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Nurses' education, knowledge and perceptions of peripheral intravenous catheter management: A web-based, cross-sectional survey

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ABSTRACT

Background: Peripheral intravenous catheters (PIVCs) are the most used invasive medical device. Unfortunately, PIVCs fail for a variety of reasons and failure often results in serious adverse events leading to patient discomfort, infection, delays in treatment, increased healthcare costs, and even death. In Australia, qualified nurses assess, manage, and remove a PIVC as part of their clinical role. To date, no study has described the current state of knowledge and confidence (self-efficacy) about PIVCs from the perspectives of qualified nurses working in Australian hospital settings.
Aims: To describe the current state of knowledge and confidence (self-efficacy) about PIVC management from the perspectives of qualified nurses working in Australian hospital settings. To explore how these related to the education received by these nurses.
Methods: An online cross-sectional survey.
Findings: Qualified nurses in Australia thought that education about PIVCs was important and that it should be underpinned by evidence-based guidelines. Knowledge Test score for the sample was 12.4/17 (SD 2.1), this equates to a mean grade of 73.0%. Respondents reported very high levels of confidence about caring for a patient with a PIVC in situ.
Conclusion: Despite the frequent and increasing use of PIVCs and importantly the documented adverse events associated with poor assessment, management and inappropriate removal, qualified nurses' knowledge and confidence remain poorly reported. We demonstrated fundamental gaps in qualified nurses' knowledge in relation to assessment, management, and removal of PIVCs.

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Summary of relevance

Problem or Issue

To date, no study has described the current state of knowledge and confidence (self-efficacy) about peripheral intravenous catheters from the perspectives of qualified nurses working in Australian hospital settings.

What is already known

Peripheral intravenous catheters are the most commonly used invasive medical device. In Australia, qualified nurses assess, manage and remove a peripheral intravenous catheter as part of their clinical role.

What this paper adds

Fundamental gaps exist in qualified nurses' knowledge in relation to assessment, management, and removal of peripheral intravenous catheters. Strategies need to be developed to improve qualified nurses' knowledge so that patient outcomes are optimised.

1. Introduction

Around 80% of hospital patients require a peripheral intravenous catheter (PIVC) for essential medications and fluid therapies (Alexandrou et al., 2018; Kearney et al., 2021). Unfortunately, more than one-third of adult patients (Marsh et al., 2018b) and one-half of paediatric patients (Kleidon, Cattanach, Mihala, & Ullman, 2019) will experience PIVC complications, requiring the insertion of another catheter to complete their medical treatment. PIVC failure includes dislodgement, occlusion, infiltration, and phlebitis, any of which can result in patient discomfort, delays in therapy and associated hospital costs, and a minority of patients will experience potentially deadly bloodstream infection (Indarwati, Mathew, Munday, & Keogh, 2020; Marsh et al., 2020).

To reduce the prevalence of complications, research has focused largely on insertion, with improved vasculature assessment and insertion techniques (Carr et al., 2019; Marsh et al., 2018a), and innovations in catheter design and dressings (Galang et al., 2020; Rickard et al., 2018). Despite these efforts, and a great deal of expense (Tuffaha et al., 2019), catheter failure continues to be common, and much still needs to be done to improve the patient experience and reduce the risk of patient harm from avoidable complications (Cooke et al., 2018). Catheter insertion is vitally important, but it remains one small step in the PIVC trajectory, with the bulk of the patient's experience depending on catheter management.

While PIVC insertion can be performed by medical or nursing staff, the assessment, management, and removal of these devices is a nursing responsibility (Alexandrou et al., 2018). Qualified nurses are expected to troubleshoot problems, identify complications and take appropriate action. Yet, several studies have reported that nurses' knowledge and implementation of evidence-based guidelines for PIVC maintenance are limited (August, Ullman, Rickard, & New, 2019; Cicolini et al., 2014; Keogh et al., 2015; Melo Conceição et al., 2020; Raynak et al., 2020; Siew Eng, 2016; Simonetti et al., 2019).

