EMA Emergency Medicine Australasia

Emergency Medicine Australasia (2021) doi: 10.1111/1742-6723.13904

ORIGINAL RESEARCH

Australasian emergency ultrasound: A survey on the current status

Vijay MANIVEL,[1,2,3] Elissa KENNEDY-SMITH,[4] Behzad MIRMIRAN,[5] Carolynne J CORMACK,[6] Alan GARNER[1,3] and George CONDOUS[3,7]

[1]Emergency Department, Nepean Hospital, Sydney, New South Wales, Australia, [2]Emergency Care, Sydney Adventist Hospital, Sydney, New South Wales, Australia, [3]Nepean Clinical School, The University of Sydney, Sydney, New South Wales, Australia, [4]Emergency Department, Sandringham Hospital, Melbourne, Victoria, Australia, [5]Emergency Ultrasound, Nepean Hospital, Sydney, New South Wales, Australia, [6]Emergency Department, Monash Health, Melbourne, Victoria, Australia, and [7]OMNI Gynaecological Care, Sydney, New South Wales, Australia

Abstract

Objective: Emergency ultrasound (EUS) has become an integral part of emergency medicine, and the core pillars of governance, infrastructure, administration, education and quality assurance (QA) are vital for its quality and continued growth. We aimed to assess the status of these vital pillars among Australasian EDs.

Methods: A survey among the clinical leads in ultrasound (CLUS) in Australasian EDs from November 2020 to April 2021.

Results: We analysed a total of 98 responses from CLUS representing 98 EDs. Most CLUS (85%) held EUS qualifications (CCPU 57%, DDU 18%, other 9%) but 15% had none. Only 66% of CLUS had dedicated clinical support time, and a mere 5% had administrative personnel support. Up to three ultrasound machines in 62% of EDs, but only 26% of EDs had secured image archiving facilities. In-house credentialing and the Australasian College for Emergency Medicine (ACEM) trainee special skills placement were available in 50% and 32% of EDs, respectively. Only 11% of EDs had regular EUS training for FACEMs, and only 66% of EDs had regular EUS education for emergency medicine trainees. Only 20 EDs had sonographer educators. Regarding EUS QA, only 33% of EDs provided formal EUS report, 23% of EDs conducted regular image reviews and 37% of EDs audited EUS performance. Only 35% of EDs had high-level disinfection equipment, and 56% of EDs had formal transducer disinfection protocols.

Conclusion: Despite ACEM recommendations for the practice of EUS, Australasian EDs still lack vital governance, administrative support, infrastructure, education and QA processes. Prompt actions such as ACEM mandating these recommendations are required to improve resource allocation by health services.

Key words: *emergency ultrasound, governance, infrastructure, point-of-care ultrasound, quality assurance.*

Key findings

- 15% of CLUS had no ultrasound qualification.
- Only 66% of CLUS had dedicated clinical support time.
- Only 26% of EDs had secured image archiving facilities.

Introduction

Point-of-care ultrasound (POCUS) is a disruptive innovation, as it challenges the notion of traditional comprehensive ultrasound service by bringing it to the patient's bedside, requiring no referral and making it available at all times.[1] Emergency ultrasound (EUS) is synonymous with the terms POCUS, clinical, bedside and focussed ultrasound in EDs, but it is a part of the larger field of clinical ultrasonography.[2,3] EUS has become an integral modality in emergency medicine (EM), providing invaluable dynamic anatomical and functional information that is often not obtainable through physical examination.[2] Rapid advancement in ultrasound device technology with mounting clinical evidence is driving the field of EUS at lightning speed. Despite its utility and widespread usage, EUS suffers a great deal of misunderstanding as it has lacked the same level of comprehensive framework, quality control measures and governance compared to traditional radiology practice.[1]

The Australasian College for Emergency Medicine (ACEM), through its strong collaboration with organisations like the Australasian Society for Ultrasound in Medicine (ASUM) and Emergency Medicine Ultrasound Groups (EMUGs), has recognised EUS as an essential skill for FACEMs to acquire. ACEM has taken various steps to facilitate this, including developing guidelines and policies supporting EUS education among fellows and trainees and the

Correspondence: Dr Vijay Manivel, Emergency Department, Nepean Hospital, 1 Derby Street, Kingswood, NSW 2747, Australia. Email: vijay.manivel@health.nsw.gov.au

Vijay Manivel, MBBS, FACEM, DDU, Senior Staff Specialist, CLUS, Director, Clinical Senior Lecturer; Elissa Kennedy-Smith, MBBS, FACEM, DDU, Chair, ACEM Ultrasound Committee, Staff Specialist, CLUS; Behzad Mirmiran, MD, FACEM, Emergency Ultrasound Fellow; Carolynne J Cormack, BAppSc (MedRad), GDUlt, GCHPE, FASA, AMS, PoCUS Program Sonographer Educator (SEED); Alan Garner, OAM, MBBS, FACEM, MSc, PhD, Senior Staff Specialist, Clinical Associate Professor; George Condous, MBBS (Adel), FRCOG, FRANZCOG, MD (Lon), Associate Professor, Director.

Accepted 29 October 2021

appointment of clinical leads in ultrasound (CLUS) for a leadership role in the governance, education, credentialing, quality assurance (QA) and audit of EUS.[4] As ACEM does not credential EUS,[4] ED clinicians are trained through private organisations or in-house EUS training courses, but the education and credentialing processes are optional and unclear. Also, there is a paucity of knowledge about Australasian EUS infrastructure and QA processes. To assess the current status of the vital pillars of governance, administration, infrastructure, education and QA in EUS,[5] we conducted this survey among CLUS in Australasian EDs.

Methods

We surveyed CLUS in EDs across Australia and New Zealand from November 2020 to April 2021 through an online survey platform, SurveyMonkey™ (Momentive Inc., San Mateo, CA, USA).

