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ORIGINAL RESEARCH

POCUS literature primer: key papers on POCUS in cardiac arrest and shock

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Abstract

Objective The objective of this study is to identify the top five most influential papers published on the use of point-of-care ultrasound (POCUS) in cardiac arrest and the top five most influential papers on the use of POCUS in shock in adult patients.
Methods An expert panel of 14 members was recruited from the Canadian Association of Emergency Physicians (CAEP) Emergency Ultrasound Committee and the Canadian Ultrasound Fellowship Collaborative. The members of the panel are ultrasound fellowship trained or equivalent, are engaged in POCUS research, and are leaders in POCUS locally and nationally in Canada. A modified Delphi process was used, consisting of three rounds of sequential surveys and discussion to achieve consensus on the top five most influential papers for the use of POCUS in cardiac arrest and shock.
Results The panel identified 39 relevant papers on POCUS in cardiac arrest and 42 relevant papers on POCUS in shock. All panel members participated in all three rounds of the modified Delphi process, and we ultimately identified the top five most influential papers on POCUS in cardiac arrest and also on POCUS in shock. Studies include descriptions and analysis of safe POCUS protocols that add value from a diagnostic and prognostic perspective in both populations during resuscitation.
Conclusion We have developed a reading list of the top five influential papers on the use of POCUS in cardiac arrest and shock to better inform residents, fellows, clinicians, and researchers on integrating and studying POCUS in a more evidence-based manner.

Keywords Point-of-care ultrasound · POCUS · Ultrasound · Cardiac arrest · Resuscitation · Shock · Hypotension

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Résumé

Objectif L'objectif de cette étude est d'identifier les cinq articles les plus influents publiés sur l'utilisation de l'échographie au point de soin (POCUS) dans l'arrêt cardiaque et les cinq articles les plus influents sur l'utilisation de POCUS dans le choc chez les patients adultes.

Méthodes Un comité d'experts composé de 14 membres a été recruté par le Comité d'échographie d'urgence de l'Association canadienne des médecins d'urgence (ACMU) et le Canadian Ultrasound Fellowship Collaborative. Les membres du comité sont formés en échographie ou l'équivalent, participent à la recherche sur le POCUS et sont des chefs de file du POCUS à l'échelle locale et nationale au Canada. Un processus Delphi modifié a été utilisé, consistant en trois séries de sondages séquentiels et de discussions pour parvenir à un consensus sur les cinq articles les plus influents pour l'utilisation de POCUS dans les arrêts cardiaques et les chocs.

Résultats Le panel a identifié 39 articles pertinents sur le POCUS en arrêt cardiaque et 42 articles pertinents sur le POCUS en état de choc. Tous les membres du panel ont participé aux trois cycles du processus Delphi modifié, et nous avons finalement identifié les cinq articles les plus influents sur le POCUS en arrêt cardiaque et aussi sur le POCUS en état de choc. Les études comprennent des descriptions et des analyses de protocoles POCUS sûrs qui ajoutent de la valeur d'un point de vue diagnostique et pronostique dans les deux populations pendant la réanimation.

Conclusion Nous avons dressé une liste de lecture des cinq principaux articles influents sur l'utilisation du POCUS en cas d'arrêt cardiaque et de choc afin de mieux informer les résidents, les boursiers, les cliniciens et les chercheurs sur l'intégration et l'étude du POCUS d'une manière plus factuelle.

Motsclés Echographie au point de service · POCUS · Echographie · Arrêt cardiaque · Réanimation · Choc · Hypotension

Clinician's capsule

What is known about the topic?
The current literature base on integrating POCUS in cardiac arrest and shock is large and sometimes challenging to interpret.

What did this study ask?
What are the most influential papers published on the use of POCUS in cardiac arrest and shock?

What did this study find?
The expert panel used a modified Delphi process to identify the most influential papers on POCUS in cardiac arrest and shock highlighting how POCUS can safely inform improved resuscitation efforts.

Why does this study matter to clinicians?
This paper will help clinicians integrate POCUS in a more evidence-based manner when resuscitating patients and treating critically ill patients.

