🕮 Thieme

EFSUMB Clinical Practice Guidelines for Point-of-Care Ultrasound: Part One (Common Heart and Pulmonary Applications) LONG VERSION

EFSUMB-Leitlinien für die klinische Praxis des Point-of-Care-Ultraschalls: Teil 1 (Allgemeine Herz- und Lungenanwendungen) LANGFASSUNG

Authors

Robert David Jarman[1, 2], Cian McDermott[3], Anna Colclough[4], Morten Bøtker[5, 6], Lars Knudsen[7], Tim Harris[8, 9], Bilal Albaroudi[9], Omar Albaroudi[9], Mahmoud Haddad[9], Robert Darke[10], Edward Berry[11], Tomas Breslin[3, 12], Gareth Fitzpatrick[13], Leah Flanagan[3], Olusegun Olusanya[14], Dominic Craver[15], Adhnan Omar[16], Thomas Simpson[17], Nishant Cherian[18, 2], Martin Dore[19], Gregor Prosen[20], Sharon Kay[21], Tomás Villén-Villegas[22], Luna Gargani[23], Simon Carley[24, 25], Michael Woo[26, 27], Florence Dupriez[28], Arif Hussain[29], Gabriele Via[30], James Anthony Connolly[31], Marcus Peck[32], Larry Melniker[33], Andrew Walden[34, 35], Mark Anthony Attard Biancardi[36], Olga Żmijewska-Kaczor[37], Elizabeth Lalande[38], Paul Geukens[39], Russell McLaughlin[40, 41], Paul Olszynski[42], Beatrice Hoffmann[43], Eric Chin[44], Christopher Muhr[45], Daniel J. Kim[46, 47], Andre Mercieca[36], Dharmesh Shukla[9], Simon Hayward[48], Michael Smith[49], Romolo Gaspari[50, 51], Nick Smallwood[52], Philippe Pes[53], Guido Tavazzi[54, 55], Francesco Corradi[56], Michael Lambert[57], Craig Morris[58], Michael Trauer[59], Kylie Baker[60, 61], Adam Bystrzycki[18, 62], Adrian Goudie[63], Rachel Liu[64], Lynne Rudd[65], Christoph F. Dietrich[66], Christian Jenssen[67], Paul S. Sidhu[68]

Affiliations

1 Emergency Department, Royal Victoria Infirmary, Newcastle upon Tyne, United Kingdom of Great Britain and Northern Ireland

2 School of Health and Life Sciences, Teesside University, Middlesbrough, United Kingdom of Great Britain and Northern Ireland

3 Emergency Medicine, Mater Misericordiae University Hospital, Dublin, Ireland

4 Emergency Medicine, University Hospital Lewisham, London, United Kingdom of Great Britain and Northern Ireland

5 Department of Clinical Medicine, Aarhus University, Aarhus, Denmark

6 Prehospital Emergency Medical Services, Central Denmark Region, Viborg, Denmark

7 Department of Anaesthesia, Aarhus University Hospital, Aarhus, Denmark

8 Emergency Medicine, Queen Mary University of London, United Kingdom of Great Britain and Northern Ireland

9 Emergency Medicine, Hamad Medical Corporation, Doha, Qatar

10 Emergency Medicine and Intensive Care Medicine, Health Education England North East, Newcastle upon Tyne, United Kingdom of Great Britain and Northern Ireland

11 Emergency Medicine, Torbay Hospital, Torquay, United Kingdom of Great Britain and Northern Ireland

12 School of Medicine, University College Dublin, Ireland

13 Emergency Medicine, St Vincent's University Hospital, Dublin, Ireland

14 Intensive Care Medicine, University College Hospital, London, United Kingdom of Great Britain and Northern Ireland

15 Emergency Medicine, The Royal London Hospital, London, United Kingdom of Great Britain and Northern Ireland

16 Respiratory Medicine, University Hospital Lewisham, London, United Kingdom of Great Britain and Northern Ireland

17 Respiratory Medicine, Lewisham and Greenwich NHS Trust, London, United Kingdom of Great Britain and Northern Ireland

18 Emergency Medicine, The Alfred Emergency & Trauma Centre, Melbourne, Australia

19 Emergency Medicine, Royal Devon and Exeter NHS Foundation Trust, Exeter, United Kingdom of Great Britain and Northern Ireland

20 Center for Emergency Medicine, University Medical Centre Maribor, Slovenia

21 Cardiac Physiology and Echocardiography, The University of Sydney, Australia

22 Department of Medicine, Francisco de Vitoria University, Pozuelo de Alarcon, Spain

23 Cardiology, Institute of Clinical Physiology National Research Council, Pisa, Italy

24 Emergency Medicine, Manchester University NHS Foundation Trust, Manchester, United Kingdom of Great Britain and Northern Ireland

25 Emergency Medicine, Manchester Metropolitan University, Manchester, United Kingdom of Great Britain and Northern Ireland

26 Emergency Medicine, University of Ottawa, Canada

27 Emergency Medicine, Ottawa Hospital Research Institute, Ottawa, Canada

28 Emergency Medicine, Cliniques universitaires Saint-Luc, Bruxelles, Belgium

29 Cardiac Critical Care, King Abdulaziz Medical City, Riyadh, Saudi Arabia

30 Anesthesiology, Intensive Care and Pain Medicine, Istituto Cardiocentro Ticino Ente Ospedaliero Cantonale, Lugano, Switzerland, Pavia, Italy

31 Emergency Medicine, Royal Victoria Infirmary, Newcastle-upon-Tyne, United Kingdom of Great Britain and Northern Ireland

32 Anaesthesia and Intensive Care, Frimley Park Hospital NHS Trust, Frimley, United Kingdom of Great Britain and Northern Ireland

33 Emergency Medicine, New York-Presbyterian Brooklyn Methodist Hospital, Brooklyn, United States

34 Acute and Intensive Care Medicine, Royal Berkshire Hospital, Reading, United Kingdom of Great Britain and Northern Ireland

35 Acute Medicine and Intensive Care Medicine, University of Oxford, United Kingdom of Great Britain and Northern Ireland

36 Emergency Medicine, Mater Dei Hospital, Msida, Malta

37 Emergency Medicine, Royal Cornwall Hospital, Truro, United Kingdom of Great Britain and Northern Ireland

38 Emergency Medicine, Centre Hospitalier de l'Université Laval, Sainte-Foy, Canada

39 Intensive Care Medicine, Hopital de Jolimont, Haine-Saint-Paul, Belgium

40 Emergency Medicine, Royal Victoria Hospital, Belfast, United Kingdom of Great Britain and Northern Ireland

41 Medical Director, Northern Ireland Ambulance Service, Belfast, United Kingdom of Great Britain and Northern Ireland

42 Emergency Medicine, University of Saskatchewan, Saskatoon, Canada

43 Emergency Department, Harvard Medical School Department of Emergency Medicine Beth Israel Deaconess Medical Center, Boston, United States

44 Emergency Medicine, Brooke Army Medical Center, Fort Sam Houston, United States

45 Emergency Medicine and Internal Medicine, Capio Sankt Gorans Sjukhus, Stockholm, Sweden

46 Emergency Medicine, The University of British Columbia, Vancouver, Canada

47 Emergency Medicine, Vancouver General Hospital, Vancouver, Canada

48 Physiotherapy, Blackpool Teaching Hospitals NHS Foundation Trust, Blackpool, United Kingdom of Great Britain and Northern Ireland

49 School of Healthcare Sciences, Cardiff University College of Biomedical and Life Sciences, Cardiff, United Kingdom of Great Britain and Northern Ireland

50 Emergency Medicine, UMass Memorial Medical Center, Worcester, United States

51 Emergency Medicine, UMass Medical School, Worcester, United States

52 Acute Medicine, East Surrey Hospital, Redhill, United Kingdom of Great Britain and Northern Ireland

53 Emergency Medicine, University Hospital Centre Nantes, France

54 Anesthesia and Intensive Care Unit, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy

55 Dipartimento di Scienze Clinico-Chirurgiche, Diagnostiche e Pediatriche, Università degli Studi di Pavia Facoltà di Medicina e Chirurgia, Pavia, Italy

56 Surgical, Medical and Molecular Pathology and Critical Care Medicine, University of Pisa, Italy

57 Emergency Medicine, Advocate Christ Medical Center, Oak Lawn, United States

58 Intensive Care, Royal Derby Hospital, Derby, United Kingdom of Great Britain and Northern Ireland

59 Emergency Medicine, St Thomas' Hospital, London, United Kingdom of Great Britain and Northern Ireland

60 Emergency Medicine, Ipswich Hospital, Ipswich, Australia

61 Faculty of Medicine, The University of Queensland, Saint Lucia, Australia

62 Department of Epidemiology & Preventive Medicine, Monash University, Clayton, Australia

63 Emergency Medicine, Fiona Stanley Hospital, Murdoch, Australia

64 Emergency Medicine, Yale School of Medicine, New Haven, United States

65 General Secretary, European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB), London, United Kingdom of Great Britain and Northern Ireland

66 Department Allgemeine Innere Medizin, Kliniken Hirslanden Beau Site, Salem und Permanence, Bern, Switzerland

67 Klinik für Innere Medizin, Krankenhaus Märkisch Oderland Strausberg/ Wriezen, Germany

68 Radiology, King's College London, United Kingdom of Great Britain and Northern Ireland

Correspondence
Prof. Robert David Jarman
Emergency Department, Royal Victoria Infirmary, Queen Victoria Road, NE1 4LP Newcastle upon Tyne, United Kingdom of Great Britain and Northern Ireland
Tel.: +44/01 91/2 83 97 08
bob.jarman@mac.com

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ABSTRACT

Aims To evaluate the evidence and produce a summary and recommendations for the most common heart and lung applications of point-of-care ultrasound (PoCUS).

