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Blood sampling through peripheral intravenous cannulas: A look at current practice in Australia

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ABSTRACT

Background: Sampling blood from a peripheral intravenous cannula offers an alternative to venepuncture. This practice can reduce frequency of venepuncture and patient discomfort. Opponents argue the practice increases the chance of haemolysis, risk of infection and device failure.
Aim: To describe the prevalence and practice of blood sampling from peripheral intravenous cannulas by Australian nurses.
Methods: This study used a descriptive cross-sectional design and data were collected using an electronic survey. The survey examined Australian nurses' practice of sampling blood from peripheral intravenous cannulas. Quantitative descriptive data was analysed and presented as frequencies, percentages, medians and ranges.
Findings: A total of 542 nurses participated in the survey. Of these, 338 (62.4%) completed the survey. The majority of responses came from the State of Victoria (n = 137, 40.5%) and one-third were emergency nurses (n = 112, 33.1%). Sampling of blood from peripheral intravenous cannulas occurred between 37.5% and 66.7% throughout the State and Territories of Australia. Peripheral intravenous cannula blood sampling was most common in the emergency department (n = 93, 53.4%). The most frequent reasons given were difficulty of access (n = 223, 66.0%) followed by patient comfort (n = 194, 57.4%).
Discussion: Blood sampling is required to diagnose and monitor treatment responses. A peripheral intravenous cannula offers the opportunity to sample blood without the need for venepuncture. Practice recommendations on when to sample blood and correct sampling technique are based on limited or conflicting evidence.
Conclusion: Findings from this study indicate it is common practice to draw blood samples from a peripheral intravenous cannula. Further research is required to examine the accuracy and safety of this practice to further inform policy.

1. Introduction

Blood sampling is a common intervention associated with hospital admission (Thakkar et al., 2015). Drawing of blood for haematological and biochemistry laboratory testing is required for most patients for diagnostic purposes and for ongoing treatment. The frequency of blood sampling was demonstrated by an audit conducted over seven days in three Australian tertiary teaching hospitals, during which a total of 940 blood sampling episodes were recorded from 96 patients in an adult, paediatric or neonatal intensive care setting (Ullman et al., 2016). This demonstrates an average of nearly ten blood samples per person per week. Direct access to blood is achieved by venepuncture using a straight needle, vacutainer or syringe and collection tubes (Trebo, 2012). Should the patient require the insertion of a peripheral intravenous cannula (PIVC) an alternative method for sampling blood is provided that avoids another venepuncture being performed (Ortells-Abuye, Busquets-Puigdevall, Diaz-Bergara, Paguina-Marcos, & Sanchez-Perez, 2014).

Government health policy across different Australian states and territories are not consistent with regard to the practice of using PIVCs to sample blood, with some states or territories

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Summary of Relevance
Problem

- Little is known on the prevalence and practice of blood sampling from PIVCs by Australian nurses working in acute care.

What is already known

- Venepuncture exposes the patient to more trauma and pain and this is potentiated if access is difficult or when frequent blood sampling is required.
- There is lack of agreement amongst clinicians on whether blood samples from PIVCs are accurate and safe due to limited and conflicting evidence.

What this paper adds

- The prevalence of blood sampling from PIVCs may be common practice amongst Australian nurses working in acute care.
- There are differences in clinical practice of blood sampling from PIVCs across Australia.
- Inconsistences have been identified between the practice of obtaining blood sampled from PIVCs compared with policy recommendations based on Australian State and Territory and international guidelines.

prohibiting the practice, others allowing it in special conditions and some making no recommendations (Department of Health (Northern Territory), 2015; Government of Western Australia Department of Health, 2017; Health Directorate (Australian Capital Territory), 2017; New South Wales Government, 2013; Queensland Department of Health, 2015; St Vincent's Hospital, 2008; Tasmanian Health Service - North West Region, 2016). With such variation in recommendations, nursing practices in regards to blood collection through PIVCs are expected to vary.

2. Literature review

The use of a separate venepuncture site is considered by many as the only appropriate laboratory sample collection method (Infusion Nurses Society, 2016; World Health Organisation, 2010). Using this method reduces the likelihood of contamination that can otherwise affect the accuracy of the blood sampled. Nevertheless, venepuncture is an invasive technique that can cause trauma at the insertion site and can be painful for the patient, and these effects are potentiated when repeated blood samples are required (Buowari, 2013). Difficulty in finding and accessing a suitable venepuncture site can also cause a delay in treatment particularly during an emergency situation (Bodansky et al., 2017). This delay can occur despite the presence of a PIVC if the device is not permitted for use for blood samples (Ortells-Abuye et al., 2014).

Similar to venepuncture, the insertion of a PIVC is common practice for patients admitted to hospital (Cox, Dages, Jarjoura, & Hazelett, 2004). Most are inserted to administer intravenous fluids and medications (Wong, Cooper, Brown, Boyd, & Levinson, 2018). Although blood samples have traditionally been drawn from peripheral venepuncture, it has been reported PIVCs are being used for the purpose of taking bloods other than in emergency situations (Carr et al., 2016; Decker et al., 2016; Dietrich, 2004). Arguments for obtaining blood samples from PIVCs include patient comfort as the patient is only 'stabbed' once, convenience of access if frequent sampling is required (Mulloy, Lee, Gregas, Hoffman, & Ashley, 2018), and it may be more appropriate for certain populations such as paediatrics and patients on anticoagulants (Berger-Achituv, Budde-Schwartzman, Ellis, Shenkman, & Erez, 2010; Zengin & Enc, 2008).

