A snapshot of guideline compliance reveals room for improvement: A survey of peripheral arterial catheter practices in Australian operating theatres.

(Journal of Advanced Nursing. 2013, 69(7): 1584-1594.)

ABSTRACT

Aim

This paper is a report of a study in Australian operating theatres of compliance by the anaesthetic team with best peripheral arterial catheter practice for blood gas sampling and infection prevention. Comparisons are made with research recommendations and Centres for Disease Control Guidelines.

Background

There is wide global usage of peripheral arterial catheters in the operating theatre for haemodynamic monitoring and blood gas analysis. Frequent blood sampling from arterial catheters can lead to significant blood loss and provide an infective potential. Evidence-based research and clinical guidelines prescribe best practice.

Design

Cross-sectional descriptive survey

Methods

The design is a cross-sectional descriptive study. Data were collected in 2009 from 64 major Australian hospitals using a self-designed internet survey.

Results/Findings

Hand hygiene prior to catheter insertion was the only infection prevention practice entirely adherent with guidelines. The recommended ratio of discard to deadspace volume of 2:1 to decrease unnecessary blood loss during blood gas sampling was reported by only 11 (17%) respondents. Less than 32 (50%) respondents used the preferred solution, chlorhexidine to disinfect the insertion site. Access ports were reported as ‘never disinfected’ before use by 30 (47%) respondents.

Conclusion

The complex operating theatre environment presents barriers which contribute to non-adherence with guidelines. These barriers need to be identified to plan strategies for improvement. A quality audit tool is proposed for development by nurses in collaboration with the anaesthetic team, providing a needed method to assess ongoing compliance with best peripheral arterial catheter care. Further international research would test the generalisability of our Australian findings.

SUMMARY STATEMENT

What is already known about this topic

- Peripheral arterial catheters are widely used internationally in the operating theatre for anaesthetic monitoring and blood gas sampling.
- Frequent blood sampling from peripheral arterial catheters can lead to iatrogenic anaemia.
- The number of infections in peripheral arterial catheters is equal to infections in short-term central venous catheters.

What this paper adds

- Identification of common non-adherence with the evidence-based recommendation to discard a blood volume of twice the dead space to minimise blood loss during blood gas sampling.
- Finding of a frequent lack of compliance with Centers for Disease Control Guidelines for infection prevention during insertion and access of peripheral arterial catheters.
- Recognition of a widespread lack of knowledge of evidence-based recommendations and Centres for Disease Control Guidelines for the Prevention of Intravascular Catheter-Related Infections across Australian operating theatres.

Implications for practice and/or policy

- Further international research is needed to identify barriers to compliant behaviours in the operating theatre environment, to facilitate strategies to improve guideline adherence for best arterial catheter practice.
- A quality audit tool should be developed by nurses to assess knowledge deficits and ongoing compliance of correct blood gas sampling techniques and infection prevention practices during arterial catheter insertion and management by the anaesthetic team.
- Institutional policies need to be current with the latest research recommendations and infection prevention guidelines.

Keywords

Anaesthesia; clinical guidelines; infection control; theatre nursing.

INTRODUCTION

Peripheral arterial catheters are widely used internationally and routinely inserted in the operating theatre (OT) for continuous haemodynamic monitoring and to provide convenient access for frequent arterial blood gas (ABG) analysis during major surgery (Harley 2000). Approximately 8 million and 2.5 million arterial catheters are inserted in the United States of America and Europe respectively each year for major surgery and critical care, with comparative widespread usage in Australia (Australian Institute of Health & Welfare 2009, Gardner 1990, Lorente *et al.* 2004, Scheer *et al.* 2002). In spite of this extensive and well-documented global use of arterial lines, research about their management has not matched their universal application.

Although these catheters are considered generally safe by health practitioners, management options require consideration. Two important aspects of care are blood loss associated with multiple blood sampling (O'Hare & Chilvers 2001) and infections related to arterial catheter management and handling (Gowardman *et al*. 2010, Loftus *et al*. 2011, Traore *et al*. 2005).

BACKGROUND

In view of the common usage of peripheral arterial catheters, there are risks associated with their application which may challenge patient safety. The potential adverse outcomes of excessive blood loss from blood sampling and healthcare associated infection both present specific risks to patient safety in relation to the use of these catheters in the OT. Clinical practice is clearly influential regarding these adverse outcomes.

