Paramedic point of care ultrasound at Australian mass gatherings

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Abstract

Point of care ultrasound (POCUS) is not traditionally performed by paramedics, and where it is used, is generally limited to resuscitative-type ultrasound examinations. We describe a select series of patient care cases collected between August 2017 and February 2018 which are the first known examples of expanded POCUS performed by a paramedic in this context. These point of care scans were performed for both high and lower acuity patient presentations and are felt to have contributed to improved decision-making in the treatment and onward referral of patients in the Australian festival and event medicine.

Keywords: case reports, festival, mass gathering, paramedic, point of care ultrasound, ultrasound.

Introduction

This select case series was collected between August 2017 and February 2018 and describes the first known series of patient care cases in which expanded point of care ultrasound (POCUS) was performed by a paramedic in a festival and event medicine context in Australia. The expanded approach to POCUS differs from its regular use by paramedics in that it relies on a wide array of organ-system examinations that lie outside the remit of general pre-hospital POCUS use; largely the extended focused assessment with sonography in trauma (eFAST) and focussed cardiac ultrasound examinations.^{1–5} The expanded use of POCUS was felt to have contributed to the care of patients in this relatively resource-limited environment. The contribution of POCUS in these cases is believed to be increased diagnostic clarity and reduced clinical uncertainty. This is a recognised effect of POCUS within acute and critical care.⁶ It also is possible that this expanded use of POCUS has implications for future community paramedicine practice.

There is generally a low incidence of seriously unwell patients seen by healthcare providers at Australian mass gatherings (it is estimated that between 0.5% and 2.0% of patrons at events will require medical care, and that between 0.02–0.55% will require

transportation to hospital).^{7,8} According to 2011 data, the average health system cost of a rotary wing (helicopter) aeromedical retrieval in eastern Australia was approximately \$34,000.00 AUD (Australian dollars), and a fixed wing (aeroplane) was conservatively estimated as \$10,000 AUD (for a transport lasting <2 h), and a road vehicle approximately \$1–4000 AUD depending on region.^{9,10} More so, emergency ambulance assets are valuable and finite resources. Tasking a local ground ambulance with transportation of a patient to hospital removes it from local service and can leave large areas (including major gatherings themselves) uncovered for hours at a time. In remote event medicine contexts, decisions regarding transport must be carefully evaluated in the light of the limited transportation assets available for both local health systems and mass gatherings.

It is the anecdotal experience of the author (AB) that multiple factors make POCUS a less frequently utilised diagnostic and interventional tool than in other healthcare environments. These include the predominantly lower acuity, younger age, low frequency of multiple comorbid or complex medical histories, and clear aetiology of illness/injury in the majority of patients encountered in the festival medicine context. Nonetheless, when POCUS was used, it was felt to offer a valuable addition to the assessment and treatment of patients.

This case series highlights the importance of a Bayesian approach¹¹ to POCUS due to the harms that a patient may face

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if a frequentist approach to diagnostic reasoning is employed. POCUS likely adds little value in cases where the pretest probability is extremely high (such as a fracture assessed on clinical examination to require radiography). And likely only occasionally contributes meaningful information in situations where the pretest probability is very low (such as the incidental finding of aortic aneurysm in a non-specific gastrointestinal complaint). Similarly, it is essential to safe practice and avoidance of downstream harms that clinicians recognise that different examinations have different test characteristics,^{12,13} levels of difficulty and likelihoods of interpretation error by non-experts.^{14,15} This case series occurred within a system of rigid clinical governance and the paramedic performing focussed scans was pursuing tertiary qualifications in this field. The authors caution strongly against implementation of POCUS outside of the context of highly effective clinical governance and a significant investment in education.

Cases

Case 1

An alcohol-intoxicated patient at an electronic dance music (EDM) festival presented after a fall with an unclear event history of transient loss of consciousness. The patient had experienced a recent flu-like illness and had prior cardiovascular history. ECG and clinical examination were unremarkable, and a focussed cardiac ultrasound^{16,17} was performed to detect if there were grossly abnormal structure or function, with particular attention paid to whether significant pericardial fluid, gross left ventricular dysfunction, significant effacement of the sino-tubular junction, or aneurysm or dissection of the abdominal and distal descending thoracic aorta were present. None of these were found which eliminated some differential diagnoses of concern in this patient and decreased their immediate risk stratification, allowing the patient to be more comfortably sent home (at their request) with follow-up by their primary care physician; as opposed to transport to an emergency department.

