Australian Critical Care 38 (2025) 101058

Contents lists available at ScienceDirect

Australian Critical Care

journal homepage: www.elsevier.com/locate/aucc

Brief research report

Use of point-of-care ultrasound during cardiac arrest in the intensive care unit: A cross-sectional survey

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ARTICLE INFORMATION

Article history:
Received 2 October 2023
Received in revised form
19 March 2024
Accepted 16 April 2024

Keywords:
Prevalence
Consultants
Victoria
Heart arrest
Surveys and questionnaires
Point-of-care
ultrasound
Cardiac arrest

ABSTRACT

Background: There is growing interest in the use of point-of-care ultrasound during cardiac arrest, but few studies document its use in the intensive care unit.
Objective: We hypothesised this may reflect a low prevalence of use of point-of-care ultrasound during cardiac arrest or negative attitudes towards its use. We aimed to determine the self-reported prevalence, attitudes towards, and barriers to use of point-of-care ultrasound during cardiac arrest in the intensive care unit.
Methods: We conducted a web-based survey over 3 months (08/08/2022–06/11/2022), of intensive care unit consultants and registrars in Victoria, Australia. Descriptive and mixed-methods analyses of Likert-type and free-text answers were performed.
Results: The response rate was 91/398 (22.8%), split evenly between consultants and registrars. There was a broad range of clinical and ultrasound experience. Only 22.4% (22/91) of respondents reported using point-of-care ultrasound 75–100% of the time during their management of cardiac arrest. Respondents rated the value they place in point-of-care ultrasound during cardiac arrest 3 (interquartile range: 3–4) and that of a "skilled operator" 4 ((interquartile range; 4–5) on a 5-point scale. Free-text analysis suggested exclusion of "tamponade" (40/80 [50%] comments) as the most valuable use-case and "skill" as a personal barrier (20/73 [27.4%] comments). Personal and departmental barriers were not rated highly, although registrars perceived "lack of a structured training program" as a barrier. Respondents were equivocal in the value they gave point-of-care ultrasound during cardiac arrest but saw greater value when conducted by a skilled operator.
Conclusions: Point-of-care ultrasound was reported to be infrequently used in cardiac arrest, mostly due to self-perceived skill and lack of a structured training program.

1. Introduction

Interest in the use of point-of-care ultrasound (POCUS) to enhance management of cardiac arrest (CA) resuscitation has been growing over the past 20 years.[1] Proposed uses of POCUS during CA include the following: sonographic pulse check;[2] diagnosis of reversible causes of CA (e.g., tamponade and pneumothorax);[3] stratification into "pseudo-" or "false" pulseless electrical activity, based on left ventricle contractility;[4] and prognostication based on presence or absence of mechanical ventricular activity.[5]

Several studies have examined the use of POCUS during CA in the emergency department (ED) or prehospital setting, with inconsistent results on the ability of POCUS to predict successful resuscitation.[6–8] Concerns regarding the use of POCUS during CA include interruptions to chest compressions during cardiopulmonary resuscitation[9] and variability in interpretation of images obtained between clinicians.[10]

There are relatively few studies published on the use of POCUS during CA in the intensive care setting compared to the ED.[6] A

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https://doi.org/10.1016/j.aucc.2024.04.003
1036-7314/

single study was identified that did not report on prevalence and focused solely on outcomes of POCUS during CA in the intensive care unit (ICU).[4] It is not known if this reflects indifference towards its use by intensive care physicians, and if so, what factors may have led to this state?

Accordingly, we conducted a multicentre web-based survey to determine the self-reported prevalence, attitudes towards, and barriers to use of POCUS during CA in the ICU by consultant intensivists and intensive care registrars. Based on the current literature, we hypothesise *a priori* that POCUS was not commonly used in the management of CA in the ICU.

2. Methods

2.1. Ethics approval

Ethics approval was granted by the Monash Health Human Research Ethics Committee (HREC/87635/MonH-2022-325230(v1)). The local supervisor of training for each site was responsible for promulgation of the survey in each ICU (Supplementary material).

