Received: 14 September 2021 | Accepted: 31 October 2021

DOI: 10.1002/nop2.1176

NURSE EDUCATION REPORT

NursingOpen Open Access WILEY

Evaluating peripheral intravascular catheter insertion, maintenance and removal practices in small hospitals using a standardized audit tool

Alex Hoskins[1] | Leon J Worth[1,2] | Michael J Malloy[1] | Mary Smith[3] | Sue Atkins[3] | Noleen Bennett[1,4]

[1]Victorian Healthcare Associated Infection Surveillance System (VICNISS) Coordinating Centre, Doherty Institute for Infection and Immunity, Melbourne, Vic., Australia

[2]Department of Medicine, The University of Melbourne, Melbourne, Vic., Australia

[3]Victorian Department of Health and Human Services, Regional Infection Control Advisors, Performance and Improvement Rural Health, Melbourne, Vic., Australia

[4]Department of Nursing, Melbourne School of Health Sciences, The University of Melbourne, Melbourne, Vic., Australia

Correspondence
Alex Hoskins, Victorian Healthcare Associated Infection Surveillance System (VICNISS) Coordinating Centre, The Peter Doherty Institute for Infection and Immunity, Melbourne, Vic. 3000, Australia.
Email: Alex.Hoskins@mh.org.au

Funding information
This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The Victorian Healthcare Associated Infection Surveillance System Coordinating Centre is funded by the State Government Victoria. This funding source had no role in the design or analysis of the survey data.

Abstract

Aim: The aim of this study was to evaluate clinical practice about peripheral intravenous catheter (PIVC) insertion, maintenance and removal in a cohort of Victorian hospitals.

Design: A standardized PIVC audit tool was developed, and results from point prevalent surveys were conducted.

Methods: Hospitalized patients requiring a PIVC insertion were eligible for audit. Audit data submitted between 2015 and 2019 were extracted for the current study.

Results: 3566 PIVC insertions in 15 Victorian public hospitals were evaluated. 57.6% of PIVCs were inserted in wards, 18.7% in operating theatres and 11.6% in Emergency Departments (ED). 45.2% were inserted by nurses and 38.2% by medical staff. The preferred site for insertion was the dorsum of the hand and forearm (58.8%). 22.6% did not report a visual infusion phlebitis score at least daily, and 48% did not document a daily dressing assessment. Reasons for PIVC removal included no longer required (63%) and phlebitis (4.8%). No bloodstream infections were reported.

1 | INTRODUCTION

Short-term peripheral intravenous catheters (PIVCs) are inserted for vascular access in order to facilitate medical care of hospitalized patients.

In 2005, the Victorian Healthcare Associated Infection Surveillance System (VICNISS) Coordinating Centre developed and released an audit tool to facilitate the monitoring of PIVC use in Victorian public acute care hospitals.

2 | BACKGROUND

Up to 70% of patients admitted to Australian acute healthcare facilities require PIVC insertion. Of these, it is estimated that up to 40% will fail (ACSQHC, 2019; Keogh & Mathew, 2019). Complications of catheterization include malfunctioning catheters (extravasation, infiltration or blockage), phlebitis, infection at exit site and bloodstream infections (BSIs). While the rate of PIVC-associated BSIs is low (<0.1% to 0.18%) (Mermel, 2017; Ray-Barruel et al., 2019; Zhang et al., 2016), the burden of these infections is significant given the large numbers of PIVCs used in health care (ACSQHC, 2019; Keogh & Mathew, 2019).

2.1 | Research question

The rationale for this study was to evaluate current practices related to PIVC insertion, maintenance and removal and to calculate what is the rate of PIVC-associated complications.

3 | THE STUDY

3.1 | Design

The SQUIRE 2.0 framework for quality improvement programmes was used for study design, analysis and reporting (Ogrinc et al., 2016). The current version of the point prevalence survey audit tool is comprised of two sections (Figure 1):

- **Section A**. Data captured at the time of PIVC insertion, including date, time and location of insertion, occupation of inserter, whether the reason for the PIVC insertion was documented, insertion site, whether aseptic technique was used, if hand hygiene was performed immediately prior to insertion and whether an alcohol-based skin antiseptic was applied.
- **Section B**. Data relevant to PIVC maintenance and removal, including the date of removal, whether the Visual Infusion Phlebitis (VIP) score was documented, whether dressing assessments were documented at least daily and whether the reason for the removal of PIVC was documented. Reasons include malfunctioning catheter, phlebitis, exit site infection and "other" complications.