Methods We reviewed 10 clinical domains/questions related to common heart and lung applications of PoCUS. Following review of the evidence, a summary and recommendation were produced, including assignment of levels of evidence (LoE) and grading of the recommendation, assessment, development, and evaluation (GRADE). 38 international experts, the expert review group (ERG), were invited to review the evidence presented for each question. A level of agreement of over 75 % was required to progress to the next section. The ERG then reviewed and indicated their level of agreement regarding the summary and recommendation for each question (using a 5-point Likert scale), which was approved if a level of agreement of greater than 75 % was reached. A level of agreement was defined as a summary of "strongly agree" and "agree" on the Likert scale responses.

Findings and Recommendations One question achieved a strong consensus for an assigned LoE of 3 and a weak GRADE recommendation (question 1). The remaining 9 questions achieved broad agreement with one assigned an LoE of 4 and weak GRADE recommendation (question 2), three achieving an LoE of 3 with a weak GRADE recommendation (questions 3–5), three achieved an LoE of 3 with a strong GRADE recommendation (questions 6–8), and the remaining two were assigned an LoE of 2 with a strong GRADE recommendation (questions 9 and 10).

Conclusion These consensus-derived recommendations should aid clinical practice and highlight areas of further research for PoCUS in acute settings.

ZUSAMMENFASSUNG

Ziel Bewertung der Evidenz und Erstellung einer Zusammenfassung sowie von Empfehlungen für die häufigsten Herz- und Lungenanwendungen des Point-of-Care-Ultraschalls (PoCUS).

Methoden Wir überprüften 10 klinische Bereiche bzw. Fragen im Zusammenhang mit den häufigsten Herz- und Lungenanwendungen des PoCUS. Nach der Überprüfung der Evidenz wurden eine Zusammenfassung und eine Empfehlung erstellt, einschließlich der Zuordnung von Evidenzgraden („Level of Evidence" LoE) und der Einstufung der Empfehlung, Bewertung, Entwicklung und Evaluierung (GRADE). Die Expert Review Group (ERG), bestehend aus 38 internationalen Experten, wurde aufgefordert, die für jede Fragestellung vorgelegte Evidenz zu überprüfen. Eine Zustimmung von über 75 % war erforderlich, um zum nächsten Teilbereich überzugehen. Anschließend überprüfte die ERG die Ergebnisse und gab den Grad der Zustimmung (mittels 5-stufiger Likert-Skala) bezüglich der Zusammenfassung und Empfehlung für jede Fragestellung an. Diese wurde anerkannt, wenn der Grad der Zustimmung – definiert als Summe der Antworten „stimme voll zu" und „stimme zu" auf der Likert-Skala – mehr als 75 % betrug.

Ergebnisse und Empfehlungen Bei einer Frage wurde ein starker Konsens bei einem zugeordneten LoE von 3 und einer schwachen GRADE-Empfehlung erzielt (Frage 1). Die übrigen 9 Fragen erzielten eine breite Zustimmung, wobei eine Frage einen LoE von 4 und eine schwache GRADE-Empfehlung erhielt (Frage 2), 3 Fragen erreichten einen LoE von 3 mit schwacher GRADE-Empfehlung (Fragen 3–5), 3 Fragen erreichten einen LoE von 3 mit starker GRADE-Empfehlung (Fragen 6–8) und die verbleibenden 2 Fragen erhielten einen LoE von 2 mit einer starken GRADE-Empfehlung (Fragen 9 und 10).

Schlussfolgerung Diese konsensbasierten Empfehlungen sollen die klinische Praxis unterstützen und Bereiche für weitere Forschung im Bereich des PoCUS in der Akutversorgung aufzeigen.

Introduction

Point-of-care ultrasound (PoCUS) has become an increasingly popular clinical tool over the past three decades [1]. Using ultrasound to augment clinical assessment and guide procedures is the key principle underpinning such use in clinical settings, and, in most cases, the clinician managing the patient also performs the scan [2, 3].

Advancements in PoCUS technology have resulted in cheaper, more compact, and portable ultrasound systems becoming available – often without a significant reduction in image quality and machine features. Many systems used in clinical areas are cart-based with reduced functionality, which is reflected in their lower cost. Nevertheless, advantageous features include being battery-powered, having rapid boot-up times, and having an enhanced design to withstand a harsher working environment. There are an increasing number of small devices that are handheld and are owned and used by individual clinicians – some systems are currently available for under USD$2000. Handheld machines have been shown to be effective in clinical practice when used to answer specific clinical questions [4, 5]. Terms such as PoCUS, echoscopy, sonoscopy, and clinician-performed ultrasound have been used to describe this practice, and it has been likened to an ultrasonic stethoscope [6–9]. However, ultrasound should not merely be considered a replacement for a stethoscope. Appropriate training and governance is important to ensure that it is used with diligence in clinical practice [10]. Ultrasound is a safe modality compared to other imaging tools but there are still potential risks that need to be considered by all users [11]. ECMUS, the safety committee of EFSUMB, has produced guidance on the regulatory aspects of hand-held machines [12]. In addition, EFSUMB has produced a position statement on the use of handheld ultrasound devices [13].

Regardless of the type of ultrasound system adopted, PoCUS has been used in a wide range of clinical environments by an increasing number of specialties: its applications can cover a range of body systems, for example, heart, lungs, biliary, renal, vascular, and ocular systems, and cover a spectrum of patient presentations, for example, trauma, emergency, prehospital, general practice, as well as routine elective activity. The underlying principles of PoCUS are usually based on a timely, focused examination, often used to aid the answering of a binary clinical question, i. e., is there pericardial effusion? It differs, in many aspects, from traditional ultrasound practice but should not be considered an inferior examination [14]. Clinical procedures have seen improved success rates and enhanced safety profiles when PoCUS is used [15]. Many national and international specialty bodies have included PoCUS in their training curricula [16–18]. In addition, such skills are now being taught at an undergraduate level in some medical schools [19–24].

The need for clinical practice guidelines (CPGs) for PoCUS has been supported by the EFSUMB Executive. However, producing CPGs that cover all aspects of established and emerging PoCUS applications is challenging due to the sheer breadth of the spectrum of practice. To produce CPGs, a robust search and review of the evidence base is necessary prior to a consensus decision on any recommendation. Hence, for these CPGs, we focused on the most common PoCUS applications and grouped them into three parts, based on body systems and whether they are used for clinical evaluation or procedural guidance: Part 1 covers thoracic-themed applications (heart and pulmonary), Part 2 covers abdominopelvic and head/neck applications, and Part 3 covers procedural applications. Deep vein thrombosis has been included in Part 1 as part of an overall thromboembolic theme along with pulmonary embolism.

Methods

Ethics approval was granted by the Ethics Subcommittee of the School of Health and Life Sciences, Teesside University (registration number 2021 Mar 5449) for the review and consensus process undertaken as part of the CPGs methodology. The data gathering approach was based on the EFSUMB policy document strategy [25]. Due to the COVID-19 pandemic, modifications were made to these methods to ensure that all aspects of the process could be conducted without the need for face-to-face sessions. Three phases were adopted. Phase 1 was concerned with defining the research question and searching for the evidence. In phase 2, we summarized the evidence and recommendation, including the assigning of levels of evidence. Phase 3 was the review and consensus process. A coordinating group assembled several research teams to undertake the phase 1 and 2 activities and recruited members for the expert review group (ERG) who were tasked with participating in phase 3.

Phase 1

Initially the scope of practice and broad themes were established, and teams of researchers were assembled with the task of defining a research question using a population, intervention, comparator, and outcome framework (PICO). Recruitment of team members was performed via face-to-face and email contact to ascertain ex-

pressions of interest. Some of the members were current and past students of a postgraduate master's program in medical ultrasound at the lead authors institution, some were recruited from contacts proffered by the EFSUMB administration, and others were known to the coordinating group and had presented and published in the field of PoCUS. We did not specify further mandatory qualifications or experience as full support and instructions were provided. For each research question the teams were asked to map out a search strategy, which included defining search terms, sources of evidence, and eligibility criteria. Following the searches, teams were asked to remove duplicates and screen the studies against the defined eligibility criteria, firstly based on review of titles and abstracts and then based on a review of the full paper. A record of the number of studies evaluated, from the initial searches to the final selection, was recorded using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow template [26]. The reasons for exclusion of studies on the second round of screening were recorded. The teams were asked to assess the quality of the final selection of studies using the revised tool for the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) for guidance, or the updated tool – A MeaSurement Tool to Assess Systematic Reviews (AMSTAR-2) [27, 28]. For the purposes of these guidelines, a short summary of the quality assessment for each study, rather than full QUADAS-2/AMSTAR-2 results, was required. Data were extracted using the provided summary table template, which also included the summary of the quality assessment. The teams were asked to upload four documents, per research question, into a designated cloud-based folder (Dropbox; Dropbox Inc, San Francisco, Ca, USA): a completed proforma (detailing the research question, search terms and strategy, and eligibility criteria), a PRISMA flow diagram, a summary table, and a reference list of the final included studies.

Phase 2

The teams were then asked to prepare a statement and recommendation, which was structured using a template proforma. This consisted of a summary of the quantity and quality of evidence that was found, the clinical relevance and applicability and any potential harms and benefits. In addition, a summary of the best level of evidence rating was formulated using the Oxford Centre for Evidence Based Medicine (OCEBM) 2011 criteria and the strength of recommendation was determined using the GRADE criteria [29, 30]. The teams were asked to upload this summary into a designated cloud-based folder.

Phase 3

An ERG was assembled to provide a review and consensus opinion of the phase 1 and 2 results. Members of the ERG were independent of other study personnel and the research question teams. There were two required criteria for membership: at least five years of experience in point-of-care ultrasound and an understanding of evidence-based medicine. With regard to the latter, we did not mandate specific qualifications and it was left to individual members to decide whether they met the criteria. Invites for the ERG were disseminated via established email distribution lists covering several international regions, backgrounds, and specialties, including academic and clinical. Potential participants

were sent an electronic participant information sheet, which included details of the review process, consent, and privacy terms.

The ERG was provided with a handbook covering the methods of this project and was invited to contact the coordinators via email for further information and clarification. A webinar was hosted and recorded, which included a presentation and question and answer session – all ERG participants were provided with access to this. Further contacts were made, via email, to update the ERG on progress and to clarify any queries.