To date, there has been little research investigating the role nursing education plays in developing nurses' knowledge and skills for managing PIVCs in the clinical setting (Massey et al., 2020). A web-based questionnaire of US and Canadian healthcare institution representatives assessed the type of education related to PIVCs provided to post-registration nurses, and found that 38% reported spending less than one hour on PIVC education for staff (Hunter, Vandenhouten, Raynak, Owens, & Thompson, 2018). In a recent qualitative study, Massey et al. (2020) conducted exploratory interviews with undergraduate nursing students, revealing that the current university curriculum provides limited foundational knowledge about PIVC assessment, management and removal, which is then consolidated with clinical experience. Inconsistency between curriculum and clinical practice was also identified as a factor in creating uncertainty and impacting on nurses' ability to follow evidence-based guidelines (Massey et al., 2020). Other researchers have also identified that nurses' knowledge about PIVC evidenced-based guidelines is low (Cicolini et al., 2014; Simonetti, 2019). Although nurses' knowledge about PIVC guidelines has been reported (Cicolini et al., 2014; Simonetti, 2019), there is very little understanding of qualified nurses' knowledge and confidence about the assessment, management, and removal of PIVCs. Without this information, it remains challenging to develop targeted educational strategies. In addition, patient care and safety in relation to PIVC assessment management and removal may be suboptimal.

With this important gap in knowledge identified, this study aimed to describe the current state of knowledge and confidence (self-efficacy) about PIVC management from the perspectives of qualified nurses working in Australian hospital settings and to explore how these related to the education received by these nurses. We used an online cross-sectional survey to achieve these aims.

The research questions that guided this study were:

1. What is the level of knowledge of PIVC assessment, maintenance, and removal of qualified nurses in Australia?
2. What is the level of qualified nurses' self-efficacy in relation to PIVC assessment, maintenance, and removal?
3. What are qualified nurses' perceptions of the education they received regarding PIVC assessment, maintenance, and assessment?
4. What is the relationship between qualified nurses' PIVC education and their knowledge of PIVC assessment, maintenance, and removal?

This study used Lunberg's (2008) definition of self-confidence, which derives from Bandura's (1977) construct of self-efficacy, whereby the individual holds the belief that they have the capability to complete a task successfully. Other researchers have used similar strategies, aligning the two concepts of self-confidence and self-efficacy (Watson, Cooke, & Walker, 2016; Panduragan, Abdullah, Hassan, & Mat, 2011; Thomas & Mackey, 2012).

2. Methods

In this cross-sectional, descriptive study, an online survey was used to collect data. The study is reported in accordance with the STROBE guidelines (Elm et al., 2007).

2.1. Sample

Participants were recruited via posts to the social media platform of Twitter, Inc© enabling a convenience sample of qualified nurses from Australia to be accessed. In this context, qualified nurses are defined as nurses who have completed an approved program of nursing education and are currently registered to practise as a registered or enrolled nurse with the Nursing and Midwifery Board of Australia (NMBA). In Australia, enrolled nurses complete a two-year nursing diploma course, and registered nurses complete a three-year bachelor's degree. Enrolled nurses have a different scope of practice to, and work under the supervision of, registered nurses (NMBA, 2016). An early question in the survey asked if participants were registered with the NMBA; a negative response to this question ended their survey.

2.2. Data collection

2.2.1. Survey instrument development

The survey consisted of multiple-response-option demographic and professional practice descriptors (n = 8), PIVC education

descriptors (n = 12), a knowledge test (n = 17), and a Self-Efficacy Scale (SE Scale) (n = 10) (Schwarzer & Jerusalem, 1995). The demographic, professional practice, and PIVC educational descriptors were collected for eligibility and sample characterisation. Items reflected similar data collected from other clinical procedural knowledge and educational surveys (Cicolini et al., 2014; Harley et al., 2021; Simonetti, 2019). The knowledge test survey questions and response alternatives were developed based on findings from the literature and evidence-based guidelines (Cicolini et al., 2014; Gorski, 2017; Nicholson, 2018; Simonetti, 2019). Knowledge Test questions and response alternatives were created by two of the authors (DM, GRB) with guidance from two experts in survey development (MC, MW), and then circulated for content and face validity assessment with all authors and a panel of vascular access nurse researchers (n = 4) (Polit & Beck, 2008).

