

Integrated versus non-integrated peripheral intravenous catheters: a cross-sectional survey of nurse experiences

Rebecca S Paterson, Emily N Larsen, Marie Cooke, Claire M Rickard, Rachel M Walker and Nicole Marsh

ABSTRACT

Background: Integrated peripheral intravenous catheters (PIVCs) demonstrate clinical efficacy, however, device complexity and design differences may be a potential barrier to implementation. **Aims:** To assess nurse acceptability of integrated PIVC systems. **Methods:** A cross-sectional survey was nested within a multicentre randomised controlled trial. One hundred nurses caring for patients with integrated and non-integrated PIVCs completed a 17-item survey about key differences between devices (eg function and appearance, perceived patient comfort and skin injuries). **Findings:** Most nurses reported the integrated PIVC wings prevented device movement (80%), achieved patient comfort in areas of flexion (78%), and no patients developed skin injuries (100%). Nurses rated the ease of accessing and overall confidence using the integrated PIVC as significantly higher than the non-integrated design ($P < 0.001$). **Conclusion:** The integrated PIVC received positive feedback from nurses and had few barriers to implementation.

Key words: Adults ■ Catheterisation ■ Peripheral intravenous catheter ■ Observational study ■ Vascular access devices

Rebecca S Paterson, Senior Research Assistant, School of Nursing, Midwifery and Social Work, The University of Queensland, Brisbane, Australia

Emily N Larsen, Research Fellow, Vascular Access, Griffith University and Royal Brisbane and Women's Hospital, Brisbane, Australia

Marie Cooke, Professor Emeritus, School of Nursing and Midwifery, Griffith University, Brisbane, Australia

Claire M Rickard, Professor, Infection Prevention and Vascular Access, School of Nursing, Midwifery and Social Work, The University of Queensland, Brisbane, Australia

Rachel M Walker, Associate Professor, School of Nursing and Midwifery, Menzies Health Institute Queensland, Griffith University and Division of Surgery, Princess Alexandra Hospital, Brisbane, Australia

Nicole Marsh, Professor and Nursing and Midwifery Director (Research), Griffith University and Royal Brisbane and Women's Hospital, Brisbane, Australia, nicole.marsh@health.qld.gov.au

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Peripheral intravenous catheters (PIVCs) are the most commonly used invasive health device worldwide (Chen et al, 2021); as a result of this high demand, there is a multitude of products available, from various international manufacturers. Options for PIVCs include a retractable internal needle, to minimise needle-stick injuries (Prunet et al, 2008); blood control, which inhibits the reflux of blood into the open catheter hub immediately following insertion or on disconnection (Seiberlich et al, 2016); a stabilising platform, to minimise movement/rotation of the PIVC once in situ (Brimhall and Thorensen, 2004); and closed systems (integrated systems), which consist of a fused extension tubing to the primary PIVC, to minimise subsequent manipulation of attachments (González López et al, 2014).

Unfortunately, despite guidelines suggesting the preferential use of safety features, blood control, and integrated devices (Gorski et al, 2021) there is little evidence to guide healthcare services on their specific choice of device. PIVCs frequently fail before the completion of therapy due to complications including dislodgement (partial or complete), occlusion/blockage, infiltration (with or without extravasation), phlebitis, and infection (local or bloodstream) (Helm et al, 2015; Marsh et al, 2020). The sequelae of PIVC failure can include both negative clinical outcomes, such as compromised long-term vasculature, morbidity and mortality (in extreme cases) (Dychter et al, 2012; Saliba et al, 2018), and personal stressors for patients, such as pain, anxiety and dissatisfaction (Larsen et al, 2017).

With up to 69% of all PIVCs failing before completion of therapy (Bolton, 2010; Rickard et al, 2010; 2012), there is increasing demand for high-quality products to improve outcomes. One such example is the use of closed systems, also known as integrated systems. The first large randomised controlled trial (RCT) to compare the use of an integrated PIVC system with a non-integrated system (in a total of 1199 PIVCs), by González López et al (2014), found that patients with integrated systems were less likely to present with phlebitis (16.9% non-integrated v 12.0% integrated systems, $P=0.01$) and other complications (51.1% non-integrated v 42.6% integrated systems, $P=0.004$). Integrated systems, however, were less likely to be inserted successfully (98.1% non-integrated v 95.0% integrated systems, $P=0.004$), particularly on the first attempt (76.3% non-integrated v 66.0% integrated systems, $P=0.001$).

