Peripheral intravenous catheters in the care of oncology and haematology patients

Emily N Larsen[*1,2,3] • RN, BHlthSci, GDip(HlthRes), PhD (Candidate)
Fellow (Vascular Access), Griffith University, Royal Brisbane and Women's Hospital, Brisbane, QLD 4121, Australia
Level 2, Nursing and Midwifery Research Centre, Building 34, Royal Brisbane and Women's Hospital, Cnr. Bowen Bridge Road and Butterfield Street, Herston, QLD 4029, Australia
Email e.larsen@griffith.edu.au

Dr Gillian Ray-Barruel[3,4,9] • RN, BSN, BA(Hons), GCert(ICU), PhD
Senior Research Fellow, The University of Queensland, Brisbane, QLD 4029, Australia

Mari Takashima[1,3,4] • RN, MEpi, PhD (Candidate)
Senior Research Assistant, Griffith University, Brisbane, QLD 4111, Australia

Professor Nicole Marsh[1,2,3,4] • RN, MAdvPracNurs, PhD
Nursing and Midwifery Director, Research, Royal Brisbane and Women's Hospital, Brisbane, QLD 4029, Australia

Professor Christopher R Friese[5] • RN, FAAN, PhD
Elizabeth Tone Hosmer Professor of Nursing, University of Michigan, Ann Arbor, Michigan 48109, USA

Dr Vineet Chopra[6] • M.D., MSc
Chairman, Department of Medicine, University of Colorado, Denver, Colorado 80204, USA

Dr Evan Alexandrou[3,7,8] • BHlth, DipHlthSci, GCert(ICU), MPubHlth, PhD
Senior Lecturer, Western Sydney University, Liverpool, NSW 2170, Australia

Professor Claire M Rickard[1–4,9] • RN, GDip N(CritCare), PhD, FAAN, FAHMS, FACN
Professor of Infection Prevention and Vascular Access, The University of Queensland, Metro North Health, Brisbane, QLD 4029, Australia

[1]School of Nursing and Midwifery, Griffith University, Brisbane, QLD, Australia
[2]Nursing and Midwifery Research Centre, Royal Brisbane and Women's Hospital, Brisbane, QLD, Australia
[3]Alliance for Vascular Access Teaching and Research, Griffith University, Brisbane, QLD, Australia
[4]School of Nursing, Midwifery and Social Work, The University of Queensland, Brisbane, QLD, Australia
[5]School of Nursing and Rogel Cancer Center, University of Michigan, Ann Arbor, Michigan 48109, USA
[6]Department of Medicine, University of Colorado, Denver, Colorado 80204, USA
[7]School of Nursing and Midwifery, Western Sydney University, Sydney, NSW, Australia
[8]Liverpool Hospital, Sydney, NSW, Australia
[9]Herston Infectious Diseases Institute, Metro North Health, Brisbane, QLD, Australia

*Corresponding author

Keywords oncology, haematology, peripheral venous catheter

For referencing Larsen EN et al. Peripheral intravenous catheters in the care of oncology and haematology patients. Australian Journal of Cancer Nursing 2022; 23(1):16-22.

DOI https://doi.org/10.33235/ajcn.23.1.16-22

Submitted 11 February 2022, Accepted 18 May 2022

Abstract

Aim To determine peripheral intravenous catheter (PIVC) characteristics, complications and risk factors among patients in cancer units.

Methods A secondary analysis of a global, cross-sectional study (127 hospitals in 24 countries). Participants (≥18 years) admitted to cancer units were assessed once for PIVC characteristics and the presence of complications. Variables included patient demographics, device characteristics, treatment details, and device and/or site complications. PIVC characteristics were presented using qualitative descriptors; mixed-effects logistic regression models determined risk factors for PIVC complications.

Results: In total, 1,807 participants (1,812 PIVCs) were included; 12% (n=215) of PIVCs presented with complications. Risk factors included: insertion by doctors; insertion in ED and ambulance/other locations; poor PIVC dressing integrity; dwell time ≥49 hours; and administration of colloids/blood products and antiemetics.