The VIP score is a standardized and internationally accepted assessment tool for phlebitis (Infusion Nurses Society, 2016; Jackson, 1998). The VIP tool guides clinicians to determine the possible cause of phlebitis and timely removal of venous access devices (Infusion Nurses Society, 2016). To enable assessment, it is recommended that signs and symptoms of phlebitis are monitored by clinical staff each shift. These include erythema, pain, swelling, induration, the presence of a palpable venous cord and fever (Jackson, 1998).

3.2 | Method

1.1.1. *Data collection and submission*.

Victorian public acute care hospitals are invited to audit PIVC insertion, maintenance and removal for periods of at least one month using the standardized VICNISS tool. Surveillance can be conducted hospital-wide or in specific ward settings. All patients requiring multi-day admission and insertion of a PIVC are eligible for inclusion.

At a patient level, auditing is performed prospectively until each PIVC is removed. To ensure accuracy, it is recommended that data be collected as close as possible to the time of the insertion and removal of the PIVC. All data are submitted via a secure online portal.

3.3 | Analysis

For the purposes of the current study, all submitted data for the period 2015–2019 were extracted. The evaluable denominator was the number of PIVCs inserted during the surveillance period. Processes and outcomes were summarized as proportions, and relevant subcategories (e.g. HCW groups) were used for reporting.

3.4 | Ethics

Consistent with Australia's National Health and Medical Research Council's defined Quality Assurance activities, no HCW-identifying data are collected, and pooled data are captured for purposes of quality improvement within participating healthcare facilities. Ethics approval was therefore not required (National Health and Medical Research Council (NHMRC), 2014).

4 | RESULTS

4.1 | PIVC insertion

The majority of audited PIVCs were inserted in a ward environment (57.6%), operating theatre (OT) (18.7%) or Emergency Department (ED) (11.6%). Most were inserted by nursing staff (45.2%) and medical staff (38.2%). Reasons for insertion were documented for 88.4% of audited PIVCs (Table 1 Section A).

Hospital & Patient Details	Hospital Name:		
Location of Surveillance: ☐ Hospital-wide or ☐ Ward (Name): _____ **If ward:** Medical ☐ Surgical ☐ Other ☐			
MRN (UR No.):	**Sex:** ☐ M ☐ F ☐ Other	**DOB:** / /	**Admission Date:** / /

Section A *(ideally complete at time of PVC insertion)*	**Date of Insertion:** / / ☐ Unknown - *estimate date of insertion:* / /
Time of Insertion: ☐ Before Admission (prior to hospital arrival) ☐ During Admission	
Place where PVC Inserted: ☐ Ambulance ☐ GP Clinic ☐ Emergency Department ☐ Operating Theatre ☐ Intensive Care Unit ☐ Ward ☐ Not Documented ☐ Other *(specify)*: _____	
Occupation of Inserter: ☐ Medical Practitioner ☐ Medical Student ☐ Nurse ☐ Ambulance Officer ☐ IV Team ☐ Not Documented ☐ Other (specify): _____	
Reason for Insertion Documented: ☐ Yes ☐ No	**Inserted in an Emergency Situation:** ☐ Yes ☐ No *NOTE: All PVC insertions before admission, select Yes*
Insertion Site: ☐ Lower Limb ☐ Scalp ☐ Other - *specify:* _____ ☐ Upper Limb - *specify:* ☐ Back of hand ☐ Wrist ☐ Forearm ☐ Cubital fossa ☐ Upper arm	
Aseptic Technique Used: ☐ Yes ☐ No ☐ Unknown	
Hand Hygiene Performed Immediately Prior to Insertion *(according to hospital protocol)* **:** ☐ Yes ☐ No ☐ Unknown	
Alcohol Based Antiseptic Used: ☐ Yes ☐ No, *specify antiseptic used:* _____ ☐ Unknown	
Semi-permeable Transparent Dressing or Sterile Gauze Applied: ☐ Yes ☐ No - *specify dressing type used:* _____	

