

BMJ Open Experiences and perceptions of critical care nurses on the use of point-of-care ultrasound (POCUS) to establish peripheral venous access in patients with difficult intravenous access: a qualitative study

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ABSTRACT

Objectives This study aims to explore and describe critical care nurses' (CCNs) experiences and perceptions of using point-of-care ultrasound (POCUS) to establish peripheral intravenous access in patients with difficult intravenous access (DIVA).

Design A qualitative design with a hermeneutic approach was chosen for this study. From May to August 2022, data were collected using individual, face-to-face, and digital semistructured interviews and analysed using Braun and Clarke's reflexive thematic analysis.

Setting The study were conducted in six intensive care units in both Norway and Sweden.

Participants Nine CCNs experienced in using point-of-care ultrasound (POCUS) to establish peripheral intravenous access in patients with DIVA were recruited.

Results Data analysis led to the construction of the overarching theme: '*POCUS simplifies a complicated procedure*' based on the following five subthemes: '*Sharing the experience*', '*Seeing inside the body*', '*Independent in establishing difficult intravenous access*', '*Using POCUS to increase action readiness*', and '*Appreciating an expanded role as critical care nurses*'.

Conclusion Ultrasound-guided peripheral intravenous access can become a valuable skill for CCN's caring for patients with DIVA in the intensive care unit. This practice can potentially reduce patient suffering, improve patient outcomes, enable the CCN to provide high-quality care, improve action readiness, time management and job satisfaction for the nurses.

INTRODUCTION

Critical care nurses (CCNs) working in intensive care units (ICUs) are characterised as having unique technological expertise and high action readiness while providing high-quality care, increasing patient well-being and outcome, and reducing the risk of complications.¹⁻⁴ The demands of critically ill patients who need specialised care, multiple nursing interventions and a high-tech environment

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ In-depth interviews with critical care nurses' working in intensive care units (ICUs) allowed us to explore their experiences using ultrasound-guided peripheral intravenous catheters.
- ⇒ Despite the modest sample size, participants were recruited from diverse sizes and types of ICUs in six different hospitals, yet they provided consistent responses, strengthening the study's credibility.
- ⇒ The findings may not be generalisable to other healthcare institutions and countries not represented in this study.

create a complex working environment for CCNs.^{1 3 5}

The experience of being critically ill, requiring intensive care around the clock, confined to bed and tethered to lines, tubes and other equipment can cause ICU patients to suffer.^{1 5} Watson⁶ states that caring is the essence of nursing and the most central and unifying focus of nursing practice. CCNs should aim to comfort, ease or alleviate suffering. Excellent nursing competence, skills and nurse-patient relationships are essential for high-quality care.⁷ However, CCNs' workload and job satisfaction may influence their ability to provide high-quality care.⁵ Although using technology in nursing provides opportunities for better care and treatment, it can also create barriers to a trusting relationship between CCNs and their patients by causing patients to feel objectified and alienated and experience a loss of control over their bodies.^{1 3 6 8} Therefore, CCNs' technological knowledge should not be limited merely to the practical use of medical technology but should also include a thorough

understanding of the challenges of using technology in nursing.^{1 3 4 8} To establish and maintain a caring patient relationship in the ICU, CCNs must make the technology work as an extension of themselves so that their focus is on the patient, not the technology.⁸