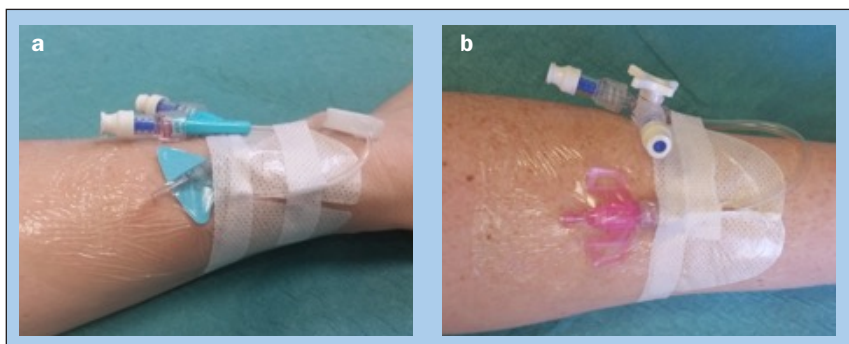


Figure 1. Integrated (Nexiva closed IV catheter system dual port with SmartSite needle-free connectors, BD) (a) and non-integrated (Introcan Safety 3 catheter, B Braun) (b) peripheral intravenous catheters considered in the survey

These findings suggest that, although establishing clinical efficacy in the reduction of PIVC complications, insertion failure and multiple insertion attempts may demonstrate potential complexity of device insertion or implementation difficulties with unfamiliar devices. To substantiate these claims, a similar large partially-blinded RCT ($n=1759$ PIVCs) was conducted in Australia (during 2018–2020) to compare integrated and non-integrated PIVC systems, which found all-cause failure (adjusted for other confounders) was significantly lower for integrated,

compared with non-integrated PIVCs (hazard ratio 0.80, 95% confidence interval per-protocol analysis 0.68–0.95) (Rickard et al, 2023). First-time insertion success was comparable between groups.

In the past, innovative PIVC designs such as injection safety and blood control features have resulted in positive practice changes and attitudes among nurses and other healthcare workers (Tarabay et al, 2016). However, implementation of new designs or devices sometimes involves learning curves and ongoing education to achieve the best possible patient outcomes in the long term. In the case of PIVCs, more complicated technologies such as ultrasound, although demonstrating efficacy (Stolz et al, 2015), have been difficult to implement due to the need for advanced education and practical training (Stolz et al, 2016). Methods such as virtual and simulated training techniques have become popular as a result (Adhikari et al, 2015; Torossian et al, 2019), however, staff attitudes continue to play a large role in effective implementation of innovative healthcare methods.

Overall, although integrated devices appear to demonstrate superiority in clinical outcomes, device differences may remain a potential barrier to implementation. The aim of this study was to assess acceptability to nurses of integrated PIVC systems, and to identify possible barriers and enablers for implementation of best practice.

Table 1. Participant and device characteristics	
Participant and device characteristics (n=100)	n (%)
Device	
Integrated	50 (50)
Non-integrated	50 (50)
Hospital	
Princess Alexandra Hospital	13 (13)
Royal Brisbane and Women's Hospital	87 (87)
Primary clinical field/area	
Surgical	95 (95)
Coronary care	5 (5)
Nursing experience (in years)	
< 5 years	38 (38)
> 5 years	62 (62)
PIVCs care per month*	
0 PIVCs	2 (2)
< 5 PIVCs	4 (4)
> 5 PIVCs	92 (94)
Credentials to insert PIVC	
Yes	28 (28)
No	72 (72)

PIVC=peripheral intravenous catheter

*Data missing for $n=2$ clinicians

Method

Study design

This study was undertaken as part of a large-scale, multicentre RCT investigating the efficacy and cost-utility of an integrated PIVC system in adult medical/surgical patients (Castillo et al, 2018; Rickard et al, 2023). Using a cross-sectional survey design, nurses' experiences of, and level of satisfaction with, the integrated PIVC system were explored. The study is reported in accordance with the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) guidelines for reporting survey studies (Sharma et al, 2021). Qualitative data in the form of free-text responses is reported using the Standards for Reporting Qualitative Research (SRQR) (O'Brien et al, 2014).