Section B *(ideally complete at time of PVC removal)*	**Date of Removal:** / / ☐ Unknown - *estimate date of removal:* / /
VIP Score Documented: + ☐ No ☐ Yes, specify how often: ☐ Every shift ☐ Daily ☐ Other (specify) _____	
Dressing Assessment Documented +**:** ☐ No ☐ Yes, specify how often: ☐ Every shift ☐ Daily ☐ Other (specify): _____	
Last Date PVC Accessed (for IV fluids, medications, antibiotics, flushes)**:** / / ☐ Unknown - *estimate date:* / /	
Reason for Removal: ☐ As per hospital protocol ☐ No longer required for medical management ☐ Unknown ☐ Complications - *specify:* ☐ Malfunctioning catheter ☐ Phlebitis ☐ Exit site infection ☐ Other - *specify:* _____ **If reason for removal was Phlebitis, what was VIP score‡ on removal:** ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A	

IV site appears healthy	0	No signs of phlebitis ***Observe Cannula***
One of the following is evident: • Slight pain near IV site • Slight redness near IV site	1	Possible first signs of phlebitis ***Observe Cannula***
Two of the following is evident: • Pain near IV site • Erythema • Swelling	2	Early stage of phlebitis ***Resite Cannula***
All of the following are evident: • Pain along path of cannula • Erythema • Induration₴	3	Medium stage of phlebitis ***Resite Cannula; Consider Treatment#***
All of the following are evident and extensive: • Pain along path of cannula • Erythema • Swelling • Palpable venous cord	4	Advanced stage phlebitis & start of thrombophlebitis ***Resite Cannula; Consider Treatment#***
All of the following are evident and extensive: • Pain along path of cannula • Erythema • Swelling • Palpable venous cord • Pyrexia	5	Advanced stage of thrombophlebitis ***Resite Cannula; Initiate Treatment#***

\+ Assessments may be documented on patient care plan, medical notes or other forms
‡ Visual Infusion Phlebitis Score (VIP Score) *Jackson 1997* –see below
₴ Induration - presence of hardening at IV site (red, inflamed & tender); # Treatment - antibiotic therapy; Stage 4 & 5 - consider swab of IV site

FIGURE 1 Peripheral intravascular catheter audit tool

TABLE 1 Audited peripheral intravascular catheters: insertion practices

	Measurement	No.	%
Section A: insertion			
Gender	Female	1986	55.7
	Male	1580	44.3
Date of insertion	Documented	3530	99.0
Time of insertion	Before admission	307	8.6
	During admission	3259	91.4
Location	Ambulance	42	1.2
	Emergency Department	414	11.6
	Operating theatre	667	18.7
	Ward	2054	57.6
	General Practice Clinic	188	5.3
	Other location	103	2.9
	Not documented	84	2.4
Occupation of inserter	Ambulance officer	42	1.2
	IV Team	60	1.7
	Medical Staff	1363	38.2
	Nursing Staff	1610	45.6
	Other staff	8	0.2
	Not documented	448	12.6
Reason for insertion	Documented	3152	88.4
Inserted in an emergency situation[a]	Yes	408	11.4
Insertion site	Back of hand	1053	29.5
	Cubital fossa	691	19.4
	Forearm	1060	29.7
	Wrist	530	14.9
	Other insertion site	232	6.5
Section B: maintenance and removal			
Date of removal	Documented	3323	93.2
VIP score	Documented at least daily	2760	77.4
	Documented every shift	1904	53.4
Dressing assessment	Documented at least daily	1854	52.0
Reason for removal *Complications*	As per hospital protocol	391	11.0
	No longer required	2250	63.1
	Malfunctioning catheter	294	8.2
	Phlebitis	177	5.0
	Bloodstream infection	0	0
	Infection at exit site	1	0
	Other reason	280	7.9

[a]Ambulance or Emergency Department.

The preferred site for PIVC insertion was the upper limb (94.6%). The forearm (29.7%), dorsum of the hand (29.5%) and cubital fossa (19.4%) were most frequently used (Table 1). The cubital fossa was used more frequently for PIVCs inserted by ambulance staff (42.9%) and ED staff (38.4%), while the forearm or dorsum of the hand was used most frequently by OT staff (36.5%).

Documentation was lacking with respect to whether aseptic technique was used, hand hygiene performed or alcohol-based antiseptic applied prior to insertion in 45.9%, 46.1% and 43.9% of audited PIVCs respectively. A semi-permeable transparent or sterile dressing was applied following the majority (99.8%) of cannula insertions.

4.2 | PIVC maintenance, removal and complications

The mean dwell time for all PIVCs was 1.9 days. For the 377 PIVCs inserted in an emergency situation, the mean dwell time was 2.4 days (Table 1, Section B).