In ICUs, advanced and specialised technological equipment is essential in the care of critically ill patients,^{1 2} and timely and accurate administration of infusion therapy is imperative.^{2 9} ICU patients often receive infusions with medicines such as norepinephrine, amiodarone and potassium via central or peripheral venous catheters. Administering these types of medicine using a peripheral intravenous catheter (PICV) can make patients susceptible to serious infusions-related complications such as local ischaemia, venous irritation, phlebitis or tissue damage if extravasation occurs.^{9–15} Therefore, these types of infusions are referred to as ‘high-risk infusions’.¹¹ Although central venous catheters (CVCs) provide a safer administration of high-risk infusions, their insertion can be time-consuming in time-critical situations when early drug administration is vital to sustaining patient’s life.^{9 13 15} Further, insertion and use of CVCs carry a significantly higher risk of serious complications compared with PIVCs.^{10 11 13–15} Therefore, PIVCs are often the first venous access established and used as the primary access or as a supplement to CVCs.^{9–11} Administration of high-risk infusions via PIVCs is not unusual in the critical care setting.^{9 11} However, infusions can be administered more safely by selecting a longer PIVC with an appropriate diameter and suitable catheter placement for the prescribed treatment.^{9–16} Inserting a well-placed PIVC is a crucial and significant skill for CCNs.^{14 17} Nevertheless, nurses often describe it as challenging in patients with difficult intravenous access (DIVA), requiring time and resources from the CCN and delaying essential care.^{18–20}

Patients with DIVA are defined by two or more failed attempts at PIVC insertion, a history of DIVA, or non-palpable and invisible veins.²¹ The international prevalence of DIVA is estimated to be 45%–59.3%.²¹ Several studies have reported that patients with DIVA suffer from inconvenient PIVC placement, which makes movement and mobilisation difficult and causes frequent annoying occlusion alarms on attached infusion pumps.^{22–24} In addition, patients with DIVA report that they encounter

a lack of communication and information from nurses during PIVC insertion procedures.^{18 21–23 25} Patients with DIVA use words such as ‘*Subjection, hopelessness and powerlessness*’²² to describe the emotional and physical pain they endure. The physical pain intensifies and changes in quality with repeated cannulation attempts.^{18 21–23 25} However, attempts to improve the procedural experience for patients with DIVA through distraction or other means of pain relief are also rare.^{22 23 26}

More than 50% of patients with DIVA have PIVC placed in an anatomical location unsuitable for the prescribed treatment, leaving them vulnerable to complications.²⁷ Schults *et al*²⁴ claimed that nurses find providing adequate care to patients with DIVA challenging. When caring for patients with DIVA in the ICU, CCNs risk experiencing moral distress due to their inability to deliver the care that patients with DIVA need.^{28 29}

Novel technology, such as point-of-care ultrasound (POCUS), is recommended when establishing peripheral intravenous access in patients with DIVA (figure 1),^{10 30} and patients describe the insertion of ultrasound-guided peripheral intravenous catheters (USGPIVCs) as more comfortable than traditional landmark methods.^{22 23} In patients with DIVA, the time to establish venous access is significantly shorter when using USGPIVC,^{10 18} and this time is even shorter when bedside nurses perform USGPIVC compared with physicians.^{18 24} In addition, the results from USGPIVC educational programmes for CCNs show a USGPIVC first-pass success rate of $\geq 85\%$.^{17 31}

Current knowledge of CCNs’ use of USGPIVC for critically ill patients with DIVA appears to be limited to quantitative research exploring education programmes in USGPIVC for CCNs, the number of attempts required, first-pass success, time to successful venous access or complications associated with medicine administration via PIVC.^{12–14 16 17 31} To our knowledge, no studies have reported on CCNs’ experience using USGPIVC in patients with DIVA.

Objectives

This study aimed to explore and describe the CCN’s experience and perception of using POCUS to establish peripheral venous access in patients with DIVA.

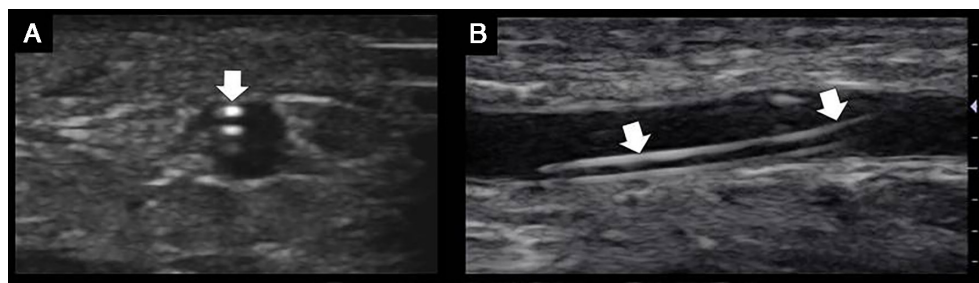


Figure 1 An ultrasound picture out-of-plane (A) and in-plane (B) view of a peripheral intravenous catheter (PICV) located inside of the vein. Reproduced with permission from Ref 30.