2.2. Survey design

Survey items were modified from a study by Singh et al., evaluating POCUS use during CA by emergency physicians,[11] to reflect intensive care practice. The items consisted of multiple-choice questions, including a 5-point Likert-type item. Each multiple-choice question required an answer to progress with the survey. Free-text boxes were included for themes of value and barriers but were not mandatory. A pilot survey was conducted, for feedback and development, in a convenience sample of paediatric intensivists who were not eligible to participate in the final study. The final web-based, electronic survey was hosted on a secure Monash Health–administered Microsoft Forms (Microsoft Corporation, Redmond, VA) platform. We followed the Checklist for Reporting Results of Internet E-Surveys guideline when reporting data.[12]

2.3. Setting

The survey was conducted over a 3-month period (08/08/2022–06/11/2022), coinciding with the standard medical training term, to minimise the possibility of staffing changes during the study. All Victorian ICUs accredited for general training were eligible, and supervisors of training for each site were contacted to distribute the survey and provide support for participants. Recruitment was open to ICU registrars and fellows who were College of Intensive Care Medicine (CICM) trainees and working at an accredited unit at the time of recruitment. ICU consultants were eligible if they were on the active-duty roster during the study period. Supervisors of training for each site provided numbers of consultants and registrars to whom the survey was distributed to, allowing calculation of the response rate.

2.4. Survey implementation

Invitations to the survey, participant information forms, and a brief description of the study were sent via email to supervisors of training at each site for distribution. A follow-up email was sent 1–2 weeks after initial contact. Participants were free to exit the survey at any time before submission. Consent was implied by participation in the survey, participation was voluntary, and no identifying data were stored.

2.5. Data analysis

Results from the survey were exported from Microsoft Forms to Jamovi (the Jamovi project, Sydney, Australia) for visualisation and descriptive statistics. Summative content analysis[13] was performed by author D.W. by making a word map of free-text answers to identify key phrases (Figures A1 & A2); then manual word count of free-text concepts was conducted using an explicit translation (e.g., "diagnosis of tamponade" becomes "tamponade"). Likert-type item data were treated as ordinal from 1 to 5 with the midpoint representing a neutral item. Comparisons between groups were performed using the Mann–Whitney *U* test, with statistical significance set at $p < 0.05$. Results are presented as counts or medians (interquartile range [IQR]). There were no missing data as completing all items was required to submit the survey.

3. Results

3.1. Response rate and participant details

The response rate was 91/398 overall (22.8%); 43/202 for registrars (21.3%), and 48/196 (24.5%) for consultants (Supplementary Table A1). All multiple-choice items in the survey were mandatory, and there were no missing data. Years of experience was evenly divided between categories for both groups (Supplementary Table A2). Most (71/91, 78%) respondents were working in a centre that performed cardiac bypass surgery (Supplementary Table A2). Almost all (89/91, 98%) respondents had recent experience managing CA (Table 1). Nearly half of respondents (45/91) selected "ultrasound short-course" as their training in POCUS, and there was a broad range of years of ultrasound experience (Table 1).

3.2. Perceptions about POCUS use during CA

Only 24.2% (22/91) of respondents reported using POCUS 75–100% of the time during their management of CA (Table 1). Respondents rated the value of use of POCUS during CA by a skilled operator higher than their own use, scoring three (IQR: 3–4) and

Table 1
Ultrasound background for 91 ICU doctors from Victoria, Australia.

	N	%
In the last year, how many episodes of cardiac arrest did you manage?		
0	2	2.2
1–5	60	65.9
6–10	21	23.1
>10	8	8.8
How often did you use point of care ultrasound in your management of cardiac arrest?		
0%	17	18.7
25%	29	31.9
50%	23	25.3
75%	8	8.8
100%	14	15.4
What best describes your training in point of care ultrasound?		
No experience	5	5.5
Primarily self-taught	10	11.0
Bedside instruction	10	11.0
Ultrasound short course	45	49.5
Diploma or equivalent	16	17.6
Ultrasound fellowship	5	5.5
How many years' experience do you have in point of care ultrasound?		
0	8	8.8
1–3	30	33.0
4–7	24	26.4
>7	29	31.9

Abbreviation: ICU: intensive care unit.

four (IQR: 4–5) on a five-point scale, respectively (Fig. 1). Registrars placed higher value on POCUS during CA than consultants when used by a skilled operator (median: 5 [IQR: 4–5] vs median: 4 [IQR: 3–5], $p = 0.004$) but not for their own use (median: 4 [IQR: 3–4] vs median: 3 [IQR: 3–4], $p = 0.151$) (Supplementary Table A4).