Survey tool design and validation

Creation of the survey tool was based on previous similar studies[6–11] by a working group of authors (VM, EKS, BM, CJC) with qualifications and experience in emergency care and EUS, and validated by the modified Delphi method with consensus as the 'stopping guideline'. During step 1, drafted questions through literature review and focus group discussions. In step 2, designed a structured questionnaire, distributed and analysed for agreement in the following domains: adequate coverage of the topics of interest, format and wording of the questions and choices, ease of understanding of questions and conflicts. Finally, in step 3, refined questions to achieve consensus. The survey was piloted with 10 FACEMs to assess the content and technical robustness of the survey platform; this resulted in no change in the questionnaire. All authors agreed on the final version of the survey tool before dissemination (Fig. 1).

Questions included multiple selections and free-text answers across seven sections, covering infrastructure, education, credentialing, EUS applications, disinfection practice, QA and governance (Appendix S1). The estimated time to completion was 15 min.

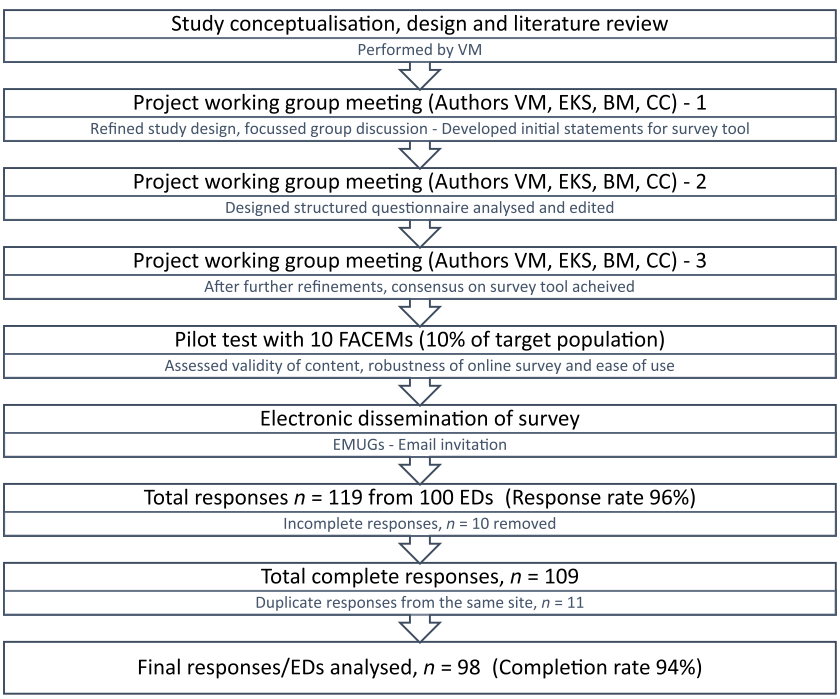

Figure 1. *Methodology.*

Survey dissemination

A survey link via an email list generated by the EMUGs organisation was sent to all CLUS in Australia and New Zealand EDs. There were 113 CLUS registered with ACEM from 104 EDs (C Burrows, ACEM. Email communication, 20 August 2021).

Ethics

Nepean Blue-Mountains Human Research Ethics Committee approved the study (approval reference ID: 2020/ETH02838). Participation in the survey was voluntary and implied consent. No monetary or non-monetary incentive was offered to participants.

Data analysis

Collated data into Microsoft Excel™ (Microsoft, Redmond, WA, USA) for descriptive analysis. Analysed qualitative data using NVivo v12™ (QSR International (Americas) Inc., Burlington, MA, USA). Excluded incomplete responses. Manually reviewed duplicate responses from the same site and merged into one entry by two authors VM and BM; contacted the CLUS to clarify any discrepancy.

Results

We received a total of 119 responses from 100 EDs (response rate of 96%, 100/104). After removal of incomplete responses and duplicate entries, we analysed a total of 98 responses representing 98 EDs: a completion rate of 94% (98/104) (Fig. 1).

Demographics of respondents (Table 1) showed 82 Australian and 16 New Zealand EDs with an almost equal representation from major referral (MR), urban district (UD) and rural regional (RR) centres; 36%, 34% and 30%,respectively.

Administration/governance

Only 66% of CLUS had dedicated clinical support time (CST), and a mere 5% had administrative personnel support. The majority of participants (79/98) preferred more CST

TABLE 1. *Respondent demographics, role and ultrasound credentials*

	MR ($n = 35$) n (%)	UD ($n = 33$) n (%)	RR ($n = 30$) n (%)	Total ($n = 98$) n (%)
Location				
New Zealand	5 (14)	4 (12)	7 (23)	16 (16)
Australian Capital Territory	–	1 (3)	–	1 (1)
New South Wales	11 (31)	9 (27)	11 (37)	31 (32)
Northern Territory	1 (3)	–	1 (3)	2 (2)
Queensland	6 (17)	5 (15)	5 (17)	16 (16)
South Australia	2 (6)	2 (6)	–	4 (4)
Tasmania	1 (3)	–	1 (3)	2 (2)
Victoria	5 (14)	8 (24)	5 (17)	18 (18)
Western Australia	4 (11)	4 (12)	–	8 (8)
Role				
DEUS	9 (26)	4 (12)	6 (20)	19 (19)
CLUS and DEMT	2 (6)	4 (12)	4 (13)	10 (10)
CLUS	24 (69)	25 (76)	20 (67)	69 (70)
Time in the role				
<3 months	–	1 (3)	3 (10)	4 (4)
3–12 months	4 (11)	7 (21)	14 (47)	25 (26)
12–24 months	5 (14)	9 (27)	4 (13)	18 (18)
>24 months	26 (74)	16 (48)	9 (30)	51 (52)
Ultrasound credentials				
DDU	10 (29)	6 (18)	2 (7)	18 (18)
CCPU	20 (57)	20 (61)	16 (53)	56 (57)
POCUS fellowship	1 (3)	2 (6)	2 (7)	5 (5)
Post-graduate ultrasound certificate	2 (6)	2 (6)	–	4 (4)
No formal credentials	2 (6)	3 (9)	10 (33)	15 (15)

CLUS, clinical lead in ultrasound; DEMT, director of emergency medicine training; DEUS, director of emergency ultrasound; MR, major referral; RR, rural regional; UD, urban district.

for the CLUS role, and most (69/98) suggested more than 8 h per fortnight. FACEMs shared CLUS position in 58% of EDs, and only 37% received help from other FACEMs with ultrasound credentials.