Introduction

While point-of-care ultrasound (POCUS) has been integrated across many practice settings by a wide range of specialties [1], emergency physicians (EPs) were among the earliest groups of physicians to adopt its use [2]. National emergency medicine (EM) specialty organizations endorsed its use as early as 1990 by the American College of Emergency Physicians [2], and in 1999 by the Canadian Association of Emergency Physicians (CAEP) [3]. EM as a specialty has demonstrated leadership in POCUS education [4], clinical guideline creation [2, 3], administrative integration [5], and research [6, 7]. The POCUS evidence base is growing at a dramatic rate, but with this growth, it has become challenging to identify a collection of papers in this field with the greatest clinical impact.

Given this challenge, the POCUS Literature Primer series [8] was created with the objective to systematically identify the most influential papers for each major application or use of POCUS. The initial publications in this series identified the top five most influential papers published on focused assessment with sonography in trauma (FAST) and extended FAST (E-FAST) [8] as well as renal and biliary POCUS [9]. While the first two publications assessed specific POCUS applications [8, 9], we have shifted our focus for this paper onto two important clinical use cases for POCUS: cardiac arrest and shock. As such, the objective of this study is to use a modified Delphi process to identify the five most influential papers published on the use of POCUS in cardiac arrest and the five most influential papers published on the use of POCUS in shock in adult patients.

Methods

Study design

The study used a modified Delphi process [10, 11] of sequential surveys and discussion among the expert panel

to build consensus and identify the most influential papers on the use of POCUS in cardiac arrest and shock. It is part of an ongoing series to identify the most influential papers in the field of POCUS. We used the same study design and protocol described in the initial paper of this series [8].

Participants

The 14-member expert panel was recruited from the CAEP Emergency Ultrasound Committee and the Canadian Ultrasound Fellowship Collaborative. The expert panel members have all had ultrasound fellowship training or equivalent, are actively engaged in POCUS research, and are involved with POCUS both locally and nationally. We sent invitations to these individuals by e-mail to participate in this modified Delphi process.

Modified Delphi process

We used a modified Delphi process of sequential surveys as outlined in Supplementary Appendix A.

Results

All 14 members of the expert panel completed all three rounds of the modified Delphi process. The members of the panel and their academic affiliation are listed in Supplementary Appendix B. A total of 39 papers were nominated in round 1 for the use of POCUS in cardiac arrest, and a total of 42 papers were nominated for the use of POCUS in shock. All nominated papers were included as part of the survey instrument for round 2. After completion of round 2, there were 12 candidate papers for the use of POCUS in cardiac arrest and 8 candidate papers for the use of POCUS in shock. No additional papers were included in the third round survey instrument. At the completion of this process, we were left with a rank order list of these papers in the order of most to least influential in Tables 1 and 2. The top five papers on the use of POCUS in cardiac arrest and shock are listed below with focused summaries, while Appendix C contains detailed summaries of these publications.

Cardiac arrest

1. Gaspari R et al. Emergency department point-of-care ultrasound in out-of-hospital and in-ED cardiac arrest. Resuscitation. 2016;109:33–9 [12]

This was the first large-scale study of POCUS in cardiac arrest which enrolled 793 patients, of whom 13 survived to hospital discharge. Patients with cardiac activity on the initial POCUS scan were more likely to survive to hospital admission (29% vs 7.2%), have return of spontaneous circulation (ROSC) (51% vs 14%,) and survive to hospital discharge (3.8% vs. 0.6%). POCUS identified conditions like pericardial effusion and pulmonary embolism that led physicians to additional interventions, and patients with pericardial effusion who underwent pericardiocentesis had higher survival rates (15%) compared to all other patients (1.3%).

2. Blaivas M, Fox JC. Outcome in cardiac arrest patients found to have cardiac standstill on the bedside emergency department echocardiogram. Acad Emerg Med. 2001;8(6):616–21 [13]

This is one of the first ED-based studies of the use of focused echocardiography in cardiac arrest. The authors enrolled a convenience sample of 169 patients presenting in cardiac arrest, of whom 20 survived to hospital admission. Of these 20 patients, none had cardiac standstill on initial POCUS; cardiac standstill on initial POCUS had a 100% positive predictive value for death in the ED. While this paper is historically important, recent studies have demonstrated more nuanced results where the absence of cardiac activity is not always predictive of unsuccessful resuscitation [14].