3.3. Self-reported barriers to POCUS use in CA

Personal barriers were not rated highly; however, several items were rated differently between consultants and registrars. Responses for "I don't feel confident in acting on my findings" (median: 2 [IQR: 2–3] vs median: 3 [IQR: 2–4], $p < 0.001$), "I do not feel confident in my ability to acquire diagnostic images" (median: 2 [IQR: 1.75–4] vs median: 4 [IQR: 2–4], $p < 0.001$), and "I don't manage enough cases to maintain my skills" (median: 2 [IQR: 2–3.25] vs median: 4 [IQR: 2–4], $p = 0.002$) were scored lower by consultants (more confident) and higher by registrars (less confident) (Supplementary Table A4).

Survey sections focused on negative attributes of POCUS during CA scored low, suggesting a positive sentiment towards its use (Supplementary Table A3). Departmental barriers scored low, aside from "There is no structured training program", with an even distribution around the neutral value, in aggregate. This was rated as a barrier particularly by registrars when compared with consultants when results were grouped (median: 4 [IQR: 2.5–4] vs median: 2.5 [IQR: 2–3], $p = 0.002$) (Supplementary Table A4).

3.4. Content analysis of free-text responses

Free-text responses were entered by 80/91 (87.9%) of respondents for the question "When do you think point of care ultrasound in cardiac arrest is most useful?" (Table 2). Content analysis revealed two main concepts: firstly, the use of POCUS to rule out reversible causes of CA; including pericardial tamponade, tension pneumothorax, and pulmonary embolism. The second concept was use of POCUS in prognostication and terminating resuscitation.

Seventy-three (80.2%) out of 91 respondents gave free-text responses to "What are your personal barriers to using point of care ultrasound during cardiac arrest in the intensive care unit?" (Table 3). Common personal barriers were identified as follows: insufficient skill to perform scans and interpret images, the competing roles of being the resuscitation leader and ultrasound operator, the need for more training, absent or bulky ultrasound machines, and a perceived lack of benefit of POCUS during CA.

Table 2
Frequency of themes related to use of POCUS in cardiac arrest.

When do you think point-of-care ultrasound in cardiac arrest is most useful? (responses = 80)	Count *n*
Tamponade	46
Stopping resuscitation	15
PEA arrest	13
Reversible causes	10
PE	10
Post cardiac surgery	5
Pneumothorax	3
RV difficult to assess	3

PE: pulmonary embolism; PEA: pulseless electrical activity; POCUS: point-of-care ultrasound; RV: right ventricle.

4. Discussion

4.1. Summary of findings

We conducted a survey to evaluate ICU doctors' self-reported use and attitudes towards POCUS use during CA in the ICU. CA was reported as an uncommon occurrence, and POCUS was not used routinely by respondents during CA. There was high variability in respondents' confidence of use of POCUS during CA. Registrars, in particular, appeared to feel less confident in their ultrasound skills and training than consultants. Respondents found most value in using POCUS to rule out reversible causes of CA, specifically pericardial tamponade.

4.2. Comparison with other literature

Whilst there are very few prior studies on POCUS use during CA in the ICU, there are several previous studies conducted in other areas of the hospital (Supplementary material Appendix B). We found the

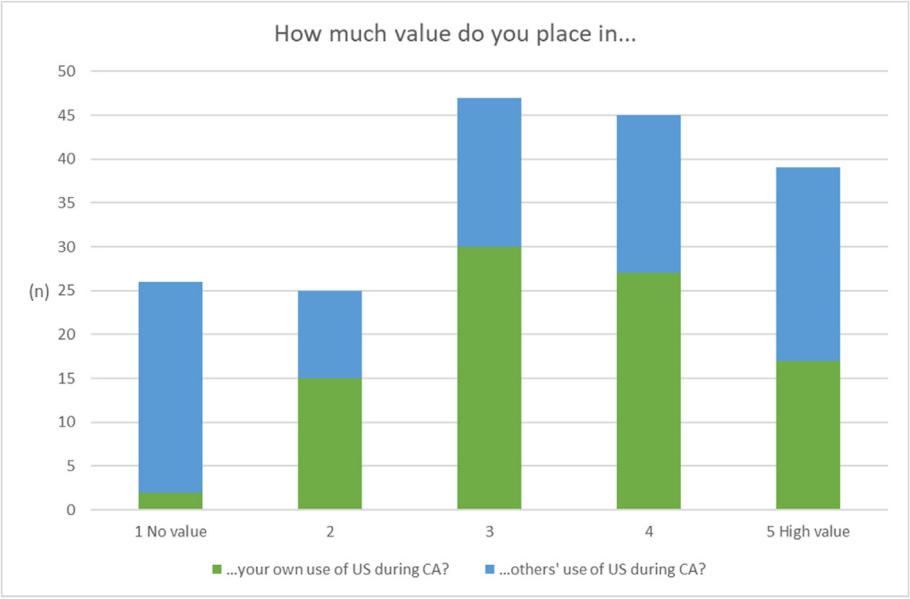

Fig. 1. Value placed on use of point-of-care ultrasound during cardiac arrest.