Conclusions At least one in ten PIVCs in cancer units present with complications; regular PIVC assessment and improved dressing integrity is likely to reduce risk and improve outcomes.

Introduction

The prevalence of cancer is a growing burden upon healthcare systems, with approximately 14 million new cases identified each year worldwide[1]. Cancer survivors are also an expanding population; in the United States alone, this number is soon expected to reach 18 million[2], with 61% aged ≥65 years[3]. For many patients with cancer, vascular access devices are an essential lifeline during treatment and beyond.

Peripheral intravenous catheters (PIVCs) are regularly used to administer intravenous (IV) infusates, including blood, chemotherapy, fluids and supportive care drugs, in the treatment of cancer[4]. These devices are indicated for short-term, peripherally-compatible IV treatments[5] but have garnered concern, particularly in relation to extravasation risk following infusion of anti-neoplastic agents[6]. A recent study found 35% of PIVCs within an oncology/haematology population failed, due to mechanical (i.e. infiltration / occlusion) and/or infective and inflammatory (i.e. local or bloodstream infection (BSI) / phlebitis) complications[4]. Despite being common, PIVC failure may have dire consequences. The chronic nature of cancer and the frequency of treatment required often results in venous depletion due to recurrent cannulation attempts[7]. Moreover, these patients often present with risk factors such as immunosuppression, malnutrition and complex treatment needs, potentially increasing the likelihood of severe complications such as BSI[8,9].

While central venous access device (CVAD) use is common among oncology and haematology patients for long-term IV treatments and high-risk or peripherally-incompatible infusates (e.g. parenteral nutrition),[6] PIVC use is often a practical and unavoidable solution for emergent treatments and when drug incompatibilities exist[10]. However, there is a paucity of research investigating PIVC characteristics among this cohort. To address this evidence gap, we conducted a secondary analysis of data collected from a large multi-national, cross-sectional PIVC study[11]. Our goal was to identify characteristics of PIVCs and both modifiable and non-modifiable risk factors of PIVC complications, specific to inpatients in acute hospital cancer units.

Methods

Objectives

- To determine the characteristics of PIVCs in patients admitted to cancer units internationally.
- To establish risk factors (both modifiable and inherent) for presence of PIVC complications.

Sample population

The One Million Global Catheters (OMG) study was an international cross-sectional study of PIVC characteristics and use conducted between 1 June 2014 and 31 July 2015[11]. This large project collected data from 40,620 PIVCs (38,161 patients) in 51 countries[11]. All patients (and PIVCs) admitted to cancer units (oncology and haematology), regardless of underlying diagnosis, were eligible for this sub-analysis. Individual patient level data was not collected; therefore, aspects such as admitting diagnosis or underlying oncological or haematological condition could not be ascertained.

Ethical considerations

Human Research Ethics Committee approval for the sub-analysis was provided by Griffith University (2019/437). As de-identified data was sourced from an existing (ethically approved) dataset, patient consent was not required.

Variables

The OMG study used a point-prevalence design where participant and device characteristics, and signs and symptoms of PIVC site complications were observed for each patient at each site at a single point in time. Variables included:

- Participant characteristics: age (in years); gender; treatment (e.g. fluids, medications) administered on the assessment day.
- Insertion setting: location of patient (e.g. ward, emergency); time of day (e.g. Monday–/Friday; weekend; day; evening).
- Device characteristics: inserting clinician; reason for insertion; gauge/size; insertion site (e.g. forearm, hand); PIVC dwell time (in hours) at time of assessment.
- Device and site assessment: signs and symptoms of complications related to phlebitis and infection; malfunction; and skin reaction.
- Patient satisfaction: patient's experience with PIVC, scored on an 11-point numerical rating scale (0, worst; 10, best).

The data collection form/s are publicly available[11].

Outcomes

The primary outcome of interest was a composite measure of the presence of PIVC complications including any of:

- Signs and symptoms of phlebitis and infection: this included pain/tenderness, redness/erythema, swelling, palpable cord, vein streak, extravasation/infiltration, induration/hardness, and/or purulence, AND/OR
- Signs of malfunction: including leakage or partial/complete dislodgement.