3. Lalande E et al. Is point-of-care ultrasound a reliable predictor of outcome during atraumatic, non-shockable cardiac arrest? A systematic review and meta-analysis from the SHoC investigators. Resuscitation. 2019;139:159–66 [14]

This systematic review and meta-analysis included ten studies and 1486 patients presenting with non-traumatic, non-shockable out-of-hospital or ED cardiac arrest. Cardiac activity on POCUS compared to its absence had an odds ratio (OR) of 16.9 for ROSC, 10.3 for survival to hospital admission, and 8.0 for survival to hospital discharge. The positive likelihood ratio (LR+) of cardiac activity on POCUS was 6.9 and negative LR (LR–) was 0.27 for ROSC. The absence of cardiac activity was less likely to predict unsuccessful resuscitation compared to other previously published studies.

4. Gaspari R et al. A retrospective study of pulseless electrical activity, bedside ultrasound identifies interventions during resuscitation associated with improved survival to hospital admission. A REASON Study. Resuscitation. 2017;120:103–7 [15]

This secondary analysis of the previously published Gaspari et al.'s prospective study [12] found that in 225 patients in pulseless electrical activity (PEA) arrest with cardiac

Table 1 All papers on POCUS in cardiac arrest eligible for round 3 of the Delphi process, along with their votes in round 2 and votes and total score in round 3

Paper	Round 2 votes for top 5 [No (%)]	Round 3 votes for top 5 [No (%)]	Round 3 total score	Final rank
Gaspari R et al. Emergency department point-of-care ultrasound in out-of-hospital and in-ED cardiac arrest. *Resuscitation.* 2016;109:33–9 [12]	**7 (50%)**	**13 (93%)**	**57**	**1**
Blaivas M, Fox JC. Outcome in cardiac arrest patients found to have cardiac standstill on the bedside emergency department echocardiogram. *Acad Emerg Med.* 2001;8(6):616–21 [13]	**5 (36%)**	**11 (79%)**	**36**	**2**
Lalande E et al. Is point-of-care ultrasound a reliable predictor of outcome during atraumatic, non-shockable cardiac arrest? A systematic review and meta-analysis from the SHoC investigators. *Resuscitation.* 2019;139:159–66 [14]	**8 (57%)**	**10 (71%)**	**32**	**3**
Gaspari R et al. A retrospective study of pulseless electrical activity, bedside ultrasound identifies interventions during resuscitation associated with improved survival to hospital admission. A REASON Study. *Resuscitation.* 2017;120:103–7 [15]	**4 (29%)**	**6 (43%)**	**22**	**4**
Atkinson P et al. International Federation for Emergency Medicine consensus statement: Sonography in hypotension and cardiac arrest (SHoC): An international consensus on the use of point of care ultrasound for undifferentiated hypotension and during cardiac arrest. *CJEM.* 2017;19(6):459–70 [16]	**3 (21%)**	**6 (43%)**	**18**	**5**
Huis In't Veld MA et al. Ultrasound use during cardiopulmonary resuscitation is associated with delays in chest compressions. *Resuscitation.* 2017;119:95–8 [23]	3 (21%)	6 (43%)	17	
Teran F et al. Evaluation of out-of-hospital cardiac arrest using transesophageal echocardiography in the emergency department. *Resuscitation.* 2019;137:140–7 [28]	5 (36%)	5 (36%)	9	
Inaba K et al. FAST ultrasound examination as a predictor of outcomes after resuscitative thoracotomy: A prospective evaluation. *Ann Surg.* 2015;262(3):512–8; discussion 516–518 [29]	3 (21%)	4 (29%)	7	
Clattenburg EJ et al. Point-of-care ultrasound use in patients with cardiac arrest is associated with prolonged cardiopulmonary resuscitation pauses: A prospective cohort study. *Resuscitation.* 2018;122:65–8 [24]	3 (21%)	3 (21%)	4	
Hu K et al. Variability in interpretation of cardiac standstill among physician sonographers. *Ann Emerg Med.* 2018;71(2):193–8 [30]	3 (21%)	3 (21%)	4	
Atkinson PR et al. Does point-of-care ultrasound use impact resuscitation length, rates of intervention, and clinical outcomes during cardiac arrest? A study from the Sonography in Hypotension and Cardiac Arrest in the Emergency Department (SHoC-ED) investigators. *Cureus.* 2019;11(4):e4456 [31]	3 (21%)	2 (14%)	3	
Gottlieb M, Alerhand S. Managing cardiac arrest using ultrasound. *Ann Emerg Med.* 2023;81(5):532–42 [32]	3 (21%)	1 (7%)	1	