Only 20 EDs had sonographer educator in the ED (SEED), and 11 of them were MR centres. Most SEEDs (13/20) were on a temporary appointment, funded mainly by FACEMs through education allowance. Other than education, they were also involved in QA (9/20), administrative (6/20) and research (3/20) activities (Table 2).

Infrastructure

Almost all EDs had EUS specific portable cartwheel machines, and only 20 EDs had handheld ultrasound devices. Eighteen MR EDs had at least five ultrasound machines, whereas most UD (25/33) and RR (22/30) centres had three or fewer machines. Most of the UD CLUS (23/33) reported the need for more ultrasound machines. Only 26% of EDs had secure storage facility for EUS images, and only 4% of EDs (all MR) had middleware software. EUS images were readily accessible to other clinicians in only 20% of EDs. High-level transducer disinfection (HLD) equipment was available in only 35% EDs: Trophon™ (Nanosonics Limited, Sydney, Australia) 17/98, Tristel Trio™ wipes (Tristel Pty Ltd, Melbourne, Australia) 15/98 and UV light-based HLD system 4/98. Only five EDs bill for EUS (Table 3).

Education and credentialing

Most of the CLUS (75%) had ASUM credentials (DDU 18%, CCPU 57%),

TABLE 2. *Administration and governance*

Clinical lead in ultrasound (CLUS)				
	MR ($n = 35$) *n* (%)	UD ($n = 33$) *n* (%)	RR ($n = 30$) *n* (%)	Total ($n = 98$) *n* (%)
EDs with shared position for the CLUS role				
Total	17 (49)	20 (61)	4 (13)	41 (42)
Non-clinical time allocated for CLUS				
No dedicated time	10 (29)	18 (55)	15 (50)	43 (44)
1–8 h/fortnight	10 (29)	6 (18)	7 (23)	23 (23)
9–16 h/fortnight	8 (23)	7 (21)	8 (27)	23 (23)
>16 h/fortnight	7 (20)	2 (6)	–	9 (9)
Preferred non-clinical time required for CLUS				
No dedicated time	–	–	2 (7)	2 (2)
1–8 h/fortnight	7 (20)	8 (24)	12 (40)	25 (28)
9–16 h/fortnight	12 (34)	16 (48)	8 (27)	36 (37)
>16 h/fortnight	16 (46)	9 (27)	8 (27)	33 (34)
EDs with dedicated administrative personnel support for CLUS				
Total	3 (9)	2 (6)	–	5 (5)
CLUS who receive support from ultrasound qualified FACEMs				
Total	20 (57)	11 (33)	6 (20)	37 (38)
Sonographer educator in the ED (SEED)				
	MR ($n = 11$) *n* (%)	UD ($n = 7$) *n* (%)	RR ($n = 2$) *n* (%)	Total ($n = 20$†) *n* (%)
SEED's hours of work in ED				
1–8 h/fortnight	6 (55)	3 (43)	2 (100)	11 (55)
9–16 h/fortnight	3 (27)	1 (14)	–	4 (20)
>16 h/fortnight	2 (18)	3 (43)	–	5 (25)
SEED's role(s) in ED				
Ad-hoc education	2 (18)	1 (14)	2 (100)	5 (25)
Formal education	9 (82)	6 (86)	–	15 (75)
Quality assurance	5 (45)	4 (57)	–	9 (45)
Research	2 (18)	1 (14)	–	3 (15)
Admin	3 (27)	3 (43)	–	6 (30)
SEED's employment contract				
Permanent	3 (27)	4 (57)	–	7 (35)
Temporary	8 (73)	3 (43)	2 (100)	13 (65)

†Only EDs with SEED. MR, major referral; RR, rural regional; UD, urban district.

and a few (9%) had non-ASUM credentials. Interestingly, 15% of CLUS had no formal ultrasound credentials (Table 4).

Among the 98 EDs, FACEMs held various ultrasound credentials, including DDU (24%), CCPU (85%), post-graduate ultrasound certificate (33%), in-house credentials as per ACEM credentialing guidelines (17%), independent local institutional credentials (17%) and masters in ultrasound (4%).

Forty-nine EDs (50%) had an in-house EUS credentialing programme, and the most commonly covered modules were EFAST (92%, 45/49) and AAA examination (80%, 39/49), followed by ultrasound-guided vascular access (65%, 32/49) and BELS (61%, 30/49). However, only 11% (11/98) of EDs reported having a regular EUS training programme for FACEMs.

TABLE 3. *Infrastructure*

	MR (*n* = 35) *n* (%)	UD (*n* = 33) *n* (%)	RR (*n* = 30) *n* (%)	Total (*n* = 98) *n* (%)
EUS machine quantity				
One	1 (3)	3 (9)	13 (43)	17 (17)
Two	4 (11)	9 (27)	9 (30)	22 (22)
Three	7 (20)	13 (39)	3 (10)	23 (23)
Four	5 (14)	4 (12)	4 (13)	13 (13)
Five	10 (29)	2 (6)	1 (3)	13 (13)
Six or more	8 (23)	2 (6)	–	10 (10)
Median (IQR)	5 (3–5)	3 (2–3)	2 (1–2.75)	3 (2–4)
Types of EUS machines				
Handheld devices	9 (26)	9 (27)	2 (7)	20 (20)
Cartwheel machine	35 (100)	32 (97)	28 (97)	95 (97)
High-end machines	9 (26)	3 (9)	2 (7)	14 (14)
EDs that require additional ultrasound machines				
Total	12 (34)	23 (70)	12 (40)	47 (48)
Number of additional ultrasound machines required				
Median (IQR)	2 (2–3.25)	2 (1–2)	2 (1–2)	2 (1.5–2)
Archiving of EUS images				
No archiving	4 (11)	4 (12)	5 (17)	13 (13)
Personal hard drive	8 (23)	14 (42)	20 (67)	42 (43)
ED portable hard drive	6 (17)	7 (21)	4 (13)	17 (17)
ED NAS	3 (9)	3 (9)	–	6 (6)
PACS/VNA/Cloud	14 (40)	5 (15)	1 (3)	20 (20)
EDs with middleware software for image processing				
Total	4 (11)	–	–	4 (4)
EDs with online accessibility of EUS images to other clinicians				
Total	15 (43)	4 (12)	1 (3)	20 (20)
EDs that bill for EUS				
Total	3 (9)	1 (3)	1 (3)	5 (5)
EDs with high-level disinfectant (HLD)				
Total	11 (31)	13 (39)	10 (33)	34 (35)
Trophon	5	7†	5	17
Tristel Trio	3	7†	5	15
Antigermix	3	1	–	4