For the purposes of the analysis, other reported complications such as blood in line, bruising/dried blood, and skin reactions (itch/rash, blistering/skin tears) were presented descriptively but not included in the multivariable analyses as *complications*.

Analysis

PIVC insertion and treatment characteristics and presence of complications were reported descriptively (using absolute numbers and proportions). Missing data were not imputed as they were not assumed to be missing at random given the data

collection method. Mixed-effects logistic regression models were used to assess predictors of complications, accounting for the clustering of the data within hospitals and regions. Odds Ratio (OR) with 95% Confidence Intervals (CI) were reported. Variables significant at p<0.2 in the univariable modelling were included in the multivariable model. Clinically relevant variables selected *a priori* were included in multivariable modelling irrespective of statistical significance at univariable analysis, including patient age, PIVC location (anatomical position), and PIVC gauge/size[12,13]. Data were analysed using Stata (V13; StataCorp, College Station, TX).

Results

Oncology and haematology participants made up 4.7% (n=1,807/38,161) of the total OMG study population, representing 24 countries and accounting for 4.5% (n=1,812/40,620) of the included PIVCs. There was a low incidence of concurrent (multiple) PIVC use (<1%).

Participants had a median age of 61 years (IQR, 49–72) and 53% were male (Table 1). PIVCs were most frequently inserted in the general ward setting (75%) and the emergency department (12%). A majority of PIVCs were inserted by nurses (80%), with fewer inserted by doctors (8%) or IV teams (3%). The most common insertion sites were the forearm (37%) and hand (34%), followed by the wrist (12%) and antecubital fossa (12%). Only 17% of PIVCs were used for chemotherapy administration, and 8% were used for administration of blood products. The administration of fluids

Table 1. Patient and device insertion characteristics

Participants (n=1,807)	Oncology/ haematology n (%)
Age, median (IQR), years	61 (49–72)
Male, gender, n(%)	939 (53)
Devices (n=1,812)	
Primary insertion area n (%) (*n=1,793)	
General ward/unit/clinic	1,350 (75)
Emergency department	215 (12)
Operating theatre	54 (3)
Radiology/procedure room	37 (2)
Intensive/critical care unit	14 (1)
Ambulance/emergency services	13 (1)
Other	4 (0)
Unknown	106 (6)
Primary inserter, n (%)	
Nurse	1,458 (80)
Doctor	146 (8)
IV team	53 (3)
Technician	33 (2)
Unknown	122 (7)
Other	0 (0)
Time of the day inserted n (%)	
Mon-Fri 7–5	689 (38)
Evening/night	347 (19)
Weekend 7–5	165 (9)
Unknown	611 (34)
PIVC dwell at assessment (Median (IQR), hours)	24 (4–51)
PIVC dwell at assessment n (%)	
0–24 hours	583 (32)
24–48 hours	249 (14)
48–72 hours	127 (7)
>72 hours	195 (11)
Unknown	658 (36)

Devices (n=1,812)	Oncology/ haematology n (%)
Reasons for PIVC insertion n (%)^	
IV medications	1,159 (64)
IV fluids	1,055 (58)
Chemotherapy	304 (17)
Blood product transfusion	146 (8)
Taking blood	65 (4)
Parenteral nutrition	41 (2)
Unstable/requiring resuscitation	25 (1)
Unknown	71 (4)
Primary PIVC size n (%)	
14G	5 (0)
16G	12 (0)
18G	126 (7)
20G	482 (27)
22G	660 (36)
24G	478 (26)
26G	2 (0)
Other	7 (0)
Unknown	40 (2)
Primary insertion site, n (%)	
Forearm	672 (37)
Hand	620 (34)
Wrist	221 (12)
Antecubital fossa	209 (12)
Upper arm	53 (3)
Foot	17 (1)
Other	15 (1)
Unknown	5 (0)

*Sample size <1,812 where missing data existed
^Multiple selections could be made.

(58%) and other IV medications (64%) was more common. PIVCs were predominantly sized between 20G–24G (89%), with the preferred size being 22G (36%).

