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ORIGINAL RESEARCH

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Barriers and facilitators to vascular access point-of-care ultrasound in haemodialysis: An international survey of haemodialysis clinicians

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Abstract

Background: Utilising point-of-care ultrasound for assessment and cannulation of vascular access in people receiving haemodialysis has shown positive clinical results. Nonetheless, there is variation in how renal health care professionals worldwide embrace this method, and there's a lack of research on the factors that promote or hinder its adoption.

Objectives: To explore regional differences, and barriers and facilitators, to the use of point-of-care ultrasound for assessment and cannulation of vascular access in haemodialysis.

Design: Exploratory descriptive cross-sectional web-based survey.

Participants: Healthcare clinicians working in haemodialysis responsible for cannulation of arteriovenous fistula or grafts.

Results: The survey was completed by 645 health care clinicians from 38 countries. 75% to 93% of respondents from Australia/New Zealand, Canada, Europe and United Kingdom/Ireland reported access to ultrasound, compared to 26% (n = 43/167) from the United States. United States respondent's reported lower levels of ultrasound training than other regions. Facilitators for using ultrasound were: the availability of ultrasound training (87%, n = 558), to reduce miscannulations (76%, n = 255/336) and to improve patient outcomes (73%, n = 246/336). Point-of-care ultrasound barriers were lack of access to ultrasound education (82%, n = 196/239), lack of ultrasound machines (33%, n = 212/645) or believing that ultrasound was someone else's role (38%, n = 29/86).

Conclusions: This study revealed national and regional differences related to haemodialysis point-of-care ultrasound. Understanding the regions requiring more education and implementation of ultrasound and what motivates staff, or deters from using ultrasound, is crucial for effectiveness of future implementation and workplace change initiatives.

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KEYWORDS
cannulation, haemodialysis, point-of-care, renal, ultrasound

INTRODUCTION

Haemodialysis is dependent on the availability of a functioning vascular access. Those with arteriovenous fistula (AVF) or arteriovenous graft (AVG) require cannulation each dialysis treatment. Patient experiences of vascular access cannulation are reported as burdensome with miscannulations occurring regularly (Fielding et al., 2023). Nurse use of point-of-care ultrasound (POCUS) for vascular access assessment and cannulation is a promising strategy to improve cannulation success (Iglesias et al., 2021; Schoch et al., 2020).

LITERATURE REVIEW

POCUS utilises portable and noninvasive imaging and has been increasingly used in nephrology for assessing vascular access sites (Voiculescu et al., 2021). POCUS has been used for the assessment of AVF patency, blood flow, depth and diameter, as well as for identifying stenosis, thrombosis, and other complications (Saati et al., 2023; Schoch et al., 2015). POCUS is increasingly being reported for guiding cannulation before haemodialysis, as it allows for real-time visualisation of the target vessel and surrounding structures, reducing the risk of cannulation related complications including miscannulation and extravasation (Marticorena et al., 2018; Schoch et al., 2020). Incorporating POCUS into routine clinical practice can improve the accuracy of AVF assessment and cannulation, which may lead to better outcomes for people undertaking haemodialysis (Eves et al., 2020; Mullangi et al., 2018).

POCUS-guided cannulation has been shown to have positive outcomes for people undertaking haemodialysis. However, the uptake of this technique by health care professionals is variable, and there is a paucity of research about the facilitators and barriers to its adoption (Schoch et al., 2020). Consequently, this study sought to identify the facilitators and barriers to the use of POCUS for haemodialysis related vascular access and explore the factors that influence its adoption and integration into clinical practice. This study was designed to better understand the supports or interventions that enable staff to learn and use POCUS in haemodialysis cannulation, the obstacles that prevent them from doing so and whether there are regional variations in barriers or facilitators.

MATERIAL AND METHODS

An exploratory descriptive study design was used consisting of a 21-item international web-based cross-sectional survey. The survey was developed through an extensive literature review highlighting gaps in the knowledge about the barriers and facilitators. M. S. developed initial questions to address these gaps, and this was followed by consensus from international experts who had clinical experience and published on the topic (M. S., R. M., C. F., R. I., and G. S.). The survey instrument used branching logic that was developed and pilot-tested with 10 experienced vascular access nurses (See Supporting Information S1: 1). The survey was distributed in English and also translated into Spanish by RM and checked by RI.

