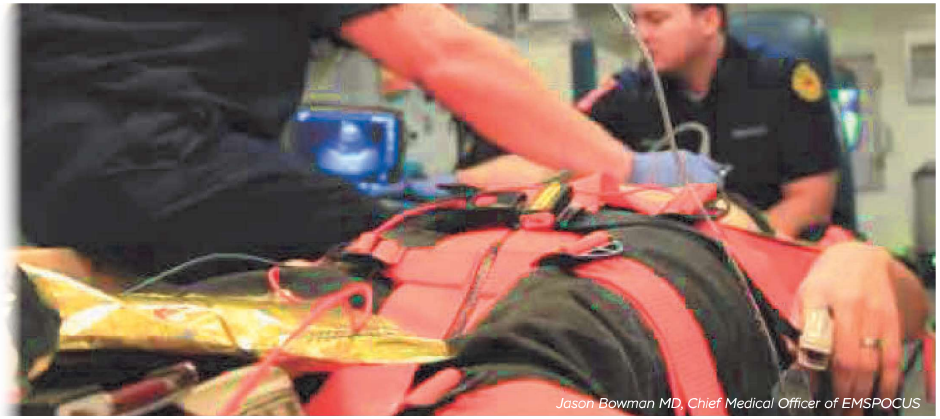
POCUS can do this.

Imagine if there were a way to diagnose massive pulmonary embolism using a combination of a 30-second DVT ultrasound and a 30 second cardiac ultrasound? Paramedics could begin thrombolysis in the field and potentially save lives and preserve organ function[11]. POCUS makes this possible.

As a community paramedic, ultrasound can help differentiate between thromboses, phlebitis, cellulitis, abscesses, topical dermatitis, and deep tissue infections (like necrotising fasciitis) [12], [13]. >>







Jason Bowman MD, Chief Medical Officer of EMSPOCUS

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Paramedic performed ultrasound can also offer valuable diagnoses such as; kidney stones (nephrolithiasis), heart failure, hypovolaemia, ectopic pregnancy, bladder distention, cholecystitis and choledocholithiasis (gall bladder inflammation and gall stones), empyema (lung infections), ascites, retinal and vitreous detachments, and many more [14]. POCUS might even allow interventions that we had never before considered. Ultrasound-guided IV cannulation provides a solution for difficult cannulation in the sick, but not 'needs-an-IO-level-sick', patient [15], [16].

This might enter specialist paramedic practice, alongside the ability to insert radial arterial lines for invasive pressure monitoring in rural critically ill transfers.

In the more distant future, Ultrasound might help to diagnose stroke and differentiate between haemorrhagic and ischaemic stroke pre-hospital [17], [18]. Even more radical a concept is that focussed ultrasound beams combined with microbubbles might be a future alternative to thrombolysis for ischaemic stroke[19] (it turns out that keeping the ultrasound beam focussed on a clot for 30-60 minutes in combination with microbubbles causes enough agitation to trigger clots to break down themselves and re-open occluded vessels. [20]) The Regensburg Stroke ambulance was one of the first recorded uses of this technology outside the hospital and research in this area is continuing [18].

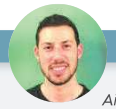
It's a wonderful utopian picture of an ultrasound-guided future that can be easily painted.

The reality is, that as with all things, ultrasound is a skill. And it is not an easy skill [21]–[23]. Paramedics should perhaps expect to spend at least three to six months part time, learning to use it holistically as described above (this is purely conjecture on the author's behalf). We still do not have consensus regarding what educational standards are required for integrated and safe POCUS use [24]. We do know however, that proficient POCUS application requires regular use, credentialing, clinical governance, and organisational buy-in to pay for costly staff education.

The actual purchase of the ultrasound machine is the cheap part. It is the initial and continuous commitment to education, hundreds if not thousands of hours of time across an organisation, that is the costly element.

So, is it really worth it?

We need to wait for the science to give us an answer [5], [25].



AIDAN BARON

Aidan is a Sydney-born paramedic researcher with interests in point of care ultrasound, patient advocacy, and applied ethics.

He is currently an Honorary Researcher in emergency, cardiovascular, and critical care at the centre for health and social care research, Kingston and St George's University London; and a sessional academic in the paramedic faculty at Charles Sturt University, NSW.

Aidan is the founder of the international paramedic ultrasound research group, and course director for The PoCUS Course in the UK and EU. He is also a consultant to the Australian Institute of Ultrasound, and has taught ultrasound for the UK Intensive Care Society, Sydney HEMS, and the Royal Australian Navy. After his B.Paramedic Practice at the University of Tasmania Sydney, he completed a BSc Hons with first class honours examining ultrasound-guided IVs by paramedics, followed by a Graduate Certificate in clinical ultrasound, both at Central Queensland University.

*You can find him on twitter **@aLittleMedic** and at **www.paramedicresearch.org***

a) Honorary Researcher, Emergency Cardiovascular and Critical Care Research Group, Faculty of Health, Social Care and Education, Kingston University London and St George's, University of London, UK

b) The Paramedic Ultrasound Research Group www.paramedicresearch.org

c) Sessional Academic, Discipline of Paramedicine, School of Biomedical Sciences, Faculty of Science, Charles Sturt University, NSW Australia

Declarations:

The Author receives financial profit for their role as faculty lead on The PoCUS Course UK which is a point of care ultrasound course for healthcare professionals working in pre-hospital, emergency, and critical care in the United Kingdom. The author also has a financial relationship as a consultant and faculty member for the Australian Institute of Ultrasound (QLD, Australia).

The author has previously undertaken research which was supported by Sonosite Australia through the use of their ultrasound machines. The author does not have any financial relationships with ultrasound device manufacturers.

If readers are interested in finding out more about paramedic ultrasound research or perhaps participating in future studies, they can go to **www.paramedicresearch.org.**

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