Signs and symptoms of complications were present in 12% of PIVCs (Table 2). The most common symptom of PIVC complication was pain/tenderness at the site of insertion (6%). Nine percent of PIVCs in cancer units were idle (i.e. not in use on the day of assessment). Dwell-time had the highest rate of missing data, with 36% of PIVC insertion times undocumented.

Cancer units from various geographic regions (Africa, Asia, Australia/New Zealand, Europe, North America, and South America) were compared for differences in PIVC characteristics and complications; no notable differences were found. No cancer units in the Middle East or South Pacific contributed data to the larger study.

Multivariable modelling

In multivariable logistic models (Table 3), PIVC insertion by a doctor, compared with nurse-led insertion, was significantly associated with an increase in the presence of PIVC complications (OR 2.78, 95% CI 1.29–6.00, p≤0.01). PIVC insertions in emergency departments (OR 2.15, 95% CI 1.07–4.31, p=0.03) and ambulance/other/unknown units (OR 3.22, 95% CI 1.43–7.23, p≤0.01) vs. ward placement was were also associated with PIVC complications. Treatment factors, including the administration of colloids/blood products (OR 2.20, 95% CI 1.09–4.43, p=0.03) and IV anti-emetics (OR 1.94, 95% CI 1.18–3.18, p≤0.01), along with poor observed dressing integrity (not clean, dry and/or intact) (OR 3.58, 95% CI 2.30–5.58, p≤0.01) were also associated with increased risk of PIVC complications. Finally, incremental increases in dwell time from 49–72 hours (OR 6.55, 95% CI 3.03–14.18, p≤0.01) and >73 hours (OR 2.22, 95% CI 1.07–4.63, p=0.03), compared with those dwelling less than 24 hours, were associated with increased risk of PIVC complications.

A documented PIVC assessment (in the previous 24 hours before study observation) was associated with *decreased* risk of PIVC complications (OR 0.60, 95% CI 0.39–0.99, p≤0.04), as did male gender (OR 0.56, 95%CI 0.37–0.86, p=<0.01).

Table 2. Device and patient outcomes

Complications (n=1,812)	Oncology/ haematology n (%)
Group size	n=1,812
No clinical symptoms	1,597 (88)
With clinical symptoms	215 (12)
Phlebitis and infection	
Pain/tenderness	102 (6)
Redness (>1cm)	30 (2)
Swelling (>1cm)	25 (1)
Palpable cord	5 (<1)
Vein streak	7 (<1)
Extravasation/infiltration	4 (<1)
Induration/hardness (>1cm)	4 (<1)
Purulence	0 (0)
Malfunction	
Blood in line	77 (4)
Bruising/dried blood	42 (2.3)
Leaking	12 (<1)
Partial/complete dislodgement	4 (<1)
Skin reaction	
Itch/rash	6 (<1)
Blistering/skin tears	1 (<1)
PIVC not in use (on day of assessment)	157 (9)

Discussion

This sub-analysis is the first international study to demonstrate the state of PIVC characteristics and complications among hospitalised adults in cancer units. Overall, 12% of PIVCs in the cancer setting had signs and symptoms of complications. Pain and/or tenderness was the most common PIVC complication reported at the time of assessment (5.6%); this is consistent with a recent study identifying tenderness as the most frequently reported PIVC complication[14]. Notably, extravasation and infiltration (key concerns for the cancer population)[7] were identified in four PIVCs (<1%). We cannot be certain, however, that extravasation injuries would not have occurred later, as the data report one time-point of assessment. Unfortunately, the true incidence of extravasation remains unclear; a review (2013) found reported rates of 0.1–39%[15]; it is likely these rate differences stem from definition inconsistencies, or poor documentation and reporting[16].

Several modifiable risk factors were associated with an increased risk of PIVC complications. PIVC insertion by doctors demonstrated poorer outcomes compared with insertion by nurses. It is difficult to draw conclusions from this, however, as practices for 'inserter' ranged greatly, not only between facilities but also geographic regions, with some reporting a majority of doctor-inserted devices (e.g. Australia/New Zealand, 45%) compared with other regions where doctor-led insertions are rare (e.g. Europe, 9%)[11]. Furthermore, 'vascular access specialists,' hypothesised to improve PIVC insertion success and other outcomes[17], were not differentiated in the larger study data.