Ethical approval was granted from Deakin University, Victoria, Australia (HEAG-H 153_2022). To recruit participants, a study invitation along with participant information statement was disseminated via email and newsletter across international peak professional organisations. This included the Renal Society of Australasia, American Nephrology Nurses Association, Canadian Association of Nephrology Nurses and Technologists, European Dialysis and Transplant Association, Association of Nephrology Nurses UK, Vascular Access Society of Britain and Ireland, Vascular Access Society, Catalan Association of Nephrology Nurses, Spanish Multidisciplinary Group of Vascular Access and Spanish Society of Nephrology Nursing. The survey was open from November 2022 to May 2023. Only participants who physically cannulated AVFs and AVGs were included in the survey. Participants provided consent on the survey landing page. Study data were collected and managed using REDCap electronic data capture tools hosted at Deakin University.

Statistical analysis

Frequency distributions were used for categorising ordinal and nominal data. Cross-tabulations were generated to explore relationships between key variables.

RESULTS

Demographic characteristics of the survey respondents are presented in Table 1. A total of 645 respondents from 38 countries completed the survey. Countries were grouped in 9 regions. A total of 75% respondents were from United States of America (26%), Australia/New Zealand (25%) and Europe (excluding UK and Ireland) (24%). Ninety six percent of respondents were from high income countries. Just over half of the respondents worked in hospital haemodialysis (57%), a third in stand-alone haemodialysis clinics (30%) and the remainder in hospital wards (5%), home haemodialysis (5%) and multiple sites (3%). Most respondents worked in clinical areas that had less than 200 haemodialysis patients (92%). The majority of respondents were registered nurses (72%) with 25% identifying themselves as nurse managers (Table 1). One-third of respondents had over 20 years haemodialysis vascular access cannulation experience, with the majority of respondents (83%) having 6 years or more experience. Just over 50% of respondents

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TABLE 1 Point-of-care ultrasound for haemodialysis vascular access survey respondent characteristics (n = 645).

Characteristic	Frequency (n = 645)	Percentage (%)
Region		
United States of America	168	26%
Australia/New Zealand	164	25%
Europe (Excluding United Kingdom)	156	24%
United Kingdom and Ireland	66	10%
Canada	60	9%
South/Latin America	20	3%
Middle East	6	1%
Africa	3	<1%
Asia	1	<1%
Not stated	1	<1%
Country income status		
High income	619	96%
Upper middle income	22	3%
Low middle income	3	<1%
Low income	0	0%
Not stated	1	1%
Employment role		
Registered nurse (bachelor)	303	47%
Nurse manager	164	25%
Vascular access coordinator	69	11%
Renal educator	46	7%
Enroled nurse (diploma)	34	5%
Patient care technician	11	2%
Nephrologist	13	2%
Vascular surgeon	3	<1%
Other	2	<1%
Haemodialysis area of work		
Hospital haemodialysis	366	57%
Satellite/Community haemodialysis	195	30%
Hospital renal ward	35	5%
Home haemodialysis	31	5%
Multiple areas	17	3%
Not stated	1	<1%
Number of haemodialysis patients in unit		
<50 patients	215	33%
51–100 patients	220	34%
101–200 patients	160	25%
201–300 patients	22	3%
301–400 patients	11	2%
401–500 patients	4	<1%
>500 patients	13	2%
Years of cannulation experience		
<1 year	16	3%
1–2 years	34	5%
3–5 years	61	10%
6–10 years	114	18%
11–15 years	98	15%
16–20 years	118	18%
>20 years	204	32%

cannulated between 6 and 20 vascular access' per week, with 31% cannulating between 1 and 5 accesses.

Facilitators for use of POCUS

Two thirds of respondents reported POCUS availability in their units. Of those, half said there was one ultrasound available, while one quarter had two ultrasounds available. Of the 439 respondents who said they had POCUS available 77% reported that they personally used ultrasound and half of those respondents had been using it between 3 and 10 years. Of the 408 respondents who answered how often POCUS was used in their unit, 86% reported that POCUS was used, sometimes (34%), often (37%) or all the time (15%) (See Supporting Information S2: 2).