Opponents of sampling blood from a PIVC argue against the practice based on concern regarding an increased risk of haemolysis in comparison to sampling blood by venepuncture. Haemolysis occurs when excessive turbulence damages red blood cells and falsely raises potassium levels (Azman, Omar, Koon, & Ismail, 2019). This can lead to a delay in treatment as another blood sample needs to be taken. Sampling blood from a PIVC also carries the possibility of dislodgement if excessive manipulation of the device is applied by the collector (Helm, Klausner, Klemperer, Flint, & Huang, 2015). The associated increased handling of the device during blood sampling may also increase the potential of bacteraemia if infection control measures are not followed (Zhang et al., 2016).

The reliability of blood results obtained either by venepuncture or through a PIVC, is often dependent upon how the blood sample is drawn and the degree of damage that occurs influenced by personal preference, training and competency (Berg, Ahee, & Berg, 2011). A number of studies have investigated the efficacy of sampling blood from PIVC's. Studies investigating the practice have focused on the prevalence of haemolysis (Grant, 2003; Lowe et al., 2008; Phelan et al., 2018; Seemann & Reinhardt, 2000; Stauss et al., 2012; Wollowitz, Bijur, Esses, & Gallagher, 2013); equivalence with laboratory values drawn from venepuncture (Corbo, Fu, Silver, Atallah, & Bijur, 2007; Hambleton, Gomez, & Andreu, 2014; Zlotowski, Kupas, & Wood, 2001); the risk of blood culture contamination (Kelly & Klim, 2013; Self et al., 2012); and device failure caused by blood sampling (Mulloy et al., 2018). As a result of differences in how studies were conducted, mixed findings on the efficacy of sampling blood from PIVCs have not produced strong evidence-based practice recommendations. Systematic reviews by Coventry et al. (2019) and Jeong et al. (2019) found equivalence in the accuracy of blood results, but outlined limitations with the studies and recommended further research into the practice of obtaining blood samples from PIVCs. Awareness of policy guidelines across Australia on the practice, and the prevalence of obtaining blood samples from PIVCs, has not been examined in a national survey.

3. Aim

The aim of this study was to describe the prevalence and practice of blood sampling from PIVCs by Australian nurses.

4. Methods

4.1. Design

A descriptive, cross-sectional design was used to survey the prevalence and practices of blood sampling from PIVCs.

4.2. Setting and sample

The study population included Registered Nurses employed in acute care services across all states and territories of Australia. Distribution was achieved electronically by surveying members of the Australian Nursing and Midwifery Federation and the Australian College of Nursing. Members were invited to participate in the survey between September and December 2017 based on information about the study placed on each organisation's website. The authors also emailed the survey to individual nursing networks to distribute by snowball sampling (Atkinson & Flint, 2001).

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4.3. Survey tool and data collection

This study used an anonymous survey developed by the authors and piloted with five nurses working in acute care. This allowed the meaning of questions to be checked between respondents. The validity of questions was strengthened by reviewing the literature to ensure questions covered issues identified in the literature such as cannula size, use of syringe or vacutainer and insertion site to sample blood. The survey was created using Qualtrics Software (Experience Management, Seattle, WA), and comprised of closed questions with multiple coded responses on the prevalence of blood sampling from a PIVC. At the end of the survey, the final question was open-ended to allow participants to make additional comments. This paper only analyses and reports on quantitative survey data.

4.4. Data analysis

Data was analysed using SPSS software, version 23 (IBM, Chicago, Ill). Descriptive data were presented as frequencies, percentages, medians and range. The STROBE checklist was used in the reporting of the cross-sectional study (Vandenbroucke et al., 2007).

4.5. Ethical considerations

Approval was received from the Edith Cowan University Human Research Ethics Committee (Project Code 18384) prior to distribution of the anonymous survey. The study conformed to the National Statement on Ethical Conduct in Human Research (National Health & Medical Research Council, 2018). Information explaining the study and the voluntary nature of participation was provided at the beginning of the survey. As per the National Statement, informed consent was implied with completion of the survey. Privacy and confidentiality of the data were maintained throughout the study.

5. Results

The survey included 542 participants representing a small proportion of nurses working across Australia. Of these, 204 had incomplete data leaving 338 for analysis. As shown in Table 1, the majority of responses came from the State of Victoria (n = 137, 40.5%), were mainly from experienced nurses (median nursing experience 9 years, IQR 4–21) and one-third were emergency nurses (n = 112, 33.1%). A Bachelor of Science/Nursing Degree was the highest qualification for 32.8% (n = 111) with 14.5% (n = 49) of nurses surveyed holding a Masters Degree.

The practice of obtaining a blood sample from a PIVC occurred in 51.5% of survey responses (n = 174). As shown in Table 2, the number of nurses who obtained blood samples from PIVC's varied between 37.5% and 66.7% across the different states and territories. Among respondents, 55.9% (n = 189) were aware that policies existed on the use of PIVCs for blood sampling, with 28.4% (n = 96) of respondents indicating they were unsure of hospital policy, and 15.4% (n = 52) of respondents indicating no such policy existed at their workplace. Irrespective of state or territory in Australia, PIVC blood sampling was most common in the emergency department (n = 93, 53.4%). See Table 3. The second most common speciality identified in the survey was Oncology (n = 15, 8.6%).