The review and consensus processes were conducted in two sections. The ERG was asked to review the documents provided in the online folders for each research question. Links to the folders were provided along with links to an online questionnaire platform (Google Forms; Google LLC, Mountain View, Ca, USA). Section 1 and 2 questionnaires were accessed via separate links. The online questionnaire for section 1 also required ERG participants to include their name, email, affiliations, conflicts of interest (COI), affirmation that they met the criteria for ERG membership and to confirm informed consent.

Section 1 required the ERG participants to confirm that they had accessed and reviewed all four components of the phase 1 results for each research question and to answer whether the presented research question, search strategy, and evidence were of an acceptable standard in their opinion (yes or no), with answers being given via the online questionnaire platform. ERG participants were encouraged to leave comments, especially in cases where they did not think the results reached an acceptable level. This section was incorporated into the methods to ensure that the research questions and related evidence presented for phase 1 were of an acceptable level to be the foundation for the summary statements and recommendations provided for phase 2.

A level of agreement of greater than 75 % from the ERG in section 1 determined whether the phase 1 results were accepted for each research question. When this was not achieved, the responsible team was informed of the outcome and provided with the comments made by the ERG. They were given an opportunity to undertake remedial changes prior to presentation of the revised content to the ERG in a second round. A subsequent online questionnaire was prepared and limited to questions that failed to achieve an acceptable level of agreement in the first round and the updated documents were uploaded to the relevant online folder. The ERG was then invited to review the updated results for this second round and only questions that achieved a level of agreement greater than 75 % were allowed to progress to the next section.

Section 2 required the ERG participants to confirm that they had accessed and reviewed the completed summary statement document, OCEBM level of evidence rating, and GRADE recommendation of the phase 2 results for each research question. Following review of these documents, they were asked to specify their level of agreement using a five-point Likert scale [31]. ERG participants were encouraged to leave comments, especially in cases where they did not agree with the phase 2 results. Individual participants of the ERG were also allowed to abstain from voting on any individual summary statements and recommendations in the case of potential conflicts of interest (COI) or inadequate knowledge related to a particular topic.

▶ Table 1 Table of Question Research Domains and Researchers.

Question Number	Domain	Researchers
1	Pericardial Effusion and Tamponade	Morten Thingemann Bøetker Lars Knudsen
2	Aortic Dissection	Morten Thingemann Bøetker Lars Knudsen
3	Cardiac Arrest	Bilal Albaroudi Omar Albaroudi Mahmoud Haddad Tim Harris Robert Jarman
4	Left Ventricular function	Omar Albaroudi Bilal Albaroudi Mahmoud Haddad Tim Harris Robert Jarman
5	Pulmonary Embolism	Robert Darke Edward Berry Robert Jarman
6	Deep Vein Thrombosis	Tomás Breslin Gareth fitzpatrick Leah flanagan Cian McDermott
7	Pneumothorax	Olusegun Olusanya
8	Pleural Effusions	Olusegun Olusanya
9	Consolidation	Adhnan Omar Dominic craver Thomas Simpson Anna Colclough
10	Interstitial Syndrome	Nishant Cherian Martin Dore Gregor Prosen

A summary statement and recommendation for a particular question were approved in the case of a level of agreement of greater than 75 % (broad agreement: greater than 75–95 % of votes; strong consensus: greater than 95 % of votes) from the ERG. A level of agreement was defined as a summary of "strongly agree" and "agree" on the Likert responses.

Following the first round in section 2, all of the teams were advised of the results for their questions (and any comments made by the ERG) and given the opportunity to amend the phase 2 results, regardless of whether the level of agreement was greater than 75 %. All questions that were amended were presented again to the ERG in a second round. No further rounds were permitted. If any revised question's phase 2 results scored a reduced level of agreement in the second round, the original phase 2 results were used. If the level of agreement was the same for each round, the coordinating group chose the final version, with specification of their rationale.

Results

▶ **Table 1** summarizes the ten question domains, covering common PoCUS applications in the heart and pulmonary systems, which were reviewed using the predefined methodology. While conducting phases 1 and 2, there were several changes to the anticipated contributing researchers due to a variety of reasons – the revised and final names of the researchers are also detailed in ▶ **Table 1**. 38 members were recruited to the ERG covering a range of global locations and specialties (▶ **Table 2**). All 38 members confirmed that they had at least 5 years of experience in PoCUS, had an understanding of evidence-based medicine, consented to participate, and contributed to both rounds of section 1. One member of the ERG was unable to contribute to both rounds of section 2 for unspecified reasons.

Tables included for each of the following question domains have been edited for the purposes of improving formatting, syntax, and grammar. However, the content reflects what was received from the researchers and what the ERG had access to during the relevant sections of phase 3.

Question 1: PoCUS use for diagnosing pericardial effusion and cardiac tamponade

The final research question and search strategy, PRISMA flow diagram, and summary table of the final included studies are shown in tables Q1.1, Q1.2, and Q1.3, respectively. 21 references were represented [32–52]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q1.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. Only 27 considered the presented research question, search strategy, and evidence to be of an acceptable standard (71.1 %). Comments made by the ERG were supplied to the research team who were responsible for this question so that remedial changes could be made.

Revisions were made to the phase 1 evidence by the researchers, and the revised content was presented in a second round to the ERG. All 38 members of the ERG reviewed these four documents and 38 considered the presented research question, search strategy, and evidence to be of an acceptable standard (100 %). Thus, the revised phase 1 evidence was approved with a strong consensus.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 13 (35.1 %) members strongly agreed, 23 (62.2 %) agreed, and one (2.7 %) neither agreed nor disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 36 (97.3 %).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 19 (51.4 %) members strongly agreed, 16 (43.2 %) agreed, one (2.7 %) neither agreed nor disagreed, and one (2.7 %) disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 35 (94.6 %). Table Q1.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the original phase 2 results were used as the final version with strong consensus of the ERG.

Question 2: PoCUS use for diagnosing aortic root dissection

The final research question and search strategy, PRISMA flow diagram and results table of the final included studies are shown in tables Q2.1, Q2.2, and Q2.3 respectively. Four references were presented [39, 43, 50, 53]. The final summary of evidence, assignment of levels of evidence and GRADE recommendation for this question are shown in table Q2.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. 29 members considered the presented research question, search strategy, and evidence to be of an acceptable standard (76.3 %). Therefore, the presented phase 1 evidence was approved with a broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 24 (64.9 %) members strongly agreed, 8 (21.6 %) agreed, and five (13.5 %) neither agreed nor disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.5 %).

Following feedback of the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 16 (43.2 %) members strongly agreed, 18 (48.6 %) agreed, one (2.7 %) neither agreed nor disagreed, and two (5.4 %) disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 34 (91.8 %). Table Q2.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Question 3: PoCUS use in cardiac arrest

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in tables Q3.1, Q3.2, and Q3.3, respectively. 22 references were presented [36, 54–74]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q3.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. Only 28 considered the presented research question, search strategy, and evidence to be of an acceptable standard (73.7 %). Comments made by the ERG were supplied to the research team who were responsible for this question so that remedial changes could be made.

Revisions were made to the phase 1 evidence by the researchers, and the revised content was presented in a second round to the ERG. All 38 members of the ERG reviewed these four documents and 37 considered the presented research question, search strategy, and evidence to be of an acceptable standard (97.4 %). Thus, the revised phase 1 evidence was approved with a strong consensus.

▶ **Table 2** Table of Expert Review Group Members.

Member Name	Country	Specialty	Phase Reviewed (1 or 2 or both)
Sharon Kay	Australia	Cardiology	1 and 2
Rachel Liu	USA	Emergency Medicine	1
Tomas Villen	Madrid	Intensive Care	1 and 2
Luna Gargani	Italy	Cardiology	1 and 2
Simon Carley	UK	Emergency Medicine	1 and 2
Michael Woo	Canada	Emergency Medicine	1 and 2
Florence Dupriez	Belgium	Emergency Medicine	1 and 2
Arif Hussain	Saudi Arabia	Intensive Care	1 and 2
Gabrielle Via	Switzerland	Intensive Care	1 and 2
James Connolly	UK	Emergency Medicine	1 and 2
Marcus Peck	UK	Intensive Care	1 and 2
Lawrence Melniker	USA	Emergency Medicine	1 and 2
Andrew Walden	UK	Acute Medicine	1 and 2
Konrad Borg	Malta	Emergency Medicine	1 and 2
Mark Biancardi	Malta	Emergency Medicine	1 and 2
Olga Zmijewska-Kaczor	UK	Emergency Medicine	1 and 2
Elizabeth Lalande	Canada	Emergency Medicine	1 and 2
Eric Chin	USA	Emergency Medicine	1 and 2
Paul I.A. Geukens	Belgium	Intensive Care	1 and 2
Paul Olzinski	Canada	Emergency Medicine	1 and 2
Russell McLaughlin	NI, UK	Emergency Medicine	1 and 2
Beatrice Hoffmann	USA	Emergency Medicine	1 and 2
Christofer Muhr	Sweden	Cardiology	1 and 2
Daniel Kim	Canada	Emergency Medicine	1 and 2
Andre Mercieca	Malta	Emergency Medicine	1 and 2
Dharmesh Shukla	Qatar	Emergency Medicine	1 and 2
Simon Hayward	UK	Physiotherapy	1 and 2
Michael Smith	UK	Physiotherapy	1 and 2
Romolo J Gaspari	USA	Emergency Medicine	1 and 2
Nick Smallwood	UK	Acute Medicine	1 and 2
Philippe Pes	France	Emergency Medicine	1 and 2
Francesco Corradi	Italy	Anaesthetics	1 and 2
Michael Lambert	USA	Emergency Medicine	1 and 2
Craig Morris	UK	Intensive Care	1 and 2
Michael Trauer	Netherlands/UK	Emergency Medicine	1 and 2
Kylie Baker	Australia	Emergency Medicine	1 and 2
Guido Tavazzi	Italy	Intensive Care	1 and 2
Adam Bystrzycki	Australia	Emergency Medicine	1 and 2
Adrian Goudie	Australia	Emergency Medicine	1 and 2

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 12 (32.4%) members strongly agreed, 20 (54.1%) agreed, four (10.8%) neither agreed nor disagreed, and one (2.7%) disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.5%).