In the context of extensive worldwide usage of arterial catheters, the problem of iatrogenic anaemia from unnecessary discarding of blood during arterial sampling has only been studied in the Intensive Care Unit (ICU). Several past studies show blood loss from frequent sampling contributes to patients' transfusion

requirements (Corwin *et al.* 1995, O'Hare & Chilvers 2001, Andrews & Waterman 2008). Earlier research found that up to a third of all blood drawn for sampling was most likely discarded and therefore wasted (Henry *et al.* 1986). Recommendations to reduce blood loss were considered in a study in the United Kingdom (Andrews *et al*. 1999). These researchers observed diagnostic blood loss from sampling of up to 46 ml per patient day in the ICU, which concurred with other reported daily sampling volumes of 41 ml (Vincent *et al*. 2002) in the USA and 70 ml (O'Hare & Chilvers 2001) in the UK. Over a one week period in ICU, these volumes equate to the volume in a bag of packed red blood cells for transfusion. All of the reported blood sampling volumes contributed to anaemia in these studies. Recommendations were made to use conservation devices, to reduce the frequency of diagnostic sampling, to introduce protocols and to reduce discard volumes to decrease patient blood loss and the risk of iatrogenic anaemia. A subsequent study (Andrews & Waterman 2008) looked at the success of these recommendations in the ICU, with findings that they had not been acted on.

An historical perspective provides a clear view of the development of the concept of the use of a minimal discard volume to conserve arterial blood loss during sampling. American and British studies were at the forefront of this research. A study was undertaken which considered minimising blood loss to determine the blood gas effects of incompletely purging heparinised saline flush solution from peripheral arterial catheters (Dennis *et al*. 1985). It was estimated that approximately 4 ml of blood was wasted for each sampling procedure. As no standard existed, it was suggested that each ICU undertook studies to find the volume of flush-blood solutions to be aspirated before sampling, to achieve acceptable blood gas results which minimised blood loss. Discard volumes were investigated in relation to the arterial line deadspace, using the deadspace of the volume from the peripheral arterial catheter tip to the sampling port. A further study (Clapham *et al*. 1987) investigated the minimum discard volume required for accuracy. A discard volume of 4 ml was found to be sufficient with a deadspace of approximately 2 ml. Study of this minimum discard volume was continued (Preusser *et al*. 1989) to quantify the minimum discard sample needed for accurate arterial blood gas analysis. These researchers found that a 2 ml discard volume was sufficient to ensure accurate blood gases, using an arterial catheter with a 1 ml deadspace volume.

Australian research consolidated these earlier findings (Rickard *et al*. 2003) and confirmed that the blood discard volume required for accurate blood gas sampling and electrolyte testing was twice the deadspace for all variables.

Given the concurrence of findings in the body of ICU research undertaken with arterial catheters, we consider that OT sampling practices may also include blood being unnecessarily discarded without strict attention to protocols to minimise blood loss. This could add to the problem of iatrogenic anaemia in postoperative ICU patients.

In addition, OT practice may impact on the incidence of post-operative catheter-related blood stream infection (CRBSI). This is a serious health care infection that contributes to morbidity, mortality and a large use of hospital resources (Pittet *et al.* 1994, Sax & Pittet 2002). A rate of 4% CRBSI is reported in an American study for peripheral arterial catheters placed for greater than four days and in the same study 12% of all the hospital-acquired bacteraemia in ICU originated from peripheral arterial catheters (Band & Maki 1979). Colonization and bacteraemia have more recently been compared in peripheral arterial catheters and central venous catheters in the ICU setting (Koh *et al*. 2008, Traore *et al*. 2005). These studies concluded that catheter colonization and rates of CRBSI were similar in similarly managed central venous catheters and peripheral arterial catheters, so therefore peripheral arterial catheters were just as important a potential source of sepsis. In a current review, pooled results of prospective studies have shown that arterial catheter-related blood stream infection and colonization rates are equal to those in short-term, non-tunnelled central venous catheters (Gowardman *et al*. 2010). Possible causes of CRBSI related to arterial catheters are multiple blood extractions (Esteve *et al*. 2007, Rijnders 2005), improper handling of catheters and stopcocks (Esteve *et al*. 2007, Durie *et al.* 2002) and hub contamination (Mermel 2008, Rijnders 2005).