Shown in Table 4 are the survey responses to questions on the practice regarding PIVC blood sampling. The most frequent reason given for sampling blood from a PIVC instead of venepuncture was difficulty of access (n = 223, 66.0%). This was followed by reasons for patient comfort (n = 194, 57.4%) and frequency of blood sampling (n = 179, 53.0%). The foot was considered by 26.3% (n = 89) of nurses surveyed as the least suitable PIVC insertion site to sample blood. A variety of gauge sizes were used to sample blood from a PIVC. The most common was an 18-gauge cannula (n = 260, 76.9%). Blood was withdrawn and discarded by 84.9% (n = 287) of respondents before sampling. The volume most discarded by respondents was 5 mL (n = 162, 47.9%). The responses were not uniform on the device used. A syringe was used by 57.7% (n = 195) of nurses compared to 12.7% (n = 43) who preferred a vacutainer, and 26.6% (n = 90) who used either device to sample blood. Some form of flushing was undertaken by 92.9% (n = 314) of nurses, with 10.4% (n = 35) indicating the PIVC was flushed before a blood draw, compared with a larger number (72.5%, n = 245) who flushed the device after blood had been drawn. Of those surveyed 16% (n = 54) indicated they would sample blood through a PIVC connected to an intravenous line once the infusion had been discontinued; compared with 15.4% (n = 52) who indicated they would pause an on-going infusion before blood was sampled; whilst the majority (n = 250, 74%) indicated they would not sample blood if the PIVC was connected to an infusion line.

There was almost unanimous agreement (n = 337, 99.7%) that blood drawn from a PIVC posed an infection risk but practices to prevent cross contamination differed. As shown in Table 4, hand hygiene was practised by 94.4% (n = 319) of respondents, 83.7% (n = 283) used non-sterile gloves as opposed to sterile gloves worn by 10.9% (n = 37). An alcohol-wipe was used by 90.5% (n = 306) of respondents to clean the cannula bung before blood was sampled and a fresh bung applied by 21.6% (n = 73) of respondents after a blood draw.

Table 1
Characteristics of Survey Participants.

Variable	Median (IQR)	n338	%(100)
Age, years	38 (29–49)		
Nursing experience, years	9 (4–21)		
Current hospital experience, years	4 (2–10)		
Current ward/unit experience, years	3 (1–7)		
Gender:			
Female		312	92.3
Male		26	7.6
State or territory[a]:			
NSW		31	9.2
VIC		137	40.5
WA		60	17.8
SA		16	4.7
QLD		67	19.8
TAS		7	2.1
NT		8	2.4
ACT		11	3.3
Area of nursing speciality[a]:			
Medical		45	13.3
Surgical		25	7.4
Cardiac		14	4.1
Critical Care		31	9.2
Emergency		112	33.1
Oncology		25	7.4
Community		7	2.1
Other		77	22.8
Highest qualification[a]			
RN Hospital Certificate		11	3.3
RN Post-basic Certificate		10	3.0
RN Diploma		18	5.3
BScN/BN		111	32.8
Graduate Certificate		70	20.7
Graduate Diploma		48	14.2
Master Degree		49	14.5
PhD		2	0.6
Other		18	5.3

NSW = New South Wales, VIC = Victoria, WA = Western Australia, SA = South Australia, QLD = Queensland, TAS = Tasmania, NT = Northern Territory, ACT = Australian Capital Territory.
[a] Frequencies that do not add up to the total n have missing data.

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Table 2
Blood sampling from a PIVC and awareness of hospital policy according to Australian States and Territories.

Variable	State / Territory	Yes n (%)	No n (%)	Unsuren (%)	Totaln = 337
Do you take blood samples from a PIVC?	NSW[a]	14 (45.2)	16 (51.6)	0	31
	VIC	64 (46.7)	70 (51.1)	3 (2.2)	137
	WA	40 (66.7)	19 (31.7)	1 (1.7)	60
	SA	10 (62.5)	5 (31.2)	1 (6.2)	16
	QLD	34 (50.7)	32 (47.8)	1 (1.5)	67
	TAS	3 (42.8)	4 (57.1)	0	7
	NT	3 (37.5)	5 (62.5)	0	8
	ACT	6 (54.5)	5 (45.4)	0	11
Are you aware of your hospital policy regarding use of PIVCs for blood sampling?	NSW	12 (38.7)	10 (32.2)	9 (29.0)	31
	VIC	82 (59.8)	19 (13.9)	36 (26.3)	137
	WA	33 (55.0)	7 (11.7)	20 (33.3)	60
	SA	7 (43.8)	2 (12.5)	7 (43.8)	16
	QLD	40 (59.7)	8 (11.9)	19 (28.4)	67
	TAS	2 (28.6)	4 (57.1)	1 (14.3)	7
	NT	4 (50.0)	1 (12.5)	3 (37.5)	8
	ACT	9 (81.8)	1 (9.1)	1 (9.1)	11

NSW = New South Wales, VIC = Victoria, WA = Western Australia, SA = South Australia, QLD = Queensland, TAS = Tasmania, NT = Northern Territory, ACT = Australian Capital Territory.
[a] Frequencies that do not add up to the total n have missing data.

Table 3
PIVC blood sampling according to nursing speciality (n = 174).