PIVCs inserted in geographic locations where conditions may preclude optimal insertion technique, such as emergency and ambulance/other, were associated with more complications, compared with ward-inserted PIVCs. The authors postulate this may relate to urgency of insertion, and limitations on prospective and considered device selection (e.g. PIVC v. CVAD) based on the treatment required[18]. Increased dwell time was similarly associated with an increased risk of complications, as increased dwell time offers greater days of exposure to develop complications. High-

Table 3. Logistic multivariable regression modelling (univariable and multivariable)

Variables	Complications n(%)	Univariable OR (95%CI)	p value	Multivariable (n=1,560) OR (95%CI)	p value
Age: mean(SD) (n=1,798)	57.03 (18.46)*	0.99 (0.98–1.00)	NS	0.99 (0.99–1.01)	NS
Inserted by (n=1,812)					
Nurse	109 (7.5)	Reference (group)		Reference (group)	
Doctor	24 (16.4)	2.83 (1.51–5.32)	<0.01	2.78 (1.29–6.00)	<0.01
Other	26 (12.5)	2.02 (1.15–3.53)	0.02	1.56 (0.76–3.20)	NS
Where it was inserted (n=1,793)					
General ward	97 (7.2)	Reference (group)		Reference (group)	
ED	22 (10.2)	1.83 (1.05–3.19)	0.03	2.15 (1.07–4.31)	0.03
ICU/OT/radiology	18 (17.1)	1.93 (0.99–3.76)	0.05	1.83 (0.81–4.16)	NS
Ambulance/other/unknown	22 (17.9)	3.41 (1.89–6.19)	<0.01	3.22 (1.43–7.23)	<0.01
Gender (n=1,803)					
Female	91 (10.5)	Reference (group)		Reference (group)	
Male	66 (7.0)	0.63 (0.44–0.90)	0.01	0.56 (0.37–0.86)	<0.01
PIVC position (n=1,807)					
Hand/wrist	71 (8.4)	Reference (group)		Reference (group)	
Lower arm	57 (8.5)	1.02 (0.69–1.51)	NS	1.13 (0.71–1.81)	NS
CF	22 (10.5)	1.10 (0.62–1.93)	NS	0.78 (0.39–1.57)	NS
Upper arm	9 (10.6)	1.44 (0.65–3.19)	NS	1.77 (0.71–4.42)	NS
Gauge (n=1,772)					
14–18G	19 (13.3)	1.25 (0.69–2.26)	NS	0.73 (0.34–1.56)	NS
22–24G	101 (8.8)	Ref		Reference (group)	
Bigger than 24G	36 (7.4)	0.88 (0.49–1.55)	NS	1.15 (0.58–2.28)	NS
PIVC assessment documented in the last 24 hours (n=1,812)					
No	85 (10.2)	Reference (group)		Reference (group)	
Yes	74 (7.5)	0.66 (0.43–1.01)	NS	0.60 (0.39–0.99)	0.04
PIVC dressing assessment (n=1,757)					
Clean, dry and intact	95 (6.6)	Reference (group)		Reference (group)	
Not clean, dry and intact	63 (20.3)	3.73 (2.54–5.49)	<0.01	3.58 (2.30–5.58)	<0.01
Colloid/blood product fluids today (n=1,756)					
No	136 (8.3)	Reference (group)		Reference (group)	
Yes	18 (16.1)	2.15 (1.19–3.87)	0.01	2.20 (1.09–4.43)	0.03
Anti-emetic medication today (n=1,725)					
No	106 (7.8)	Reference (group)		Reference (group)	
Yes	44 (12.3)	1.58 (1.03–2.41)	0.04	1.94 (1.18–3.18)	<0.01
Chemotherapy medication today (n=1,725)					
No	134 (9.4)	Reference (group)		Reference (group)	
Yes	16 (5.3)	0.54 (0.30–0.96)	0.04	0.71 (0.36–1.41)	NS
Time of the day inserted (n=1,812)					
Mon-Fri 7–5	47 (6.8)	Reference (group)		Ref	
Weekend 7–5	21 (12.7)	2.08 (1.13–3.83)	0.02	1.38 (0.68–2.80)	NS
Evening/nights	31 (8.9)	1.48 (0.87–2.51)	NS	1.18 (0.63–2.18)	NS
Unknown	60 (9.8)	1.50 (0.97–2.33)	NS	1.26 (0.31–5.13)	NS
Dwell time (n=1,812)					
0–24 hours	27 (4.6)	Reference (group)		Ref	
25–48 hours	21 (8.4)	1.88 (1.00–3.51)	0.05	1.27 (0.62–2.60)	NS