The process described by Considine, Botti, and Thomas (2005) was used in this study to further develop the Knowledge Test multiple-choice questions and establish validity and reliability. Knowledge Test performance is described via standard item analysis, and was processed using Lertap 5© (Haladyna, 2004; Lertap, 2014). The difficulty level of an item is defined as the proportion of respondents who answer the question correctly with the possible values ranging from 0.0 to 1.0 (Considine et al., 2005; Haladyna, 2004). Items are considered too easy if they are answered correctly by more than 90% of the respondents (value > 0.9) and too difficult if they were answered correctly by less than 10% of the respondents (value < 0.1) (Haladyna, 2004). Item discrimination was analysed by examining how each item was related to overall test performance. Haladyna (2004) recommends the use of item to total correlations to examine item discrimination by analysing the relationship between each item and the total test score. Values of 0.35 and higher are defined as 'good' values, values from 0.25 to 0.35 as 'satisfying/good', values from 0.15 to 0.25 as 'mediocre/satisfying', and values less than 0.15 as 'bad/mediocre' (Considine et al., 2005). The quality of a response alternative is defined by calculating the proportion of respondents who choose an alternative value (Considine et al., 2005; Haladyna, 2004). Values range from 0.0 to 1.0, where 0.0 is not attractive and a value of 1.0 might be too attractive (Haladyna, 2004).

The Generalised Self Efficacy Scale (Schwarzer & Jerusalem, 1995) was selected to measure self-efficacy, as it has been used in studies in 23 different nations and has consistently demonstrated high reliability and criterion-related validity (Schwarzer & Jerusalem, 2022). The Cronbach's alpha for the SE Scale for this study was 0.93.

The entire survey was pilot-tested among five respondents to ensure user-friendliness, ease of electronic interface, and effective response collection. Once the pilot phase was successfully completed, the survey was distributed to the broader target participant group. The pilot data are not included in the results. A similar process has been described by other researchers when developing surveys (Chen et al., 2021; Harley et al., 2021) to assess knowledge and confidence.

2.2.2. Survey administration

The social media posts linked potential participants to an online survey delivered via the Qualtrics platform (Qualtrics, Provo, UT) hosted by Southern Cross University. Participants could save their progress and exit the platform to return at a later time.

2.3. Data management

For the purpose of data cleaning, the below criteria were established:

1. Respondents who recorded more than 12 h to complete the survey (up to a maximum of 16.8 days) may have returned to the survey a number of times; if they did finally complete the survey, their data were retained. However, the time taken to complete the survey (duration) was deleted and left as missing data (n = 6).
2. Where subjects did not record an answer for one item in the Knowledge Test, an 'incorrect' answer was recorded to enable total score calculation (n = 22).
3. For the question about being an enrolled or registered nurse, respondents who were recorded as 'Other', that is, *not* an enrolled or registered nurse, did not complete past Question 5 and all were deleted (n = 9).
4. For those who missed one or two items on the SE Scale (Schwarzer & Jerusalem, 1995), the missing data were replaced by the mode score for that individual to allow calculation of a total score (n = 9).

Question 9 of the survey asked, "In your practice do you care for PIVCs?"; if respondents answered 'No', they were thanked and exited the survey.

2.4. Data analysis

All results were analysed descriptively according to their characteristics and distribution. Continuous variables are described as mean and standard deviation (SD) or median, and interquartile range, as appropriate. Categorical data were described using frequencies and percentages (Ullman et al., 2020). Summary statistics were computed to describe the sample and to describe participants' education, knowledge levels, and self-efficacy related to PIVC assessment, management, and removal. Parametric and nonparametric tests, as appropriate, were used to explore associations between demographic characteristics and PIVC knowledge and self-efficacy. PIVC knowledge test performance was examined for difficulty and discrimination via standard item analysis (Haladyna & Rodriguez, 2013) using the Lertap© program (Lertap, 2014).