The date of PIVC removal was documented in the majority of instances (93.2%). The VIP score and dressing assessment was documented at least daily in patient's notes for 77.4% and 52.0% of PIVCs respectively. Most removals were in the setting of the PIVC being "no longer required" (63.1%) and less frequently because of complications (25.9%). Of the complications, phlebitis and blood stream infections were the least common—5.0% and 0% respectively.

5 | DISCUSSION

To our knowledge, this study is the first of this size to report PIVC insertion, maintenance and removal practices in Australian healthcare facilities. Findings demonstrated a low burden of complications, particularly bloodstream infections (0%) and phlebitis (5%). However, a number of opportunities to improve practice were identified. These included the need for improved documentation, education about the preferred site for PIVC insertion and regular use of a VIP (or similar) tool to assess a cannula site (Infusion Nurses Society, 2016; National Health and Medical Research Council (NHMRC), 2019;;; Queensland Department of Health, 2015; Tuffaha et al., 2014;;;).

International guidelines support the preferred PIVC sites to be the forearm and dorsum of the hand (Abolfotouh et al., 2014). It is

noted that the least preferred sites for PIVC are at points of flexion, for example cubital fossa and wrist (Gorski et al., 2016). These sites are commonly chosen for their ease of insertion and convenience and represented close to 25% of all insertions in our study. We note that these sites were predominantly used in ED and by ambulance technicians.

In contrast to the findings of an international study by Alexandrou et al. (2018), we observed that the majority of PIVCs were inserted by nursing staff (46.6%). This is likely due to many of the participating hospitals being smaller in size and therefore having potentially less access to onsite medical teams. In this context, ward care is predominantly delivered and supported by nursing staff skilled in the practice of PIVC insertion.

We identified some challenges to auditing, especially the ability to capture data concerning insertion practices. We acknowledge the introduction of electronic medical records in many Australian healthcare facilities and promote the need for PIVC insertion and maintenance processes to be documented through EMR systems. While EMR holds great potential for streamlining the collection of timely surveillance data, this is yet to be tested (Birkhead et al., 2015; Mehta & Partin, 2007).

5.1 | Limitations

One limitation of our study is that twelve of the fifteen audited hospitals were those with <100 beds, and findings may therefore not represent practices within larger hospitals in our region. Smaller healthcare facilities may provide patient care that is unique with respect to shorter patient stays and lower acuity of care. This may be reflected by fewer PIVC insertions and reduced dwell times in these facilities, when compared to larger facilities. Looking ahead, we propose that our auditing tool be available to all Victorian rural and metropolitan healthcare facilities, including public and private sectors and facilities with >100 beds. Such data will potentially be more reflective of regional practices and more adequately identify gaps or opportunities for practice improvement.

Another limitation is the fact that clinical auditing is frequently performed retrospectively. We acknowledge that our findings may, therefore, reflect poor documentation, rather than poor practice.

6 | CONCLUSION

This audit tool is a means of continuous and systematic assessment that can lead to measurable improvements in patient care associated with the safe management of peripheral intravenous catheters. This quality improvement strategy works towards ensuring the positive health status of targeted patient groups.

We report a low prevalence of complications related to PIVC insertion and maintenance in a surveyed population of patients admitted to small Victorian hospitals. Our audit tool provides a comprehensive method to review PIVC insertion and management and can be used to identify opportunities for practice improvement. We therefore recommend use of this tool in response to identification of increased complications, and as a periodic method for documenting quality of care as part of routine nursing assessment and patient care.

ACKNOWLEDGEMENT

Thanks to all hospital Infection Control Nurses who collect the peripheral intravenous cannula insertion and management audit data.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS APPROVAL

Consistent with Australia's National Health and Medical Research Council's defined Quality Assurance activities, no HCW-identifying data are collected, and pooled data are captured for purposes of quality improvement within participating healthcare facilities. Ethics approval was therefore not required.