State or Territory	Medical n (%)	Surgical n (%)	Cardiac n (%)	Critical Care n (%)	Emergency n (%)	Oncology n (%)	Community n (%)	Other n (%)	Total n (%)
NSW	1 (7.1)	0	0	0	7 (50)	1 (7.1)	0	5 (35.7)	14 (8.0)
VIC	1 (1.6)	3 (4.7)	0	10 (15.6)	32 (50)	7 (10.9)	1 (1.6)	10 (15.6)	64 (36.8)
WA	2 (5.0)	2 (5.0)	0	1 (2.5)	22 (55)	4 (10)	1 (2.5)	8 (20)	40 (23.0)
SA	0	0	1 (10)	1 (10)	3 (30)	0	0	5 (50)	10 (5.7)
QLD	3 (8.8)	0	4 (11.8)	2 (5.9)	21 (61.8)	2 (5.9)	0	2 (5.9)	34 (19.5)
TAS	0	0	1 (33.3)	0	2 (66.7)	0	0	0	2 (1.7)
NT	0	0	0	0	3 (100)	0	0	0	3 (1.7)
ACT	0	0	0	0	3 (50)	1 (16.7)	0	2 (33.3)	6 (3.4)
Total	7 (4.0)	5 (2.9)	6 (3.4)	14 (8.0)	93 (53.4)	15 (8.6)	2 (1.1)	32 (18.4)	174 (100)

6. Discussion

Based on this study's findings, sampling of blood from PIVCs is practised differently around Australia in a variety of clinical settings. Of those surveyed, differences occurred between when blood could be sampled through a PIVC and inconsistences identified on the blood sampling technique. Each state and territory government had different health policies on the suitability of sampling blood through a PIVC (Department of Health (Northern Territory), 2015; Government of Western Australia Department of Health, 2017; Health Directorate (Australian Capital Territory), 2017; New South Wales Government, 2013; Queensland Department of Health, 2015; St Vincent's Hospital, 2008; Tasmanian Health Service - North West Region, 2016). A number of these policies also followed international guidelines on the practice of sampling blood from PIVCs (Infusion Nurses Society, 2016; Royal College of Nursing, 2016; World Health Organisation, 2010).

Policy information provide details on when PIVCs can be used to sample blood, what procedure to follow, and whether there are exceptions. In some areas of policy there is not common agreement and variations occur in practice recommendations. One policy document allows for routine blood sampling if the PIVC was inserted solely for this purpose (New South Wales Government, 2013), whereas in other policies sampling is only allowed straight after insertion (Queensland Department of Health, 2015), or in emergency situations where vascular access is limited (Government of Western Australia Department of Health, 2017). Policy on procedures for drawing blood through a PIVC also differ on whether to use a vacutainer or syringe (St Vincent's Hospital, 2008; Tasmanian Health Service - North West Region, 2016), and on the frequency and volume flushed through the PIVC when blood is sampled (Department of Health (Northern Territory), 2015; Government of Western Australia Department of Health, 2017; Health Directorate (Australian Capital Territory), 2017). The present survey identified differences in the level of knowledge participants had on government health policy regarding the use of PIVCs for sampling blood (see Table 2), and differences in policy recommendations between states and territories may be a possible reason for variations in clinical practice (see Table 4).

Findings from the survey indicate respondents drew blood from PIVCs using a variety of different gauge needle sizes. One-third (n = 108, 32.0%) indicated they would use a 22-gauge PIVC with two-thirds using a gauge size that was larger. Studies have shown the prevalence of haemolysis is increased when smaller gauge sizes (>20) are used to draw blood (Dugan, Leech, Speroni, & Corriher, 2005; Kennedy et al., 1996; Tanabe, Kyriacou, & Garland, 2003).

The device used to sample blood from a PIVC can be either a syringe or vacutainer. Blood samples drawn through a vacutainer apply constant pressure, whereas the amount of pressure exerted can be manipulated using a syringe. Of those surveyed, 57.7% (n = 195) indicated they would only use a syringe to sample blood, whilst 12.7% (n = 43) of responses indicated preference for using a vacutainer. In 26.6% (n = 90) of responses, both devices were used to sample blood. Samples obtained from PIVCs using a vacutainer compared with a syringe was shown to cause more haemolysis in two studies (Grant, 2003; Ong, Chan, & Lim, 2008), whilst one study found no difference between either method (Phelan et al., 2018). The chances of a haemolysed sample using a syringe was shown in one study more likely to occur if aspiration through the PIVC was perceived by the collector as difficult (Dwyer, Fry, Sommerville, & Holdgate, 2006). Evidence suggests that both a vacutainer or syringe are appropriate devices to sample blood, but both are influenced by ease of which blood is able to be aspirated from the PIVC.

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Table 4
Survey responses to PIVC blood sampling.