Table 3
Frequency of barriers for use of point-of-care ultrasound during cardiac arrest in the intensive care unit.

What are your personal barriers to using point-of-care ultrasound during cardiac arrest in the intensive care unit? (responses = 73)	Count *n*
Skill	20
Equipment	11
Leadership role	11
No value	8
Training	6
Adequate views	6

most common self-reported barriers to use of POCUS during CA in the ICU to be a lack of confidence in acquiring and interpreting images and a perceived deficiency of training. Equipment and departmental factors were not seen as substantial barriers.

In a study by Singh et al. of POCUS use in the ED,[11] demographics, confidence levels, and self-rated proficiency were rated by 110 consultant emergency physicians and 96 trainees. They found that POCUS was used by 37.9% (78/206) of respondents 75–100% of the time, compared with 22.4% in our study. ED respondents had higher self-reported scores for confidence than in our ICU sample (median 4/5 vs 3/5).

In our review of the literature (Supplementary material Appendix B), we found no previous studies on the prevalence, self-reported or otherwise, of POCUS use during CA. Of 40 studies related to POCUS during CA identified during our search, we found one contemporary observational study by Flato et al. of its use in the ICU.[4] Flato's study demonstrated the feasibility of POCUS use during CA; however, this was in the setting of qualified intensivist echocardiographers using a formal protocol (FEEL protocol),[14] with ICU staff trained on incorporating POCUS in advanced life-support algorithms.

The reported incidence of CA was 6.28 per 1000 admissions (0.6%) in one study of a tertiary Australian ICU.[15] This is consistent with our finding that most respondents reported managing one–five cases of CA per year.

4.3. Strengths and limitations

This study provides a unique insight into the contemporary self-reported use of POCUS during CA in the ICU. To our knowledge, this represents the first study of this topic in the ICU setting. Strengths include respondents being from a wide range of experiences levels, split evenly between registrar and consultant positions; the use of a mixed-methods design, allowing free-text answers; and a data set with no missing entries.

There are also limitations to this study design. The response rate was low, perhaps due to the anonymous and online nature of the survey. Selection bias may have caused recruitment of clinicians with a favourable opinion of POCUS, and the effect of mandatory questions on attrition was not measured. The low response rate and lack of demographic data may also limit assessment of generalisability of our findings. Respondents were not asked to specify their current workplace to promote anonymity; therefore, the number of participants of particular centres is not quantifiable. The survey was conducted in a single state of Australia, and findings may not represent practices in other regions.

4.4. Implications for education

Despite 73% of the group reporting having undergone some degree of formal training, most commonly an ultrasound short-course, training and confidence levels were not rated highly by respondents. CICM training requires an ultrasound short-course in bedside echocardiography to be completed before fellowship is granted. Uses and limitations of POCUS during CA may represent an area for development in POCUS course curricula. The infrequency of CA in the ICU has implications for skill decay and strategies to address this such as trainees performing scans in the ED, given the greatly increased incidence of CA in ED, may improve confidence levels.

4.5. Future research

Future studies are required to ascertain if POCUS provides useful information towards prognostication and terminating efforts at resuscitation in the ICU, given the different patient populations compared to the ED. The incidence of POCUS use for CA should be determined through prospective data collection, which may be facilitated by documenting POCUS use on standard resuscitation forms.

5. Conclusion

POCUS during CA was used infrequently by respondents, and self-reported value in its use was equivocal. POCUS during CA was seen as more valuable when performed by a “skilled operator”. Respondents indicated low confidence in acquiring and acting upon images, due to a self-perceived lack of a structured training program and difficulty maintaining currency of skills.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

David A West: Conceptualisation, methodology, data curation, formal analysis, visualization, writing—original draft, writing—review and editing. **Caroline Killick:** Conceptualisation, methodology, formal analysis, writing—original draft, writing—review and editing, supervision. **Daryl Jones:** Conceptualisation, methodology, formal analysis, writing—original draft, writing—review and editing, supervision. **The POCUS-CA Collaborators:** Project administration.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

Data availability statement

Due to the sensitive nature of the questions asked in this study, survey respondents were assured raw data would remain confidential and would not be shared.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.aucc.2024.04.003.

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