METHODS

A qualitative design with hermeneutic methodology was chosen.³² A hermeneutic research approach allows researchers to actively and openly participate in the dialogue with the participants and the data. A hermeneutic dialogue and systematic whole-part-whole-data analysis can lead to a deeper understanding.³³

Setting, participants and recruitment

In a Scandinavian context, CCNs rarely use POCUS for peripheral venous access. Other vascular devices, such as midlines and CVCs, are predominantly inserted by anaesthesiologists.

Managers of 40 Norwegian ICUs were contacted. Five ICUs had CCNs who met the inclusion criteria: CCN with experience in using POCUS to establish peripheral intravenous access in patients with DIVA. As recruitment proved challenging, we decided to invite participants from Sweden into the study, as the Norwegian and Swedish healthcare systems are generally comparable, using a gatekeeper in a Swedish hospital. Managers informed eligible CCNs about the study, invited them to participate and obtained permission to provide their email addresses to the researchers.

We invited 12 potential participants, 10 from Norway and 2 from Sweden and received responses from 9 who were included: 3 female (n=3) and 6 male (n=6). They had between 4 years and 27 years of experience as nurses (mean 14.8 years), between 0.7 years and 22 years of experience as a CCN (mean 7.1 years), and between 0.6 years and 7 years of experience with USGPIVC (mean 3.3 years).

The study was initiated without a predetermined number of participants. Transcribing interviews right after their completion gave consecutive insight into the data material. Despite no new data surfacing after seven interviews, we conducted two more to ensure sufficient data collection.³²

Data collection

Interviews were conducted, with eight performed online using Microsoft Teams³⁴ and one face-to-face meeting. A semistructured interview guide (online supplemental file 1) with open-ended questions was designed to create an open dialogue and to allow new topics to emerge while previously established topics were explored.³² A pilot interview was conducted by ØMH in the presence of RS with formal training and expertise in qualitative research. It resulted in minor adjustments to the interview guide. Data from the pilot interview was not included in this study. Subsequently, the first author conducted all nine in-depth interviews between May and August 2022. All interviews were audio recorded and lasted an average of 40 min.

Data analysis

The interviews were transcribed verbatim using Microsoft Word.³⁵ They were considered rich data material,

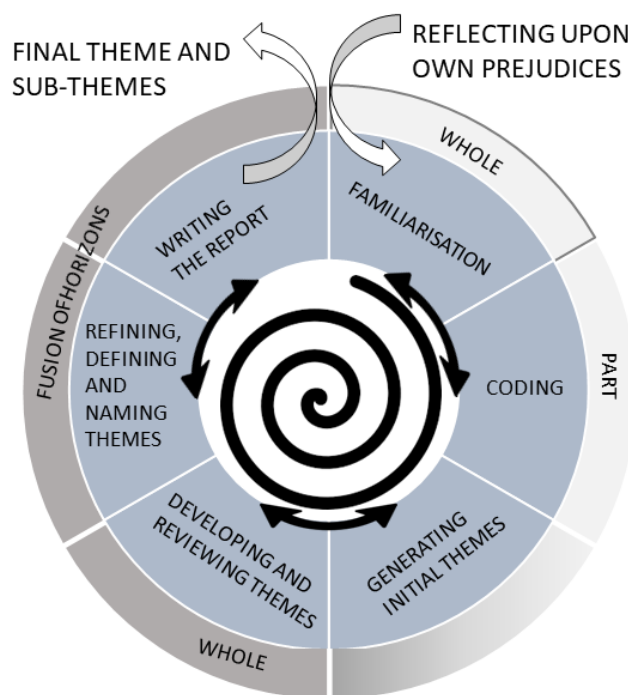


Figure 2 An illustration developed by the authors to show how thematic analysis is adapted to hermeneutic theory.