There is a large body of literature to guide infection prevention in arterial and intravascular catheters in general. Comprehensive clinical practice guidelines which synthesize evidence and advise strategies to

avoid CRBSI are available in many countries, with the best known document being that produced by the United States of America Centers for Disease Control (CDC) (O'Grady *et al*. 2011).

International surveys (El Mikatti *et al.* 1999, Rosenberg *et al.* 1989, Ryan *et al.* 2006, Tait & Tuttle 1995) have studied infection prevention adherence to guidelines in anaesthetic practice and results have revealed varied adherence to guidelines which may reflect difficulties with adherence to practice guidelines in general. A survey of current Hepatitis B immunization status and glove wearing habits of anaesthetists in Wales showed a high percentage of anaesthetists (89%) wore gloves for insertion of arterial lines, however the types of gloves were not specified (Harrison *et al*. 1990). A survey of infection prevention practices of consultant anaesthetists in the United Kingdom highlighted poor compliance with Association of Anaesthetists' Guidelines. It was reported that only 14.5% of anaesthetists used gloves for insertion of intravascular catheters and only 36.4% washed their hands between cases (El Mikatti et al. 1999). A wide range of variation was reported in New Zealand anaesthetists' hand preparation before sterile procedures in a clinical audit of hand hygiene practice in the OT (Merry *et al*. 2001). Reasons for varied guideline adherence in anaesthetic practice are not well studied. Explanations include inadequate role modeling, where trainees may have learnt poor patterns of practice from senior practitioners (El Mikatti *et al*. 1999) and a lack of reading of policy documents on infection prevention by one third of Australian and New Zealand anaesthetists (Ryan *et al*. 2006).

American research has confirmed intra-operative transmission of pathogenic bacterial organisms in the anaesthetic work area and has shown that pathogenic organisms spread to previously sterile intravascular stopcock sets (Loftus *et al*. 2008). Most recently, bacterial hand contamination as a risk factor for direct intra-operative bacterial transmission has been studied and the contaminated hands of anaesthesia providers have been directly implicated in the contamination of stopcock sets (Loftus *et al*. 2011). Thus, the practice of anaesthesia providers clearly plays a key role in the prevention of CRBSI when managing peripheral arterial catheters.

THE STUDY

Aim

The aim of the study was to investigate reported practice compared with research recommendations to minimise diagnostic blood loss and CDC Guidelines to maximise CRBSI prevention during insertion and access of peripheral arterial catheters in Australian OTs.

Design

A cross-sectional descriptive survey was used.

Sample

A purposive sample of 106 OTs was screened from the population of Australian OTs. These hospitals were selected from the Australian and New Zealand Intensive Care Society (ANZICS) adult database (Australian & New Zealand Intensive Care Society 2009), as they carried out complex surgical procedures requiring arterial catheter monitoring and reflected a wide geographical distribution around Australia. Nurse unit managers of anaesthetic services were selected to provide an informed single response from each site. The final available sample was 92 OTs where nurse unit managers were present during the survey period, had expressed interest in participation during initial phone contact and had personal computer access at their workplace.

Methods

Data Collection Instrument

A 19 question internet survey was developed by the primary author from the software development website: http://www.limesurvey.org/. Demographic data were obtained from questions which described the health care sector, the number of OTs and the number of peripheral arterial catheters inserted per annum. Questions were constructed regarding peripheral arterial catheter management related to diagnostic blood loss using evidence-based practice recommendations. Similarly, questions were developed to reflect recommended peripheral arterial catheter management according to the CDC

Guidelines. The relevant sections in the CDC Guidelines' Recommendations for the Prevention of Intravascular Catheter-Related Infections (O'Grady *et al*. 2002) were: Hand hygiene; Aseptic technique during catheter insertion and care; Catheter site care; Catheter site dressing; Needleless intravascular devices; and Intravascular access ports.