Setting and participants

The survey was undertaken in Queensland, Australia, at two quaternary and tertiary referral teaching hospitals: the Royal Brisbane and Women's Hospital (929 bed) and Princess Alexandra Hospital (1050 bed), during June–September 2018. Participants were nurses caring for patients with an integrated PIVC (Nexiva Closed IV Catheter System Dual Port with SmartSite needle-free connectors; BD, Utah, USA) or a non-integrated PIVC (Introcan Safety 3 Catheter; B Braun, Melsungen, Germany) (Figure 1). A purposive sample of 100 nurses (50 per hospital) caring for patients with an integrated or non-integrated PIVC system were invited to participate in the survey.

Outcomes

The initial data collection form was designed by a clinical expert (NM) and underwent iterative review with the research team. The final survey included 17 items (including 6 free-text responses). The focus of the survey was on the key differences between

the two systems regarding their function and appearance, and the subsequent differences in perceived comfort and injuries. Nurse-reported outcomes included perceived device securement (Did the wings prevent movement? Yes/No), perceived patient comfort when the system was placed in or adjacent to areas of flexion, such as the cubital fossa (Comfortable placing device in flexion area? Yes/No), observed injury or reaction related to device (Skin reaction or injuries? Yes/No), confidence dressing PIVC system (0=not easy to 10=very easy), ease of accessing the PIVC system (eg, delivering medications, flushing device; 0=not easy to 10=very easy), and overall confidence (0=not easy to 10=very easy).

Study procedures

The survey was disseminated in person by research nurses attending the wards. Nurses who were caring for patients with an integrated or a non-integrated PIVC device during a larger RCT (Rickard et al, 2023) were approached for participation once recruitment was well established, and asked to complete the survey based on the device they were currently caring for. Surveys were completed on a paper-based survey; surveys took less than 5 minutes to complete. Responses were entered onto a purpose-built Microsoft Excel spreadsheet by a research nurse.

Statistical analysis

Descriptive characteristics and survey results are presented using means and standard deviations or medians and interquartile ranges for continuous variables, and counts and percentages for categorical variables. Between-group differences were evaluated using t tests and chi-squared tests. An alpha value less than 0.05 was considered statistically significant. Data cleaning and analysis was undertaken using IBM SPSS Statistics for Macintosh, version 25.0. Free-text responses were analysed using a thematic synthesis approach, with responses organised into ‘descriptive’ themes in order to integrate key quotes with quantitative findings (Thomas and Harden, 2008).

Ethical considerations

Human research ethics committee (HREC) approval was granted by the Royal Brisbane and Women’s Hospital HREC (HREC/16/QRBW/527), Griffith University Human Research Ethics Committee (Ref No. 2017/002) and the South Metropolitan Health Services HREC (Ref No. 2016–239). Consent was implied by completion of the survey.

Results

Participant characteristics

Between June and September 2018, 100 nurses completed the survey questions (100% response rate). Overall, most surveys were completed by surgical nurses (n=95) with more than 5 years of clinical experience (n=62) from the Royal Brisbane and Women’s Hospital (n=87).

Nurses typically cared for more than 5 PIVCs per month (n=92) and were not credentialed to insert PIVCs (n=72) - ie, were not vascular access specialists. A summary of participant and device characteristics is outlined in Table 1.

Outcomes

Nurse-reported experiences of the devices are summarised in Table 2. Free text responses provided by nurses are included in Table 3.

Device movement

Most nurses reported that the wings on the integrated PIVC system prevented device movement (n=40, 80%, P=0.019), with one nurse commenting that the device was ‘more secure’. In comparison, significantly fewer nurses reported that the wings of the non-integrated system helped to prevent movement (n=27, 54%). Additionally, a larger group of nurses (n=19, 38%) were unsure if the non-integrated system prevented movement overall.

Device comfort

Similarly, a significant majority of nurses reported patient comfort using the integrated system in an area of flexion (n=39, 78%, P=0.002), with one participant providing feedback that the device ‘gives extra movement for the [patient]’. Overall, 56% of nurses reported patient comfort using a non-integrated system in an area of flexion (n=28). Of those nurses who reported that this system was not comfortable, feedback included: ‘Hard and rigid plastic negative to [patient’s] skin if in cubital fossa etc’.