†Two EDs have both Trophon unit and Tristel Trio HLD. MR, major referral; NAS, network-attached storage; PACS, picture archiving and communications; RR, rural regional; UD, urban district; VNA, vendor neutral archive.

ACEM special skill placement for ultrasound (SSP-US) for trainees was available in 32% of EDs (13 MR, 13 UD and five RR). ASUM had also approved 20 of these SSP-US for CCPU course equivalency. Most (90%, 28/31) of these SSP-US catered for one or two trainees (median 1, IQR 1–2, maximum 6). Of the 67 EDs without SSP-US, only 34 had regular EUS training programmes for trainees, and the frequency of training sessions varied significantly.

Quality assurance

All 98 EDs had included ACEM recommended core modules[4] in their scope of practice, and more than two-thirds of EDs were performing beyond the recommended modules. Advanced EUS examinations such as transvaginal scans and trans-oesophageal echocardiogram were performed in 12 and four EDs, respectively (Table 5).

Only 56% of EDs had a formal transducer disinfection protocol and only 35% of EDs had HLD equipment for transducer disinfection. Most EDs with HLD (27/34)

TABLE 4. *Education, training and credentialing*

	MR ($n = 35$) n (%)	UD ($n = 33$) n (%)	RR ($n = 30$) n (%)	Total ($n = 98$) n (%)
FACEMs with ultrasound qualification				
DDU	11 (31)	9 (27)	4 (13)	24 (24)
CCPU	32 (91)	32 (97)	22 (73)	85 (87)
PGCert/Dip of clinical ultrasound	14 (40)	13 (39)	5 (17)	32 (33)
Masters of ultrasound	2 (6)	2 (6)	–	4 (4)
Locally credentialed – as per ACEM guidelines	12 (34)	3 (9)	2 (7)	17 (17)
Locally credentialed – independent	10 (29)	6 (18)	1 (3)	17 (17)
EDs with regular EUS training for FACEMs				
Total	6 (17)	5 (15)	–	11 (11)
EDs with ACEM accredited SSP-US placement				
Total	13 (37)	13 (36)	5 (17)	31 (31)
Approved for CCPU	9 (26)	9 (27)	2 (7)	20 (20)
Trainee per SSP-US term				
Median (IQR)	2 (1–2)	1 (1–1)	1 (1–1)	1 (1–2)
One	5	10	4	19
Two	6	2	1	9
Three or more	2	1	–	3
EDs with regular EUS training for trainees (except EDs with SSP-US)				
Total	16 (73)	10 (50)	8 (32)	34 (34)
Frequency of training sessions				
Monthly	3	6	2	11
Quarterly	7	2	1	10
6–12 monthly	6	2	5	13
EDs with 'in-house' EUS credentialing				
Total	27 (77)	15 (45)	7 (23)	49 (50)
Modules				
E-FAST	25	14	6	45
AAA	21	14	4	39
Vascular access	17	11	4	32
BELS	17	10	3	30
Biliary	9	7	2	18
Renal	7	6	2	15
Proximal DVT	7	5	1	13
Musculoskeletal	3	2	1	6
Rapid echo	6	7	2	15

ASUM, Australasian Society for Ultrasound in Medicine; CCPU, certificate in clinician performed ultrasound; DDU, diploma of diagnostic ultrasound; JMO, junior medical officer; MR, major referral; RR, rural regional; SSP-US, special skills placement for ultrasound; UD, urban district.

reported not using it regularly, and there was no consensus on the triggers to use HLD equipment.

There was a significant variation in the type of transducer cover used for peripheral IV cannulation, and 11% of EDs reported that they do not use any protective cover. All EDs reported using a long sterile cover for central venous cannulations, and 14% used short sterile covers interchangeably.

Reporting templates were available in 38% of EDs, and only 33%

TABLE 5. *Quality assurance*

	MR ($n = 35$) n (%)	UD ($n = 33$) n (%)	RR ($n = 30$) n (%)	Total ($n = 98$) n (%)
Scope of practice				
Ultrasound examination/procedure(s) performed in ED				
ACEM core modules	35 (100)	33 (100)	30 (100)	98 (100)
Nerve blocks	32 (91)	31 (94)	26 (87)	89 (91)
Musculoskeletal	32 (91)	25 (76)	26 (87)	83 (85)
Hepatobiliary	29 (83)	29 (88)	25 (83)	83 (85)
Renal tract	28 (80)	28 (85)	19 (63)	75 (77)
Early pregnancy	25 (71)	24 (73)	20 (67)	69 (70)
Ocular	24 (69)	20 (61)	15 (50)	59 (60)
Bowel	20 (57)	15 (45)	8 (27)	43 (44)
Scrotal	18 (51)	12 (36)	7 (23)	37 (38)
Transvaginal	5 (14)	5 (15)	2 (7)	12 (12)
Trans-oesophageal	–	4 (12)	–	4 (4)
Infection prevention and control				
EDs with a formalised protocol for transducer disinfection	23 (66)	20 (61)	12 (40)	55 (56)
EDs with HLD equipment	11 (31)	13 (39)	10 (33)	34 (35)
Trophon	5	7†	5	17
Tristel Trio wipes	3	7†	5	15
Antigermix	3	1	–	4
Indication for HLD use (only sites with HLD, $n = 34$)				
Every patient contact	2	2	1	5
Any invasive procedure	3	6	5	14
Invasive procedure without cover	2	2	–	4
Obvious contamination	6	6	3	15
'*Ad-hoc*' when feasible	1	2	4	7
Frequency of HLD use (only sites with HLD, $n = 34$)				
Daily	2	–	1	3
Weekly	1	3	–	4
Not regular	8	10	9	27
Type of transducer cover used for ultrasound-guided peripheral cannulations				
No cover	2 (6)	4 (12)	5 (17)	11 (11)
Non-sterile glove	5 (14)	5 (15)	7 (23)	17 (17)
Tegaderm	5 (14)	8 (24)	6 (20)	19 (19)
Short sleeve sterile	19 (54)	16 (48)	16 (53)	51 (52)
Long sleeve sterile	13 (37)	10 (30)	8 (27)	31 (32)
Type of transducer cover used for ultrasound-guided central cannulations				
Short sleeve sterile	3 (9)	4 (12)	7 (23)	14 (14)
Long sleeve sterile	35 (100)	33 (100)	30 (100)	98 (100)