The top five papers are indicated in bold

activity on ultrasound, patients treated with standard ACLS who had organized cardiac activity had higher rates of survival to hospital admission compared to those without organized cardiac activity (38% vs 18%). Additionally, PEA patients with organized cardiac activity treated with continuous infusions of adrenergic agents had higher rates of survival to hospital admission (46% vs 0%) and ROSC (91% vs 47%) compared to those with disorganized cardiac activity. This suggests a subset of PEA cardiac arrest patients (described elsewhere in the literature as "pseudo-PEA") who may represent a distinct physiological state of profound shock that may respond with a more favorable prognosis.

5. Atkinson P et al. International Federation for Emergency Medicine consensus statement: Sonography in hypotension and cardiac arrest (SHoC): An international consensus on the use of point-of-care ultrasound for undifferentiated hypotension and during cardiac arrest. CJEM. 2017;19(6):459–70 [16]

This modified Delphi process involving 24 international leaders in POCUS from both EM and critical care developed a Bayesian hierarchical protocol for the use of POCUS in undifferentiated hypotension and cardiac arrest. The recommended core views in cardiac arrest are limited to either subxiphoid or parasternal long axis

Table 2 All papers on POCUS in shock eligible for round 3 of the Delphi process, along with their votes in round 2 and votes and total score in round 3

Paper	Round 2 votes for top 5 [No (%)]	Round 3 votes for top 5 [No (%)]	Round 3 total score	Final rank
Jones AE et al. Randomized, controlled trial of immediate versus delayed goal-directed ultrasound to identify the cause of nontraumatic hypotension in emergency department patients. *Crit Care Med.* 2004;32(8):1703–8 [17]	**3 (21%)**	**11 (79%)**	**45**	**1**
Atkinson PR et al. Does point-of-care ultrasonography improve clinical outcomes in emergency department patients with undifferentiated hypotension? An international randomized controlled trial from the SHoC-ED investigators. *Ann Emerg Med.* 2018;72(4):478–89 [18]	**9 (64%)**	**11 (79%)**	**40**	**2**
Shokoohi H et al. Bedside ultrasound reduces diagnostic uncertainty and guides resuscitation in patients with undifferentiated hypotension. *Crit Care Med.* 2015;43(12):2562–9 [19]	**5 (36%)**	**12 (86%)**	**33**	**3**
Stickles SP et al. The diagnostic accuracy of a point-of-care ultrasound protocol for shock etiology: A systematic review and meta-analysis. *CJEM.* 2019;21(3):406–17 [20]	**5 (36%)**	**9 (64%)**	**22**	**4**
Perera P et al. The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically lll. *Emerg Med Clin North Am.* 2010;28(1):29–56, vii [21]	**6 (43%)**	**9 (64%)**	**22**	**5**
Volpicelli G et al. Point-of-care multiorgan ultrasonography for the evaluation of undifferentiated hypotension in the emergency department. *Intensive Care Med.* 2013;39(7):1290–8 [33]	3 (21%)	6 (43%)	18	
Peach M et al. Does point-of-care ultrasonography improve diagnostic accuracy in emergency department patients with undifferentiated hypotension? An international randomized controlled trial from the SHOC-ED investigators. *CJEM.* 2023;25(1):48–56 [34]	4 (29%)	7 (50%)	16	
Atkinson P et al. International Federation for Emergency Medicine consensus statement: Sonography in hypotension and cardiac arrest (SHoC): An international consensus on the use of point of care ultrasound for undifferentiated hypotension and during cardiac arrest. *CJEM.* 2017;19(6):459–70 [16]	3 (21%)	5 (36%)	14	

The top five papers are indicated in bold

cardiac windows, and must be performed during the pulse check, with image review performed following resumption of cardiopulmonary resuscitation (CPR). In addition, a practical operator checklist was developed introducing the "4 F" approach: fluid, form, function, and filling.