Injuries

Most nurses reported no skin reactions or injuries for either the integrated (n=47, 94%) or non-integrated (n=35, 70%)

Table 2. Nurse rating by device type

	Device		P value
	Non-integrated PIVC system n (%)	Integrated PIVC system n (%)	
Wings help prevent movement?			0.019
Yes	27 (54.0)	40 (80.0)	
No	4 (8.0)	1 (2.0)	
Unsure	19 (38.0)	9 (18.0)	
Comfortable using PIVC in flexion area?			0.002
Yes	28 (56.0)	39 (78.0)	
No	13 (26.0)	1 (2.0)	
Unsure	9 (18.0)	10 (20.0)	
Skin reaction or injuries?			0.003
Yes	8 (16.0)	–	
No	35 (70.0)	47 (94.0)	
Unsure	7 (14.0)	3 (6.0)	
Confidence (applying dressing), median (IQR)	7.0 (5.3-8.0)	8 (6.0-9.0)	0.113
Tubing used, median (IQR)	–	9.5 (8.0-10.0)	–
Ease of access, median (IQR)	8.0 (6.3-9.0)	10.0 (9.0-10.0)	<0.001
Overall confidence, median (IQR)	8.0 (7.0-10.0)	10.0 (8.3-10.0)	<0.001

IQR=Interquartile range; PIVC=peripheral intravenous catheter

systems; skin reactions and injuries were reported in the non-integrated group only ($n=8$, 16%, $P=0.003$). Feedback for the non-integrated system included concern about a higher risk of pressure injury ('Pressure indentation under [device] wings when [PIVC] removed'; 'Pressure areas – none that have passed Stage 2 however'), particularly in patients with frail skin. Other comments included noticing 'marks' and 'redness'. In comparison,

one nurse in the integrated group commented that 'Our current ones do cause pressure areas from wings – these don't'.

Ease of use and confidence

Median ratings for ease of access were significantly higher for the integrated compared to the non-integrated ($P<0.001$) system, as was the median rating of overall confidence using the device

Table 3. Additional comments and feedback from nurses

Device characteristic	Device	
	Non-integrated PIVC system	Integrated PIVC system
Wings for securement	–	<ul style="list-style-type: none"> ■ 'Depends where IVC is inserted' ■ 'No more than the current cannulas however' ■ 'More secure'
Comfortable in flexion area	<ul style="list-style-type: none"> ■ 'Hard and rigid plastic negative to pt's skin if in cubital fossa etc' ■ 'We do it on a daily basis' ■ 'Cubital fossa a notorious pain in the arm!' 	<ul style="list-style-type: none"> ■ 'It gives extra movement for the pt' ■ 'If there was no other appropriate site available'
Skin reaction or injury	<ul style="list-style-type: none"> ■ 'Pressure indentation under dx of wings when IVC removed' ■ 'Marks' ■ 'Redness' ■ 'Pressure areas – none that have passed Stage 2 however' ■ 'Especially with frail skin patients more [prone] to get pressure area' ■ 'With some pt with soft skin' 	<ul style="list-style-type: none"> ■ 'Our current ones do cause pressure areas from wings – these don't!'
Confidence	<ul style="list-style-type: none"> ■ 'However, depends on staff action (shaving around PIVC site)' ■ 'Often use hyperfix for reinforcing or bandage over top' ■ 'Depends on the location and type of line' 	<ul style="list-style-type: none"> ■ 'The dx is fine, but if the skin is wet/hairy this will obviously affect its integrity'
Overall confidence	<ul style="list-style-type: none"> ■ 'Difficult to hold when inserting' ■ 'Got used to it' 	<ul style="list-style-type: none"> ■ 'The design of this PIVC makes it less likely to be dislodged' ■ 'Great. Better than usual lines' ■ 'Haven't used them enough yet' ■ 'Smooth, easy to use, comfortable for pts' ■ 'This is particularly good from the perspective of inserting the PIVC'
Further feedback	<ul style="list-style-type: none"> ■ 'The cannula protrudes higher from skin surface – hinders pt more – getting caught on sheets/blankets etc. When removing needle – can get caught at hub of IVC prior to removal if not taken out straight' ■ 'Depending insertion location – the wings can be quite big, eg pt had PIVC at wrist and wings were wider than wrist' ■ 'Prefer the Nexiva PIVC' 	<ul style="list-style-type: none"> ■ 'Great idea that can be flushed under positive pressure/ clamped without use (cost of 3-way tap and priming it) of 3-way extension set. Already inbuilt with IVC on this set. Still provides 2 x access points for lines' ■ 'This PIVC is much easier to access' ■ 'Doctors often only put a PIVC bung on the cannulas – the inbuilt extension tubing negates the need for doctors to remember to attach an extension tube' ■ 'They are much more useful and cause less issues than our current PIVC' ■ 'I prefer the Tegaderm IV cannula dx over the dx in the PIVC pack as it is more adhesive' ■ 'Feel very secure, easy to care for' ■ 'The long extension tubing is really helpful. It gives pts that extra cms to move around whilst connected to IVABs/meds/fluids. You can flush through one bung and connect the line through the other and not risk the bung touching the pt/bed so no need to alcowipe' ■ 'Have not had the chance to look after these long-term, but from brief explores they have been much more user-friendly than traditional PIVCs'