consisting of a total of 65 A4 pages, and were analysed using Braun and Clarke's³⁶ reflective thematic analysis (RTA). RTA allows for the discovery of patterns of meaning across datasets; it is flexible and was adapted to hermeneutic philosophy (figure 2).^{33 36}

RTA consists of six phases.³⁶ The first four phases (familiarisation, coding, generating initial themes and developing and reviewing themes) were conducted by ØMH. Familiarisation with the data material was achieved by transcribing the audio recordings, reading the transcripts several times, and summarising the transcripts in writing. Analyses were carried out using NVIVO software.³⁷ A whole-part-whole approach is essential for a hermeneutic analysis,³³ and it was conducted in a nonlinear manner. New insight in one phase often required a return to previous phases. In phases 2–5, data were deconstructed and merged into a new understanding, with frequent discussions between the authors.

In phase 5 (refining, defining and naming themes), theme boundaries were clearly defined, and themes were named.³⁶ All themes underwent minor adjustments during phase 5. Phase 6 (writing the report) was mainly carried out by ØMH in discussion with RS. An example from the analysis is shown in table 1.

Scientific curiosity and a reflective ethical stance guided this study. Therefore, it was essential to highlight and reflect on the authors' prejudices to create an openness to the data material and a prerequisite for the hermeneutic dialogue. ØMH had previous experience in using POCUS. Both ØMH and RS are experienced intensive care nurses, but ØMH's experience is more recent than

Table 1 Example from the analysis—from meaningful utterance to theme

Meaningful utterance	Code	Theme
'I'm feeling more confident because, because I know I have this tool that can help me like this (snaps fingers in the air).'	Independent and Confident	<i>Using POCUS to increase action readiness</i>
'It is an essential and excellent competence, especially when forced to wait for help and you can't start treatment. It offers much in the way of patient safety, at least in a given situation. After all, we don't have an anaesthesiologist present at night. They are on call. Several times, we have been left standing around waiting for the anaesthesiologists to get in and place a PIVC.'	Action readiness	
PICV, peripheral intravenous catheter.		

RS's. Therefore, RS was distanced from the phenomenon and questioned what was taken for granted. The results of each phase were discussed and reflected on (and sometimes adjusted) between the two authors, leading to new insights.

Patient and public involvement

None.

RESULTS

Data analysis led to the construction of the overarching theme: 'POCUS simplifies a complicated procedure' based on the following five subthemes: 'Sharing the experience', 'Seeing inside the body', 'Independent in establishing difficult venous access', 'Using POCUS to increase action readiness' and 'Appreciating an expanded role as critical care nurses.' Data analysis revealed few inconsistencies in the participants' experiences using POCUS to obtain peripheral venous access.

Sharing the experience

Four of the nine participants explained how they strategically placed the ultrasound machine in a manner that facilitated simultaneous viewing by both the patient and the participant during the procedure.

I like to show the patient what I'm doing. The patients find it interesting, and you can distract them, like if they don't like the pain from the needle stick. (Participant 9)

This practice may accommodate need of patients with DIVA for information and distraction from a painful procedure. Furthermore, when the CCN and the patient view the screen together, they can share the experience of inserting a PIVC.

Sharing the experience creates an opportunity for the CCN to build trust, strengthen the nurse–patient relationship and use the screen as a basis for information and pain distraction.

Seeing inside the body

Using POCUS allows the CCN to see inside the patient's body, thus enabling the CCN to provide the patient with a more practical and convenient PIVC placement. The participants emphasised that practical and comfortable

placements of PIVCs can help patients experience better control over their bodies, as they can mobilise more freely and with less interference caused by occlusion alarms from attached infusions pumps.