2.5. Ethics

This study received approval from the Human Research Ethics of Southern Cross University (ECN-19-219). Consent to participate in the study was implied by clicking the link to enter the online survey. Participants were provided with a short explanation of the study, including study objectives before commencing the questionnaire. Participation was voluntary and only aggregated data are presented.

3. Results

3.1. Sample characteristics

The total number of participants who commenced and completed the survey is described in Fig. 1. In total, 256 people commenced the survey. However, 9 were not qualified nurses, 79 did not care for clients with PIVCs in situ and 4 answered no questions after the qualification question. Of the remaining 180 participants, different numbers completed different elements of the survey (see Fig. 1).

The sample characteristics of the participants are presented in Table 1. The majority were registered nurses (75%), highly educated (over 60% had a postgraduate qualification), and worked in acute inpatient units. There was a broad array of role classifications and places of work (see Table 1). Analysis of the respondents that left the survey as they did not care for PIVCs included 100% of nurses working in residential aged care facilities and 80% of nurses working in subacute units. More enrolled nurses than registered nurses dropped out. In addition, 50% of those with a doctoral degree and 54% of nurse researchers dropped out.

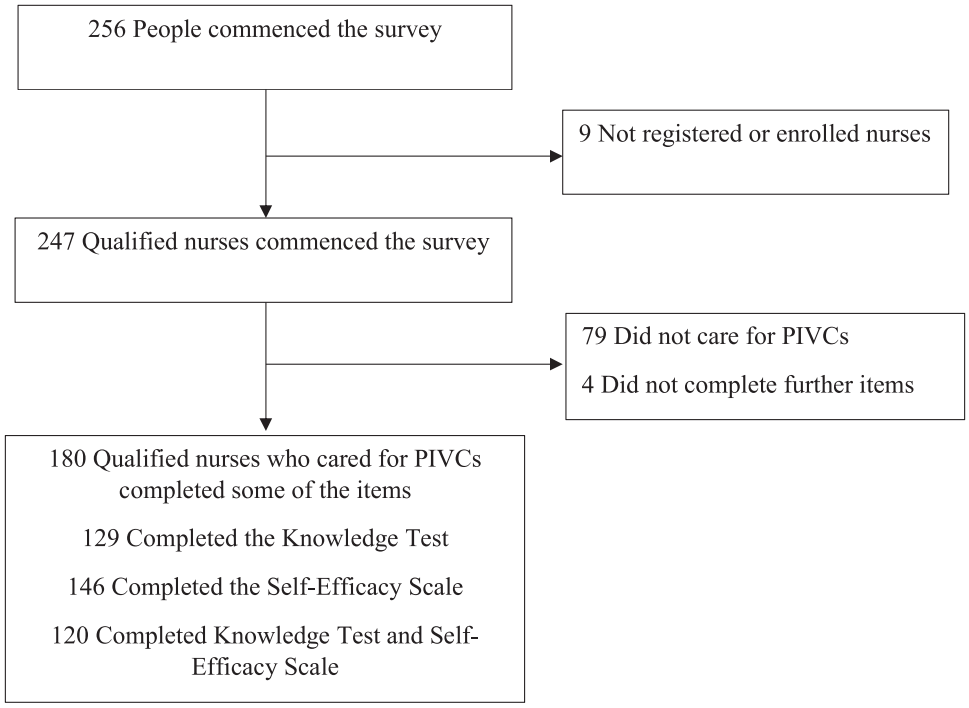

Fig. 1. Flowchart of participation.

Table 1
Sample characteristics.

Variable	Frequency (%)
Type of qualified nurse (n = 180)	
Enrolled nurse	35 (19.8%)
Registered nurse	145 (80.6%)
Highest level of qualification (n = 180)	
Diploma	32 (17.8%)
Undergraduate degree	42 (23.3%)
Postgraduate qualifications	106 (58.9%)
Current role classification (n = 180)	
Enrolled nurse	4 (2.2%)
Endorsed enrolled nurse	29 (16.1%)
Registered nurse in clinical role	109 (60.6%)
Educators, researchers and academics	38 (21.1%)
Primary place of work (n = 177)	
Acute inpatient unit	141 (79.7%)
Subacute inpatient unit	1 (6.0%)
Outpatients department	4 (2.3%)
Community	7 (4.0%)
Residential aged care facility	0 (0.0%)
Other	24 (13.6%)
Age cohort caring for (n = 179)	
Adults (only)	100 (55.9%)
Paediatrics and/or neonates	14 (7.8%)
Adults and children	65 (36.3%)

NB: Totals vary due to missing data.