Variable		n (%)338 (100)
Indicate reasons for PIVC blood sampling[a]	Frequency of blood sampling	179 (53.0)
	Difficulty of venepuncture	223 (66.0)
	Patient comfort	194 (57.4)
	Other	83 (24.6)
Would you sample blood from a PIVC?	On insertion only	194 (57.4)
	Irrespective of when cannula was inserted	136 (40.2)
	Never	8 (2.4)
What PIVC gauge size would you use to draw blood?[a]	14g	190 (56.2)
	16g	212 (62.7)
	18g	260 (76.9)
	20g	223 (66.0)
	22g	108 (32.0)
Do you withdraw and discard blood before sampling?	Yes	287 (84.9)
	No	48 (14.2)
Volume of blood discarded before blood from PIVC is sampled	2mL	26 (7.7)
	5 mL	162 (47.9)
	10 mL	80 (23.7)
	Other	19 (5.6)
In sampling blood, do you flush the PIVC?[a]	Never	24 (7.1)
	Before	35 (10.4)
	After	245 (72.5)
	Both before & after	90 (26.6)
Do you sample blood from a PIVC if?[a]	No infusion line is attached	250 (74.0)
	No infusion line is in use	54 (16.0)
	Infusion is paused	52 (15.4)
What device do you use to sample blood from a PIVC?	Syringe	195 (57.7)
	Vacutainer	43 (12.7)
	Both	90 (26.6)
	Other	7 (2.1)
	None	1 (0.3)
What infection control measures do you take when sampling blood from a PIVC bung?[a]	Hand hygiene	319 (94.4)
	Non-sterile gloves	283 (83.7)
	Sterile gloves	37 (10.9)
	Alco-wipe bung	306 (90.5)
	Fresh bung	73 (21.6)
	No	219 (64.8)
Is there a specific insertion site where you would not sample blood through a PIVC?[a]	Hand	56 (16.6)
	Forearm	4 (1.2)
	Cubital fossa	4 (1.2)
	Foot	89 (26.3)
Are there any circumstances where you would not sample blood from a PIVC?	No	51 (15.1)
	Yes	277 (82.0)
Is a phlebotomy service available in the area you work at?	No	116 (34.3)
	Yes	222 (65.7)
Have you observed your colleagues draw blood from a PIVC?	No	20 (5.9)
	Yes	318 (94.1)
Who did you observe draw blood from a PIVC?[a]	Doctor	227 (67.2)
	Nurse	299 (88.5)
	Phlebotomist	27 (8.0)
	Other	4 (1.2)

[a] Multiple responses are possible.

Before a blood sample is collected from a PIVC, blood is often withdrawn to remove saline and other contaminates that may otherwise alter laboratory values (Infusion Nurses Society, 2016). Of the responses obtained from the survey, nurses who withdrew and discarded blood, 47.9% (n = 162) discarded 5 mL before blood was sampled. The volume of blood discarded from a PIVC before sampling was reported to vary considerably (Hambleton et al., 2014; Zlotowski et al., 2001). The amount of blood discarded was influenced by the dead space of the cannula and the length of extension tubing. A draw of 1 mL using a 22-gauge PIVC and a 15 cm extension tube was shown to be sufficient to avoid sample dilution (Baker et al., 2013).

Practice recommendations on the management of PIVCs suggest the flushing volume required to remove debris and fibrin deposits is 5–10 mL of sterile 0.9% sodium chloride (Government of Western Australia Department of Health, 2017). In maintaining patency of the PIVC, a push-pause method is suggested to enhance the rinsing effect before and after blood is sampled (Guiffant et al., 2012). Of the nurses surveyed, 26.6% (n = 90) indicated routinely flushing the PIVC both before and after taking a blood sample. A study by Keogh et al. (2016) found that the frequency and volume of flushing a PIVC did not influence the patency of the device.

The choice of PIVC insertion site can affect the degree of difficulty blood is able to be aspirated (Gagne & Sharma, 2017). This survey found 64.8% (n = 219) of nurses did not indicate an insertion site they would not sample blood from, including feet and hands. Location of the insertion site and size of the vein play an important role in the degree of pressure differential and turbulence that may be caused when blood is drawn through a PIVC (Gagne & Sharma, 2017). A higher prevalence of haemolysis was reported in one study when blood was sampled through a PIVC distal to a median sized vein (Lippi, Avanzini, Aloe, & Cervellin, 2014).

A common reason for the insertion of a PIVC is for the administration of intravenous fluid and medications (Alexandrou et al., 2015). This introduces the possibility of contamination if blood is sampled from a PIVC (Giavarina & Lippi, 2017). The majority of nurses surveyed (n = 250, 74%) indicated they would not sample blood from a PIVC if connected to an infusion line. Investigation on the possibility of contamination when drawing blood from intravenous line demonstrated the influence of intravenous fluids was reduced after a second blood sample was taken (Taghizadeganzadeh, Yazdankhahfard, Farzaneh, & Mirzaei, 2016).

Introduction of micro-organisms can result in the colonisation of the PIVC by contamination of the cannula hub leading to a cannula-related blood-stream infection (Sato et al., 2017; Stuart et al., 2013). The risk of contamination increases with repeated PIVC handling at the hub when there is inadequate hand hygiene (Zhang et al., 2016). There was almost unanimous agreement amongst respondents (n = 337, 99.7%) that blood drawn from a PIVC posed an infection risk but practices to prevent cross contamination differed. The most commonly performed infection control measure taken by those surveyed before blood was sampled from a PIVC was hand hygiene (n = 319, 94.4%) and the use of alcohol-wipes (n = 306, 90.5%).

7. Strengths and limitations

The strength of this study is it is the first to report on the prevalence of blood sampling from PIVCs by Australian nurses. The number of responses received allowed observations to be made of clinical practice by acute care nurses, but respondents were not surveyed if their practice occurred in a metropolitan, regional or remote healthcare facility. Distribution of the survey also made use of local nursing networks that may have skewed the locality of responses received, but its impact was reduced by advertising for participation through national nursing organisations. Since the survey was not undertaken by all nurses, this introduced a limitation of sample non-response bias with the likelihood of responses from those who completed the survey possibly different to those who did not participate in the survey. The responses from states and territories were low and may not be representative of the whole population. Generalisations of prevalence and sampling practices according to speciality was not possible due to the small numbers of respondents who completed the survey from specific clinical areas.

8. Conclusion

Findings from this study suggest obtaining blood samples from PIVCs was regularly performed by acute care nurses in Australia.