Variables	Complications n(%)	Univariable OR (95%CI)	p value	Multivariable (n=1,560) OR (95%CI)	p value
49–72 hours	25 (19.7)	6.43 (3.36–12.32)	<0.01	6.55 (3.03–14.18)	<0.01
>73 hours	22 (11.3)	2.83 (1.48–5.39)	<0.01	2.22 (1.07–4.63)	0.03
Unknown	64 (9.7)	2.30 (1.38–3.83)	<0.01	1.18 (0.28–4.89)	NS

* Mean(SD); NS Not significant <0.05

level evidence continues to suggest that clinically indicated replacement, rather than routine replacement at dedicated time-points (e.g. 72 or 96 hours), should be incorporated as best practice[19]. Essential to this practice is consistent PIVC site-monitoring and early removal where complications exist[20]. This is supported by our study which found the risk of complications decreased where a PIVC site assessment had been completed and documented in the last 24 hours.

The one-time dressing assessment found 18% of PIVCs to be 'not clean, dry and/or intact.' Arguably, dressing and securement integrity is one of the most important risk factors for PIVC failure, and one that is easily amenable to improvement. While PIVC dressing and securement methods are diverse and the optimal method is unknown[21], focusing on integrity and early intervention for sub-optimal dressing and securement should be paramount in nursing practice.

Treatment factors including colloid/blood product and anti-emetic administration were associated with PIVC complications; there may be several causes for this. Blood products, as a result of their viscosity (estimated to be 4.5 times standard normal saline viscosity), decrease flow rate through infusion tubing and peripheral catheters[22], therefore, inadequate flushing following infusions may have resulted in later PIVC complications. Interestingly, this contrasted with findings of one study that found blood products *prolonged* PIVC dwell time, citing the possibility that pH balance played a role[23]. Further investigation is required to assess the impact of IV treatments on PIVC failure to better inform device selection and/or best practice for PIVC care. Finally, male gender was the single non-modifiable risk factor associated with a *decreased* risk of PIVC complications; this is consistent with previous research findings[12,13,24], perhaps reflecting males' larger veins and therefore smaller catheter-to-vessel ratios.

Overall, the authors found a moderate rate of idle PIVCs in this cohort (9%). Despite being lower than the larger study cohort (14%),[11] this is nonetheless concerning. While there is little evidence for the exact rate of PIVC-related BSI in a cancer population, overall risk of BSI and downstream complications is nevertheless extremely high, particularly among neutropenic patients[25]. As identifying modifiable sources of infection is key in BSI prevention[25], prompt removal of invasive devices should be considered by all clinical staff caring for cancer patients. Similarly, staff should be aware of the implications of blood in PIVC lines, identified in 4% of devices, such as the development of fibrin sheath (and thrombosis) which enable establishment of bacteria on internal surfaces of polyurethane catheters[26] and pose additional risk to an already vulnerable population.

Results may be limited as: (i) patients receiving care for cancer are not exclusively treated in cancer units; (ii) similarly, patients *not* receiving treatment for cancer may be placed in these units; and (iii) as an altered definition of complications was used, direct comparison cannot be made to the larger OMG study. Despite these limitations, results present an important, large-scale description of the state of care in cancer units and may be used to inform future rigorous research into the improvement of PIVC care in this specific, high-risk population.

Acknowledgements

The authors would like to thank the hospital staff and patients internationally who participated in the OMG study. Full details are available in the online appendix of the original article.