Participant 6 said this:

I avoid the crook of the elbow as much as possible. The PIVC can be so dependent on the position of the arm. Patients move, and most people think it's more comfortable to lie with a slight bend in the elbow.

POCUS helps visualise the needle tip and relevant anatomical structures during the cannula insertion procedure, resulting in a high first-pass success rate. In addition, participants have experienced that patients find USGPVIC often more comfortable than traditional methods.

Using POCUS, the CCN can avoid placing PIVCs near complicated anatomical structures, such as the antecubital fossa, where arteries, nerves and veins run close together, thus reducing the potential risk of complications. The use of POCUS prior to and during the cannulation process lets the CCN select the vein, location and PIVC with diameter and length appropriate for prescribed medicine. It allows a safer administration of high-risk infusions to patients with DIVA.

You can administer the drugs you need without compromising your professionalism. After all, nobody finds it okay to give norepinephrine on a peripheral... via a pink or a blue PIVC on the back of the hand. (Participant 2)

Independent in establishing DIVA

In the busy ICU environment, competency in USGPVIC can allow the CCN to be more independent with difficult PIVC insertions and enables the CCN to optimise the time to a PIVC to best suit both the patient and the CCN's task.

Independency from others, such as an anaesthesiologist, for performing difficult PIVC insertions reduces the disruption of planned interventions to both the patient and the CCN, creating an opportunity for the CCN to optimise time management and workflow. If there is no urgency in inserting a new PIVC, the CCN and the patient can determine an appropriate time for the procedure.

Including the patient in the decision-making process can give the patient a sense of control over their own time and body.

Participant 5 said the following:

A lot is going on around the critically ill. I see the patient, so we do it, not when it suits everybody else, but when it suits the patient and me.

Using POCUS to increase action readiness

Using POCUS, the CCN can efficiently provide patients with DIVA with PIVCs in the acute setting, an essential element to enable a treatment. Participants described how this increases their action readiness and makes them feel more empowered and confident in their role as CCNs.

I'm feeling more confident because I know I have this tool that can help me like this (snaps fingers in the air). (Participant 9)

The ability to help colleagues in their own and nearby departments with difficult PIVC insertions increases personal and departmental readiness. Participants feel that their competence is an important resource within their department.

I see this potential in USGPIVC as a valuable additional skill within the department. In certain situations, having someone readily available to place a USGPIVC can truly affect the patient outcome. (Participant 5)

Appreciating an expanded role as CCNs

Participants experienced success establishing vascular access where other CCNs struggled with their traditional landmark approach. Learning this valuable skill increased participants' job satisfaction and competence in placing PIVCs using POCUS. It gives them a new role within the department that they value for themselves, allowing them to assist colleagues with difficult PIVC insertions. A desire to be more self-reliant and an interest in technology were critical motivational factors that made the participants eager to learn USGPIVC. Participants described the principles of learning USGPIVC as relatively simple. However, after learning the procedure, participants felt they needed more experience with USGPIVCs to feel confident. This led the participants to use POCUS when inserting PIVCs in patients who did not meet the criteria for POCUS guidance. Frequent use of POCUS to place PIVCs caused participants to temporarily lose some of their skills with traditional PIVC insertion methods. However, participants regained these skills when they felt they had sufficient experience establishing USGPIVCs.

Participant 9 said:

Then, you become more experienced, and in a way, it becomes a symbiosis with technology, and, as it were, the patient then, and yourself.

DISCUSSION

This study aimed to explore CCNs' experience using USGPIVC in patients with DIVA. This study shows that CCNs' use of POCUS for PIVC insertion in patients with DIVA simplifies a complicated procedure.