(*Continues*)

TABLE 5. *Continued*

	MR ($n = 35$) n (%)	UD ($n = 33$) n (%)	RR ($n = 30$) n (%)	Total ($n = 98$) n (%)
Audit and research				
EDs with regular image review sessions for education	14 (40)	6 (18)	4 (13)	24 (24)
EDs with regular image review sessions for QA	12 (34)	7 (21)	4 (13)	23 (23)
EDs that had an audit on the quality of EUS	17 (49)	13 (39)	6 (20)	36 (37)
EDs with published EUS-related research	12 (34)	13 (39)	3 (10)	28 (29)
Reporting				
EDs with EUS reporting templates	18 (51)	15 (45)	4 (13)	37 (38)
EDs that provide a formal report on EUS scans	16 (46)	12 (36)	4 (13)	32 (33)
Hospital-wide POCUS				
The view of inpatient teams on EUS service				
Accept it for management	6 (17)	4 (12)	3 (10)	13 (13)
Request ultrasound by Radiology Department	29 (83)	29 (88)	27 (90)	85 (87)
Centres with hospital-wide POCUS group	9 (26)	3 (9)	6 (20)	18 (18)

†Two EDs have both Trophon unit and Tristel Trio HLD. EUS, emergency ultrasound; HLD, high-level disinfection; MR, major referral; POCUS, point-of-care ultrasound; RR, rural regional; UD, urban district.

of EDs provided a formal report on EUS examinations. Image review sessions were conducted for QA and educational purposes in 23% and 24% of EDs, respectively. Thirty-six EDs (37%) had conducted an audit on the quality of EUS at some stage, and only 29% of EDs had published EUS research activities. Hospital-wide POCUS groups existed in 18 sites. The experience of the majority of CLUS (87%) was that their inpatient colleagues (e.g. surgeons) preferred a comprehensive ultrasound by the radiology department for clinical decision making.

Table 6 summarises the survey participants' top challenges and plausible solutions reported (free text) to provide effective EUS.

Discussion

POCUS is considered the fifth element of clinical assessment, bridging inspection, palpation, percussion and auscultation.[12] Nonetheless, the exponential growth of EUS and widespread acceptance by clinicians has not been met efficiently by the development of EUS pillars, including administrative support, governance, education, research and QA.[5]

Governance and administration

ACEM has recommended all EDs appoint a CLUS with dedicated CST, to govern EUS administration, clinical service, education and QA.[4] Of the 149 EDs approved for ACEM EM training,[13,14] only 104 sites have appointed CLUS. With increasing EUS utilisation and emphasis on EM training, ACEM should address this lack of CLUS in 45 EDs promptly. Also, despite ACEM's recommendations (not yet mandated), nearly half of CLUS in this survey had no dedicated CST allocation. Notably, the topmost barrier in improving the quality of EUS (Table 5) reported was inadequate time allocation, and most CLUS preferred more than 8 h per fortnight to adequately fulfil their CLUS duties.

Only 19% of the CLUS had a formal Director of EUS (DEUS) designation. A director position, in our opinion, is a step in the right direction to improve EUS administration and governance. DEUS must be a FACEM with EUS credentials, who, besides ultrasound education, training and curriculum development, should develop governance policies and protocols, manage infrastructure procurement and maintenance, monitor QA processes and promote research activities. A DEUS position should have the necessary authority to liaise with other ultrasound service providers, executives and other POCUS stakeholders in the hospital network, leading to a 'Hospital-wide POCUS group' to enhance EUS further. Although ACEM has recommended at least 4 h per week of administrative support,[4] a 'clinical lead' role like CLUS may not be entitled to administrative support within the organisation's hierarchy. This could be a reason why only five sites reported administrative personnel support (Table 2). A structured EUS faculty including Director, CLUSs, SEEDs and clerical personnel, along with QA policies and protocols, could pave the way for 'emergency ultrasound' as a sub-speciality within EM. Organisations like ASUM and EMUGs should work closely with ACEM to further develop EUS governance and administration policies and protocols.