Of those who had received POCUS training (n = 558), most had completed either face-to-face theory and practical sessions (43%) and on-site practical training only (32%), (see Figure 1. Participants could choose multiple answers). Overall, POCUS training was mostly delivered by senior nurses (22%), access coordinators (22%) or private providers (20%) (Figure 2).

Respondents were motivated to use POCUS to reduce miscannulations (76%), for better patient outcomes (73%), to see inside the vessel to decrease damage (58%) and to prolong life of AVF/AVG (57%) but only 9.8% (n = 33) had learnt to use it when they first learnt to cannulate (see Figure 3). Respondents predominantly used POCUS for finding areas to cannulate before problem cannulations (84%) and assessing AVF maturation before first cannulation (71%) (See Table 2 Participants could choose multiple answers).

Free text comments highlighted some respondents' positive experiences with use of POCUS in their facility, one noting that 'POCUS is a

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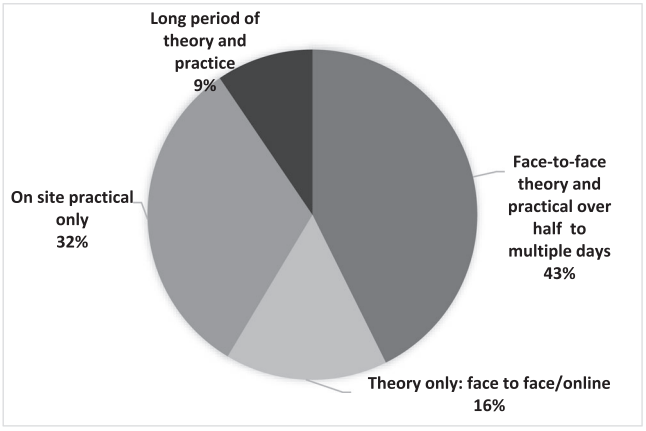

FIGURE 1 Type of point-of-care ultrasound training completed by survey respondents ($n = 558$ (participants could choose multiple answers).

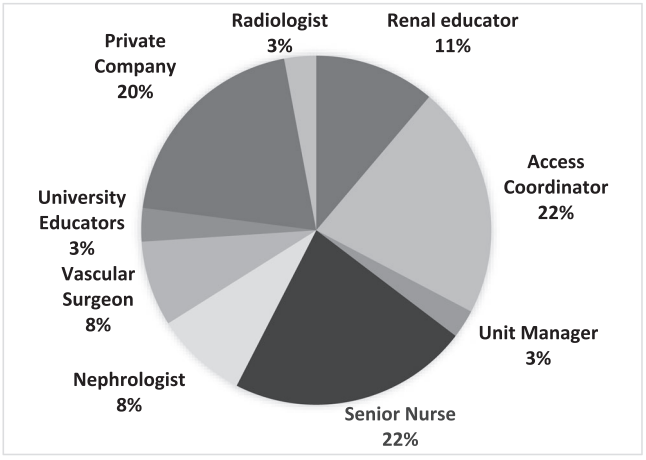

FIGURE 2 Role of point-of-care ultrasound trainer in haemodialysis ($n = 558$).

very essential tool which should be utilised more for vascular assessment and cannulation. We have noted higher cannulation success rates and fewer blows or patients being sent away for interventions when using POCUS' and this was supported with another comment 'Love it. Now taught to all haemodialysis nursing staff in training in this unit and part of usual cannulation protocol for all new and unfamiliar fistula. Has dramatically decreased number of missed cannulations and infiltrations'. Another respondent stated, 'I believe that it is a fundamental tool, and the advanced training of various professionals should be provided from hospitals to acquire competence in its management'.

Barriers to use of POCUS

A third of respondents indicated they had not completed any POCUS training ($n = 239$). 82% of these respondents said there was none available with 5% reporting it was too expensive, or they couldn't get time off work, and 4% felt that they did not require training. For those who wanted to complete training, their preferred training delivery mode was face-to-face theory and practical, either multi-day (29%), half day (20%) or full day (19%) (See Supporting Information S2: 2).

