

Prevalence and utility of point-of-care ultrasound in the emergency department: A prospective observational study

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Abstract

Objective: An observational study on the current diagnostic and procedural utility, as well as impact of point-of-care ultrasound (POCUS) in the emergency department (ED).

Background: Point-of-care ultrasound (POCUS) has been recognised as a useful non-invasive bedside tool in providing valuable information, as well as its utility in procedural guidance for clinicians. However, its current prevalence and utility in ED remain unknown.

Methods: In October 2016, a 31-day prospective observational study was performed in three Monash Health Emergency Departments in Melbourne, Australia. Data regarding patients' presenting complaints, frequency, operators' qualifications and POCUS module were collected and analysed. Factors associated with diagnostic impacts were identified.

Results: A total of 390 (2.1%) POCUS examinations were performed among 18,355 presentations in the three Monash Health EDs during the study period. POCUS was performed as a diagnostic tool in 344 (88.2%) and procedural guidance in 46 (11.8%) cases. eFAST/AAA and bedside echocardiography were the two most frequently utilised diagnostic modules. Overall, the majority of diagnostic POCUS cases were indicated for abdominal pain (35.3%), chest pain (14.0%) and trauma mainly traffic accidents (5.8%). Procedural POCUS was most commonly used for vascular access (71.7%), where dyspnoea (21.6%) was the most common presenting complaint. The majority of the cases were performed by FACEMs (Fellows of Australasian College of Emergency Medicine) (66.4%).

Conclusions: Despite known diagnostic and procedural values, the prevalence of POCUS in ED was found to be lower than what was expected. The prevalence was shown to be proportional to the level of clinical expertise among the operators. Training and utility of POCUS among physicians and trainees should be further advocated and supported.

Keywords: emergency, emergency medicine, point-of-care ultrasound, ultrasound.

Introduction

Prompt diagnosis and exclusion of life-threatening conditions are essential and critical in the emergency department (ED). Point-of-care ultrasound (POCUS) has been recognised as an excellent non-invasive tool, providing valuable information, as well as procedural guidance for clinicians at the bedside.¹ Real-time ultrasound has also been used in guiding invasive procedures such as establishment of central or peripheral intravascular (IV) access; and performance of thoracentesis, paracentesis or joint aspiration, etc., with greater safety.^{2,3} The utility of

POCUS has also been shown to reduce the ED length of stay, higher patient satisfaction and diagnostic accuracy.⁴⁻⁷

Despite known benefits and advocacy of usage from the Australasian College for Emergency Medicine (ACEM), the utility of POCUS had never been investigated. The primary aim of our study was to evaluate the prevalence of POCUS utility among patients presenting to the ED. The secondary aim was to evaluate the indication of POCUS utility in the ED.

Definitions

The prevalence of POCUS was defined as the number of cases where POCUS was performed during their ED admission

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divided by the total number of ED admissions throughout the study period.

The indications for POCUS were classified into two broad categories: 'diagnostic' and 'procedural' (ultrasound-guided procedures).

Diagnostic POCUS includes the following modalities:

- Extended focused assessment with sonography in trauma (eFAST) and/or abdominal aortic aneurysm (AAA);
- Deep vein thrombosis (DVT);
- Renal;
- Right upper quadrant (RUQ) and gallbladder;
- Bedside echocardiography (Echo), which is extrapolated from Basic Echocardiography in Life Support (BELS) protocol;
- Musculoskeletal (MSK) and soft tissue.

Monash Health bedside echocardiography has been extrapolated from the BELS protocol, which focuses on chambers size, qualitative left and right ventricular function, presence of pericardial effusion and IVC status.

Pulmonary ultrasound is not an isolated module. This could either be performed as part of eFAST, for example, in the setting of trauma, or be performed as part of bedside Echo, when patient presents with cardiopulmonary symptoms.

Obstetrics and gynaecological (O&G) POCUS is not a routine procedure in Monash Health, unless an ectopic pregnancy, with or without rupture, is suspected. All patients with moderate-to-high pre-test probability will be referred to urgent formal ultrasonography in radiology department (for either trans-abdominal or transvaginal ultrasound) and O&G review.

Musculoskeletal (MSK) and soft tissue ultrasound are mostly indicated for abscess, haematomas, effusions, fractures, dislocations, etc. It is also used to guide reduction and realignment in fracture manipulation. Ocular ultrasound is also not part of the routine POCUS.