Shock

1. Jones AE et al. Randomized, controlled trial of immediate versus delayed goal-directed ultrasound to identify the cause of nontraumatic hypotension in emergency department patients. Crit Care Med. 2004;32(8):1703–8 [17]

This randomized controlled trial of immediate versus delayed protocolized POCUS enrolled 184 patients in shock. The immediate ultrasound group with 88 patients underwent the POCUS protocol on initial assessment, whereas the delayed group with 96 patients had the POCUS protocol performed between 15 and 30 min after presentation. At 15 min, the immediate POCUS group had both a lower number of viable diagnoses (median 4 vs 9) and were more likely to have the correct etiology as the most likely diagnosis (80% vs 50%).

2. Atkinson PR et al. Does point-of-care ultrasonography improve clinical outcomes in emergency department patients with undifferentiated hypotension? An international randomized controlled trial from the SHoC-ED investigators. Ann Emerg Med. 2018;72(4):478–89 [18]

In this first randomized controlled trial comparing POCUS to standard care without POCUS, the investigators enrolled

273 patients from six different international sites, with 138 assigned to the POCUS protocol group and 135 assigned to the standard care control group. There were no important differences between the groups for survival to 30 days or hospital discharge (76% vs 76%), or for secondary outcomes of rates of computed tomography scanning, inotrope and intravenous fluid administration, hospital admission, and intensive care unit and hospital length of stay. However, patients with a clear mechanism of shock were excluded, as were pregnant patients with possible ruptured ectopic pregnancy and patients with high clinical suspicion for abdominal aortic aneurysm; this may have mitigated any survival benefit from the use of POCUS.

3. Shokoohi H et al. Bedside ultrasound reduces diagnostic uncertainty and guides resuscitation in patients with undifferentiated hypotension. Crit Care Med. 2015;43(12):2562–9 [19]

This prospective observational study enrolled a convenience sample of 118 patients presenting with undifferentiated hypotension. There was a 28% reduction in diagnostic uncertainty before and after the POCUS protocol. The leading diagnosis after the POCUS protocol matched the final diagnosis on chart review 86% of the time ($k = 0.80$). In 12% of patients, there was a change in disposition as a result of the POCUS protocol.

4. Stickles SP et al. The diagnostic accuracy of a point-of-care ultrasound protocol for shock etiology: A systematic review and meta-analysis. CJEM. 2019;21(3):406–17 [20]

This systematic review and meta-analysis included four studies with 357 patients to quantify the diagnostic accuracy of the rapid ultrasound in shock and hypotension (RUSH) examination to identify the subtype of undifferentiated shock. For hypovolemic shock, pooled LR+ was 8.3 and LR– 0.19. For cardiogenic shock, pooled LR+ was 24.1 and LR– 0.24. For obstructive shock, pooled LR+ was 40.5 and LR– 0.13. For distributive shock, pooled LR+ was 17.6 and LR– 0.30. POCUS most reliably improves diagnostic accuracy when used to confirm the cause of shock, rather than to definitively rule out specific etiologies of shock.

5. Perera P et al. The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically lll. Emerg Med Clin North Am. 2010;28(1):29–56, vii [21]

This narrative review is the first formal description of the RUSH examination in the peer-reviewed literature. However, it was first conceived of by Scott Weingart, Daniel Duque, and Bret Nelson in 2006 and then published as a blog post in 2008 [22]. It is a systematic POCUS protocol designed to rapidly assess the cause of shock in a time-sensitive manner through a stepwise ultrasound evaluation of the patient's heart, inferior vena cava, lungs, abdominal cavity, aorta, and deep venous system. It introduces the concept of sonographically assessing the "pump", the "tank", and the "pipes".

Discussion

Interpretation of findings

There is a substantial body of literature that informs the current use of POCUS in the clinical settings of cardiac arrest and shock. In this primer, we believe we have captured the most important findings and take home points from these papers, extending from the clear utility of POCUS to inform clinicians on the probability of ROSC [12, 14] to structured algorithms for approaching POCUS in cardiac arrest [16]. In shock, we outlined the history of shock protocols, including fixed and Bayesian models [16, 21], in addition to exploring the evidence for improved outcomes [17, 19]. One issue with our top five paper list for cardiac arrest is the lack of inclusion of a study demonstrating that POCUS use during cardiac arrest is associated with significantly longer pulse checks and interruptions in CPR [23, 24]. This is an important concept, as both animal [25] and human data [26] and guidelines [27] stress the importance of limiting pauses during cardiac arrest resuscitation. If using POCUS in the setting of cardiac arrest, every effort should be made to minimize interruptions to chest compressions. The Huis In't Veld et al. [23] and Clattenburg et al. [24] papers were published within several months of each other; as a result, they split the vote by the expert panel. This demonstrates that beyond our top five lists, there are additional papers of value in Tables 1 and 2 that should be included in a reading list for trainees and POCUS-engaged clinicians.