The questions were constructed to elicit demographic details of each operating theatre complex, as well as to provide specific information about peripheral arterial catheter practices. The question topics were health care sector, number of theatres, written policy for ABG sampling, number of peripheral arterial catheters inserted over one year, infusate, personnel taking ABGs, discard volume, discard returned to the patient, deadspace volume, aseptic technique, hand hygiene before insertion and sampling, glove use for insertion and sampling, personal protective equipment (PPE), care of access ports, dressings and securement of catheters, labelling of catheters and variance of sampling practices [Appendix 1, Supplementary Material].

Data collection

Data were collected from May - June, 2009. Emails containing links to the internet survey were forwarded to the prospective participants. Weekly reminder emails were sent. Completed surveys were automatically and anonymously saved in the database. Completion was noted electronically. The saved data were available for export to statistical software.

Validity and reliability

The questionnaire was validated by a panel of eight expert anaesthetic practitioners who assessed the questionnaire for face and content validity. There was consensus agreement following minor changes that the questions accurately reflected the phenomena of interest. The questionnaire's reliability was tested prior to data collection. A test-retest was performed to establish the instrument's stability over time. The questionnaire was completed by 59 anaesthetic practitioners on two occasions, two weeks apart, to measure agreement between Time 1 and Time 2. Percentage agreement and the probability for significant change were calculated using the McNemar and McNemar-Bowker tests. There was no significant change

between the answers for Time 1 and Time 2 for all 19 questions (p-values range from 0.32 - 1.00), confirming the instrument's test-retest reliability.

Ethical considerations

Ethics approval for the study was obtained from the university and hospital Human Research Ethics Committees. The participants implied consent on voluntary completion of the questionnaire and were informed of confidentiality, the ability to refuse to participate and the possibility of withdrawal from the study at any time without adverse consequences.

Data analyses

Practice was compared with evidence-based practice recommendations for minimal discard volume for ABG sampling (Dennis *et al.* 1985, Clapham *et al.* 1985, Preusser *et al*. 1989, Fowler & Berenson 2003, Rickard *et al*. 2003). Practice was also considered in relation to the Centers for Disease Control Guidelines for the Prevention of Intravascular Catheter-Related Infections (O'Grady *et al.* 2002) and the PS28 Australian and New Zealand College of Anaesthetists' (ANZCA) Guidelines on Infection Prevention in Anaesthesia in Australia and New Zealand (Australian and New Zealand College of Anaesthetists 2005). Discard volume is defined as the amount of blood discarded to clear the arterial line prior to ABG sampling (Clapham *et al.* 1987) and deadspace volume is the volume from the peripheral arterial catheter tip to the sampling port (Dennis *et al*. 1985).

Data were analysed using PASW® Statistics for Windows Version 17.0 (Chicago, IL). Categorical results are reported as number of respondents and per cent of the total respondents. The continuous variables deadspace volume and discard volume are reported as median volume, range and inter-quartile range (IQR). Bivariate analysis was conducted to determine the association of survey variables with facility type. Associations between categorical variables were tested using Pearson's chi-square test and Fisher's exact test, as appropriate. Two-sided p values < 0.05 were considered evidence of a statistically significant association.

Results

Sample characteristics

The survey was completed by 64 of the 92 potential participants, giving a response rate of 70%: 45 (70.3%) of respondents worked in a public sector facility, 15 (23.4%) in the private sector and 4 (6.3%) in a joint public/private sector facility. Respondents came from all six Australian states and the two Australian territories [Figure 1]. There was no follow up of non-respondents as their details were protected. When data were entered into the electronic survey tool, identifying characteristics were automatically removed. No significant association was found between respondents and non-respondents by health care sector ($p = 0.91$). Table 1 shows the number of OTs and number of peripheral arterial catheters inserted per year by facility type. There was no significant association between the number of OTs and the health care sector ($p = 0.26$). Differences in guideline compliance by health care sector are listed in Table 2.

Discard and deadspace volumes for blood gas sampling

Literature consensus recommends a minimum discard volume for accuracy as twice the dead space of the arterial catheter tubing (Preusser *et al*. 1989, Rickard *et al*. 2003). Respondents provided data on discard volumes which varied from 2 to 20 ml. Each respondent only provided volumes for either a short or a long line [Table 3]. Data on deadspace volumes were provided by only 17 (27%) respondents. Eleven (17%) of these respondents reported the recommended ratio of 2:1 for discard to deadspace volume, with the remainder reporting ratios of 0.6-5.0:1.