Case 2

A young adult patient was found at an urban EDM festival with a decreased level of consciousness, moderate hypotension, no identification or personal belongings and no nearby friends or relatives. Physical examination, vital signs and ECG were unremarkable (aside from a suspicion of alcohol and illicit substance intoxication). A RUSH examination¹⁸ (rapid ultrasound for shock and hypotension) was performed which found a completely collapsing inferior vena cava on spontaneous respiration and normal gross left ventricular function. A fluid challenge and 1 h of observation resulted in improved volaemic status (assessed clinically and on ultrasound); they were eventually discharged home with responsible friends later that evening after regaining an acceptable level of consciousness. The RUSH examination was used to identify a probable cause of

hypotension which was then easily correctable. Clinical assessment alone suggested a toxin-related cause of hypotension rather than hypovolaemia which would have prompted referral and ambulance transport to an emergency department. POCUS assisted the non-physician team to more confidentially treat and observe the patient rather than referring them onwards to an emergency department.

Case 3

A patient presented with significant foot pain after their local general practitioner removed a foreign body and administered tetanus prophylaxis 2 days prior.

Clinical examination revealed maximal tenderness between the pads of the 2nd and 3rd MTP (metatarsophalangeal joint) with no obvious other findings; examination was restricted by the glabrous skin of the patient's underfoot. A soft tissue ultrasound examination revealed a non-collapsible, heterogeneous hypoechoic collection with tapering edges superficial to the metatarsals and deep to the fat pad. This began medially between the 1st and 2nd metatarsals and ended laterally at the 4th metatarsophalangeal joint with sonographic evidence of oedema of the surrounding tissue. This was believed to be an abscess/fluid collection,¹⁹ and the patient was referred to their local emergency department for further investigation and definitive care; the collection was believed to be inappropriate for community-based intervention due to its depth and proximity to skeletal structures. This finding would not have been discoverable without POCUS.

Case 4

A patient presented in pain after punching a wall. Clinical examination revealed a rapidly evolving bruise and swelling with maximal tenderness over the 3rd metacarpal. Ultrasound examination of the palmar and dorsal aspects revealed a thin anechoic collection overlying the dorsal 3rd metacarpal but no gross interruption of the periosteal surface. Despite the absence of a clear fracture, the presence of periosteal fluid and clinical examination findings meant that X-ray was required^{20,21} and so the patient was advised to attend their general practitioner the following day for radiology referral. There was also a suspicion of extensor hood disruption, which can occur following the mechanism described.²² The decision against emergency department visitation was made in the light of the absence of significant periosteal interruption indicating gross deformity. This would have necessitated emergency department referral given the potential for significant misalignment requiring timely review by a surgical team. On follow-up, there was found to be significant localised bruising but no fracture or gross tendon injury requiring repair.

Case 5

A young male presented to the multidisciplinary clinical team in a remote location after a hot day with unprovoked syncope whilst seated and at rest. ECG findings were consistent with

their age group and habitus, and a familial history of cardiovascular disease was claimed to be absent. Focussed cardiac ultrasound¹⁷ was grossly normal bar a subtle irregularity in the shape of the right ventricle. This prompted deeper investigation, and the patient's family were contacted, who provided information regarding an early and unexplained death in their family history. There was concern that the abnormal focussed cardiac ultrasound findings in combination with the newly revealed history indicated that the patient may have an arrhythmogenic right ventricle. The patient (and family) was advised to see their family physician rapidly upon return from the remote area. It was communicated to both the patient and their physician that this was a limited, non-diagnostic examination using point of care methods and therefore was liable to inaccuracy. All findings, ECGs, and still images of four basic cardiac views were scanned into a letter to the patient's physician with suggestion that review by a cardiologist may have been required. It was felt that conventional care (without POCUS) would not have been able to detect this abnormal finding which had prompted more thorough investigation. The patient was unfortunately later lost to follow-up.

Case 6

A patient presented after multiple days of hiking in a remote location as part of an event with a large, mildly tender and somewhat fluctuant erythematous region >200 mm in diameter extending over the medial thigh and popliteal fossae. Differential diagnoses of envenomation, infection +/- abscess, thrombosis or dermatitis were initially considered.¹⁹ Soft tissue ultrasound²³ revealed completely normal echotexture of the underlying tissues; without any anechoic cystic structures or oedema of the subcutaneous tissues or muscle planes, as well as a negative 3-point DVT (Deep Vein Thrombosis) examination.¹³ These findings provided reassurance in proceeding with conservative management including topical steroids and oral antihistamines. There was complete symptom resolution after 24 h.

Case 7

A young female adult was brought to the medical tent with a decreased level of consciousness and moderate non-specific pelvic pain following a witnessed syncope outdoors at a remote festival. Initial assessment and normal ECG highlighted a provisional diagnosis of heat stroke. Whilst the pelvic pain was able to be attributed to heat stroke, it was felt that the patient was also within a high-risk demographic for intra-pelvic lesion (specifically ovarian cyst). The patient was unable to provide a detailed history or interact fully with the clinical team, and as such an eFAST²⁴ and RUSH¹⁸ examinations were performed with particular attention to the pelvic region. Significant findings were hyperdynamic gross left ventricular function, completely collapsible and small IVC (inferior vena cava), a fully visualised pouch of Douglas absent of free fluid and no intra-