Procedural POCUS is mostly used to guide procedures including

- Establishment of vascular access, including insertion of central venous catheter, arterial line and peripheral intravenous cannula (PIVC);
- Nerve block;
- Paracentesis;
- Thoracentesis;
- Lumbar puncture;
- Arthrocentesis.

Insertion of PIVC is commonly performed with direct visualisation of vein or landmark technique without the use of POCUS. In cases with difficult access, however, ultrasound could be helpful.

Operators were classified as Senior Medical Staffs, that is Fellows of Australasian College of Emergency Medicine (FACEMs, Emergency Medicine consultants), Senior and Junior ED Registrars and others, including Career and Hospital medical officers (CMOs and HMOs).

Method

A 31-day prospective observational study from 1st to 31st October 2016 was performed in the three Monash Health Emergency Departments, enrolling patients who had POCUS performed on them during their ED stay.

Monash Health is a major health network located in the south-east Melbourne, with an annual ED network census of approximately 200,000 presentations at the three hospitals: Monash Medical Centre (tertiary referral centre and Monash Children), Dandenong and Casey hospitals (district hospitals with mixed EDs). It is the only Victorian health network with an internal POCUS credentialing programme and 65 credentialed FACEMs and registrars. Among the credentialed practitioners, there are FACEMs with Certificates in Clinician Performed Ultrasound (CCPU) by the Australasian Society for Ultrasound in Medicine (ASUM).

The Monash credentialing programme provides courses adjusted to different levels of expertise, including introductory, advanced and refresher courses for both junior and senior medical staff. It is operated by FACEMs, trained general and cardiac point-of-care sonographers. Within Monash Emergency, each POCUS scan is reviewed and audited by the trained sonographers with specific feedback directed to the operating clinician, in order to maintain the quality and accuracy of image acquisition and interpretation.⁸

The study was approved by Monash Health and Monash University Human Research and Ethics Committees. Data collection was chiefly performed by the medical students in Emergency Medicine rotation who volunteered to be research assistants.

Starting from 1st October 2016 midnight to 31st October 2016, 23:59, patients who presented to Monash EDs and underwent POCUS were categorised into two groups:

- 1 Diagnostic POCUS, which includes five clinician-performed ultrasound (CPU) modules: eFAST/AAA, DVT, Renal, RUQ and gallbladder, BELS, as well as MSK and soft tissue.
- 2 Procedural POCUS (ultrasound-guided procedures).

Research assistants were present in the ED seven days a week from 08:00 till midnight to monitor the use of ultrasound machine and ensure the POCUS either was recorded on electronic medical record (EMR) system or on the designated study form attached to the ultrasound machine with the title and aim of this study stated. Details regarding the operator's qualification, date, indication, POCUS module and outcome of the procedure were collected, respectively.

The ED consultants, senior and junior registrars overnight were reminded at the beginning and the end of each shift during the study period, to document the details as mentioned above.

Documentation continued until 23:59 31st October 2016.

Main diagnostic POCUS modules, including eFAST/AAA, DVT, Renal, RUQ, and BELS, are routinely recorded on ED intrinsic EMR system (Symphony, EMIS Health, Leads, UK) as

clinician-performed ultrasound (CPU), with the findings entered by the operator. Images are also saved on the machine and transferred to the online server automatically for audit (by dedicated ED point-of-care sonographers) and educational purposes.

Other modules, including MSK/soft tissue and procedural POCUS, are not routinely recorded on the EMR. Cases were recorded individually by either the operator or the research assistant on the dedicated form attached to the ultrasound machine. Recorded information included patients' demographics (age and gender), presenting complaints, provisional diagnosis, attending clinicians, and subsequently disposition, that is discharge home, or referred to further investigations and management. Details of the subsequent admission for further management were retrieved from Symphony.

The CPU entries were further cross-checked with the written records collected by the research assistants at the end of each day and recorded on the designated excel spreadsheet.

At the end of the study period, to ensure there were not any missed cases mainly for procedural POCUS, using disposition via Symphony search, cases with specific discharge diagnosis (i.e. sepsis) or disposition (i.e. CCU or ICU) which potentially could have had POCUS during their ED stay were identified and reviewed in detail. The number of retrieved cases was similar to the written records which suggested a good compliance.