Discard blood

Use of a closed blood sampling system including returning patients' blood is associated with reduced blood wastage and increased haemoglobin (Preusser *et al*. 1989). Sixty four per cent (41) of respondents said that discard blood was not returned to the patient and three (5%) reported that discard blood was always returned to the patient. The remaining 20 (31%) respondents stated that discarded blood was sometimes returned to the patient.

Written policy

Nineteen (30%) of respondents did not have a written policy for ABG sampling and 4 (6%) did not know if a policy existed.

Infusate

The use of normal saline as the arterial line flush solution decreases the amount of required discard blood volume needed for accurate test results (Del Cotillo *et al.* 2008). A majority of 56 (88%) respondents used 0.9% sodium chloride as the flush solution for peripheral arterial catheters in their facility, while the remaining 8 (12%) respondents reported heparinised saline for this purpose.

Personnel

A variety of personnel were reported as performing ABG sampling, with multiple personnel involved. Anaesthetists performed the procedure in 62 (97%) of responses, while nurses performed the procedure in 44 (68%) surveys. Anaesthetic technicians took ABG samples in 13 (20%) reports. Other team members who collected ABG samples were anaesthetic registrars, anaesthetic residents/interns, medical perfusionists, physiologists and recovery nurses.

Infection prevention for insertion

Compliance with CDC Guidelines for the required use of sterile gloves for peripheral arterial catheter insertion (O'Grady *et al*. 2002) was 58% (37 respondents) [Table 4]. The use of both sterile and non-sterile gloves was reported by 12 (19%) respondents. Only one report stated that no gloves were worn for

insertion. Compliance of 100% by 64 respondents with the CDC Guidelines was reported for correct use of either a conventional handwash or alcoholic hand rub prior to peripheral arterial catheter insertion. The preferred solution of chlorhexidine to disinfect the insertion site (O'Grady et al. 2002) was reported by 30 (47%) respondents.

Infection prevention for access

Gloves are required according to occupational safety and health requirements as standard precautions for the prevention of bloodborne pathogen exposure prior to accessing an arterial line. This correct procedure includes an aseptic technique and use of non-sterile gloves (O'Grady *et al*. 2002). Practice compliance with the use of non-sterile gloves was a frequently reported infection prevention measure prior to ABG sampling and this occurred in 50 (78%) of reports. Handwashing prior to sampling was only reported by 19 (30%) respondents and the use of alcoholic rub before sampling was reported by 16 (25%) respondents [Table 4]. Importantly, 26 (40%) respondents reported access ports as never wiped. Access ports were estimated to be wiped 75-100% of the time in only 14 (22%) reports with the required 70% alcohol or an iodophor of iodine, according to CDC Guidelines (O'Grady *et al*. 2002).

Practice variation

Wide estimated variation of between 25-100% was rated for ABG sampling practices performed by anaesthetists by 32 (50%) respondents. That is, variation was reported to occur 75% of the time.

Discussion

With ABG sampling being a recognized contributor to iatrogenic anaemia which may require blood transfusion (O'Hare & Chilvers 2001), the most important measures to decrease diagnostic blood loss have been to discard a blood volume of twice the deadspace from the peripheral arterial catheter tip to the sampling port (Preusser *et al*. 1989, Rickard *et al*. 2003), or to return the discard blood to the patient through a closed arterial line system (Gleason et al. 1992, Peruzzi et al. 1993, Silver et al. 1993). Our wide range of reported discard volumes (2-20 ml) for different lines suggests that varying amounts of blood are discarded and indicates a lack of understanding of the recommended discard volume of twice

the deadspace. Many respondents (64%) reported that this blood was never returned to the patient and there was no reported use of closed collection systems. Thus, varying amounts of blood loss can be inferred. Consequently, accuracy and consistency of blood test results cannot be guaranteed unless a minimum discard volume calculated for a specific arterial line is withdrawn (Rickard et al. 2003). Most respondents (88%) reported compliance with the practice of using 0.9% sodium chloride flush solution and this was a positive finding that assisted in minimising blood loss. Less discard volume is required when using sodium chloride compared with heparised saline (Tuncali *et al*. 2005, Del Cotillo *et al*. 2008).