Of the respondents who said that they do not personally use POCUS or said they would not use it, the main reasons given were that they felt it was is someone else's role (34%), had never been taught (31%), felt it was too difficult to manipulate probe and needle (20%), were not confident (16%) and others felt they were good cannulators and did not need to use POCUS (14%) (see Supporting Information S2: 2). Of the 212 respondents who do not have POCUS in their unit, they were asked whose role it was to purchase POCUS; 38.7% were not sure, 29% reported that it was the Unit Manager's responsibility, whereas 19% said it was Hospital administrator's responsibility.

In free text comments barriers to using POCUS were highlighted as; lack of access to education and training, time constraints and perceptions that it is not required due to already proficient cannulation skills. One respondent commented that 'education, practice and time limitations are big factors in doing POCUS guided cannulations. Also need passionate and motivated leaders in providing time for education and practice'. This comment was supported by others stating that 'I think the barriers to use the POCUS in haemodialysis are the time constraints, awareness of the importance of using it, especially in "older needlers," and insufficient training at work'. Other comments focussed on the lack of availability with one stating 'we also only have one ultrasound machine, and it is used for all five of our clinics in this area, so it is not always in our building when we need it'. Other respondents felt their cannulation skills were already high level, stating 'why use something, to do something that I am very good at?' and 'I have learned to cannulate fistula and graft without the use of scanner and so far, I successfully cannulate fistula by palpating and auscultating'.

Global differences in barriers or facilitators

There was a difference in the availability of POCUS in regions that had >20 respondents. Most regions had between 75% and 93% of respondents reporting they had POCUS available in their haemodialysis facility, however in the United States (US) only 26% reported that POCUS was available. Similarly, the number of respondents who had completed POCUS training in the US was very low compared with much higher numbers in Australia/New Zealand (NZ), Canada, Europe and United Kingdom (UK)/Ireland (see Figure 4). One of the respondents from Africa reported that they did have POCUS available, however all three respondents had not completed any POCUS training. In the Middle East and South/Latin America approximately half the respondents had POCUS available and had also completed training. In the regions where POCUS training was completed the spread of types of training were very similar, as was the role of the people delivering the training (see Supporting Information S3: 3).

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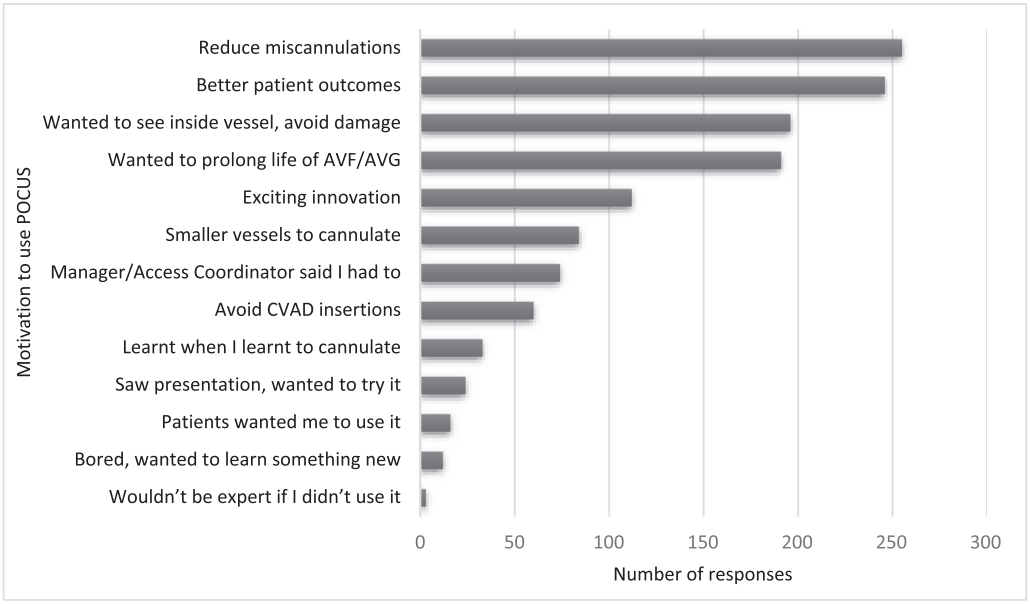

FIGURE 3 Respondents' motivation for use of POCUS in haemodialysis (n = 336). POCUS, point-of-care ultrasound.