ORCID

Alex Hoskins https://orcid.org/0000-0002-9112-6965

REFERENCES

Abolfotouh, M. F., Salam, M., Bani-Mustafa, A., White, D., & Balkhy, H. H. (2014). Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. *Therapeutics and Clinical Risk Management*, *4*, 993–1001. doi:https://doi.org/10.2147/TCRM.S74685

Alexandrou, E., Ray-Barruel, G., Carr, P. J., Frost, S. A., Inwood, S., Higgins, N., Alberto, L., Mermel, L., & Rickard, C. M. (2018). Use of Short Peripheral Intravenous Catheters: Characteristics, Management and Outcomes Worldwide. https://www.journalofhospitalmedicine.com/jhospmed/article/166494/hospital-medicine/use-short-peripheral-intravenous-catheters-characteristics

Australian Commission on Safety and Quality in Health Care. (2019) Consultation Draft – Peripheral Venous Access Clinical Care Standard. Sydney: ACSQHC. Accessed 20th September, 2020. https://safetyandquality.govcms.gov.au/publications-and-resources/resource-library/peripheral-venous-access-clinical-care-standard-and-indicators-consultation-draft

Birkhead, G. S., Klompas, M., & Shah, N. R. (2015). Uses of Electronic Health Records for Public Health Surveillance to Advance Public Health, Annual Review of Public Health, Vol *36*, pp 345–359, Accessed 13th December 2019, https://www.annualreviews.org/doi/full/ https://doi.org/10.1146/annurev-publhealth-031914-122747

Gorski, L., Hadaway, L., Hagle, M., McGoldrick, M., Orr, M., & Doellman, D. (2016). Infusion therapy standards of practice. *Journal of Infusion Nursing*, *39*(suppl 1), S1–S159.

Infusion Nurses Society (2016). Infusion therapy standards of practice. *Journal of Infusion Nursing*, *39*(1S), 1–159.

Jackson, A. (1998). Infection control – a battle in vein: Infusion phlebitis. *Nursing Times*, *94*(4), 68–71.

Keogh, S., & Mathew, S. (2019). Peripheral intravenous catheters: A review of guidelines and research. Sydney: ACSQHC. Accessed 20th September, 2019, https://www.safetyandquality.gov.au/publications-and-resources/resource-library/peripheral-intravenous-catheters-review-guidelines-and-research

Mehta, N. B., & Partin, M. H. (2007). Electronic health records: A primer for practicing physicians. *Cleveland Clinic Journal of Medicine*, *74*(11), 826–830.

Mermel, L. A. (2017). Short-term peripheral venous catheter-related bloodstream infections: A systematic review. *Clinical Infectious Diseases*, *65*(10), 1757–1762. doi:https://doi.org/10.1093/cid/cix562

National Health and Medical Research Council (NHMRC) (2014). Ethical considerations in quality assurance and evaluation activities. Accessed 19th April, 2019. https://www.nhmrc.gov.au/guidelines-publications/e111

National Health and Medical Research Council (NHMRC) (2019). Australian Guidelines for the Prevention and Control of Infection in Healthcare: Commonwealth of Australia. Accessed 11th June 2019, https://www.nhmrc.gov.au/about-us/publications/australian-guidelines-prevention-and-control-infection-healthcare-2019

Ogrinc, G., Davies, L., Goodman, D., Batalden, P. B., Davidoff, F., & Stevens, D. (2016). SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): Revised publication guidelines from a detailed consensus process. *BMJ Quality and Safety*, *25*, 986–992.

Queensland Department of Health (2015). Peripheral Intravenous Catheter Guideline. Accessed 1st November 2019, https://www.health.qld.gov.au/__data/assets/pdf_file/0025/444490/icare-pivc-guideline.pdf

Ray-Barruel, G., Xu, H., Marsh, N., Cooke, M., & Rickard, C. M. (2019). Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: A systematic review. Infection Disease & Health, 2019, accessed 10th October, 2020, doi:https://doi.org/10.1016/j.idh.2019.03.001

Tuffaha, H. W., Rickard, C. M., Webster, J., Marsh, N., Gordon, L., Wallis, M., & Scuffham, P. A. (2014). Cost-effectiveness analysis of clinically indicated versus routine replacement of peripheral intravenous catheters. *Appl Health Econ Health Policy*, *12*:51-58. doi:https://doi.org/10.1007/s40258-013-0077-2

Zhang, L., Cao, S., Marsh, N., Ray-Barruel, G., Flynn, J., Larsen, E., & Rickard, C. M. (2016). Infection risks associated with peripheral vascular catheters. *Journal of Infection Prevention*, *17*(5): 207–213. doi:https://doi.org/10.1177/1757177416655472

How to cite this article: Hoskins, A., Worth, L. J., Malloy, M. J., Smith, M., Atkins, S., & Bennett, N. (2022). valuating peripheral intravascular catheter insertion, maintenance and removal practices in small hospitals using a standardized audit tool. *Nursing Open*, *9*, 1912–1917. https://doi.org/10.1002/nop2.1176