TABLE 6. *Collation of comments on top three challenges for EUS and plausible solutions*

	Challenges	Plausible solutions
Administration	• Lack of dedicated/protected clinical support time for DEUS/CLUS • Buy in from administration • Lack of funding	• ACEM to mandate time allocation to DEUS/CLUS (like DEMT) • Implement billing for EUS
Governance	• Poor governance for EUS • Lack of clear policies and protocols	• More active and collaborative measures from ACEM, ASUM and EMUGs regarding governance structures, polices and protocols • ACEM to recognise EUS as a subspeciality of emergency medicine • Incorporate SEEDs into EUS faculty
Infrastructure	• Inadequate quantity and quality of ultrasound machines • Lack of image archiving and processing • Lack of HLD equipment	• Acquire more 'built for purpose' ultrasound machines • Implement seamless EUS image workflow solution • Acquire HLD equipment that is suitable for fast paced emergency medicine
Education	• Lack of time to provide adequate supervision • Variability in the skill level of FACEMs in EUS • Lack of EUS interest and engagement from Senior FACEMs	• ACEM to mandate EUS education and training for ED trainees • Improved resource allocation • SEED would be helpful
Credentialing	• Lack of EUS credentialed supervisors • No archiving of EUS images • Lack of clear credentialing pathways; ACEM *versus* ASUM • Recent changes in credentialing criteria by ASUM is less encouraging, restrictive and expensive	• ACEM should be the primary credentialing body • EUS credentialing should be mandated for all CLUS and future FACEMs • Adopting newer education and credentialing models, like remote education and flipped EUS classrooms
Quality assurance	• Lack of time to perform QA activities • Lack of image archiving solutions, including middleware software • Poor documentation of EUS • Poor acceptance and restrictive approach from other specialities • Lack of formal departmental guidelines for EUS	• Implement seamless ultrasound image workflow solution, including middleware with EMR integration • Establish interdepartmental policies and protocols on EUS clinical practice and governance • 'Hospital-wide' POCUS group • Regular audits on EUS performance • Active involvement in EUS research

CLUS, clinical lead in ultrasound; DEMT, director of emergency medicine training; DEUS, director of emergency ultrasound; EMUGs, Emergency Medicine Ultrasound Group; EUS, emergency ultrasound; HLD, high-level disinfection; POCUS, point-of-care ultrasound; SEED, sonographer educator in the ED.

SEEDs are an excellent resource for ultrasound training and supervision, especially for EDs with limited access to EUS credentialed clinicians. Their expertise as a highly trained and qualified sonographer is a huge asset to teach correct scanning techniques for the novice and to refine the skills of an advanced EUS practitioner. However, there is a sense of reluctance and lack of administrative support in employing a SEED. Most SEEDs are currently on a temporary agreement and mostly funded through the TESL or CME allowance

of FACEMs. Incorporating SEEDs into EUS faculty or sourcing through other departments (Imaging or Cardiology) may alleviate some barriers with recruitment into permanent positions and strengthen collaborative inter-departmental relationships.[15]

Infrastructure

EDs needing more ultrasound machines should consider purpose-built EUS machines that are portable, robust and versatile for educational and clinical needs. While high-end ultrasound machines, like the radiology department, have a niche role in advanced EUS,[16] they are heavy, less manoeuvrable, require a live power supply while scanning and are expensive. However, moving forward, a combination of portable, handheld and high-end machines may be an appropriate strategy to cater to both clinical and educational requirements.

Although nearly all modern EUS machines have Wi-Fi capabilities and can send images wirelessly to hospital network storage and the existing picture archiving system, it is not widely implemented for various reasons. Around 73% of EDs store EUS images using personal or departmental memory sticks or external hard drives, which are insecure and have serious implications for quality control, education and research. EUS images are sensitive medical records and failing to secure these may leave the institution and clinician liable to medico-legal risks. Although EUS is typically performed, interpreted and reported by the treating clinician, these images should also be readily available to other clinicians involved in the patient's care. Seamless integration of EUS images to EMR through middleware is vital. Middleware software, currently available in only four EDs, enables communication with various existing hospital information technology systems to create an effective workflow solution for EUS image archiving, segregating educational from clinical images, generating reports, tracking provider credentials, aiding QA and billing.[2]

ACEM's recommendation for disinfection of transducers adheres to Australian/New Zealand Standard (AS/NZS 4187:2014). Although clear indications for HLD after minor procedures remains controversial, ACEM agrees that most transducers will require HLD at some point, and hospitals should provide HLD equipment within EDs.[17] Only 35% of EDs have access to HLD, and chemical-based HLD are more prevalent than UV light-based systems. The HLD system should suit a fast-paced emergency care environment with minimal start-up time, quick processing, automated log of disinfection activities and minimal maintenance. The newer UV light-based systems satisfy these requirements; however, the initial cost is substantially higher than chemical-based HLD.

Although only 5% of EDs gain revenue through EUS billing, investing in adequate infrastructure for EUS will add significant value to healthcare. Value in healthcare has been defined as outcomes that matter to the patient relative to cost.[18] EUS improves clinical decision making, reduces medical errors and complications during procedures, and improves patient satisfaction. EUS also improves departmental resource utilisation, patient flow and significantly reduces the need for unnecessary costly investigations and invasive procedures.[3] As such, it is an excellent risk and cost reduction tool. Noteworthy reviews of lawsuits in the USA related to EUS were all due to failure to perform an ultrasound study or failure to perform one on time. None involved failure to interpret or misdiagnosis due to POCUS.[19]

Education and training

EUS, unlike comprehensive scans in the medical imaging department, are focused and faster but by no means easier to master. Adequate education, training and QA are mandatory to maintain the highest standards and avoid potential misinterpretation that may adversely affect patient outcomes.[1]

ACEM encourages FACEMs to be skilled and credentialed to perform the core EUS modules, EFAST, AAA, procedural guidance, lung and BELS.[20] As only 11% of EDs provide regular EUS training for FACEMs, reliance on third-party EUS trainers or organisations is unavoidable. As long as EUS credentialing is not mandatory, only motivated FACEMs will take the initiative to undergo EUS training amidst busy work schedules and logistical difficulties. Moreover, most of these EUS courses do not offer continued supervision, assessment or progress tracking and FACEMs are left alone to use their learned EUS skills unsupervised and without any quality control measures. ACEM should provide a clearer pathway and the necessary resources to those FACEMs who missed out on EUS education during their EM training.

EM trainees are also encouraged to be proficient in core EUS modules and, if possible, to undergo intense training through SSP-US. Only 31 EDs surveyed have SSP-US (total of 32 sites as per ACEM SSP report[21]), and with only one or two trainees per SSP-US term, many trainees are denied of this intense training option. Of the remainder of EDs without SSP-US, only half have regular EUS education sessions for their trainees. These results imply that many trainees are completing their training without adequate EUS skills, which should be addressed promptly.