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It occurred in a number of speciality settings and amongst different patient populations, but most prominently in the emergency department. Limited knowledge of policies and differences in policy recommendations may have contributed to variations in prevalence and practice reported by survey participants. To inform policy recommendations further research is needed to examine if there are differences in blood result accuracy, rates of haemolysis, rates of device failure, rates of phlebitis and cannula-related blood stream infections of blood samples obtained from a PIVC compared with venepuncture.

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Author contributions

HD, EJ, LS and LC conceived the study. HD complied the survey and questions reviewed by EJ, LS and LC. Acquisition of survey responses was managed by AJ. Interpretation of findings was conducted by HD, EJ, LC and AJ. HD drafted the manuscript. Draft for publication was approved by all listed authors.

Declaration of Competing Interest

The authors declare no conflict of interest.

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References

Alexandrou, E., Ray-Barruel, G., Carr, P. C., Frost, S., Inwood, S., Higgins, N., . . . & Rickard, C. M. (2015). International prevalance of the use of peripheral intravenous catheters. *Journal of Hospital Medicine*, *10*(8), 530–533.

Atkinson, R., & Flint, J. (2001). *Accessing hidden and hard-to-reach populations: Snowball research strategies. Social research update*. pp. 33. Accessed 23 March 2018. http://sru.soc.surrey.ac.uk/SRU33.html

Azman, W. N. W., Omar, J., Koon, T. S., & Ismail, T. S. T. (2019). Hemolyzed specimens: Major challenge for identifying and rejecting specimens in clinical laboratories. *Oman Medical Journal*, *34*(2), 94–98.

Baker, R. B., Summer, S. S., Lawrence, M., Shova, A., McGraw, C. A., & Khoury, J. (2013). Determining optimal waste volume from an intravenous catheter. *Journal of Infusion Nursing*, *36*(2), 92–96.

Berg, J. E., Ahee, P., & Berg, J. D. (2011). Variation in phlebotomy techniques in emergency medicine and the incidence of haemolysed samples. *Annals of Clinical Biochemistry*, *48*, 562–565. http://dx.doi.org/10.1258/acb.2011.011099

Berger-Achituv, S., Budde-Schwartzman, B., Ellis, M. H., Shenkman, Z., & Erez, I. (2010). Blood sampling through peripheral venous catheters is reliable for selected basic analytes in children. *Pediatrics*, *126*(1), e179–e186.

Bodansky, D. M. S., Lumley, S. E., Chakraborty, R., Mani, D., Hodson, J., Hallissey, M. T., & Tucker, O. N. (2017). Potential cost savings by minimisation of blood sample delays on care decision making in urgent care services. *Annals of Medicine and Surgery*, *20*, 37–40.

Buowari, O. Y. (2013). Complications of venepuncture. *Advances in Bioscience and Biotechnology*, *4*, 126–128. http://dx.doi.org/10.4236/abb.2013.4241A4018

Carr, P. C., Rippey, J., Moore, T., Ngo, H., Cooke, M. L., Higgins, N. S., & Rickard, C. M. (2016). Reasons for removal of emergency department-inserted peripheral intravenous cannulae in admitted patients: A retrospective medical chart audit in Australia. *Infection Control and Hospital Epidemiology*, *37*(7), 874–876.

Corbo, J., Fu, L., Silver, M., Atallah, H., & Bijur, P. (2007). Comparison of laboratory values obtained by phlebotomy versus saline lock devices. *Academic Emergency Medicine*, *14*, 23–28.

Coventry, L. L., Jacob, A. M., Davies, H. T., Stoneman, L., Keogh, S., & Jacob, E. R. (2019). Drawing blood from peripheral intravenous cannula compared with venepuncture: A systematic review and meta-analysis. *Journal of Advanced Nursing*, http://dx.doi.org/10.1111/jan.14078. Early view 20 June 2019

Cox, S. R., Dages, J., Jarjoura, D., & Hazelett, S. (2004). Blood samples drawn from IV catheters have less hemolysis when 5-mL (vs 10-mL) collection tubes are used. *Journal of Emergency Nursing*, *30*(6), 529–533.

Decker, K., Ireland, S., O'Sullivan, L., Boucher, S., Kite, L., & Mitra, B. (2016). Peripheral intravenous catheter insertion in the emergency department. *Australasian Emergency Nursing Journal*, *19*, 138–142. http://dx.doi.org/10.1016/j.aenj.2015.1012.1003

Department of Health (Northern Territory). (2015). *Peripheral intravascular catheters (PIVC) insertion and management (adult) NT health services procedure. Doc-ID: HEALTHINTRA-1880-2301*. Northern Territory Government.

Dietrich, H. (2004). One poke or two: can intravenous catheters provide an acceptable blood sample? A data set presentation, review of previous data sets, and discussion. *Journal of Emergency Nursing*, *30*(6), 529–533.

Dugan, L., Leech, L., Speroni, K. G., & Corriher, J. (2005). Factors affecting hemolysis rates in blood samples drawn from newly placed IV sites in the emergency department. *Journal of Emergency Nursing*, *31*(4), 338–345.