Following feedback of the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 15 (40.5%) members strongly agreed, 19 (51.4%) agreed, two (5.4%) neither agreed nor disagreed, and one (2.7%) disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 34 (91.9%). Table Q3.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Question 4: PoCUS use for evaluating left ventricular function

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in Tables Q4.1, Q4.2, and Q4.3, respectively. Ten references were presented [75–84]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q4.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. Thirty members considered the presented research question, search strategy, and evidence to be of an acceptable standard (78.9%). Therefore, the presented phase 1 evidence was approved with broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 16 (43.2%) members strongly agreed, 18 (48.6%) agreed, two (5.4%) neither agreed nor disagreed, and one (2.7%) disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 34 (91.8%).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 15 (40.5%) members strongly agreed, 17 (45.9%) agreed, two (5.4%) neither agreed nor disagreed, two (5.4%) disagreed, and one (2.7%) strongly disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.4%). Table Q4.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the original phase 2 results were used as the final version with broad agreement of the ERG.

Question 5: PoCUS use for diagnosing pulmonary embolism

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in tables Q5.1, Q5.2, and Q5.3, respectively. Five references were presented [85–89]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q5.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. 31 members considered the presented research question, search strategy, and evidence to be of an acceptable standard (81.6%). Therefore, the presented phase 1 evidence was approved with broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 14 (37.8%) members strongly agreed, 18 (48.6%) agreed, two (5.4%) neither agreed nor disagreed, one (2.7%) disagreed, and two (5.4%) strongly disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.4%).

Following feedback of the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 16 (43.2%) members strongly agreed, 16 (43.2%) agreed, one (2.7%) neither agreed nor disagreed, three (8.1%) disagreed, and one (2.7%) strongly disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.4%). Table Q5.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, despite the same overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG, based on the increase in the proportion of strongly agreed versus agreed responses.

Question 6: PoCUS use for diagnosing deep vein thrombosis

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in tables Q6.1, Q6.2, and Q6.3, respectively. 23 references were presented [6, 90–111]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q6.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. 33 members considered the presented research question, search strategy, and evidence to be of an acceptable standard (86.8%). Therefore, the presented phase 1 evidence was approved with a broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 11 (29.7%) members strongly agreed, 15 (40.5%) agreed, seven (18.9%) neither agreed nor disagreed, three (8.1%) disagreed, and one (2.7%) strongly disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 28 (70.2%).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 16 (43.2%) members strongly agreed, 16 (43.2%) agreed, one (2.7%) neither agreed nor disagreed, and four (10.8%) disagreed. The overall level of agreement (sum of strongly agreed

and agreed) was 32 (86.4 %). Table Q6.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Question 7: PoCUS use for diagnosing pneumothorax

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in tables Q7.1, Q7.2, and Q7.3, respectively. 46 references were presented [112–157]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q7.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. 31 members considered the presented research question, search strategy, and evidence to be of an acceptable standard (81.6 %). Therefore, the presented phase 1 evidence was approved with broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, seven (18.9 %) members strongly agreed, 16 (43.2 %) agreed, eight (21.6 %) neither agreed nor disagreed, two (5.4 %) disagreed, and four (10.8 %) strongly disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 23 (62.1 %).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 17 (45.9 %) members strongly agreed, 15 (40.5 %) agreed, three (8.1 %) neither agreed nor disagreed, and two (5.4 %) disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.4 %). Table Q7.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Question 8: PoCUS use for diagnosing pleural effusion

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in tables Q8.1, Q8.2, and Q8.3, respectively. Eleven references were presented [127, 150, 158–166]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q8.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. 30 members considered the presented research question, search strategy, and evidence to be of an acceptable standard (78.9 %). Therefore, the phase 1 evidence presented was approved with broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 11 (29.7 %) members strongly agreed, 13 (35.1 %) agreed, two (5.4 %) neither agreed nor disagreed, eight (21.6 %) disagreed, and three (8.1 %) strongly disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 24 (64.8 %).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 20 (54.1 %) members strongly agreed, 13 (35.1 %) agreed, two (5.4 %) neither agreed nor disagreed, one (2.7 %) disagreed, and one (2.7 %) strongly disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 33 (89.2 %). Table Q8.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Question 9: PoCUS use for diagnosing lung consolidations

The final research question and search strategy, PRISMA flow diagram and results table of the final included studies are shown in tables Q9.1, Q9.2, and Q9.3 respectively. Nine references were presented [167–175]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q9.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. 33 members considered the presented research question, search strategy, and evidence to be of an acceptable standard (86.8 %). Therefore, the presented phase 1 evidence was approved with broad agreement.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 16 (43.2 %) members strongly agreed, 16 (43.2 %) agreed, two (5.4 %) neither agreed nor disagreed, two (5.4 %) disagreed, and one (2.7 %) strongly disagreed with the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 32 (86.4 %).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 19 (51.4 %) members strongly agreed, 15 (40.5 %) agreed, and three (8.1 %) neither agreed nor disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 34 (91.9 %). Table Q9.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Question 10: PoCUS use for diagnosing interstitial fluid syndrome

The final research question and search strategy, PRISMA flow diagram, and results table of the final included studies are shown in tables Q10.1, Q10.2, and Q10.3, respectively. Eleven references were presented [35, 172, 176–184]. The final summary of evidence, assignment of levels of evidence, and GRADE recommendation for this question are shown in table Q10.4.

All 38 members of the ERG reviewed the four documents presented as phase 1 evidence for this question. Only 27 considered the presented research question, search strategy, and evidence

to be of an acceptable standard (73 %). Comments made by the ERG were supplied to the research team who were responsible for this question so that remedial changes could be made.

Revisions were made to the phase 1 evidence by the researchers, and the revised content was presented in a second round to the ERG. All 38 members of the ERG reviewed these four documents and 38 considered the presented research question, search strategy, and evidence to be of an acceptable standard (100 %). Thus, the revised phase 1 evidence was approved with a strong consensus.

37 members of the ERG reviewed the phase 2 results (summary statement, level of evidence, and GRADE recommendation) for this question. In the first round, 10 (27 %) members strongly agreed, 14 (37.8 %) agreed, four (10.8 %) neither agreed nor disagreed, six (16.2 %) disagreed, two (5.4 %) strongly disagreed, and one (2.7 %) abstained from answering based on the presented results. The overall level of agreement (sum of strongly agreed and agreed) was 24 (64.8 %).

Following feedback regarding the first-round results and comments to the researchers tasked with this question, the revised phase 2 results were presented for ERG review. In the second round, 14 (37.8 %) members strongly agreed, 21 (56.8 %) agreed, one (2.7 %) neither agreed nor disagreed, and one (2.7 %) strongly disagreed. The overall level of agreement (sum of strongly agreed and agreed) was 35 (94.6 %). Table Q10.5 summarizes the results of the consensus process for section 2 (both rounds).

Therefore, in view of the better overall level of agreement, the revised phase 2 results were used as the final version with broad agreement of the ERG.

Summary of findings and recommendations

In the following section, the evidence, conclusions, and any recommendations for each research question/domain are summarized. These are based on what was presented for review by the ERG to ascertain the level of agreement in the phase 3 consensus process. Minor changes to original statements have been made to correct syntax and grammatical errors and improve clarity for the reader. ▶ Table 3 summarizes the key points for each question.

The following recommendations assume that the PoCUS operator is appropriately trained and skilled for each particular application.

Question 1: PoCUS use for diagnosing pericardial effusion and cardiac tamponade

In emergency patients is PoCUS superior compared to physical examination in terms of:
1. Recognition of pericardial effusion
2. Patient management in the case of pericardial effusion
3. Patient outcome in the case of pericardial effusion

Summary of quantity and quality of evidence

21 studies, comparing PoCUS to physical examination in emergency patients with any incidence of pericardial effusion, were included in the final analysis. All studies were original studies. No

systematic reviews and/or meta-analyses specifically compared PoCUS to physical examination. Of the included studies, three were randomized controlled trials (RCT), 14 were prospective observational studies with before/after methodology, one was a prospective observational study with two parallel tracks, and three were retrospective cohort studies. The three RCT studies included patients with shock, cardiac arrest, and respiratory symptoms, respectively. Generally, the number of patients with pericardial effusion was very low in these studies (2/273 in the shock study, 7/100 in the cardiac arrest study, and 4/315 in the study including patients with respiratory symptoms). The prospective observational studies included patients with acute dyspnea (four), shock (three), suspected acute cardiac disease (three), emergency conditions (two), chest pain/dyspnea (one), chest pain/dyspnea/palpitations (one), and cardiac arrest (one). The proportion of patients with pericardial effusion ranged from 0.7 % to 14 % in these studies with a generally higher proportion in studies including shock patients than in the other patient groups. One study, which was undertaken in Rwanda, included dyspneic patients with a very high incidence of extrapulmonary tuberculosis, and in this study, 25 % of patients had a pericardial effusion. The three retrospective cohort studies examined patients with tamponade/large pericardial effusions (n = 73), patients with penetrating cardiac injuries (n = 49), and patients undergoing pericardiocentesis (n = 342).

All 15 prospective observational studies consistently demonstrated either a change in primary diagnosis, a reduction in the number of differential diagnoses, additional diagnoses disclosed (including pericardial effusion), an improvement in diagnostic certainty, or a reduced time to correct diagnoses with POCUS compared to physical examination alone. The quality of these studies was generally acceptable, but assessors establishing final diagnoses (i. e., the reference standard) were rarely blinded to the results of the PoCUS examination, which may bias the results towards increased effects of the scan. The findings are, however, also consistent across studies with good assessor blinding and are supported by findings of the two RCTs examining diagnostic accuracy (in the third RCT only patient-related outcome measures were evaluated). Both RCTs demonstrated an increase in the proportion of patients who had correct presumptive diagnoses and improved recognition of pericardial effusion with the use of PoCUS compared to physical examination alone.

In three of the fifteen prospective observational studies, PoCUS led to a change in treatment in 25 %–52 % of the patients included. Specific data on changes in management in patients with pericardial effusion were not reported.