dx=dressing; IVABs=intravenous antibiotics; IVC=intravenous catheter; PIVC=peripheral intravenous catheter; pt=patient

($P < 0.001$). In terms of confidence, one nurse reported that for the non-integrated system, they 'often use [extra secure dressing] for reinforcing or bandage over top', while another reported the device was 'Difficult to hold when inserting'. Nurses provided feedback that other factors impacted confidence for both systems, eg, 'The [integrated device] is fine, but if the skin is wet/hairy this will obviously affect its integrity', and '...depends on staff action (shaving around [non-integrated device] site)'. Nurses also provided feedback that 'The design of this [integrated system] makes it less likely to be dislodged', and, 'This is particularly good from the perspective of inserting the PIVC', for the integrated PIVC system.

Discussion

This study aimed to assess nurse-reported acceptability of the integrated PIVC systems. Primarily, the nurses providing feedback were not vascular access specialists but they were routinely required to provide care for patients with PIVCs in situ. Previous research has emphasised that understanding end-user knowledge, observations, and preferences when adopting new clinical practices is essential for ensuring both user acceptability and the successful implementation into routine practice (Franklin et al, 2012; Tarabay et al, 2016). In this study, clinicians' overall level of satisfaction with the integrated PIVC system was significantly higher compared to the non-integrated PIVC system; consistent with other studies (Galang et al, 2020). Additionally, nurse-reported confidence in the dressing, tubing and clamp used with the integrated PIVC system, and overall ease of use and confidence, was 'very easy', indicating few barriers to the use of the integrated system. The high overall confidence and perceived ease of use should therefore facilitate the implementation of this system in clinical practice. In comparison, although nurses reported similar ratings of confidence in dressing the non-integrated PIVC device, ease of use and overall confidence was significantly lower.

Overall, none of the nurses using the integrated system reported skin injuries in their patients. In comparison, 16% of nurses who used the non-integrated system reported skin injuries in their patients, which was reflected in the feedback provided about risk of pressure injury concerns. Although pressure injuries and skin damage associated with intravenous therapy are well-documented (Thayer, 2012; Hitchcock and Savine, 2017; Ullman et al, 2019), adverse skin reactions potentially related to dressing and securement (eg, itching, rash, blister, skin tear, and bruising) when using integrated versus non-integrated devices are not well understood. Results from this study indicated that nurses perceived greater numbers of skin injuries in the non-integrated system, and further research to explore this finding is needed.

Additionally, much of the focus on device securement has centred on dressing securement rather than device characteristics; eg, in their study, Bausone-Gazda et al (2010) compared integrated and standard PIVC devices. However, they were focused on comparing securement-related complications between a standard PIVC without dressing for securement, and an integrated PIVC device with wings, plus a specially designed Tegaderm dressing for securement. In the current study,

nurses who used the non-integrated PIVC system reported that the wings of the device did not prevent movement, or uncertainty at the wings preventing movement, at significantly higher rates compared to the integrated PIVC system. Nurses reported uncertainty related to the effectiveness of wings for securement, however, for both PIVC systems. The reason for this was unclear from feedback, and determining whether this is due to a perceived higher profile may warrant further evaluation. Overall, this finding suggests that perceptions regarding the device wings may still create a barrier to its implementation into clinical practice.