Dwyer, D. G., Fry, M., Sommerville, A., & Holdgate, A. (2006). Randomized, single blinded control trial comparing haemolysis rate between two cannula aspiration techniques. *Emergency Medicine Australasia*, *18*(5–6), 484–488. http://dx.doi.org/10.1111/j.1742-6723.2006.00895.x

Gagne, P., & Sharma, K. (2017). Relationship of common vascular anatomy to cannulated catheters. *Journal of Vascular Medicine & Surgery*, *2017*, 5157914 http://dx.doi.org/10.1155/2017/5157914

Giavarina, D., & Lippi, G. (2017). Blood venous sample collection: Recommendations overview and a checklist to improve quality. *Clinical Biochemistry*, *50*(10–11), 568–573. http://dx.doi.org/10.1016/j.clinbiochem.2017.1002.1021

Government of Western Australia Department of Health. (2017). *Insertion and management of peripheral intravenous cannulae in Western Australian healthcare facilities policy*.. Accessed 14 April 2018. http://www.health.wa.gov.au/circularsnew/pdfs/13345.pdf

Grant, M. S. (2003). The effect of blood drawing techniques and equipment on the hemolysis of ED laboratory blood samples. *Journal of Emergency Nursing*, *29*(2), 116–121.

Guiffant, G., Durussel, J. J., Merckx, J., Flaud, P., Vigier, J. P., & Mousset, P. (2012). Flushing of intravascular access devices (IVADs) - efficacy of pulsed and continuous infusions. *The Journal of Vascular Access*, *13*(1), 75–78. http://dx.doi.org/10.5301/JVA.2011.8487

Hambleton, V. L., Gomez, I. A., & Andreu, F. A. B. (2014). Venipuncture versus peripheral catheter: do infusions alter laboratory results? *Journal of Emergency Nursing*, *40*(1), 20–26.

Health Directorate (Australian Capital Territory). (2017). *Canberra hospital and health services procedure: Peripheral intravenous cannula, adults and children (not neonates). CHHS15/116*. ACT Government Health, Canberra Hospital and Health Services.

Helm, R. E., Klausner, J. D., Klemperer, J. D., Flint, L. M., & Huang, E. (2015). Accepted but unacceptable: Peripheral IV catheter failure. *Journal of Infusion Nursing*, *38*(3), 189–203.

Infusion Nurses Society. (2016). Infusion therapy standards of practice. *Journal of Infusion Nursing*, *39*(1S), S1–S159.

Jeong, Y., Park, H., Jung, M. J., Kim, M. S., Byun, S., & Choi, Y. (2019). Comparisons of laboratory results between two blood samplings: Venipuncture versus peripheral venous catheter – A systematic review with meta-analysis. *Journal of Clinical Nursing*, http://dx.doi.org/10.1111/jocn.14918. Early view 10th June 2019

Kelly, A.-M., & Klim, S. (2013). Taking blood cultures from a newly established intravenous catheter in the emergency department does not increase the rate of contaminated blood cultures. *Emergency Medicine Australasia*, *25*, 435–438. http://dx.doi.org/10.1111/1742-6723.12121

Kennedy, C., Angermuller, S., King, R., Noviello, S., Walker, J., Warden, J., & Vang, S. (1996). A comparison of hemolysis rates using intravenous catheters versus venipuncture tubes for obtaining blood samples. *Journal of Emergency Nursing*, *22*(6), 566–569.

Keogh, S., Flynn, J., Marsh, N., Mihala, G., Davies, K., & Rickard, C. M. (2016). Varied flushing frequency and volume to prevent peripheral intravenous catheter failure: A pilot, factorial randomised controlled trial in adult medical-surgical hospital patients. *BioMed Central*, *17*(1), 348. http://dx.doi.org/10.1186/s13063-13016-11470-13066

Lippi, G., Avanzini, P., Aloe, R., & Cervellin, G. (2014). Blood collection from intravenous line: is one drawing site better than others? *Lab Medicine*, *45*(2), 172–175.

Lowe, G., Stike, R., Pollock, M., Bosley, J., O'Brien, P., Hake, A., . . . & Stover, T. (2008). Nursing blood specimen collection techniques and hemolysis rates in an emergency department: Analysis of venipuncture versus intravenous catheter collection techniques. *Journal of Emergency Nursing*, *34*(1), 26–32. http://dx.doi.org/10.1016/j.jen.2007.1002.1006

Mulloy, D. F., Lee, S. M., Gregas, M., Hoffman, K. E., & Ashley, S. W. (2018). Effect of peripheral IV based blood collection on catheter dwell time, blood collection, and patient response. *Applied Nursing Research*, *40*, 76–79. http://dx.doi.org/10.1016/j.apnr.2017.1012.1006

National Health and Medical Research Council. (2018). *National statement on ethical conduct in human research (2007) – Updated 2018* Retrieved from:. Canberra: Commonwealth of Australia. http://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018

New South Wales Government. (2013). *Guideline for PIVC insertion and post insertion care in adult patients*.. Accessed 14 April 2018. http://www1.health.nsw.gov.au/pds/ActivePDSDocuments/GL2013_013.pdf

Ong, M. E. H., Chan, Y. H., & Lim, C. S. (2008). Observational study to determine factors associated with blood sample haemolysis in the emergency department. *Annals of the Academy of Medicine, Singapore*, *37*, 745–748.