Based on the three retrospective cohort studies, PoCUS reduced the time to pericardiocentesis and/or operation in patients with tamponade/large effusions resulting in an improvement in survival. However, the retrospective study design based on chart reviews in both studies carries an inherent risk of bias favoring PoCUS. None of the RCTs demonstrated changes in patient outcome measured as 30-day mortality, intensive care unit (ICU) length of stay, or hospital length of stay with the use of PoCUS compared to physical examination alone.

The research team concluded that there is sufficient good evidence demonstrating improved recognition of pericardial effusion

▶ **Table 3** Overall Recommendations for EFSUMB PoCUS Part 1 Clinical Practice Guidelines.

PoCUS Application	Research Question	Overall Recommendation	Level of Evidence*, GRADE Recommendation & Level of Consensus Agreement
Question 1: PoCUS use for diagnosing pericardial effusion and cardiac tamponade	In emergency patients is PoCUS superior compared to physical examination in terms of: 1) Recognition of pericardial effusion; 2) Patient management in the case of pericardial effusion; 3) Patient outcome in the case of pericardial effusion?	EFSUMB suggests supplementing the physical examination with PoCUS in patients with hypotension and/or cardio-respiratory symptoms for early recognition of pericardial effusion/tamponade.	LoE 3 weak recommendation strong consensus
Question 2: PoCUS use for diagnosing aortic root dissection	In emergency patients is point-of-care ultrasound (POCUS) superior compared to physical examination in terms of: 1) Recognition of type A aortic dissection; 2) Patient management in the case of type A aortic dissection; 3) Patient outcome in the case of type A aortic dissection?	EFSUMB suggests that there is insufficient evidence to recommend supplementing the physical examination with PoCUS for early recognition of type A aortic dissection.	LoE 4 weak recommendation broad agreement
Question 3: PoCUS use in cardiac arrest	In adult patients with cardiac arrest does the use of PoCUS echocardiography during resuscitation predict survival in patients with cardiac activity and death in those with no cardiac activity?	EFSUMB suggests that the use of PoCUS to assess for the presence of cardiac activity may be useful as an adjunct tool to predict survival in cardiac arrest patients. EFSUMB suggests that the absence of cardiac activity on PoCUS is associated with a very poor chance of survival and may assist in the decision to terminate resuscitation in TCA (no survivors in patients with no cardiac activity). In MCA the absence of cardiac activity is associated with a low but not no chance of ROSC/survival and should not be used as the main basis to cease resuscitation.	LoE 3 weak recommendation broad agreement
Question 4: POCUS use for evaluating left ventricular performance	Does bedside PoCUS focused echocardiography assessment of left ventricular (LV) performance by clinician sonographer (CS) emergency physicians (EPs) agree with echocardiographic assessment (echo) by experienced sonographers (ESs) (cardiologists/graduated sonographers/emergency physicians who have completed ultrasound – echocardiography fellowship)?	EFSUMB suggests that novice emergency physician sonographers are able to assess left ventricular function using visual estimation (graded as normal, reduced, or severely reduced) or EPSS. Despite the moderate to good agreement, the potential selection bias in the studies and the fact that, in many cases, the novice sonographers received additional training means that this level of agreement is not generalizable. There is insufficient data to comment on the use of VTI.	LoE 3 weak recommendation broad agreement
Question 5: PoCUS use for diagnosing hemodynamically significant pulmonary embolism	Is PoCUS useful in the diagnosis of hemodynamically unstable pulmonary embolism (PE)?	EFSUMB suggests that non-specialist PoCUS may be useful in the diagnosis of hemodynamically unstable PE.	LoE 3 weak recommendation broad agreement
Question 6: PoCUS use in diagnosing deep vein thrombosis	Is PoCUS useful in the diagnosis of deep vein thrombosis (DVT) in the ED?	EFSUMB recommends that PoCUS may be useful in the diagnosis of DVT in the ED. Emergency physicians with less experience may be able to perform a limited PoCUS exam for DVT with considerable but not perfect accuracy, especially after a period of focused instruction.	LoE 3 strong recommendation broad agreement
Question 7: PoCUS use for diagnosing pneumothorax	What is the diagnostic accuracy of PoCUS for the detection of pneumothorax?	EFSUMB recommends that PoCUS may be used to detect pneumothorax. It has good diagnostic accuracy.	LoE 3 strong recommendation broad agreement
Question 8: PoCUS use for diagnosing pleural effusion	What is the diagnostic accuracy of PoCUS for the detection of pleural effusion?	EFSUMB recommends that PoCUS may be used to diagnose pleural effusions. It has superior diagnostic accuracy compared to CXR and clinical examination for the detection of pleural effusions.	LoE 3 strong recommendation broad agreement

▶ **Table 3** (Continuation)

PoCUS Application	Research Question	Overall Recommendation	Level of Evidence*, GRADE Recommendation & Level of Consensus Agreement
Question 9: PoCUS use for diagnosing pneumonia	What is the diagnostic accuracy of PoCUS for the detection of pneumonia?	EFSUMB recommends that PoCUS may be used in the diagnosis of pneumonia.	LoE 2 strong recommendation broad agreement
Question 10: PoCUS use for diagnosing interstitial syndrome	How accurate is PoCUS for diagnosing interstitial fluid syndrome in the ED in patients with acute dyspnea?	EFSUMB recommends that PoCUS may be used in the diagnosis of interstitial fluid syndromes in adult patients in the ED.	LoE 2 strong recommendation broad agreement

* OCEBM(2011) [29].

with the use of PoCUS compared to clinical examination alone. Whether or not changes in management based on these findings have an impact on patient outcome is unknown.

What is the clinical relevance and applicability?

Pericardial effusion can be caused by a range of diseases including infectious and rheumatological diseases, malignancies, and trauma.

Small amounts of pericardial effusion are rarely clinically significant, but larger effusions build up over time or rapidly developed smaller effusions can lead to cardiac tamponade, compromising circulation, leading to cardiac arrest and ultimately to death.

Early identification of significant effusions – and especially signs of tamponade – can potentially improve patient triage, management, and treatment. Clinical signs of significant effusions and tamponade are non-specific, and PoCUS may increase the proportion of patients in whom these conditions are identified and correctly managed earlier.

What are the benefits or harms?

The potential benefits of early identification of significant effusions and/or tamponade are improved triage (patients in need can be taken to relevant institutions with the highest possible competences to manage the condition earlier) as well as earlier and more correct management. These benefits may improve patient outcomes.

Ultrasound in itself carries no risks but use of PoCUS in inexperienced hands may lead to false negatives (i. e., ruling out of effusion in a patient with significant effusion) leading to a worse patient outcome. It may also lead to a high number of false positives causing an increase in upstream resource consumption.

Overall recommendation

EFSUMB suggests supplementing the physical examination with PoCUS in patients with hypotension and/or cardio-respiratory symptoms for early recognition of pericardial effusion/tamponade (LoE 3, weak recommendation, strong consensus).

Question 2: PoCUS use for diagnosing aortic root dissection

In emergency patients is point-of-care ultrasound (POCUS) superior compared to physical examination in terms of:
1. Recognition of type A aortic dissection
2. Patient management in the case of type A aortic dissection
3. Patient outcome in the case of type A aortic dissection

Summary of quantity and quality of evidence

Four studies in which POCUS was compared to physical examination in emergency patients with any incidence of type A dissection were included in the final analysis. All studies were original studies. No systematic reviews and/or meta-analyses specifically compared POCUS to physical examination. Of the included studies, three were prospective observational studies with before/after methodology and one was a retrospective cohort study based on chart reviews and autopsies. The prospective observational studies included patients with suspected cardiac disease (two), chest pain/dyspnea/palpitations (one). The number of patients with aortic dissection was extremely low in these studies, rendering the studies at a quality level of case-series for this research question. The retrospective cohort study included patients with confirmed dissection (n = 32) and represents the best available evidence on this research question.

All three prospective observational studies demonstrated changes in initially suspected diagnosis with POCUS compared to clinical examination alone, including identification of aortic dissection in two studies. One study demonstrated changes in patient management with POCUS, but not specifically for patients with type A dissection.

In the retrospective cohort study, it was reported that the median time to diagnosis was lower (80 vs. 226 minutes, p = 0.023), the misdiagnosis rate was lower (0 % vs. 43.8 %), and there was a non-significant trend towards lower adjusted mortality (15.4 % vs. 37.5 %, p = 0.24) with POCUS compared to clinical examination.

In conclusion, there is very weak evidence suggesting a possible effect on improved recognition of type A aortic dissection with POCUS compared to clinical examination alone. There is insufficient evidence to arrive at conclusions regarding changes in patient

management and patient outcome with POCUS compared to clinical examination.

What is the clinical relevance and applicability?

Type A aortic dissection can cause a range of severe conditions including stroke, other ischemic events, and cardiac tamponade, compromising circulation, leading to cardiac arrest and ultimately to death.

It has previously been established that not even expert echocardiography can be used to rule out type A dissection. Thus, the potential of POCUS lies in early identification of type A dissection. This early identification can potentially improve patient triage, management, and treatment. Clinical signs of type A dissection can be ambiguous, and POCUS may increase the proportion of patients who have this condition so they can be identified and correctly managed earlier.

What are the benefits or harms?

The potential benefits of early identification of type A aortic dissection are improved triage (patients in need can be taken to relevant institutions with the highest possible competences to manage the condition early) and early correct management – and thus improved patient outcome.

Ultrasound in itself carries no risks but use of POCUS in inexperienced hands may lead to false negatives (i. e., the ruling out of type A dissection in a patient with dissection) that may cause clinicians to accept false safety leading to a worse patient outcome. It may also lead to a high number of false positives causing an increase in upstream resource consumption.

Overall recommendation

EFSUMB suggests that there is insufficient evidence to recommend supplementing the physical examination with PoCUS for early recognition of type A aortic dissection (LoE 4, weak recommendation, broad agreement).

Question 3: PoCUS use in cardiac arrest

In adult patients with cardiac arrest, does the use of PoCUS echocardiography during resuscitation predict survival in patients with cardiac activity and death in those with no cardiac activity?