It is of concern that many respondents (73%) did not know the deadspace volumes of their arterial lines. This suggests that calculation of a discard volume of twice the deadspace was most likely not performed. Discard volumes from either short or long lines of 10 ml were reported by 14 (22%) respondents and it is possible these discard volumes may have been standardised to some other criteria, for example syringe size. The results show a wide range in ABG sampling practices which may reflect the different practitioners who performed the ABG sampling procedure in the OT. With discard volumes often exceeding the recommended ratio, patients in the OT are likely to be experiencing unnecessary blood loss.

Infection prevention practices also showed a wide diversity and varying compliance with guidelines. Non-sterile gloves were used more frequently than the required sterile gloves during insertion of peripheral arterial catheters, contrary to CDC Guidelines. Although gloves are widely used for catheter insertion and ABG sampling, the correct choice of sterile gloves as opposed to non-sterile, is not well followed. Some anaesthetists may refer to ANZCA Guidelines on Infection Control in Anaesthesia (Australian and New Zealand College of Anaesthetists 2005) in preference to CDC Guidelines to guide practice, where glove types are not specified for individual procedures. Hand hygiene in contrast to glove use was reported as being well performed prior to insertion, but poorly practiced prior to ABG sampling. This latter lack of compliance may reflect an inaccurate belief that use of gloves alone meets infection prevention standards. Our study concurs with previous reports of lack of knowledge of guidelines and inconsistent guideline

adherence (Kempen & Learned 1989, O'Donnell & Asbury 1992, McNamara & Stacey 1999, Asai *et al.* 2000, Stein *et al.* 2003). Fewer than half of the surveys reported use of the CDC recommended chlorhexidine as the preferred solution to disinfect the peripheral arterial catheter site prior to insertion (O'Grady *et al*. 2002). This indicates a need to ensure that written policies are up-to-date to reflect current guidelines. It is concerning that this survey reports that access ports were never disinfected prior to use in 40% of reports. Research has shown that accessing peripheral arterial catheters with multiple extractions and improper handling of arterial catheters and lines may increase infection risk (Band & Maki 1979, Durie *et al*. 2002, Esteve *et al*. 2007). It is noted that the 2011 update of the CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections (O'Grady *et al*. 2011) was published during the preparation of this paper. There were no major changes to the guidelines addressed in our study.

There were two important outcomes in this study across Australian OTs. First, the results showed that ABG sampling practice infrequently matched evidence-based practice recommendations. Second, only one area of infection prevention practice, hand hygiene before peripheral arterial catheter insertion, was totally compliant with guidelines. Diversity and inconsistency in practices are highlighted. These findings are congruent with the inconsistent practice and lack of adherence to CDC Guidelines previously reported in surveys of central venous line practices in settings outside the OT (Harbath *et al*. 2002, Rickard *et al*. 2004), non-compliant use of gloves and sub-optimal hand hygiene (Harrison *et al.* 1990, Merry *et al.* 2001, Trampuz & Widmer 2004).

Our results reveal contrasting compliance in the health sector for 3 key variables. The private health care sector in particular, was less likely to use the required sterile gloves for peripheral arterial catheter insertion and protective eyewear for ABG sampling than public hospitals. However, there was a universal correct use of 0.9% sodium chloride for flushing arterial lines in the private sector. The public sector also had a high (84%) compliance with this procedure. Audits of practice are needed to assess currency of protocols and how they reflect guidelines in the private health care sector. This would be useful data, as

there is a lack of literature which investigates compliance differences and reasons for these in different health care sectors.

The cross-sectional survey method has been effectively used by health care researchers to investigate clinical practice (Tarpey & Lawler 1990, Alvaran *et al.* 1994, Henry *et al.* 1994, Clemence *et al.* 1995. Beaujean *et al.* 2000, Tait *et al.* 2000. There are, however, some limitations particular to this study. Firstly, there is an inability to comment on trends over time. Also, self-reported questionnaires have been shown to overestimate infection prevention adherence (Henry *et al*. 1994) which increases our concerns about the reported non-compliance. A further limitation is that the study relies on the nurse unit managers' perception of OT practices. However, we chose nurse unit managers as they are highly skilled and knowledgeable clinicians who are in a position to comment on the clinical practices of a range of health practitioners in the OT environment (Queensland Health 2008). Direct observation of practice, while reducing recall bias, would have required resources beyond the scope of this project. It is also acknowledged that the results of this study should not be generalized to represent practices in OTs outside Australia.