uterine (pseudo)/gestational sac. Further, using focused pelvic ultrasound there was visualisation of the right and left ovary with a reasonable number of right ovarian antral follicles. Finally, no adnexal structures were visualised which would suggest ruptured tubo-ovarian cyst. In this case, it was acknowledged that POCUS had poor test characteristics for the exclusion of an intra-pelvic cause of fluid loss²⁵; however, the likelihood of subtle findings, undetectable using a basic sonographic examination being the cause of the patient's significantly hypovolaemic state was felt to be extremely low. The integration of POCUS was approached from a simplified Bayesian perspective¹¹ which would either yield a positive finding upon which to act or yield a negative/inconclusive finding. In this case, a negative/inconclusive finding maintained the pretest probability of the disease (tubo-ovarian cyst +/- intra-pelvic free fluid) at its approximate baseline frequency without excluding this as a differential. The patient responded well to intravenous fluids and was re-scanned an hour later which found grossly normal left ventricular function, normal IVC size and collapsibility, and an absence of abdominal free fluid. Serial or repeat ultrasound examination has been demonstrated to improve the sensitivity and safety of POCUS, particularly with regard to the detection of intra-abdominal free fluid.^{26,27} The syncope, transient decreased consciousness and pelvic pain were attributed to heat-related illness and fully subsided with rehydration. The patient was followed up at 2 weeks and reported no further complications. A lengthy, expensive and unnecessary transportation to hospital was avoided.

Case 8

A patient presented to the clinical centre at a remote event with a 1-day history of progressively worsening diffuse abdominal pain with maximal tenderness in the right lower quadrant. Clinical examination and history were otherwise normal aside from the patient reporting decreased bowel movements and recent alcohol consumption. The patient was in pain and distressed enough to warrant a consideration of evacuation to the nearest hospital (which was a significant distance away). Due to a lack of a firm provisional diagnosis, and inability to exclude serious pathology, preparations began for evacuation to hospital. POCUS was offered as a potential avenue to increase diagnostic clarity in the light of the treating team's quandary. The patient was asked to place the transducer over the area of maximal pain. Below this, there was no evidence of appendicitis, fluid or wall thickening of the local structures. A modified GUTS²⁸ (gastrointestinal and urinary tract sonography) examination was conducted; adjacent to the specified region began a loop of small bowel which appeared somewhat distended, thin walled, with frequent peristalsis of brightly gaseous contents, and which was <3 cm in diameter. This was followed for some distance, and no gross abnormalities found (such as peritoneal free fluid, a to- and fro-obstructive motion pattern, gross dilation or wall thickening of the bowel, gastroparesis or

pneumoperitoneum). Lower pelvic views revealed what can best be described as a 'full' appearing colon; the trans-rectal diameter was qualitatively assessed and appeared enlarged. It was explained to the patient that POCUS was not a definitive diagnostic examination but was 'good at giving clues without being totally accurate'. A frank discussion centred upon shared risk-ownership and decision-making occurred, and the patient elected to trial mild aperients. They experienced bowel motions within a half hour and self-discharged a few hours later with symptom resolution. A lengthy, expensive and uncomfortable transport to hospital was avoided in this case.

Summary

In remote and non-traditional environments, such as Australian mass gatherings, festivals and event medical contexts, POCUS is felt to have assisted in clinical care where there was diagnostic uncertainty. POCUS may provide additional information to clinicians, which can enhance their ability to make more appropriate decisions regarding patient care and disposition. POCUS has the potential to be dangerous to patient care and lead to poor decision-making if it is used by clinicians who do not understand the pretest and post-test probabilities, predictive values and the test characteristics of each individual sonographic examination, in combination with insight into the limitations of their own scanning abilities and proficiency. A Bayesian approach to clinical decision-making must be practised when using this technology. Importantly, POCUS must continue to be used in a focussed manner and a clear boundary between point of care and comprehensive sonography distinguished for both clinician and patient. Further research is needed to explore these hypotheses and establish whether there is a demonstrable benefit to patient-centred outcomes with the use of POCUS.²⁹

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Authorship

The authorship listing conforms to the journal's authorship policy, and all authors are in agreement with the content of the submitted manuscript.

Disclosure

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Ethics

This case series is a retrospective description of clinical findings in an observed course of events that document a new aspect of patient management during the normal course of clinical treatment. Since there is no hypothesis testing, no systematic data collection beyond that which is part of routine clinical practice, no data analysis, and the described work has already been performed, per the Helsinki Declaration, this case series does not qualify as research requiring approval from ethics boards designed to protect humans involved in clinical research. The patients included have been anonymised as comprehensively as is possible, and it is unlikely they would be able to identify themselves from this article. It is not possible to trace those patients whose care is reported on due to the nature of medical records storage methods used. Permission to record anonymised data for quality assurance purposes during clinical care, as well as publish such data where appropriate, has been granted by the director of the health provider responsible for service provision where the care described occurred.

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