Authorship and manuscript preparation

The authors agree to meeting all International Committee of Medical Journal Editors criteria for authorship. EL, GRB, CF, NM, EA, VC and CR wrote the grant application. GRB and EA provided the de-identified data-sets. MT was the data analyst. EL drafted the first manuscript. All authors provided final approval of the final submitted manuscript.

Conflicts of interest

EL's employer/affiliates (Griffith University and the University of Queensland) have received, on her behalf, from manufacturers of vascular access device products: an investigator-initiated research grant from Eloquest Healthcare and a scholarship for conference attendance supported by Angiodynamics. GRB reports investigator-initiated research grants, speaker fees and consultancy payments provided to Griffith University by product manufacturers (3M, Becton Dickinson) and education providers (Ausmed, Wolters Kluwer). NM reports that Griffith University or The University of Queensland has received on her behalf: investigator-initiated research grants and unrestricted educational grants from Becton Dickinson, Cardinal Health and Eloquest Healthcare, and consultancy payments for educational lectures/expert advice from Becton Dickinson and 3M. CMR's employers (Griffith University or The University of Queensland) have received on her behalf: investigator-initiated research or educational grants from Becton Dickinson-Bard, Cardinal Health,

Eloquest Healthcare, and consultancy payments for educational lectures/expert advice from 3M, Becton Dickinson-Bard. VC has received grant funding from the Agency for Healthcare Research and Quality, Blue Cross/Blue Shield of Michigan, and the National Institute for Health. EA's employer (Western Sydney University) has received on his behalf from manufacturers of vascular devices and products: investigator-initiated research from BD-Bard, Cook Medical Flo Medical and consultancy payments for educational lectures/expert advice from 3M, Bard, BBraun, BD. MT and CF declare no relevant competing interests.

Funding

This study received an investigator-initiated project grant from Griffith University and the University of Michigan. The authors wish to declare the OMG study received unrestricted investigator-initiated research grants from Becton Dickinson (BD), CareFusion and 3M. B Braun provided funds for professional translation of data collection tools into several languages. All funds were made payable to Griffith University or Western Sydney University and not to individual researchers. Dr. Friese was supported by the National Cancer Institute of the National Institutes of Health under award number P30CA046592.