TABLE 2 Respondents' use of POCUS for haemodialysis access (n = 336) (could choose multiple responses).

POCUS interventions	Frequency (n)	Percentage (%)
Find areas to cannulate before cannulation problems	281	84%
Assess maturation before first cannulation	240	71%
Real-time guidance (1 operator)	228	68%
To check needle position after cannulation	213	63%
Assessment for thrombus/damage and so on	205	61%
Pictorial mapping of access	153	46%
Find areas to cannulate after cannulation problems	119	35%
Real-time guidance (2 operator)	82	24%
To measure access blood flow	70	21%

There was a regional difference in the number of ultrasound machines available in haemodialysis facilities as over two thirds of respondents from Canada said that facilities had between 3 and 10 ultrasounds available, whereas respondents from Australia/NZ, Europe, US, Middle East and South/Latin America mostly reported that units had one to two ultrasound machines available (See Supporting Information S3: 3). Canada also had 23% of respondents reporting that they had learnt to use POCUS when they learnt to cannulate as opposed to <6% in other regions. Another difference is that 87% of respondents from Canada reported using POCUS often or all the time, compared to the other regions with >20 respondents; Australia/NZ (68%), Europe (38%), UK/Ireland (21%) and the US (18%) (See Figure 5).

In Europe 33% of respondents reported that they used POCUS to measure access flows, whereas all other regions reported this intervention at 11% or less. Overall, 40% of 333 respondents reported that they used the ultrasound probe in either transverse (out of plane/short axis) or longitudinal (in-plane/long axis) for guided cannulation, whereas 34% used transverse plane only and 26% used longitudinal plane only. Most regions were also evenly spread with probe direction of either transverse, longitudinal or both, except for the US whose respondents reported that none used the probe in longitudinal plane (see Supporting Information S3: 3).

DISCUSSION

The present study offers critical insights into the utilisation, training, and barriers associated with POCUS in haemodialysis cannulation. Notably, most respondents, primarily from high-income countries, indicated the availability of POCUS in their facilities and its use for enhancing cannulation practices. The demographic distribution of respondents, predominantly from the USA, Australia/New Zealand, and Europe, reflects a concentration of POCUS usage in these regions. This aligns with the growing recognition of POCUS as a vital tool in many clinical settings including in nephrology, particularly for vascular access (Niyyar & O'Neill, 2018).

The adoption of POCUS in haemodialysis settings was mostly positively viewed by clinicians, with a significant majority recognising its value in reducing miscannulations, the ability to see inside the vessel to avoid damage, assistance in cannulation of smaller vessels, prolongation of access life and avoidance of central venous access device insertion. Unsurprisingly, those who cannulated AV access

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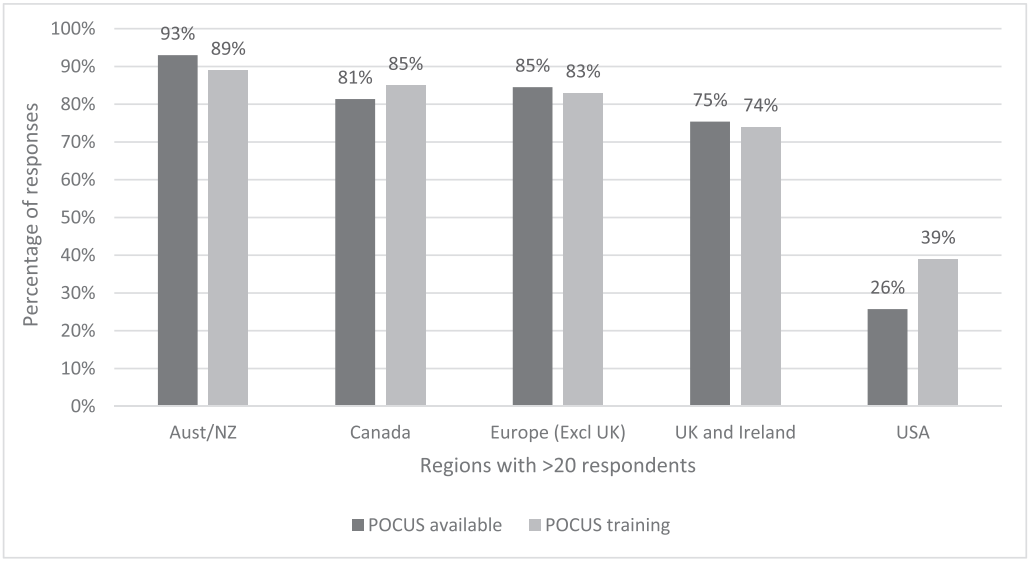