Most nurses reported patient comfort in an area of flexion for both devices, although this was significantly higher for the integrated system. Despite this, the study identified that a minority of nurses were unsure about the comfort of this system in an area of flexion. Typically, placement of PIVCs in areas of flexion is not recommended, as devices frequently become dislodged, are associated with patient discomfort, and have a higher early risk of failure (Cicolini et al, 2009; Wallis et al, 2014; Larsen et al, 2017; Alexandrou et al 2018). Decisions to insert in areas of flexion, such as the hand or antecubital fossa, are still common in routine clinical practice (Alexandrou, 2019). As evidenced by feedback from clinicians in this study, decisions to insert PIVCs in areas of flexion are often made if no other alternative is available. Consequently, considerations regarding device characteristics that increase the stability, reduce risk of failure, and ensure patient comfort when placed in high-risk areas are still necessary.

Despite the clinical benefits of integrated systems (González López et al, 2014), and the positive attitudes expressed by nurses regarding their use, financial costs associated with these devices should be considered. A recent health economic evaluation found that, despite higher initial per patient cost for an integrated system, the difference in total per patient cost between integrated vs non-integrated systems was similar (ie, US\$21.00 v US\$20.30) due to the higher risk of unplanned replacements of the non-integrated systems (Tamura et al, 2014). Similarly, a large Australian RCT found that direct hospital costs related to integrated and non-integrated PIVC was approximately AUD \$39.00 (AUD \$38.10–40.00 or £21.75–22.83) per patient (Rickard et al, 2023). Healthcare services should therefore carefully consider how a reduction in device failure, and subsequent re-insertion costs, may offset higher costs of adoption (cost-efficiency).

Previous research establishing the clinical efficacy of integrated PIVCs has highlighted that insertion failure and multiple insertion attempts may demonstrate potential complexity of device insertion or implementation difficulties with unfamiliar devices (González López et al, 2014). The current study found that, despite device complexity, many nurses were positive about integrated PIVCs. However, most nurses included in this study (72%) were not inserters. Recent research has demonstrated comparable first-time insertion success (at least 78%) between integrated and non-integrated devices (Rickard et al, 2023), but further evaluation of the perceptions of nurses credentialed to insert PIVCs, particularly with patients at highest risk of insertion failure or multiple failed insertion attempts, is needed.

KEY POINTS

- Overall, this survey of nurses caring for hospitalised patients with a peripheral intravenous catheter (PIVC) in situ found that the integrated PIVC system received significantly higher positive feedback than the non-integrated standard care product
- Although more skin injuries were identified for the non-integrated PIVC system, participant feedback indicated wings for securement did not guarantee stability for both systems
- In addition to improving clinical outcomes, establishing end-user feasibility and acceptance is important when attempting to change routine clinical practice; however, these must be balanced against any additional associated costs
- Overall, the results of this study complement existing large randomised controlled trials that have found better outcomes associated with using integrated systems

Limitations

This study has some limitations. Although designed by clinical experts, the survey was purpose built and did not undergo validity testing. As such, further validation is needed for its use in other settings. Additionally, the survey was disseminated using purposive sampling, direct comparisons between devices were not sought from the same nurse, and may have influenced responses. Each of the nurses surveyed had direct experience with both PIVC systems under evaluation, however, and their responses are reflective of the possible barriers and enablers for implementing these systems into routine clinical practice.

Conclusion

In addition to using best-practice evidence to guide decision-making, healthcare services need to consider the acceptability of the device with end users. By examining the acceptability of these integrated and non-integrated systems as reported by the clinicians who use them, this study was able to provide information on the possible barriers and enablers for implementation of best practice identified by a large RCT. In particular, the integrated system received positive feedback from clinicians who used the device, and has few barriers to its implementation. **BJN**

A copy of the survey questions is available on request

Declaration of interest: RSP has no conflicts of interest to declare; ENL's employer has received, on her behalf, an investigator-initiated research grant from Cardinal Health (formerly Medtronic) and Eloquest Healthcare; and an educational (conference) scholarship from Angiodynamics; MC's employer has received, on her behalf, investigator-initiated research grants from BD; RMW's employer has received, on her behalf, an investigator-initiated research grant from BD/Bard; CMR's employer has received, on her behalf, investigator-initiated research grants from 3M, Cardinal Health, Eloquest Healthcare and BD/Bard; and consultancy payments from 3M, BD/Bard and ITL Biomedical; NM reports Griffith University and the University of Queensland have received, on her behalf, investigator-

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Adhikari S, Schmier C, Marx J. Focused simulation training: emergency department nurses' confidence and comfort level in performing ultrasound-guided vascular access. *J Vasc Access*. 2015;16(6):515–520. <https://doi.org/10.5301/jva.5000436>