Ethics approval

Research Project No. RES-16-00000495Q

Pre-analysis audit

Since there was no similar study in the past, a crude estimate, regarding the proportion of ED presentations where POCUS would likely to be beneficial, was performed prior to data analysis, using information on Symphony including age, presenting complaints, discharge diagnosis and disposition – subsequent admission to CCU or ICU, in particular. It has shown that POCUS utility could have been potentially useful in at least 32.2% of total ED presentations (Table 1).

Results

There were 18,355 presentations (13,822 adults) to all Monash Health Emergency Departments during the 31-day study period, and a total of 390 POCUS examinations were recorded. These consisted of 344 (88.2%) diagnostic and 46 (11.8%) procedural cases, respectively. Overall POCUS prevalence was therefore calculated as 2.12% (1.87% diagnostic and 0.25% procedural).

Analysis of the patient demographics demonstrated the median patient age of 52 years, and 48.9% of patients were female (Table 2).

Diagnostic POCUS was most commonly performed on patients presenting with abdominal pain (35.3%), chest pain

Table 1: Crude estimate of proportion of ED presentations with presenting complaints where POCUS utility would likely to be beneficial during the study period, among total 18,355 presentations.

Presenting complaint	Number of presentations (%)	Comment
Abdominal (including flank) pain	1867 (10.2)	251 patients (1.37%) ≥ 65 years old One case of AAA without rupture One case of AAA with rupture 174 cases of confirmed renal colic on discharge
Chest pain	1266 (6.9)	813 cases due to cardiac causes
Dyspnoea	993 (5.4)	687 adults (≥ 18 years)
Unilateral leg swelling/Calf pain	534 (2.9)	65 (0.4%) cases of confirmed DVT 398 (2.1%) cases of cellulitis or abscess.
Torso/abdominal trauma (including MVA)	272 (1.5)	178 (0.96%) cases of MVA
Collapse/Syncope	246 (1.3)	60 (0.3%) cases of confirmed sepsis or septic shock.
Dysrhythmia/Palpitation	233 (1.3)	
Upper abdominal pain (Epigastric/RUQ)	185 (1.0)	88 confirmed biliary pathologies
Abdominal pain in early pregnancy	100 (0.5)	15 cases of confirmed ectopic pregnancies
First-trimester PV bleeding	190 (1.0)	
Cardiac/Respiratory arrest	16 (0.1)	
Total	5902 (32)	

(14.0%) and trauma (mainly motor vehicle accident) (5.8%). However, among the total ED presentations, POCUS was only used in 6.6% of cases with abdominal pain: 3.5% and 3.1% of trauma and chest pain cases, respectively.

The two most frequently used POCUS modules were eFAST/AAA (51.2%) and BELS (21.8%). eFAST/AAA was most commonly performed on patients presenting with abdominal pain (37.3%) and trauma (10.7%). Bedside Echo was mainly used for chest pain (38.3%) and dyspnoea (21.7%). The frequency for other modules was recorded as renal (13.7%), RUQ/gallbladder (11.0%), DVT (1.4%) and MSK/soft tissue (0.9%) (Table 3).

Table 2: Patient demographics for different POCUS modules.

Mode of POCUS	Gender (% Female)	Age (IQR 25–75)
eFAST/AAA	56.7	45 (30–66)
DVT	50	52 (38–65)
Renal	26.8	50 (36–59)
RUQ	62.2	53 (30–65)
BELS	49	57 (40–70)
Overall	48.9	52 (36–65)

Table 3: POCUS frequency for corresponding presenting complaints.

POCUS module		Frequency (%)	The two most frequent presenting complaints
Diagnostic (344 cases)	eFAST/AAA	176 (51.2)	Abdominal pain Trauma (mainly traffic accident)
	BELS	75 (21.8)	Chest pain Dyspnoea
	Renal	47 (13.7)	Abdominal/flank pain Trauma (mainly traffic accident)
	RUQ/ gallbladder	38 (11)	Upper abdominal pain
	DVT	5 (1.4)	Leg swelling/calf pain
	MSK/soft tissue	3 (0.9)	Fracture Foreign body
Procedural (46 cases)	Vascular access	33 (71.7)	Arterial access: 3 (9.1) Central venous catheterisation: 13 (39.4) Peripheral intravenous cannulation: 17 (51.5)
	Nerve blocks	9 (19.6)	Mainly femoral nerve
	Paracentesis	3 (6.5)	
	Lumbar puncture	1 (2.2)	
Total number of POCUS		390	