Comparison to previous studies

This is the first compilation of landmark papers focusing on POCUS in cardiac arrest and shock in the EM literature. This primer will serve as a repository for clinicians and researchers wishing to familiarize themselves with the evidence behind critical care POCUS in EM. We have not attempted to compare individual papers directly, but have summarized the key findings and impact on practice.

Strengths and limitations

Our panel exclusively consisted of Canadian EM POCUS experts. None of the panel members are cross-boarded in critical care. As such, experts from other specialties or disciplines, such as critical care, anesthesia, internal medicine, or prehospital medicine, may have selected different papers. Since this was a modified Delphi process, we did not perform a systematic search or generate an exhaustive list of published papers on the use of POCUS in cardiac arrest and shock. We also did not have specific minimum requirements for the methodologic robustness of the included papers, and left this to the discretion of the panel. As a result, there is heterogeneity in the methodology and quality of the selected papers. Out of the 14 panel members, 8 were authors on one or more of the total candidate papers, and it is possible this may have biased the way they voted and created their rank lists in the three rounds of the modified Delphi. We believe this effect was mitigated by the broader panel consisting of 14 members, and ultimately, less than half of the panel (6 members) were authors of the candidate papers in round 3. Given the Canadian EM POCUS community is small, this conflict of interest is unavoidable. Conversely, this participation by panel members in this primary research speaks favorably of the expertise of our panel.

During the panel's in-person meeting at CAEP23, the group felt it was important to include a paper on the concept of POCUS use during cardiac arrest being associated with significantly longer interruptions to CPR [23, 24]. Since two candidate papers demonstrating this were published within several months of each other [23, 24], the consensus during the meeting was that panel members should vote for the paper (Huis In't Veld et al.) first published on the concept [23]. However, after the completion of the Delphi process, there was a split in the vote with three panel members voting for the Clattenburg et al. [24] paper. If these votes had been consolidated to the Huis In't Veld et al. [23] paper, it would likely have displaced the Atkinson et al. [16] paper from the top five list for cardiac arrest. Ultimately, our methodology had the constraints of generating a top five list.

Clinical implications

POCUS in cardiac arrest, when performed safely with minimal disruption to chest compressions, can provide useful clinical information to assist in prognostication [12, 14], as well as identifying key reversible diagnoses or pathologies during resuscitation [15, 16]. In the arrest and peri-arrest setting, a Bayesian approach as outlined in the SHoC protocol provides an approach to cardiac and extracardiac assessment of this critically ill population [16]. For hypotensive ED patients in shock, the use of POCUS is safe with no increased mortality [18], and may provide additional diagnostic benefit [17, 19, 20]. Again, the use of POCUS has evolved from fixed protocols toward a selective Bayesian approach [16, 17, 21].

Research implications

Despite the growing number of studies, it remains unclear if POCUS offers a survival advantage to critically ill ED patients in cardiac arrest or with shock [15, 18]. The challenge of addressing these questions persists as POCUS is now considered standard practice for the expedited diagnosis of many critical conditions in the early phases of resuscitation. Future research may focus on what value POCUS adds to early diagnosis or treatment guidance from a patient safety and efficiency perspective, rather than in further head to head randomized controlled trials.

Conclusion

We have generated a list of the top five influential papers for the use of POCUS in cardiac arrest and shock that will be a useful resource for residents, fellows, and clinicians who want to support their use of POCUS with the current literature base in these two important clinical scenarios. This list should be informative to clinicians in all specialties who resuscitate patients and treat critically ill patients. Future papers in this series will continue to generate lists of the most influential publications for other important applications and uses of POCUS.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s43678-023-00611-1.

Declarations

Conflict of interest PA, GS, JC, RT, DL, EL, CH, TB, FM, and PO do not report any conflicts of interest. DJK provides consultant services to Fujifilm Sonosite. CRB has received honoraria from Fujifilm Sonosite. TJ provides consultant services to Butterfly Network. IMB provides educational advisory board services to Pfizer Inc.

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