3.2. Peripheral intravenous catheter education

In total, 180 respondents completed at least some of the PIVC education items. In general, qualified nurses thought that education about PIVCs was important (n = 160/163, 98.2%) and that it should be underpinned by evidence-based guidelines (n = 159/162, 98.1%). Overall, 91.0% (n = 152/167) had received education about PIVC assessment, 88.1% (n = 148/168) about management, and 81.5% (n = 137/168) about removal.

Of the 169 respondents who answered the question about the amount of time of their total PIVC education, 62.1% (n = 105) said less than 5 h, 20.7% (n = 35) said 5–10 h, 7.1% (n = 12) said more than 15 h and 9.4% (n = 17) were unsure. With respect to the format of content delivery, of the 180 respondents, 32.2% (n = 58) had attended lectures, 30.6% (n = 55) had attended tutorials, 43.9% (n = 79) had completed online learning modules, 33.3% (n = 60) received printed handouts, 42.2% (n = 76) participated in simulated practice and 45.6% (n = 82) had engaged in self-directed learning.

3.3. Level of knowledge of peripheral intravenous catheter assessment, maintenance, and removal

In total, 129 respondents completed the Knowledge Test (see Table 2). The mean (SD) Knowledge Test score for the sample was 12.4/17 (SD 2.1), this equates to a mean grade of 73.0%. Only 14 (10.8%) respondents scored over 90%, and only 1 person scored 100%. The majority of the sample correctly answered questions related to identification of infection, phlebitis, flushing, and hand hygiene. The three questions that more than two-thirds of the sample answered incorrectly related to the evidence for cleaning the catheter hub and catheter removal on clinical indication. Overall, registered nurses (n = 106) had a higher mean score (12.7, SD 2.1) compared with enrolled nurses (11.0, SD 1.7) ($p < 0.001$).

3.3.1. Knowledge Test performance

Of the 17 test items, 6 were considered very easy (> 90% correct), and 4 items were very difficult (< 10% correct). Most of the items showed a good-to-fair degree of discrimination between those who knew most of the answers compared with those who knew few. There were 5 items having discrimination indices above 0.25, 5 having indices between 0.25 and 0.1, and 7 having indices below 0.1 (see Table 2).

3.4. Relationship between peripheral intravenous catheter education and knowledge of peripheral intravenous catheter assessment, management, and removal

There was no statistically significant difference in knowledge scores for those who had received five or more hours of education

Table 2
Knowledge Test individual item analysis.

Item	Discrimination Index	Proportion correctly answered
1. How could you identify if Mrs Zhao has a PIVC?	0.19	91%
2. What would NOT be an indication for a PIVC in Mrs Zhao?	0.36	94%
3. Why is the antecubital fossa NOT recommended as a PIVC site for Mrs Zhao?	0.27	89%
4. You are assisting a junior Dr to insert a PIVC for Mrs Zhao. Which is the best site for insertion according to the research evidence?	0.18	58%
5. You assess Mrs Zhao's PIVC for phlebitis. Phlebitis or inflammation of the vein is NOT caused by:	0.32	93%
6. If you are unsure about how to manage Mrs Zhao's PIVC, your first action would be:	0.10	59%
7. It is recommended by best-practice guidelines to use steel needles (butterfly type) for the administration of Mrs Zhao's antibiotics?	0.03	67%
8. Mrs Zhao is prescribed a IV antibiotic to be administered as a bolus dose. Evidence-based guidelines recommend which solution to clean the IV access point (connector hub)?	0.15	33%
9. Before attaching the syringe to Mrs Zhao's catheter, to administer the bolus dose of antibiotic, the connector hub should be scrubbed for at least how many seconds?	0.15	32%
10. Mrs Zhao's antibiotic is due. In relation to the administration of this antibiotic, when would you perform hand hygiene?	0.06	94%
11. Once Mrs Zhao has had the bolus dose of antibiotic administered, what flushing procedure is recommended?	0.07	93%
12. When flushing Mrs Zhao's PIVC, why is a pulsatile (push–pause) technique recommended?	0.26	88%
13. You encounter resistance when flushing Mrs Zhao's PIVC. What would be your first action?	0.06	74%
14. One of Mrs Zhao's antibiotics is administered via an infusion. Before administering this medication, is it recommended, by evidence-based guidelines, that you use an aseptic, non-touch technique during connecting/disconnecting the infusion line and medication syringe?	0.34	87%
15. Mrs Zhao complains of tingling and burning pain in the arm with the PIVC, while no medication is infusing. What would be your most appropriate response?	- 0.02	65%
16. Mrs Zhao asks you when the PIVC will be removed. The most appropriate response would be.	0.04	94%
17. Mrs Zhao's PIVC has been in situ for over 48 h. Evidence from a Cochrane systematic review indicates it is safe to replace the PIVC.	0.12	29%