FIGURE 4 of respondents from regions > 20 responses showing percentage of respondents with POCUS available (n = 610) and respondents who have completed POCUS training (n = 558). POCUS, point-of-care ultrasound.

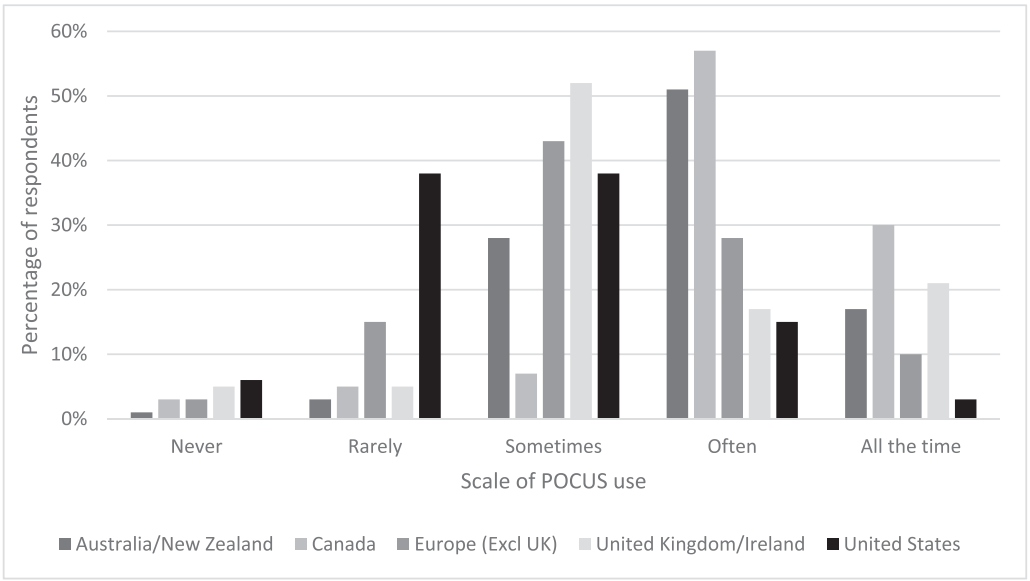

FIGURE 5 Scale of POCUS use in regions with > 20 respondents (n = 408). POCUS, point-of-care ultrasound.

demonstrated a desire to reduce the frequency of problems related to cannulation, as they recognise this is problematic for patients. This is consistent with previous research that has demonstrated POCUS's benefit in reducing miscannulation events (Luehr, 2018), although one observational study has demonstrated that non-POCUS use was associated with cannulation success (Coventry et al., 2019). However, this may have reflected practice patterns where POCUS is used to solve miscannulation after it has happened, rather than POCUS causing miscannulation.

Despite recognition of its benefits, some participants cited barriers to POCUS adoption that included a lack of training and education, accessibility issues, and the perceived complexity of using the equipment. The insights into staff motivations to use POCUS or factors that deter its use are important factors for planning and implementing POCUS into haemodialysis units in the future. Change management planning is crucial to the success of implementation programmes, particularly in the health care industry where change includes both staff and patients. As suggested by the respondents, having a 'champion' within each haemodialysis unit is crucial, and providing training for all staff either before, or during, the implementation phase will assist with success. It is not enough just to purchase one ultrasound machine for one, or multiple, units and then hope that staff will learn to use it on the job. Managers need to be invested in providing multiple machines and appropriate levels of training.