Benchmarking ACEP,[22] the ACEM training programme will benefit greatly from goal-directed EUS education with a defined curriculum and milestones. Also, incorporating this into the existing work-based assessment model would improve resource allocation for EUS education. Meanwhile, sites with no EUS educators should consider utilising ACEM's online EUS educational materials and reputable free open access medical EUS resources.[23,24] Established EUS training sites should consider sharing their educational resources with non-EUS training sites and provide support to build local FACEM trainers and SEEDs. With current advancements in information technology, remote training by webinars, e-learning, virtual face-to-face and telesonography are a reality, and geographical remoteness should no longer be a barrier to education and excellence in the performance of EUS.[23]

Credentialing

Independent in-house credentialing programmes (17% of EDs) have limitations, such as standardisation and acceptance across different health services. As ACEM does not provide EUS credentials, many FACEMs rely on ASUM for CCPU or DDU credentials, which are widely recognised across hospitals, states and even internationally (for DDU).[25] ACEM has a policy on the minimum standard credentialing pathway, which is dependent on in-house training provided by the ultrasound credentialed FACEMs and governed by CLUS. Contrary to most of the CLUS's preference for ACEM to be the primary EUS credentialing body (Table 6), only 17% of EDs have followed the ACEM credentialing pathway.

We believe that EUS should be a mandatory core credential for FACEMs without the need for external certification, similar to ACEP[3] and RCEM.[26] Local factors are critical to the success of any credentialing process, and ED directors are strongly encouraged to make this process mandatory for their department.[4] This is achievable in Australasia despite inadequate human resources by adopting innovative training and credentialing models like Hartnett's model,[27] individualised education and assessment methods using online technology, flipped EUS classroom model using free open access medical resources and tele-sonography.

Quality assurance

Quality improvement is the engine that drives a successful clinical ultrasound programme. A robust EUS QA plan integrated into the overall ED operations should be in place to ensure quality, facilitate education and satisfy credentialing pathways.[2,3]

The five key aspects of EUS QA are:

1. Defined scope of practice and formal protocols
2. Efficient and secure image storage and archiving
3. Proper documentation of EUS findings
4. Regular image review sessions and feedback
5. Audit and research

ACEM has clearly defined the core EUS modules,[4] similar to RCEM[26] and CAEP[28] and considerably less extensive compared to ACEP.[3] All 98 EDs have adopted ACEM core modules in their scope of practice. While it is promising to see that a small proportion of EDs is performing advanced ultrasound examinations like scrotal ultrasound, transvaginal and trans-oesophageal echocardiogram, protocols with defined quality control measures and adequate infrastructures (like HLD) must be in place for safe EUS practice. The lack of formal transducer disinfection protocol in nearly half of the surveyed EDs, particularly in the middle of a pandemic, is a significant concern. There are inconsistencies in recommendations by ACEM[17] and ASUM[29] regarding HLD use after invasive procedures, which is reflected in inconsistent practice within EDs. Clear evidence-based guidelines are needed to address this issue promptly.

A proper archiving system with middleware software is essential for all QA activities. Middleware software should have functionality like segregation of educational *versus* clinical EUS examinations, feedback provision, easier documentation, EMR integration and auditing. Only 26% of EDs have a secure archiving facility, and a mere 4% have middleware installed. Institutions should consider this as a significant medico-legal risk and address this deficit as a priority. Clinicians should document EUS findings like any other medical record, and middleware could make this easier with inbuilt reporting templates. CLUS/DEUS should conduct mandatory periodic image review sessions for educational and quality control purposes (currently in only 23% of EDs). These sessions are excellent educational opportunities and reduce the risk of misdiagnosis and missed diagnosis. A minimum of 10% of images are reviewed periodically for the image quality (depth, gain, focus), correct interpretation and clinical integration is vital for QA and risk management.[3] Incorporating other POCUS or comprehensive ultrasound users from the hospital in a hospital-wide POCUS group during image review sessions would improve the quality of EUS and rapport between specialities. Importantly, all these QA measures require adequate time and resource allocation for CLUS.

Limitations

ACEM did not disseminate the survey, and the authors did not have the resources to check the validity of responses. An ED's EUS status could have changed since the CLUS completed this survey. We gathered no information on EDs that do not have a CLUS.

Conclusion

Australasian EUS currently lack the necessary administrative support and resource allocation for CLUS to oversee EUS governance, education and credentialing. Poor infrastructure, including lack of image archiving, HLD equipment and lack of QA processes and auditing, is a potential recipe for disaster that poses a significant medico-legal risk. It is certainly not the recipe to pass on to emerging FACEMs, who should be developing competencies in ACEM EUS core modalities. ACEM's recommendations for EUS are not adhered to by many health services, and mandating these recommendations is an essential step in the right direction.

Acknowledgements

The authors acknowledge EMUGs in disseminating the survey and the ACEM ultrasound committee in providing valuable de-identified information.

Author contributions

VM is the project supervisor, conceptualised the study, obtained ethics approval, drafted and revised the survey tool, manuscripts and figures. EKS, BM, CJC contributed to the

study design, survey questions and manuscript writing and revisions. BM performed data analysis and drafted the tables. AG and GC are the overall supervisors and advisors for the project, provided expert opinions and edited manuscripts. All authors approve of the final version and agree to be accountable for all aspects of the work.