PIVC — Peripheral intravenous catheters, ACF — antecubital fossa.

(score = 21.1) compared with those who had received less than 5 h (score = 12.7) (p = 0.11). The only variable that indicated a statistically significant difference in Knowledge Test Scores was whether the respondent had received education at a Technical and Further Education College (enrolled nursing programs); such respondents scored, on average, 1.5 points less than those not educated in universities (p = 0.017).

3.5. Level of qualified nurses' self-efficacy in relation to peripheral intravenous catheter assessment, maintenance, and removal

Of the 180 nurses who completed some of each section of the survey, 146 completed the SE Scale. Respondents reported very high levels of confidence about caring for a patient with a PIVC in situ. The mean SE Scale score was 43.3 (SD 5.5) of a maximum score of 50.

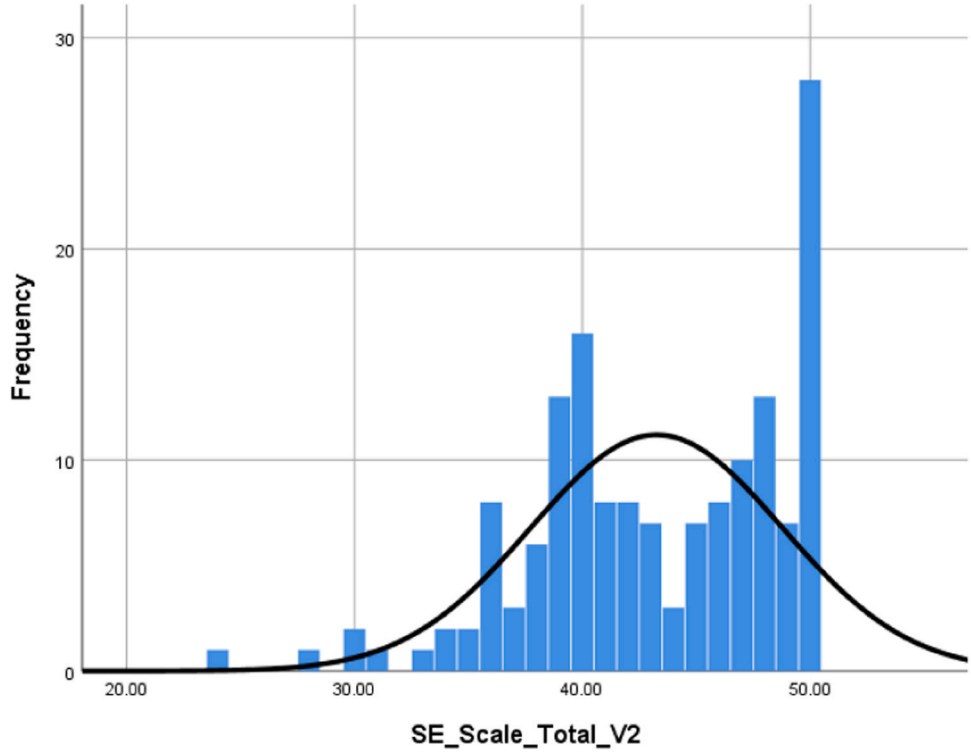

Fig. 2. Histogram of SE Scale score.