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Overall, most respondents identified that they had been trained in POCUS use, however over 200 respondents reported that either no training was available to them or that they had difficulty attending training due to costs or gaining time away from the workplace. Previous research has identified increased time to cannulate and lack of adequate training and education in POCUS use, as barriers to adopt the technique (Kumbar et al., 2018; Schoch et al., 2020). Participants who identified they had undertaken training did so using a variety of training methods. However, combined theory and practical sessions were the preferred format for respondents and might be considered for the development of an international training standard or competency assessment in the future. Additionally, respondents reported a variety of roles and use of POCUS within their practice, from POCUS for needle guidance for cannulation only to use in assessment of AVF maturity and even flow monitoring. Clearly these very different uses of POCUS will require different levels of training matched to each use to promote its use safely.

The uptake of POCUS for dialysis access was high in Australia/New Zealand, Europe, United Kingdom/Ireland and Canada. The lower levels of POCUS use in the United States may be attributed to the different dialysis provider model or varying health care policies and resource allocation strategies across regions. The US also has high patient care technician use and higher patient/nurse ratios which results in nurses overseeing a greater number of patients which limits their capacity to assess and use POCUS. Lack of financial reimbursement for using POCUS may also influence the low uptake in the US, even though better AVF rates and lower catheter rates would assist quality metrics and income.

The success of multi-factor POCUS implementation is clear from the respondents from Canada who reported 23% had learnt to use POCUS when they learnt to cannulate that they had access to between 3 and 10 ultrasounds in their units and 87% of respondents reported that they used POCUS often or all the time for assessment and cannulation. All of these responses were well above other regional areas who reported less availability of equipment and training. Within Canada, POCUS for assessment and guided cannulation of haemodialysis access competency standards were introduced almost a decade ago, where theoretical and practical education components were targeted to specific levels of learning and categorised as basic, intermediate and advanced. Performance criteria and competency levels with their key skills are tested at each level of competency. All competencies need to be met to advance to the next level (Marticorena et al., 2015). New haemodialysis staff receive the first level of training during unit orientation. Perhaps the introduction of these standards and the apparent early introduction to POCUS as an integrated part of initial cannulation training appears to have the greatest benefit in promoting a culture of regular use of POCUS in everyday practice, though this finding may be skewed by simple access to machines as part of training and in everyday practice.

IMPLICATIONS FOR PRACTICE, POLICY AND FUTURE RESEARCH

In the absence of a global standardised training approach and with the lack of standardised competency targets it is hard to state what 'appropriate training provision' actually consists of. Perhaps the time has come for global collaboration on an international Delphi study to explore the appropriate standards and guidelines in relation to use of POCUS in haemodialysis access.

Educational activities can be targeted to those regions with less access to POCUS machines and education, and knowledge of the barriers can assist with implementation programme development.

LIMITATIONS

This study has limitations. The study relied on self-reported data through an unvalidated survey instrument. Convenience sampling limits the capacity to representative all renal health care professionals across different geographical and institutional settings. Additionally, the response rate from each of these organisations is unknown, which introduces nonresponse bias. Finally, the exploratory descriptive nature of this study inherently focuses on identifying patterns and themes without aiming to establish causality. Therefore, while the study provides valuable insights into the barriers and facilitators for implementing POCUS in haemodialysis, it does not allow for causal inferences to be made.

CONCLUSION

This research revealed regional similarities and differences, in particular the lower availability of ultrasound machines and lower POCUS education in US haemodialysis clinics compared to other high-income regions. Understanding the regions requiring more education and implementation of ultrasound and what motivates staff, or what deters them from using ultrasound, is crucial for the effectiveness of future implementation and workplace change initiatives.

AUTHOR CONTRIBUTIONS

Study conception by Monica Schoch. Study design by Monica Schoch, Paul N. Bennett and Peter M. Sinclair. Survey question development and ethics documentation by Monica Schoch, Paul N. Bennett, Rosa M. Marticorena, Catherine Fielding, George E. Smith, Ruben Iglesias, Peter M. Sinclair. Data collection by Monica Schoch. Data analysis and interpretation of results by Monica Schoch and biostatistician. Draft manuscript preparation by Monica Schoch, Paul N. Bennett, Peter M. Sinclair, Catherine Fielding, George E. Smith, Ruben Iglesias. All authors reviewed the results and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The author declare no conflict of interest.

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.

ETHICS STATEMENT

Ethics approval from Deakin University, Victoria, Australia (HEAG-H 153_2022).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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