Procedural POCUS was most performed for dyspnoea (21.6%), overdose/ingestion of poison/toxic exposure (15.3%) and cardiac/respiratory arrest (8.1%). Major utility consisted of vascular access (71.7%), which involved peripheral venous cannula (51.5%), central venous catheter (39.4%) and arterial line insertions (9.1%). Other procedures included POCUS-guided nerve (mainly femoral nerve) block (19.6%), paracentesis (6.5%) and lumbar puncture (2.2%). Femoral nerve block was conducted with ultrasound guidance in 27.3% of patients with confirmed hip fracture, where the rest were either performed with landmark or traditional technique or managed with oral or intravenous analgesia prior to transfer for definitive management to the operating theatre.

Outcome

Analysis of outcomes post-POCUS revealed that 72 (20.9%) patients with a low pre-test probability for a specific condition based on presenting complaint and physical examination were discharged home after a diagnostic POCUS, with or without an outpatient formal investigation follow-up. The remaining 272 (79.1%) cases were either further investigated in ED or admitted for subsequent inpatient investigation and management.

Among 75 bedside performed Echo, based on POCUS findings in 12 (20%) cases, diagnosis and management were altered and changed.

Operators

Out of 390 POCUS studies, 259 (66.4%) cases were performed by SMS (FACEMs) and 131 (33.6%) by senior or junior registrars (mostly supervised by a FACEM). None of the other medical staff, that is Chief and Hospital medical officers (CMOs and HMOs), were identified to perform POCUS.

Notably, there was no reported complication or adverse event during study period.

Discussion

The crude estimate through a search on EMR suggested that POCUS could be beneficial in one out of three patients (32.2%) presenting to emergency department. However, our study revealed that POCUS was only performed on 2.1% of patients throughout the one-month period, despite advocations and known advantages. The majority (88.2%) of POCUS served for diagnostic purposes.

POCUS was most commonly performed by SMS (FACEMs) and a limited number of credentialed trainees mainly senior registrars. Such phenomenon could be attributed to POCUS requiring a certain level of clinical expertise and experience. This was further suggested by the fact that 63.9% of cases where POCUS was used as the sole investigative tool was operated by SMS.

Ultrasound machines are readily available in most hospitals and almost all tertiary centres. The low utility rate demonstrated in our study could be attributed to factors, including limited time for examination by senior clinicians secondary to ED overcrowding and time pressure to comply with key performance indicators (KPI), or competency of the clinician in POCUS and interpretations. The detailed reason behind, however, is yet to be determined in detail.

Limitations

We are mindful of some potential limitations and bias in our study. Data documented as written records were highly dependent on the operator's compliance, which could have led to missed cases, especially for procedural POCUS performed overnight when the research assistants were not present. Measures were undertaken to minimise the room for loss of data, including improving compliance by reminding staff members (senior in-charge doctors, nursing staff) of the study and case documentation. To minimise the chance of missed cases, a retrospective Symphony search and review of recorded images on the ultrasound machines were performed at the end of each day and to retrieve any non-documented POCUS case.

This study was only conducted within the Monash Health network and hence does not determine the overall POCUS prevalence in other networks. The application of our research results to other parts of Australia remains limited.

Suggestion to improve POCUS utility rate

Low POCUS prevalence is multifactorial. The utility could potentially be promoted by an increased number of POCUS

machines in the hospital; an internal credentialing programme targeting potential operators (i.e. registrars and CMOs); and the development of internal, state-wide or national-specific guidelines. POCUS utility could also be advocated among emergency physicians as an extended bedside examination or procedure-guiding tool,⁹ supported by credentialing and training programmes that involve bedside supervision and teaching, especially for junior medical staff and trainees.^{8,10-12} Further researches and studies can be other identified solutions.

Conclusion

Despite ongoing advocacy and known benefits of bedside ultrasound in diagnostic and procedural aspects, the prevalence of POCUS utility in the EDs was found to be much lower than expected. POCUS mostly served for diagnostic purposes, and the prevalence increased proportionally with the level of expertise among the operating clinician. Training of POCUS utility among trainees and physicians should be further advocated and supported.

Authorship statement

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