Fig. 2 shows the spread of scores but also the high proportion who scored the maximum of 50/50 on this scale. There was no difference in SE Scale score between enrolled and registered nurses (t(df) = 0.27(0.4), p = 0.79).

3.6. Correlation KQ score and SE Scale score

Of all the respondents, 129 qualified nurses completed both the Knowledge Test and the SE Scale. There was no statistically significant correlation between the confidence nurses had in their own ability to manage PIVCs (i.e. SE Scale score) and their total knowledge score (r = −0.1, p = 0.35, 95% CI −0.26, 0.09).

4. Discussion

This is the first study to report qualified nurses' knowledge and confidence about PIVCs and thus makes an important contribution to nursing scholarship. We identified that qualified nurses were on average selecting incorrect theoretical or practical responses for 27% of items on a test of their knowledge in relation to assessment, management, and removal of PIVCs. While these knowledge scores compare favourably with findings from a study of paediatric nurses' knowledge of central venous catheter management (Ullman, Long, & Rickard, 2014), our results suggest significant gaps between research knowledge and practice: a finding echoed by other researchers (Cicolini et al., 2014; Vandijck, Labeau, Secanell, Rello, & Blot, 2009).

Nurses' knowledge of PIVC management has been previously reported (Cicolini et al., 2014; Indarwati & J Keogh, 2022), but limited literature exploring nurses' confidence in relation to PIVC assessment, maintenance, and removal exists. Our findings revealed that nurses demonstrated high levels of confidence in their skills, but this was not echoed in their knowledge scores, a finding that has been replicated recently (Indarwati et al., 2020). This may reflect Bandura's framework of self-efficacy where personal efficacy is enhanced through mastery experiences, given that most inpatients have a PIVC and caring for these is an everyday occurrence and responsibility for nurses (Bandura, 1977). A higher self-efficacy score is related to improved performance (Lee & Ko, 2010), our findings contradict this, and we argue this is an area requiring further investigation. Confidence is one of the most significant influences supporting nurses to make accurate clinical judgments (Schuster, Stahl, Murray, & Glover, 2016) and knowledge alone will not transform or develop PIVC practices. The number of years of practice managing PIVCs is relevant because deliberate practice enhances performance (Ericsson, 2004; Anders Ericsson, 2008; Welch & Carter, 2018) This is an important finding and should be included in future studies.

Only 33% of respondents in our study were aware that PIVCs may be removed based on clinical indication (Webster, Osborne, Rickard, & Marsh, 2019). Other researchers have identified similar knowledge gaps, particularly related to PIVC maintenance and prevention of complications (Cicolini et al., 2014; Simonetti, 2019). Despite detailed evidence-based guidelines (Gorski et al., 2021), nurses may be unaware that PIVCs can be safely removed when clinically indicated (Webster et al., 2019) rather than routinely. In acute care settings where regular monitoring is available, routine removal may increase time and resources replacing PIVCs that do not require removal and also contribute to a poor patient experience because of repeated and unnecessary PIVC insertion, as well as increasing the risk to vessel health because of unnecessary cannulation (ACSQHC, 2021).

In line with other researchers' findings (Higgins, Keogh, & Rickard, 2015; Massey et al., 2020; Ray-Barruel, Cooke, Chopra, Mitchell, & Rickard, 2020), participants in our study acknowledged that education about assessment, management, and removal is important and should be underpinned by evidence-based guidelines. Overall, 91% of respondents had received education about PIVC assessment, 88% about management, and 81% about removal. However, 62% had received less than 5 h of PIVC education across their whole career pertaining to this ubiquitous area of practice. Despite high levels of correct scores for theoretical questions, the item discrimination analyses revealed variable levels of understanding about application to practice. This finding concurs with findings from previous studies. For example, Massey et al. (2020) identified that student nurses perceived the education they received about PIVC assessment, management, and removal was superficial and lacked depth. Student nurses also demonstrated significant knowledge gaps in relation to PIVC evidence-based guidelines (Simonetti, 2019).