Summary of quantity and quality of evidence

Nineteen studies were included in this review. All of these studies were published between 2001 and 2019. The study design for all but one study was an observational cohort; 13 of which were prospective, and five were retrospective studies. There was one RCT. Six studies were multicenter, with the largest recruiting from 20 centers.

Different study populations were noted, all with different inclusion criteria. All 19 studies included out-of-hospital cardiac arrest patients. Eight studies also included patients in cardiac arrest in the emergency department (ED). Three studies were undertaken in a prehospital setting, and the remainder involved PoCUS performed in the ED. Three studies included only patients in traumatic cardiac arrest (TCA), and 9 studies included only

medical cardiac arrest (MCA) patients. The remaining studies included all cardiac arrest patients regardless of the cause. While most studies included both shockable and non-shockable rhythms, seven studies included patients in whom the initial presenting rhythm was non-shockable. Two studies included only patients with pulseless electrical activity. All participants in the studies were adults over 16 years of age.

Different ultrasound scanning protocols were also noted, with varying ultrasound probes, variable views used to evaluate cardiac activity, and a different number of PoCUS assessments. Only one study (Kim et al.) evaluated the correlation between serial PoCUS assessments and the return of spontaneous circulation (ROSC) and found that, in all patients with serial PoCUS cardiac standstill ≥10 minutes, no patient had an ROSC.

A variety of definitions were used for cardiac activity within the studies, which reflect the lack of standardized criteria in the literature. The accuracy of PoCUS is known to be operator-dependent, and each study required a differing level of training and clinical experience. Additionally, the inter-observer reliability for PoCUS was not reported in most studies. However, Gaspari et al. revealed agreement of 0.63 using Cohen's kappa.

Each study reported one or more of the following outcomes: ROSC (10 studies), survival to hospital admission (SHA) (10 studies), and survival to hospital discharge (SHD) (seven studies). Three studies reported the neurological outcome of the surviving patients at hospital discharge.

There was considerable heterogeneity in the methodological quality. Fourteen studies were rated as high risk of bias for patient selection, mainly because of convenience sampling and exclusion criteria (e. g., due to anatomical or technical difficulties). The PoCUS protocols that were used varied between studies, which is reflected in the scoring of the index test. Ten studies failed to define a priori the presence or absence of cardiac activity, which was the main reason for rating the index test as high risk of bias. Due to inappropriate exclusion from the analysis (e. g., loss of follow-up) in two studies, they were rated as high risk of bias in the flow and timing.

What is the clinical relevance and applicability?

PoCUS is widely used in the evaluation of patients in the ED to guide the diagnosis and resuscitation of patients with acute breathlessness, shock, and cardiac arrest. During resuscitation in cardiac arrest, PoCUS and blood gas are key in identifying reversible causes of cardiac arrest. PoCUS is easily integrated into advanced life support (ALS) and its use has been integrated into the universal ALS algorithm. The use of PoCUS for TCA has also been advocated.

What are the benefits or harms?

PoCUS may have a role in identifying patients for whom resuscitation is futile with predicted death, or successful with predicted good neurological outcome. It is also useful in the recognition of the reversible causes of cardiac arrest which are found to have a large impact on the patient's management and outcome.

Two small prospective observational studies showed that PoCUS use is associated with a longer duration of pulse checks.

However, another study suggested that the implementation of a structured ultrasound algorithm reduced the duration of pulse checks, which highlights the importance of following a strict PoCUS protocol during cardiac arrest to minimize interruptions of cardiopulmonary resuscitation (CPR).

Overall recommendation

EFSUMB suggests that the use of PoCUS to assess the presence of cardiac activity may be useful as an adjunct tool to predict survival in cardiac arrest patients (LoE 3, weak recommendation, broad agreement).

EFSUMB suggests that the absence of cardiac activity on PoCUS is associated with a very poor chance of survival and may assist in the decision to terminate resuscitation in TCA (no survivors in patients with no cardiac activity). In MCA the absence of cardiac activity is associated with a low but not no chance of ROSC/survival and should not be used as the main basis to cease resuscitation (LoE 3, weak recommendation, broad agreement).

Question 4: POCUS use for evaluating left ventricular performance

Does bedside PoCUS focused echocardiography assessment of left ventricular (LV) performance by clinician sonographer (CS) emergency physicians (EPs) agree with echocardiographic assessment (echo) by experienced sonographers (ESs) (cardiologists/ graduated sonographers/emergency physicians who have completed ultrasound – echocardiography fellowship)?

Summary of quantity and quality of evidence

Ten papers were included in the final review, with a total of 1202 PoCUS examinations involving 1104 patients being performed. Nine studies included 143 CSs (one study did not specify the number of CSs).

Nine studies were prospective observational cohort studies and one was a retrospective chart review – all were single-center studies. All studies included only patients presenting to the hospital via the ED and all used cart-based ultrasound machines with a phased array transducer. One study included PoCUS performed in the ED, ICU, and wards. In all other studies, PoCUS was performed in the ED. Only one study recruited all EPs in the recruiting ED and three recruited only EPs who met prespecified training criteria. There was considerable heterogeneity regarding the ultrasound and echo experience of the CSs. Eight studies offered study-specific training in echo to CS participants. The ESs used the same ultrasound machines as the CSs in three studies, used different machines in four studies, and reviewed the video clips made by the CS to report their findings in four studies. The inclusion criteria for patients also varied: two studies included only patients with hypotension, two recruited patients with dyspnea, five studies recruited patients who required an inpatient echo for any reason, and one included any patient with suspected cardiac disease. The ESs were also EPs in two studies and cardiologists/sonographers in nine studies (one study combined EPs and cardiologists as ESs). In five studies the CS performed PoCUS prior to the ES, while in two studies the ES scanned first. In four studies the ES

reviewed video images taken by the CS. In three studies, videos taken by sonographers were reviewed by a cardiologist ES, and, in three studies, ES cardiologists performed their own echo. In nine studies the second sonographer was blind to the findings of the first, while in one study, the ESs were not blind to E-point septal separation (EPSS) measures by the CS. In four studies there was a time difference of greater than one hour between CS and ES scans.

Quality was assessed using the QUADAS-2 tool. All studies scored high-risk in at least one domain and seven scored high-risk in two or more. Thus, the quality of the included studies was low with poor generalizability and all studies were assessed as having a high risk of bias. All studies excluded a proportion of echo studies performed, most commonly because of poor image quality. There is insufficient data to specify the exact numbers of excluded patients.

Visual estimation of LV performance

In seven studies, visual estimation using ranked categories was the most used method by CSs to assess left ventricular performance. The performance was typically ranked as normal, reduced, or severely reduced (six studies, additional categories in one paper). In six studies, performance was defined by estimated ejection fraction. In two studies, both the CS and the ES estimated visual performance, in two studies the CS estimated ventricular performance and the ES measured it using Simpson's biplanar technique, in two studies the ES estimated the ejection fraction using the Teichholz method.

There was heterogeneity in the methods used to assess agreement between the CS and the ES for visual estimation of ventricular performance: six studies reported a simple or weighted Cohen's Kappa (0.46–0.79), and one reported Pearson's correlation (for the two recruited EPs 0.77 & 0.78). Four studies reported row/overall agreement (69–93 %), two used a Bland-Altman plot, and three calculated the specificity and sensitivity for identifying a set level of ventricular performance.

Overall, there was moderate to high agreement between the CS and the ES for the visual estimation of left ventricular performance. There was good agreement in identifying left ventricular performance as normal and with severe dysfunction. Agreement was moderate in identifying moderate dysfunction.

E-point septal separation (EPSS) assessment of LV performance

EPSS was assessed in three studies. No studies compared EPSS assessment by both the CS and the ES. Two studies compared EPSS by the CS with visual estimation by the ES (one used Kappa (0.85) and the other one calculated the Spearman's correlation (0.84)). One study compared the EPSS by the CS to the ejection fraction assessed according to Teichholz by the ES and assessed agreement using Pearson correlation (0.73)

Velocity time integral (VTI) assessment of LV performance

One study assessed VTI. The agreement was moderate with a Kappa of 0.56.

In summary, the CS had moderate to high agreement with the ES in assessing left ventricular performance using visual estimation categorizing left ventricular function as normal, moderately impaired, or severely impaired, and using EPSS. There is considerable heterogeneity among studies. The findings have limited generalizability.

What is the clinical relevance and applicability?

Acute cardio-respiratory dysfunction is the most common emergency presentation in most emergency departments in Europe, North America and Australasia. Assessment of left ventricular function is a key diagnostic test in the assessment of acute dyspnea, shock, and cardiac arrest. It assists in defining etiology and guiding therapy. Due to the time-critical nature of these presentations, PoCUS is best performed on or close to the patient's arrival in the ED.

What are the benefits or harms?

The main benefit is early diagnosis of problems with LV performance, which may result in early treatment and improved outcomes.

A poorly performed or interpreted CS PoCUS leads to an incorrect diagnosis and/or wrong treatment. We found no evidence of wrong interpretation by the CS that would lead to wrong management decisions. The levels of agreement were highest for normal and severe dysfunction. There were lower levels of agreement in differentiating mild from moderate left ventricular function. However, this is unlikely to result in significant errors in care.

Overall recommendation

EFSUMB suggests that novice emergency physician sonographers are able to assess left ventricular function using visual estimation (graded as normal, reduced, or severely reduced) or EPSS. Despite the moderate to good agreement, the potential selection bias in the studies and the fact that, in many cases, the novice sonographers received additional training means that this level of agreement is not generalizable. There is insufficient data to comment on the use of VTI (LoE 3, weak recommendation, broad agreement).

Question 5: PoCUS use for diagnosing hemodynamically significant pulmonary embolism

Is PoCUS useful in the diagnosis of hemodynamically unstable pulmonary embolism (PE)?