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Ortells-Abuye, N., Busquets-Puigdevall, T., Diaz-Bergara, M., Paguina-Marcos, M., & Sanchez-Perez, I. (2014). A cross-sectional study to compare two blood collection methods: Direct venous puncture and peripheral venous catheter. *BMJ Open*, *4*, e004250 http://dx.doi.org/10.1136/bmjopen-2013-004250

Phelan, M. P., Reineks, E. Z., Schold, J. D., Hustey, F. M., Chamberlin, J., & Procop, G. W. (2018). Preanalytic factors associated with hemolysis in emergency department samples. *Archives of Pathology & Laboratory Medicine*, *142*, 229–235. http://dx.doi.org/10.5858/arpa.2016-0400-OA

Queensland Department of Health. (2015). *Guideline peripheral intravenous catheter (PIVC)*.. Accessed 14 April 2018. https://www.health.qld.gov.au/...data/assets/pdf_file/0025/444490/icare-pivc-guideline.pdf

Royal College of Nursing. (2016). *Standards for infusion therapy* (4th edition). Accessed 14 April 2018. https://www.rcn.org.uk/clinical-topics/infection-prevention-and-control/standards-for-infusion-therapy

Sato, A., Nakamura, I., Fujita, H., Tsukimori, A., Kobayashi, T., Fukushima, S., . . . & Matsumoto, T. (2017). Peripheral venous catheter-related bloodstream infection is associated with severe complications and potential death: A retrospective observational study. *BMC Infectious Diseases*, *17*, 434. http://dx.doi.org/10.1186/s12879-12017-12536-12870

Seemann, S., & Reinhardt, A. (2000). Blood sample collection from a peripheral catheter system compared with phlebotomy. *Journal of Intravenous Nursing*, *23*(5), 290–297.

Self, W. H., Speroff, T., McNaughton, C. D., Wright, P. W., Miller, G., Johnson, J. G., . . . & Talbot, T. R. (2012). Blood culture collection through peripheral intravenous catheters increases the risk of specimen contamination among adult emergency department patients. *Infection Control and Hospital Epidemiology*, *33*(5), 524–526.

St Vincent's Hospital. (2008). *Clinical skills in hospitals project, intravenous (IV) therapy*. Department of Human Services. State Government Victoria.

Stauss, M., Sherman, B., Pugh, L., Parone, D., Looby-Rodriguez, K., Bell, A., & Reed, C.-R. (2012). Hemolysis of coagulation specimens: A comparative study of intravenous draw methods. *Journal of Emergency Nursing*, *38*(1), 15–21.

Stuart, R. L., Cameron, D. R. M., Scott, C., Kotsanas, D., Grayson, M. L., Korman, T. M., . . . & Johnson, P. D. R. (2013). Peripheral intravenous catheter-associated staphylococcus aureus bacteraemia: More than 5 years of prospective data from two tertiary health services. *The Medical Journal of Australia*, *198*(10), 551–553. http://dx.doi.org/10.5694/mja5612.11699

Taghizadeganzadeh, M., Yazdankhahfard, M., Farzaneh, M., & Mirzaei, K. (2016). Blood samples of peripheral venous catheter or the usual way: do infusion fluid alter the biochemical test results? *Global Journal of Health Science*, *8*(7), 93–99.

Tanabe, P., Kyriacou, D. N., & Garland, F. (2003). Factors affecting the risk of blood bank specimen hemolysis. *Academic Emergency Medicine*, *10*(8), 897–900.

Tasmanian Health Service - North West Region. (2016). *Peripheral intravenous cannula (PIVC) insertion, care and maintenance protocol. SDMS Id Number P16/000163*. Tasmanian Government.

Thakkar, R. N., Kim, D., Knight, A. M., Riedel, S., Vaidya, D., & Wright, S. M. (2015). Impact of an educational intervention on the frequency of daily blood test orders for hospitalized patients. *American Journal of Clinical Pathology*, *143*(3), 393–397. http://dx.doi.org/10.1309/AJCPJS1304EEM1307UAUBV

Trebo, J. (2012). *How to perform venipuncture (phlebotomy training video)* Retrieved from: https://www.youtube.com/watch?v=Ie_nFCL5Hp0. Accessed 8 August 2018.

Ullman, A. J., Keogh, S., Coyer, F., Long, D. L., New, K., & Rickard, C. M. (2016). 'True Blood' the critical care story: An audit of blood sampling practice across three adult, paediatric and neonatal intensive care settings. *Australian Critical Care*, *29*(2), 90–95.

Vandenbroucke, J. P., Elm, E., Altman, D. G., Gotzsche, P. C., Mulrow, C. D., Pocock, S. J., . . . & for the STROBE Initiative. (2007). Strengthening the reporting of observational studies in epidemiology (STROBE): Explanation and elaboration. *PLoS Medicine*, *4*(10), 1628–1654.

Wollowitz, A., Bijur, P. E., Esses, D., & Gallagher, J. (2013). Use of butterfly needles to draw blood is independently associated with marked reduction in hemolysis compared to intravenous catheter. *Academic Emergency Medicine*, *20*(11), 1151–1155.

Wong, K., Cooper, A., Brown, J., Boyd, L., & Levinson, M. (2018). The prevalence of peripheral intravenous cannulae and pattern of use: A point prevalence in a private hospital setting. *Journal of Clinical Nursing*, *27*(1–2), e363–e367. http://dx.doi.org/10.1111/jocn.13961

World Health Organisation. (2010). *WHO guidelines on drawing blood: Best practices* Geneva, Switzerland.

Zengin, N., & Enc, N. (2008). Comparison of two blood sampling methods in anticoagulation therapy: Venipuncture and peripheral venous catheter. *Journal of Clinical Nursing*, *17*(3), 386–393. http://dx.doi.org/10.1111/J.1365-2702.2006.01858.x

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. http://dx.doi.org/10.1177/1757177416655472

Zlotowski, S. J., Kupas, D. F., & Wood, G. C. (2001). Comparison of laboratory values obtained by means of routine venipuncture versus peripheral intravenous catheter after a normal saline solution bolus. *Annals of Emergency Medicine*, *38*(5), 497–504.

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