Timely and appropriate PIVC removal is an important element of reducing complications associated with PIVCs (Ray-Barruel et al., 2020; Ray-Barruel, Cooke, Mitchell, Chopra, & Rickard, 2018; Webster et al., 2013) and despite clear evidence underpinning when to remove PIVCs, it appears that education and practice fail to comply with this evidence. The recently released Australian National Clinical Care Standard on management of PIVCs (ACSQHC, 2021) advocates changing PIVCs if the environment does not permit expert surveillance. One of the challenges for the future of PIVC removal is that nurses are required to follow hospital policy and procedures. Hospital policies and procedures are not always updated in a timely manner and therefore may not always reflect the most contemporary evidence (Morris, Wooding, & Grant, 2011). Additionally, gaining consensus in relation to changes such as clinically indicated removal of PIVCs remains challenging. Our findings indicate that qualified nurses remain hesitant about removing PIVCs even when clinically indicated. The hierarchal nature of the nursing practice may create a culture of submissiveness that results in a lack of autonomy in relation to PIVC removal when clinically indicated. We argue that, especially in acute hospital settings, nursing assessment of PIVCs needs to be acknowledged as valid and PIVC removal when clinically indicated is supported by hospital policies and procedures. The use of a structured and comprehensive approach to PIVC assessment and decision-making that supports PIVC removal when clinically indicated, such as the I-DECIDED® tool (Ray-Barruel et al., 2020), is recommended.

Some qualified nurses in our study reported receiving PIVC education about assessment, management, and removal in their pre-registration and enrolment programs. Reliance on pre-registration or pre-enrolment programs, in relation to education about PIVCs, may contribute to the continued knowledge gap (Massey et al., 2020). Respondents in our study also relied on hospital in-service and opinions of colleagues to support their practice rather than evidence-based guidelines.

It is important that any multiple-choice questions developed to test knowledge are valid and reliable (Considine et al., 2005). We undertook an item discrimination analysis to assess how each of the questions were related to overall test performance. The knowledge test developed for this study appears to be a tool that can discriminate between those who have high and low levels of knowledge. Where item difficulty or discrimination values were low, this reflected the area where evidence-based guidelines were not being translated into responses to a clinical situation.

4.1. Limitations

This study has limitations. This study was limited to a small sample of Australian nurses, who may have self-selected for participation due to their interest and knowledge in the topic. Therefore, a larger study using real-time methods such as observations is required. The survey was also conducted before the release of the ACSQHC Clinical Care Standard for PIVCs (ACSQHC, 2021). In response to the clinical standard, it is likely that more hospitals are planning or currently implementing education programs. The study

did not include specific questions on the instrument, focusing on self-efficacy related to the task, and may be one explanation for the results. The number of years of experience with PIVC should be included in a future study. Regardless, the findings from this survey provide important baseline data about nurses' knowledge gaps in assessing managing and removing PIVCs.

4.2. Conclusion

Despite the frequent and increasing use of PIVCs and, the documented adverse events associated with poor assessment, management and inappropriate removal, qualified nurses' knowledge and confidence about PIVCs remain poorly reported. In this study, we have demonstrated fundamental gaps in qualified nurses' knowledge in relation to PIVC assessment, management, and removal. Despite these knowledge gaps, qualified nurses appear very confident about their skills in relation to PIVC assessment, management, and removal. The study also identified a gap between theory and practice in relation to PIVC removal. The importance of preventing PIVC-related adverse events is a fundamental patient safety issue, and the findings of this study suggest significant improvements are required in relation to education and application of clinical research.

CRediT authorship contribution statement

All of the listed authors contributed to the project development, project conceptualisation, ethics application, data analysis and manuscript preparation. The lead author (DM) led the team and the project.

Ethical statement

This study received approval from the Human Research Ethics of Southern Cross University (ECN-19-219).

Conflict of interest

The authors of the manuscript have no conflict of interest.

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