Alexandrou E, Ray-Barruel G, Carr PJ et al; OMG Study Group. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J Hosp Med*. 2018;13(5). <https://doi.org/10.12788/jhm.3039>

Alexandrou E. Right assessment and vein selection. In: Moureau NL (ed). *Vessel health and preservation: the right approach for vascular access*. Springer (ebook); 2019. <https://link.springer.com/book/10.1007/978-3-030-03149-7>

Bausone-Gazda D, Lefaiver CA, Walters SA. A randomized controlled trial to compare the complications of 2 peripheral intravenous catheter-stabilization systems. *J Infus Nurs*. 2010;33(6):371–384. <https://doi.org/10.1097/NAN.0b013e3181f85be2>

Bolton D. Improving peripheral cannulation practice at an NHS Trust. *Br J Nurs*. 2010;19(21):1346–1350, 1348–1350. <https://doi.org/10.12968/bjon.2010.19.21.79998>

Brimhall GL, Thoresen SL. Catheter having a wing with a stiffening member therein. European Patent Office reference EP1392387A1. 2004

Castillo MI, Larsen E, Cooke M et al. Integrated versus non-integrated peripheral intravenous catheter. which is the most effective system for peripheral intravenous catheter management? (The OPTIMUM study): a randomised controlled trial protocol. *BMJ Open*. 2018;8(5):e019916. <https://doi.org/10.1136/bmjopen-2017-019916>

Chen S, O'Malley M, Chopra V. How common are indwelling devices in hospitalized adults? A contemporary point prevalence study in a tertiary care hospital. *Am J Infect Control*. 2021;49(2):194–197. <https://doi.org/10.1016/j.ajic.2020.06.205>

Cicolini G, Bonghi AP, Di Labio L, Di Mascio R. Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study. *J Adv Nurs*. 2009;65(6):1268–1273. <https://doi.org/10.1111/j.1365-2648.2009.04980.x>

Dychter SS, Gold DA, Carson D, Haller M. Intravenous therapy: a review of complications and economic considerations of peripheral access. *J Infus Nurs*. 2012;35(2):84–91. <https://doi.org/10.1097/NAN.0b013e31824237ce>

Franklin B, Deelchand V, Cooke M, Holmes A, Vincent C. The safe insertion of peripheral intravenous catheters: a mixed methods descriptive study of the availability of the equipment needed. *Antimicrob Resist Infect Control*. 2012;1(1):15. <https://doi.org/10.1186/2047-2994-1-15>

Galang H, Hubbard-Wright C, Hahn DS et al. A randomized trial comparing outcomes of 3 types of peripheral intravenous catheters. *J Nurs Care Qual*. 2020;35(1):6–12. <https://doi.org/10.1097/NCQ.0000000000000421>

González López JL, Arribi Vilela A, Fernández del Palacio E, Olivares Corral J, Benedicto Martí C, Herrera Portal P. Indwell times, complications and costs of open vs closed safety peripheral intravenous catheters: a randomized study. *J Hosp Infect*. 2014;86(2):117–126. <https://doi.org/10.1016/j.jhin.2013.10.008>

Gorski LA, Hadaway L, Hagle ME et al. Infusion therapy standards of practice, 8th edn. *J Infus Nurs*. 2021;44(Suppl 1):S1–S224. <https://doi.org/10.1097/NAN.0000000000000396>

Helm RE, Klausner JD, Klemperey JD, Flint LM, Huang E. Accepted but unacceptable. *J Infus Nurs*. 2015;38(3):189–203. <https://doi.org/10.1097/>

NAN.0000000000000100

Hitchcock J, Savine L. Medical adhesive-related skin injuries associated with vascular access. *Br J Nurs*. 2017;26(8):S4–S12. <https://doi.org/10.12968/bjon.2017.26.8.S4>

Larsen E, Keogh S, Marsh N, Rickard C. Experiences of peripheral IV insertion in hospital: a qualitative study. *Br J Nurs*. 2017;26(19):S18–S25. <https://doi.org/10.12968/bjon.2017.26.19.S18>

Marsh N, Webster J, Ullman AJ et al. Peripheral intravenous catheter non-infectious complications in adults: A systematic review and meta-analysis. *J Adv Nurs*. 2020;76(12):3346–3362. <https://doi.org/10.1111/jan.14565>

O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. *Acad Med*. 2014 Sp;89(9):1245–1251. <https://doi.org/10.1097/ACM.0000000000000388>