References

1. Plummer M, de Martel C, Vignat J, Ferlay J, Bray F, Franceschi S. Global burden of cancers attributable to infections in 2012: a synthetic analysis. The Lancet Global Health 2016;4(9):e609–e16.
2. De Moor JS, Mariotto AB, Parry C, Alfano CM, Padgett L, Kent EE, Forsythe L, Scoppa S, Hachey M, Rowland JH. Cancer survivors in the United States: prevalence across the survivorship trajectory and implications for care. Cancer Epidemiology, Biomarkers & Prevention 2013;22(4):561–70.
3. Rao AV, Demark-Wahnefried W. The older cancer survivor. Critical Reviews in Oncology/Hematology 2006;60(2):131–43.
4. Larsen EN, Marsh N, O'Brien C, Monteagle E, Friese C, Rickard C. Inherent and modifiable risk factors for peripheral venous catheter failure during cancer treatment: a prospective cohort study. Supportive Care in Cancer 2020.
5. Chopra V, Flanders SA, Saint S, Woller SC, O'Grady NP, Safdar N, Trerotola SO, Saran R, Moureau N, Wiseman S. The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. Annals of Internal Medicine 2015;163(Sup6):S1–S40.
6. Gallieni M, Pittiruti M, Biffi R. Vascular access in oncology patients. CA: A Cancer Journal for Clinicians 2008;58(6):323–46.
7. Wells S. Venous access in oncology and haematology patients: part one. Nursing Standard 2008;22(52):39–46.
8. Viana Taveira MR, Lima LS, de Araújo CC, de Mello MJG. Risk factors for central line-associated bloodstream infection in pediatric oncology patients with a totally implantable venous access port: a cohort study. Pediatric Blood & Cancer 2017;64(2):336–42.
9. Meyer E, Beyersmann J, Bertz H, Wenzler-Röttele S, Babikir R, Schumacher M, Daschner F, Rüden H, Dettenkofer M. Risk factor analysis of blood stream infection and pneumonia in neutropenic patients after peripheral blood stem-cell transplantation. Bone Marrow Transplantation 2007;39(3):173–8.
10. Maison O, Tardy C, Cabelguenne D, Parat S, Ducastelle S, Piriou V, Lepape A, Lalande L. Drug incompatibilities in intravenous therapy: evaluation and proposition of preventive tools in intensive care and hematology units. European Journal of Clinical Pharmacology 2019;75(2):179–87.
11. Alexandrou E, Ray-Barruel G, Carr PJ, Frost SA, Inwood S, Higgins N, Lin F, Alberto L, Mermel L, Rickard CM. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. Journal of Hospital Medicine 2018;13(5):E1–E7.
12. Wallis MC, McGrail M, Webster J, Marsh N, Gowardman J, Playford EG, Rickard CM. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. Infection Control & Hospital Epidemiology 2014;35(1):63–8.
13. Marsh N, Webster J, Larsen E, Cooke M, Mihala G, Rickard CM. Observational study of peripheral intravenous catheter outcomes in adult hospitalized patients: a multivariable analysis of peripheral intravenous catheter failure. Journal of Hospital Medicine 2018;13(2):83–9.
14. Mihala G, Ray-Barruel G, Chopra V, Webster J, Wallis M, Marsh N, McGrail M, Rickard CM. Phlebitis signs and symptoms with peripheral intravenous catheters: incidence and correlation study. Journal of Infusion Nursing 2018;41(4):260–3.
15. Al-Benna S, O'Boyle C, Holley J. Extravasation injuries in adults. ISRN Dermatology 2013;2013:1–8.
16. Kreidieh FY, Moukadem HA, El Saghir NS. Overview, prevention and management of chemotherapy extravasation. World Journal of Clinical Oncology 2016;7(1):87–97.
17. Marsh N, Larsen E, Webster J, Cooke M, Rickard CM. The benefit of a vascular access specialist placing a peripheral intravenous catheter: a narrative review of the literature. Vascular Access 2020;6(1):10–5.
18. Scoppettuolo G, Pittiruti M, Pitoni S, Dolcetti L, Emoli A, Mitidieri A, Migliorini I, Annetta MG. Ultrasound-guided "short" midline catheters for difficult venous access in the emergency department: a retrospective analysis. International Journal of Emergency Medicine 2016;9(1):1–7.
19. Webster J, Osborne S, Rickard CM, Marsh N. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. Cochrane Database of Systematic Reviews 2019(1).
20. Ray-Barruel G, Cooke M, Chopra V, Mitchell M, Rickard CM. The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. BMJ open 2020;10(e035239).
21. Marsh N, Webster J, Mihala G, Rickard CM. Devices and dressings to secure peripheral venous catheters: a Cochrane systematic review and meta-analysis. International Journal of Nursing Studies 2017;67:12–9.
22. Berman DJ, Schiavi A, Frank SM, Duarte S, Schwengel DA, Miller CR. Factors that influence flow through intravascular catheters: the clinical relevance of Poiseuille's law. Transfusion 2020;60:1410–7.
23. Shenoy S, Karunakar B. Factors influencing the peripheral venous catheter survival in critically ill children in a pediatric intensive care unit. The Indian Journal of Pediatrics 2014;81(12):1293–6.
24. Marsh N, Larsen E, Genzel J, Mihala G, Ullman AJ, Kleidon T, Cadigan S, Rickard CM. A novel integrated dressing to secure peripheral intravenous catheters in an adult acute hospital: a pilot randomised controlled trial. Trials 2018;19(1):596.
25. Raad I, Hachem R, Hanna H, Bahna P, Chatzinikolaou I, Fang X, Jiang Y, Chemaly RF, Rolston K. Sources and outcome of bloodstream infections in cancer patients: the role of central venous catheters. European Journal Clinical Microbiology & Infectious Diseases 2007;26(8):549–56.
26. Baumgartner JN, Cooper SL. Influence of thrombus components in mediating Staphylococcus aureus adhesion to polyurethane surfaces. Journal of Biomedical Materials Research 1998;40(4):660–70.