Sharing the experience

Failed PIVC insertions are a common experience for patients with DIVA that cause pain and suffering; the patients also complain of a lack of information and communication that makes them feel alienated and objectified, thereby threatening the patient–nurse relationship and making the provision of care difficult.^{7 18 22–25}

Participants in this study reported that patients enjoyed watching the procedure on the screen and displaying true facts. Viewing the ultrasound machine's screen together, the CCN and the patient can share the experience of PIVC insertion, and the CCN can use the screen as a basis for information. Despite patients with DIVA experiencing higher pain levels during PIVC insertion, the use of distraction techniques or other pain relief methods to enhance their procedural experience remains scarce.^{22 23 26} For CCNs, distraction is a readily available as a non-pharmaceutical method of pain relief.²⁶

Participants in this study reported that using the screen on the ultrasound machine distracts patients' attention away from the procedure, thus reducing the experience of procedural pain for patients with DIVA. Sharing the procedure experience can help build a stronger relationship between the CCN and the patient with DIVA, helping the CCN provide high-quality care.

POCUS and quality of care

Patients admitted to the ICU may experience suffering due to pain, being confined to bed, tethered to lines, tubes and other monitoring equipment, and the critical illness itself.^{1 5 8} In addition, ICU patients receiving high-risk infusion therapy via PIVCs are susceptible to serious infusion-related complications.^{11–15} Difficulties in establishing peripheral venous access cause patients with DIVA to have PIVCs inserted in inconvenient locations, thus causing them pain, discomfort and decreased mobility.^{22 23 25 27} In addition, they experience PIVCs that are often inappropriate for prescribed treatment, making them more susceptible to potential complications.²⁷ We can assume that patients with DIVA in the ICU are at higher risk of experiencing complications, suffering, feeling objectified and alienated and having less control over their bodies than other ICU patients.

Easing and alleviating suffering is a pivotal part of care nurses should strive for when caring for the critically ill.^{4 7} Reducing the patient's experience of pain and discomfort can increase patient well-being and reduce suffering.⁵ POCUS allows the CCN to see inside the patient's body and locate veins previously neither visible nor palpable. Finding suitable veins for cannulation and visualising the PICV during the procedure results in a high first-pass success of PIVC insertion, thus reducing the patient's

experience of pain. In line with current knowledge,^{12–15} participants described how POCUS helped them locate deeper-lying veins so they could choose the most suitable PIVC, vein and insertion site appropriate for the prescribed treatment.

Using POCUS to find veins, the CCN can place PIVCs in anatomical locations that are more convenient and comfortable for the patient. The location of the PIVC can be a shared decision between the patient and the CCN. A practical and comfortable PIVC location can help the patient move more freely, reduce the number of disturbing alarms and increase patient well-being. Thus, it can give the patient a better sense of control over their bodies, which can help to ease and alleviate patient suffering.

Working bedside, CCNs have a unique opportunity to intervene and rescue deteriorating critically ill patients, and CCNs are characterised by high readiness to act.^{2 3} Infusion therapy plays a vital role in critical care, and rapidly inserting a PIVC is a crucial skill for CCNs.^{2 9} Due to a high patient-to-physician ratio and time-consuming difficulties in obtaining venous access, patients with DIVA often experience delays in care; in critically ill patients with DIVA, these delays can have devastating consequences.^{11 18–20 27} Participants in this study describe how competence in establishing USGPVIC helps them administer lifesaving treatment, increases their action readiness and how knowing to use POCUS becomes a lifesaving skill.

Appropriate timing of PIVC insertion

The ICU is a complex environment where patients receive care and treatment around the clock and have no choice but to be available.^{1 28} CCNs describe PIVC insertion in patients with DIVA as difficult, time consuming and resource consuming. CCNs usually rely on physicians to establish USGPVIC; however, physicians must prioritise their work, making it difficult to time the procedure without disturbing the patients' daily rhythm and the CCNs' workflow.^{18–20} The lack of choice can make the patient feel objectification, alienation, subjugation and experience having little control over one's own time and body.¹ Acquiring skills in USGPVIC makes the CCN more self-reliant with difficult PIVC insertions, thus helping the CCN to plan PIVC insertion at a time that is convenient for both the patient and the CCN, thus helping the patient to feel more in control of their own time and body. With the knowledge of obtaining USGPVIC, the CCN can increase self-efficacy, time management and workflow by being more independent, thus enabling the CCN to provide better care.