Summary of quantity and quality of evidence

Five studies were identified in a systematic review of the literature – all included studies adopted prospective observational methods. Three studies were multicenter and two single-center. Across the five studies, a total of 124 patients had hemodynamic instability and a proven PE. Only one study was concerned with the population of interest; the other four studies provided a post hoc analysis of hemodynamically unstable patients representing a small subgroup. Two of the included studies solely evaluated the heart, one study utilized a protocol that included evaluation of the lungs, heart, abdomen (including IVC), one study evaluated the heart and deep veins, and one study evaluated the lung, heart, and deep veins. All of the studies were designated "high risk" in one domain of the QUADAS2 tool and had at least one or more "unclear risk".

The current evidence specifically looking at non-specialist PoCUS in the context of hemodynamically unstable patients with PE is both scarce and of poor quality. Despite the quantity and quality of the evidence being insufficient to make a strong recommendation, the results of these limited studies do suggest that PoCUS could have a role in the diagnosis of hemodynamically unstable PE. This is in keeping with the experience in specialist echocardiography as well as anecdotal and clinical experience. Further high-quality research with sufficient patient populations is required to provide better evidence regarding this question.

What is the clinical relevance and applicability?

Patients presenting with hemodynamic instability may demonstrate a range of underlying pathologies, with PE as one possibility. It can be a difficult diagnosis to make and can present in an atypical manner. In patients with a suspected PE who are hemodynamically unstable, a delay to commencing definitive treatment can have a negative impact on mortality and morbidity. However, reperfusion therapy is associated with possible adverse effects and therefore the decision to perform this type of therapy can also be difficult. It is accepted that specialist/expert echocardiography in PE can demonstrate evidence of right heart strain and failure. This is especially true for PEs causing hemodynamic instability. Given the widespread use of PoCUS in acute care settings and the use of echocardiography for identifying the cardiac sequelae of PE, it is logical there could be a role for non-specialist PoCUS in identifying signs consistent with hemodynamically unstable PE. The identification of echocardiographic findings and, therefore, the likely presence of PE as the cause of hemodynamic instability could facilitate earlier treatment and give treating physicians greater confidence regarding diagnosis and management. Conversely, the absence of echocardiographic findings could prompt physicians to consider alternative diagnoses. This systematic review investigates whether non-specialist PoCUS looking for evidence of right heart strain or failure, findings consistent with hemodynamically unstable PE, are concordant with gold standard diagnostics for PE.

What are the benefits or harms?

The benefit of PoCUS in the diagnosis of hemodynamically unstable PE would be to reduce the time to diagnosis, thereby allowing commencement of lifesaving treatment sooner. The ability to identify signs consistent with PE causing hemodynamic instability using non-specialist PoCUS would give physicians greater confidence to start a lifesaving but not entirely benign treatment. In the absence of PoCUS signs of hemodynamically unstable PE, this would prompt the attending physician to consider alternative diagnoses.

Non-specialist PoCUS does not present any direct harm to the patient. However, there are circumstances where it could indirectly cause harm. If PoCUS delayed a patient receiving a gold standard investigation, this could lead to patient harm. PoCUS is a user-

dependent modality with accuracy linked to the skill/experience of the individual operator. Incorrect interpretation of PoCUS findings leading to inappropriate provision or withholding of treatment could cause patient harm.

Overall recommendation

EFSUMB suggests that non-specialist PoCUS may be useful in the diagnosis of hemodynamically unstable PE (LoE 3, weak recommendation, broad agreement).

Question 6: PoCUS use for diagnosing deep vein thrombosis

Is PoCUS useful in the diagnosis of deep vein thrombosis (DVT) in the ED?

Summary of quantity and quality of evidence

The review examines the accuracy of EP-performed PoCUS to identify DVT when compared to gold standard radiology imaging.

23 studies were identified in a search of the literature from 2000 up to and including 2020. Most were prospective observational studies. One study was conducted as a randomized controlled trial. No meta-analyses were included. Studies were included from seven international centers. However, most originated in North America. 21 out of 23 studies were carried out at a single center.

Across all of the studies, there was a total patient population of 3,530, including 757 patients with a confirmed DVT. Most patients were selected by convenience sampling based on operator availability in the ED.

Operators had a wide level of training using PoCUS ranging from newly qualified EM residents to experienced EPs certified to perform this application.

In general, when experienced physicians carried out the PoCUS examination, the reported sensitivity and specificity were usually high with narrow confidence intervals. Less experienced operators reported a lower sensitivity and/or wide confidence intervals.

Scanning protocols differed across many of the studies. The region of interest that was examined was not standardized in this review. Different imaging techniques were also used ranging from 2-point and 3-point compression techniques to color Doppler and duplex studies. On account of this degree of heterogeneity, it is difficult to carry out a comparative quantitative analysis of the 23 studies.

Using the QUADAS-2 tool, 10 studies showed a low risk of bias, eight studies had unclear risk, and five studies had at least one domain with a high risk of bias.

What is the clinical relevance and applicability?

Patients presenting to the ED with signs and symptoms of DVT may be managed safely without hospital admission. Physician-performed PoCUS presents the opportunity to facilitate the rapid assessment, triage, and possible discharge of this cohort.

PoCUS for DVT in the ED is probably best applied as part of a rule-in strategy. The absence of occlusive thrombosis, therefore, should not rule out this diagnosis. If the clinical pretest probability is low and sonographic signs of DVT are not present, then it may be reasonable to withhold anticoagulant therapy entirely or until gold standard imaging is available.

In the hands of well-trained emergency physicians, PoCUS is generally quick and accurate, especially when used as a rule-in test for DVT. This aspect may also limit generalizability in EDs where such expertise is not available. However, the evidence supporting PoCUS for DVT is weak for less-experienced operators. This may lead to delays in disposition or failure to treat patients appropriately.

What are the benefits or harms?

ED patients are often treated empirically when DVT is suspected and there may be a delay with respect to definitive radiological diagnosis. PoCUS may reduce the use of therapeutic anticoagulation if used at the early stages of clinical evaluation rather than waiting for gold standard imaging. PoCUS may also decrease the morbidity and mortality from complications of DVT. Such end points are beyond the scope of this review. In addition, the use of PoCUS for DVT may also help identify alternative pathology such as cellulitis, abscess, superficial thrombophlebitis, popliteal cysts, and muscular tear/hematoma.

The use of PoCUS for DVT presents no direct harm to patients. However, incorrect interpretation and application of point-of-care findings may lead to inappropriate withholding or provision of anticoagulants or other therapies.

Overall recommendation

EFSUMB recommends that PoCUS may be useful in the diagnosis of DVT in the ED. It may be the case that emergency physicians with less experience can perform a limited PoCUS exam for DVT with considerable but not perfect accuracy, especially after a period of focused instruction (LoE 3, strong recommendation, broad agreement).

Question 7: PoCUS use for diagnosing pneumothorax

What is the diagnostic accuracy of PoCUS for the detection of pneumothorax?

Summary of quantity and quality of evidence

40 studies, five meta-analyses, and one narrative systematic review were identified. Many of these studies were prospective, single-center, single-blinded studies. The 40 studies included more than 7000 patients, the majority of whom were trauma patients; six studies were in patients undergoing lung biopsies, and one study was in patients post subclavian line insertion.

15 studies were considered good quality, 12 studies were of average quality, and 13 studies were of poor quality. The studies showed a high sensitivity and specificity of lung ultrasound (sensitivity range: 47–100 %; specificity range: 78–100 %). However, there was significant heterogeneity between studies.

What is the clinical relevance and applicability?

Pneumothorax remains an important cause of acute respiratory embarrassment, and its rapid detection can aid in accurate diag-

nosis and treatment (thoracocentesis). Clinical examination is poor at detecting small pneumothoraces and can have difficulty detecting tension pneumothorax. Chest X-ray (CXR) is highly specific but has poor sensitivity. Computed tomography (CT) remains the gold standard, however, may be logistically difficult in the hemodynamically unstable patient.

PoCUS has much to offer in this regard as a portable, non-ionizing diagnostic tool that can not only detect pneumothorax but can also be used to assess for other causes of breathlessness and shock. It can also be used to assess for pneumothorax after bedside procedures such as vascular access, chest drain removal, and biopsy.

What are the benefits or harms?

Potential benefits include decreased time to diagnosis of suspected pneumothorax, shortened time to potentially lifesaving intervention as well as reduced reliance on CXR and CT for diagnosis, minimization of risks to patients of transportation, and minimization of costs. Potential harms include a risk of misdiagnosis – pneumothorax PoCUS is an expert technique. The technique is prone to confounders such as endobronchial intubation, bullae, and high positive end-expiratory pressure (PEEP). A lung point is not always seen. Clinical integration and experience are thus crucial to ensuring the accuracy of the technique. PoCUS may distract the clinician (and team) from obvious clinical cues and delay the implementation of interventions (such as CPR).

Overall recommendation

EFSUMB recommends that PoCUS may be used to detect pneumothorax. It has good diagnostic accuracy (LoE 3, strong recommendation, broad agreement).

Question 8: PoCUS use for diagnosing pleural effusion

What is the diagnostic accuracy of PoCUS for the detection of pleural effusion?

Summary of quantity and quality of evidence

Nine studies and two meta-analyses were identified. Seven studies were prospective observational single-center trials, with one being a subgroup analysis of a previous trial, and one being a case-control study. The majority were single-blinded. The 9 studies contained a total of 1054 patients. The meta-analyses contained 1554 and 924 patients, respectively. The populations were a mixed group including intensive care patients, trauma patients, patients with acute heart failure, and patients with acute dyspnea presenting to the emergency department. Four studies were considered "good", three "average", and two "poor" quality. Both meta-analyses were considered average quality.

All studies showed PoCUS to have a good diagnostic accuracy, approaching that of CT and better than that of CXR and clinical examination.

What is the clinical relevance and applicability?

Pleural effusions are common and can either be a direct cause of respiratory compromise or can be secondary and associated with other illnesses, including heart failure, malignancy, and empyema. Pleural fluid drainage as a diagnostic or therapeutic maneuver is a standard competency in many hospital specialties.

What are the benefits or harms?

Potential benefits include reduction in time to diagnosis, increased diagnostic accuracy, and improved safety of pleural procedures.

The main harm is the result of user error – either due to misdiagnosis or a procedural error.