Prunet B, Meaudre E, Montcriol A et al. A prospective randomized trial of two safety peripheral intravenous catheters. *Anesth Analg*. 2008;107(1):155–158. <https://doi.org/10.1213/ane.0b013e318174df5f>

Rickard CM, McCann D, Munnings J, McGrail MR. Routine resite of peripheral intravenous devices every 3 days did not reduce complications compared with clinically indicated resite: a randomised controlled trial. *BMC Med*. 2010;8(1):53. <https://doi.org/10.1186/1741-7015-8-53>

Rickard CM, Webster J, Wallis MC et al. Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. *Lancet*. 2012;380(9847):1066–1074. [https://doi.org/10.1016/S0140-6736\(12\)61082-4](https://doi.org/10.1016/S0140-6736(12)61082-4)

Rickard CM, Larsen E, Walker RM et al. Integrated versus nonintegrated peripheral intravenous catheter in hospitalized adults (OPTIMUM): A randomized controlled trial. *J Hosp Med*. 2023. 18(1): 21–32. <https://doi.org/10.1002/jhm.12995>. Epub November 2022

Saliba P, Hornero A, Cuervo G et al. Interventions to decrease short-term peripheral venous catheter-related bloodstream infections: impact on incidence and mortality. *J Hosp Infect*. 2018;100(3):e178–e186. <https://doi.org/10.1016/j.jhin.2018.06.010>

Seiberlich LE, Keay V, Kallos S, Junghans T, Lang E, McRae AD. Clinical performance of a new blood control peripheral intravenous catheter: A prospective, randomized, controlled study. *Int Emerg Nurs*. 2016;25:59–64. <https://doi.org/10.1016/j.ienj.2015.08.005>

Sharma A, Minh Duc NT, Luu Lam Thang T et al. A consensus-based checklist for reporting of survey studies (CROSS). *J Gen Intern Med*. 2021;36(10):3179–3187. <https://doi.org/10.1007/s11606-021-06737-1>

Stolz LA, Stolz U, Howe C, Farrell IJ, Adhikari S. Ultrasound-guided peripheral venous access: a meta-analysis and systematic review. *J Vasc Access*. 2015;16(4):321–326. <https://doi.org/10.5301/jva.5000346>

Stolz LA, Cappa AR, Minckler MR et al. Prospective evaluation of the learning curve for ultrasound-guided peripheral intravenous catheter placement. *J Vasc Access*. 2016;17(4):366–370. <https://doi.org/10.5301/jva.5000574>

Tamura N, Abe S, Hagimoto K et al. Unfavorable peripheral intravenous catheter replacements can be reduced using an integrated closed intravenous catheter system. *J Vasc Access*. 2014;15(4):257–263. <https://doi.org/10.5301/jva.5000245>

Tarabay R, El Rassi R, Dakik A et al. Knowledge, attitudes, beliefs, values, preferences, and feasibility in relation to the use of injection safety devices in healthcare settings: a systematic review. *Health Qual Life Outcomes*. 2016;14(1):102. <https://doi.org/10.1186/s12955-016-0505-8>

Thayer D. Skin damage associated with intravenous therapy: common problems and strategies for prevention. *J Infus Nurs*. 2012;35(6):390–401. <https://doi.org/10.1097/NAN.0b013e318270a91e>

Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Med Res Methodol*. 2008;8(1):45. <https://doi.org/10.1186/1471-2288-8-45>

Torossian K, Benayoun S, Ottenio M, Brulez AC. Guidelines for designing a realistic peripheral venous catheter insertion simulator: A literature review. *Proc Inst Mech Eng H*. 2019;233(10):963–978. <https://doi.org/10.1177/0954411919864786>

Ullman AJ, Mihala G, O'Leary K et al. Skin complications associated with vascular access devices: A secondary analysis of 13 studies involving 10,859 devices. *Int J Nurs Stud*. 2019;91:6–13. <https://doi.org/10.1016/j.ijnurstu.2018.10.006>

Wallis MC, McGrail M, Webster J et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol*. 2014;35(1):63–68. <https://doi.org/10.1086/674398>

CPD reflective questions

- What are common reasons why peripheral intravenous catheters (PIVCs) fail before completion of therapy?
- What are some important characteristics of PIVCs that influence clinical practice?
- What are some barriers associated with incorporating integrated PIVCs into clinical practice, and how can these barriers be overcome?

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