POCUS as a novel tool for the CCN

Current guidelines recommend using POCUS when establishing peripheral venous access in patients with DIVA, and several studies have investigated the use of USGPVIC.^{10 17 18 24 31} For the participants in this study, their interest in technology was an essential motivating

factor in learning USGPVIC. Consistent with previous research,^{17 31} the results of this study conclude that USGPVIC is relatively easy to learn. In contrast, in our study, participants expressed their need for more exposure to USGPVIC. This discrepancy with previous studies is unexplained and should lead to further investigations.

Nurses often struggle when caring for patients with DIVA.²⁴ CCNs describe the insertion of PIVCs in patients with DIVA as a time-consuming and resource-consuming procedure.^{19 20} Failure to provide the right quality of care can lead to moral distress for the CCN.^{28 29} In a complex environment such as the ICU, POCUS can be a useful additional tool in their toolbox; CCNs can use POCUS to help their colleagues better care for patients with DIVA. Participants in this study described how they enjoyed having a new educational role in the department and facilitating a novel and useful approach in establishing vascular access, where helping patients and colleagues gave them higher levels of job satisfaction. CCNs' experience of job satisfaction influences their ability to provide care.⁵ Gaining skills in USGPVIC can help CCNs experience higher levels of job satisfaction and enable them to provide better care, thus helping CCNs experience less moral distress.^{5 28 29}

Caring is fundamental to nursing,⁶ and the ability to comfort, ease and alleviate patient suffering is essential to critical care nursing.^{2 7} Relieving patients of pain and discomfort to improve well-being is integral to nursing care, and patients with DIVA describe an enormous amount of pain and suffering from unsuccessful cannulation attempts.^{22–25} In line with excellent nursing practice,^{3 4 7 8} participants in this study kept their focus on the patient. They used POCUS as an extension of their eyes, thus preventing the patient from feeling objectified. CCNs' unique technological expertise obligates them to develop and use new ways of using technology to improve patient care,^{3 4} and the use of POCUS to establish venous access in patients with DIVA can be characterised as low-hanging fruit for CCNs wanting to improve patient care.

Strengths and limitations

As researchers in our field, awareness is necessary to avoid overinterpretation or misinterpretation of data.^{32 36} Reflection, discussion and a thorough description of each theme were essential to ensure the study's credibility. A semistructured interview guide tested in a pilot interview ensured coverage of relevant topics. The interview began with an informal conversation to establish an open and welcoming dialogue. The conversation seemed effortless during the interview, allowing the participants to share their experiences freely. Follow-up questions based on the participants' stories and paraphrasing in the interviews helped to reduce misunderstandings. The findings in this study should be interpreted with care, as the number of participants is relatively modest.

CONCLUSION

Using POCUS as an extension of the CCNs' eyes allows the CCN to see inside the patient's body, thus simplifying an often painful, complex and complicated procedure. Competence in using POCUS helps CCNs provide high-quality care to patients with DIVA by easing and alleviating suffering and allowing safe administration of infusion treatment without unnecessary delay, thus reducing the risk of serious complications. This study disseminates USGPV as a crucial skill for CCNs caring for patients with DIVA. Therefore, CCNs should use their technological expertise to learn and use USGPV in order to provide high-quality care to patients with DIVA in the ICU.

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Collaborators not applicable.

Contributors ØMH was the first author, responsible for the overall content as the guarantor, and led the study design and conducted the interviews, analysis and authorship. As an experienced qualitative researcher, RS contributed her extensive research experience to the design, analysis and authorship of the study.

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Competing interests ØMH had a one-time assignment for GE VingMed Ultrasound AS after conducting this study. This has not influenced the analysis and result of the study in any way. RS declares no competing interests.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was conducted in accordance with the Declaration of Helsinki. The Norwegian Agency for Shared Services in Education and Research approved this study (no. 892154). All participants received written and verbal information about the study, signed an informed consent sheet and were made aware of their right to withdraw from the study at any time without further explanation.

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