Overall Recommendation

EFSUMB recommends that PoCUS may be used to diagnose pleural effusions. It has superior diagnostic accuracy over CXR and clinical examination for the detection of pleural effusions (LoE 3, strong recommendation, broad agreement).

Question 9: PoCUS use for diagnosing pneumonia

What is the diagnostic accuracy of PoCUS for the detection of pneumonia?

Summary of quantity and quality of evidence

Nine studies were identified: two studies were systematic reviews and the remaining seven were systematic reviews and meta-analyses. Eight of these studies consistently found the sensitivity of PoCUS in detecting consolidations to be at least 80 % and the specificity over 70 %. One study identified a broader range of sensitivity and specificity results, 68–100 % and 57–100 %, respectively.

The AMSTAR-2 tool was used to assess the quality of the studies included. Although most studies were assessed with low or critically low quality, this was mostly due to *domains 2 and 7* of the AMSTAR-2 tool, which required an explicit statement on timing of establishment of review methodology, and provision of all excluded studies. Overall, the other critical *domains* relating to consideration and assessment of bias and the handling of data from included studies were mostly appropriately achieved. The research team felt that although *domains 2 and 7* are AMSTAR-2 critical domains, they are focused on the structure of the publication rather than the quality of the work done and had a consistently disproportionate impact on the reviewed papers and the overall result.

What is the clinical relevance and applicability?

Patients with pneumonia may present with symptoms that can be attributed to a number of conditions, but treatments for the broad range of differential diagnoses vary greatly and in certain conditions may be time-critical. The most common diagnostic workup for pneumonia combines the bedside clinical assessment and laboratory tests alongside plain CXR imaging or the gold standard of CT imaging. It is not feasible to perform a CT scan on all patients presenting with signs and symptoms of pneumonia due to constraints on time and resources and the exposure to radiation, but transferring patients for CXR is also time-consuming and has a lower diagnostic yield, which may contribute to uncertainty between conditions within the differential diagnoses. The competent use of PoCUS in clinical care can assist in developing a definitive diagnosis at the same time as initial clinician assess-

ment, thus reducing the time to correct diagnosis and treatment and minimizing the harm of unnecessary treatment given to cover the broad spectrum of acute differential diagnoses. Effective use in a clinical context can reduce the number of CT scans performed to confirm diagnosis, except in those cases with deeper consolidative changes not reaching the pleural line, where CT remains the gold standard investigation.

What are the benefits or harms?

In clinical practice, for both high and low resource settings, CT is rarely used to diagnose acute pneumonias. Therefore, although it is the gold standard investigation, the typical clinical comparator is the CXR and clinical assessment.

POCUS may improve the diagnostic accuracy of standard bedside clinical assessment resulting in a high sensitivity for consolidative changes reaching the pleural line which may reduce the time to correct diagnosis. The number of CT and CXR investigations performed may be reduced by utilizing PoCUS in clinical practice.

While these studies did not report any direct or indirect harm as a result of using bedside PoCUS, indirect harm may occur when its use delays gold standard investigation and treatment. The operator-dependent nature of the investigation may lead to misinterpretation which may lead to inappropriate intervention or withholding of treatment.

Overall Recommendation

EFSUMB recommends that PoCUS may be used in the diagnosis of pneumonia (LoE 2, strong recommendation, broad agreement).

Question 10: PoCUS use for diagnosing interstitial syndrome

How accurate is PoCUS in diagnosing interstitial fluid syndrome in the ED in patients with acute dyspnea?

Summary of quantity and quality of evidence

Eight prospective studies and three systematic reviews with meta-analyses were identified. Of the prospective studies, two were RCTs and six were prospective cohort studies. All of the studies included ED patients with acute dyspnea or recent worsening of chronic dyspnea. Most of the studies used a similar focused lung PoCUS protocol and diagnostic criteria for interstitial syndrome. The target condition in all studies was either acute pulmonary edema or acute decompensated heart failure. Study investigators were blinded to the reference standard in all studies. In some studies, the sonologist was not blinded to the clinical information or was involved in the clinical workup of the patient. We regarded this as a pragmatic approach as it is likely that the clinician would be performing the PoCUS scan as an adjunct to the physical exam and as part of their clinical evaluation. In many studies, PoCUS was performed by expert operators, apart from three studies where non-experts performed the scan. However, the accuracy of PoCUS was still relatively high in these studies which provided some insight into the potential benefits, even in non-expert hands. The proportion of patients with pulmonary edema or acute decom-

pensated heart failure was similar among the studies. One RCT excluded critically unwell patients with dyspnea who may have been likely to benefit from PoCUS. Published data indicated that PoCUS was highly sensitive and specific in diagnosing interstitial fluid syndrome (range: sensitivity 70–96 % and specificity: 75–95.5 %). The main limitation of the studies was non-consecutive patient enrollment with most studies considered to have an unclear or high risk of bias in the patient selection domain. There was risk of bias and applicability concerns with half of the studies. Two studies had a high risk of bias due to inconsistently applied reference standards.

Among the systematic reviews and meta-analyses, PoCUS accuracy was similar with sensitivity ranging from 73 % to 94 % and specificity from 84 % to 92 %. One of the systematic reviews included pre-hospital and ICU-based PoCUS, and another included ward-based PoCUS. Furthermore, there was significant heterogeneity among studies. However, appropriate quantitative synthesis models were used for the meta-analysis to account for this. Overall, our confidence level was moderate to high for all of the systematic reviews.

Many studies in this review were prospective cohort studies with two RCTs. While there was some heterogeneity between studies and some limitations in patient selection, all showed a trend towards good diagnostic accuracy of PoCUS compared to the final clinical diagnosis or standard care.

What is the clinical relevance and applicability?

Interstitial fluid syndromes are an important cause of acute dyspnea and respiratory failure in patients presenting to the ED. It is important to recognize this pathology early and distinguish it from other important causes of respiratory distress such as an exacerbation of chronic obstructive pulmonary disease (COPD), as the treatment is vastly different. However, this differentiation can be difficult due to the overlap of signs and symptoms. Physical examination and common investigations such as CXR and Brain Natriuretic Peptide (BNP) have limited sensitivity in the diagnosis of pulmonary interstitial fluid. PoCUS is a rapid and effective bedside tool for evaluating the acutely dyspneic patient and can improve the accuracy of clinical assessment.

What are the benefits or harms?

PoCUS may augment the sensitivity of clinical evaluation. Furthermore, it may reduce the time to diagnosis and treatment and help to categorize acute dyspnea as cardiogenic or non-cardiogenic in origin. Using PoCUS may reduce ionizing radiation resulting from CT and CXR.

Theoretical risks from mechanical and thermal effects on tissues from ultrasound use may exist but this is considered less relevant in PoCUS practice. Indirect harms could be caused by misdiagnosis – as B-lines (dynamic vertical ring-down-type artifacts seen on lung PoCUS) are not specific for interstitial fluid syndromes. Patients may be initiated on incorrect treatment based on PoCUS findings alone. Therefore, it is essential that PoCUS is integrated with the clinical assessment and applied in the appropriate context with a focused question in mind. In the context of the current Covid-19 pandemic, we now acknowledge that B-lines are a key finding in

Covid-19 pneumonitis as well. Therefore, practitioners must understand that in areas with a high prevalence of Covid-19, the specificity of B-lines for pulmonary edema may be reduced even further.

Overall recommendation

EFSUMB recommends that PoCUS may be used in the diagnosis of interstitial fluid syndromes in adult patients in the ED (LoE 2, strong recommendation, broad agreement).

Conclusion

We have adopted a robust systematic approach with regard to defining, searching for, and presenting the evidence. Due to constraints as a consequence of the COVID-19 pandemic, we chose not to incorporate any face-to-face elements in the methods.

The research teams and ERG members involved in this CPG were representative of a wide range of medical specialties using PoCUS, covering many international locations. The number of members of the ERG who contributed was initially 38. Ideally, having more members would improve the robustness of the consensus process. However, many of the clinicians who were approached were unable to commit to the time requirements and having a larger ERG would significantly increase the administration time to manage the process within the desired time frame.

The overall level of evidence ranged from LoE 2 to 4 – questions 9 and 10 were LoE 2, question 2 was LoE 4, and all others were LoE 3. Many of the studies were observational with regard to methodology and many sources of bias were identified on quality assessment. This may reflect the difficulty of conducting research on PoCUS in a clinical environment. There was also heterogeneity with regard to reference standards and PoCUS scanning protocols. However, some questions were supported by evidence based on systematic review and meta-analysis studies, which improved the overall level of evidence rating (questions 9 and 10). Interpretation of the strength of recommendation by the research teams, based on the GRADE criteria resulted in questions 1–5 being classed as weak and the rest being classed as strong.

One question/domain (question 1) achieved greater than 95 % consensus in either round with regard to the level of agreement with the final summary and recommendation, i. e., a strong consensus. All other questions only achieved broad agreement (range 86.4 % to 94.6 %).

Ten domains are presented in this first part of the EFSUMB PoCUS CPG, which does not comprehensively cover all contemporary PoCUS practice. The domains that were included were chosen because they were deemed common applications. Addressing more domains within this CPG would have required more researchers and administration time to coordinate the process. Further parts incorporating other PoCUS domains will be added in due course and, as evidence evolves, domains previously included will be reviewed through updates. In addition, further iterations may be more useful if the research question is based on presenting symptoms rather than solely on confirmation of a particular diagnosis.

Activity with regards to conducting the phases of this CPG was well established prior to the start of the COVID-19 pandemic. In addition, the evidence of PoCUS in COVID-19 patients has continued to evolve, hence it was not feasible to include this in this CPG. However, many ultrasound findings, especially with regards to lung ultrasound, seen in patients with SARS-CoV-2 are included in this CPG.

Ensuring appropriate education, training, and skills in PoCUS is essential for safe practice and better diagnostic accuracy. Further advances in artificial intelligence are now being incorporated into some ultrasound systems, which might aid in the identification of key PoCUS findings included in this CPG. The clinical benefit of such features will need to be evaluated further.

Conflict of Interest

Acknowledgement

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