Competing interests

EKS is the current Chair of the ACEM Ultrasound Committee, and CJC is the current EMUGs Central Council Director.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1. Weile J, Brix J, Moellekaer AB. Is point-of-care ultrasound disruptive innovation? Formulating why POCUS is different from conventional comprehensive ultrasound. *Crit. Ultrasound J.* 2018; **10**: 25.
2. Tayal VS, Blaivas M, Foster TR, eds. *Ultrasound Program Management*. Cham: Springer International Publishing AG, 2018.
3. American College of Emergency Physicians. Ultrasound guidelines: emergency, point-of-care and clinical ultrasound guidelines in medicine. *Ann. Emerg. Med.* 2017; **69**: e27–54.
4. Australasian College for Emergency Medicine. Provision of focused ultrasound training and governance. 2020. [Cited 7 Oct 2021.] Available from URL: https://acem.org.au/getmedia/0702004f-c669-4646-b5fc-4fa577117ba3/COR742_v1_ED_Ultrasound_Training_Governance_Guideline
5. Cormack CJ, Wald AM, Coombs PR, Kallos L, Blecher GE. Time to establish pillars in point-of-care ultrasound. *Australas. J. Ultrasound Med.* 2019; **22**: 12–4.
6. Nagaraj G, Chu Matthew, Dinh M. Emergency clinician performed ultrasound: availability, uses and credentialing in Australian emergency departments. *Emerg. Med. Australas.* 2010; **22**: 296–300.
7. Amini R, Wyman MT, Hernandez NC, Guisto JA, Adhikari S. Use of emergency ultrasound in Arizona community emergency departments. *J. Ultrasound Med.* 2017; **36**: 913–21.
8. Carnell J, Fischer JW, Stone MB, Nagdev AD. Emergency ultrasound fellowship program compliance with ACEP guidelines in 2010: a web-based survey. *Acad. Emerg. Med.* 2011; **18**: S4–S249.
9. Craig S, Egerton-Warburton D, Mellett T. Ultrasound use in Australasian emergency departments: a survey of Australasian College for Emergency Medicine fellows and trainees. *Emerg. Med. Australas.* 2014; **26**: 268–73.
10. Lescallette RD, Ferre RM. Point-of-care ultrasound documentation rate determined by physician confidence in performing and interpreting the exam. *Acad. Emerg. Med.* 2015; **22** (S1): S3–S425.
11. Das D, Kapoor M, Brown C, Ndubuisi A, Gupta S. Current status of emergency department attending physician ultrasound credentialing and quality assurance in the United States. *Crit. Ultrasound J.* 2016; **8**: 6.
12. Narula J, Chandrashekhar Y, Braunwald E. Time to add a fifth pillar to bedside physical examination. *JAMA Cardiol.* 2018; **3**: 346–50.
13. Australasian College for Emergency Medicine. ACEM accredited emergency departments. 2021. [Cited 11 Nov 2021.] Available from URL: https://portal.acem.org.au/reports-search/accreditation-reports/accreditation-report?reportName=ED
14. Australasian College for Emergency Medicine. ACEM accredited paediatric emergency departments. 2021. [Cited 11 Nov 2021.] Available from URL: https://portal.acem.org.au/reports-search/accreditation-reports/accreditation-report?reportName=PED
15. Cormack CJ, Coombs PR, Guskich KE, Blecher GE, Goldie N, Ptasznik R. Collaborative model for training and credentialing point-of-care ultrasound: 6-year experience and quality outcomes. *J. Med. Imaging Radiat. Oncol.* 2018; **62**: 330–6.
16. Bogseth MC, Gawthrope IC, Rippey JC. Emergency medicine advanced ultrasound service: a new paradigm. *Emerg. Med. Australas.* 2020; **32**: 737–46.
17. Australasian College for Emergency Medicine. Position statement: ultrasound transducers. 2021. [Cited 11 Nov 2021.] Available from URL: https://acem.org.au/getmedia/850165eb-0b9b-4aab-82f6-da91b737e406/S686_v1_Statement_Cleaning_Ultrasound_Transducers
18. Labovitz AJ, Noble VE, Bierig M *et al*. Focused cardiac ultrasound in the emergent setting: a consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. *J. Am. Soc. Echocardiogr.* 2010; **23**: 1225–30.
19. Stolz L, O'Brien K, Miller M, Winters-Brown N, Blaivas M, Adhikari S. A review of lawsuits related to point-of-care emergency ultrasound applications. *West J. Emerg. Med.* 2015; **16**: 1–4.
20. Australasian College for Emergency Medicine. The use of focused ultrasound in emergency medicine. 2019. [Cited 11 Nov 2021.] Available from URL: https://acem.org.au/getmedia/000b84ee-378f-4b65-a9a7-c174651c2542/Policy_on_the_Use_of_Focused_Ultrasound_in_Emergency_Medicine
21. Australasian College for Emergency Medicine. ACEM accredited special skills placements. 2021. [Cited 11 Nov 2021.] Available from URL: https://portal.acem.org.au/reports-search/accreditation-reports/accreditation-report?reportName=SSP
22. Beeson MS, Carter WA, Christopher TA *et al*. Emergency medicine milestones. *J. Grad. Med. Educ.* 2013; **5**: 5–13.
23. Bowra J, Dawson M, Goudie A, Mallin M. Sounding out the future of ultrasound education. *Ultrasound* 2015; **23**: 48–52.
24. SCOPUS. *FOAM-US Resources – SPOCUS*. [Cited 11 Aug 2021.]

Available from URL: https://spocus.org/resources-programs/foamed/
25. Australasian Society for Ultrasound in Medicine. Minimum education & training requirements for ultrasound practitioners. *Australas. J. Ultrasound Med.* 2017; **20**: 132–5.
26. Royal College of Emergency Medicine. RCEM ultrasound training. [Cited 7 Oct 2021.] Available from URL: https://www.rcem.ac.uk/RCEM/Exams_Training/UK_Trainees/Ultrasound_Training/RCEM/Exams_Training/UK_Trainees/Ultrasound_Training.aspx?hkey=b0565712-6409-49b9-96c3-eafbda02a404
27. Toffoli A, Hartnett L, Mattick A, Goudie A. The Hartnett model: an effective low-resource training program that facilitates formal point-of-care ultrasound credentialing of emergency medicine trainees. *Ultrasound Med. Biol.* 2019; **45**: S61.
28. Henneberry RJ, Hanson A, Healey A *et al*. Use of point of care sonography by emergency physicians. *Can. J. Emerg. Med.* 2012; **14**: 106–12.
29. Basseal JM, Westerway SC, Juraja M *et al*. Guidelines for reprocessing ultrasound transducers. *Australas. J. Ultrasound Med.* 2017; **20**: 30–40.

Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Appendix S1. Survey tool.