Conclusion

This survey has shown that there is scope for improvement in the Australian OT setting to reduce blood loss from diagnostic arterial blood sampling and to perform the correct infection prevention measures to minimise the risk of post-operative CRBSI in peripheral arterial catheters. Best practice guidelines should be incorporated into up-to-date policy, practice and unit education. Different members of the anaesthetic team may possess various views regarding compliance with guidelines and protocols (Stein et al. 2003). Compromise over these different views, taking into account the strength of evidence for various practices, should be the primary aim to assist in reconciling non-compliance. A quality audit tool developed by anaesthetic nurses in collaboration with the anaesthetic team, may assist to attend specifically to improving knowledge of the practices of using the minimum discard volume of twice the deadspace for arterial blood sampling and the use of recommended solutions to disinfect the peripheral arterial catheter

insertion site and access ports. It should also address the performance of correct hand hygiene procedures and use of gloves not only with insertion, but with access of peripheral arterial catheters as well. Similar research is suggested internationally to test generalisability of our Australian findings. The identification of barriers to compliant behaviours in the operating theatre is a future direction for further research. Thus, the proposed generation of strategies for the anaesthetic team to improve guideline compliance would facilitate the goal of best practice for peripheral arterial catheter care in Australia and beyond.

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TABLES

Table 1 Number of operating theatres and peripheral arterial catheter insertions per year by health care sector.

	Public	**Private**	**Public / Private**
	n (%)	**n (%)**	**n (%)**
Number of OTs*			
1-6	22 (48.8)	5 (33.3)	1 (25.0)
7-12	16 (35.5)	8 (53.3)	2 (50.0)
13-18	4 (8.8)	1 (5.3)	0 (0.0)
>18	3 (6.6)	1 (5.3)	1 (25.0)
Number of PACs† inserted			
1-500	19 (42.2)	4 (26.7)	2 (50.0)
501-1500	11 (24.4)	8 (53.3)	1 (25.0)
1501-2000	9 (20.0)	1 (6.7)	1 (25.0)
>2000	5 (11.1)	2 (13.3)	0 (0.0)

*OT; operating theatre † PAC; peripheral arterial catheter

Table 2 Prevalence of key nominal non-compliance variables by health care sector.

Variables	Public n (%)*	Private n (%)*	Public/ Private n (%)*	p value
Non-sterile gloves for PAC‡ insertion	23 (51.1)	13 (86.6)	3 (75.0)	0.042
No protective eyewear for ABG† sampling	29 (64.4)	14 (93.3)	4 (100.0)	0.042
Use of heparinised saline flush solution	6 (13.3)	_	2 (50.0)	0.026

* %; Refers to the number per type of facility with totals as follows: public sector (45), private (15) and public/private (4) †ABG; arterial blood gas ‡ PAC; peripheral arterial catheter

Table 3 Characteristics of deadspace volumes (ml) and discard volumes (ml) for long and short arterial lines. Values are number, median, minimum values, maximum values and IQR range.

Volumes	**Number of responses**	**Median (ml)**	**Minimum (ml)**	**Maximum (ml)**	**Interquartile range (ml)**
Deadspace volume					
Short line	11	3	0.50	10.00	1.00 – 5.00
Long line	6	3	0.50	6.50	1.63 – 3.88
Discard volume					
Short line	43	5	2.00	10.00	4.50 - 5.50
Long line	21	10	3.00	20.00	10.00 - 10.00

Table 4 Glove use and hand hygiene measures for peripheral arterial catheter insertion and arterial blood gas sampling.

Infection control measure	PAC* insertion n (%)‡	ABG† sampling n (%)‡
Gloves		
Sterile	37 (58) §	12 (19)
Non-Sterile	39 (61)	50 (78)§
Nil	1 (1.6)	2 (3)
Hand hygiene		
Handwash	41 (64)§	19 (30)§
Alcohol Rub	28 (44)§	16 (25)§
Nil	0	1 (1.6)

*PAC; peripheral arterial catheter † ABG; arterial blood gas ‡ Note; Multiple options could be selected, thus items do not add to 100% (n=64) §; Compliant with CDC Guidelines

FIGURE 1

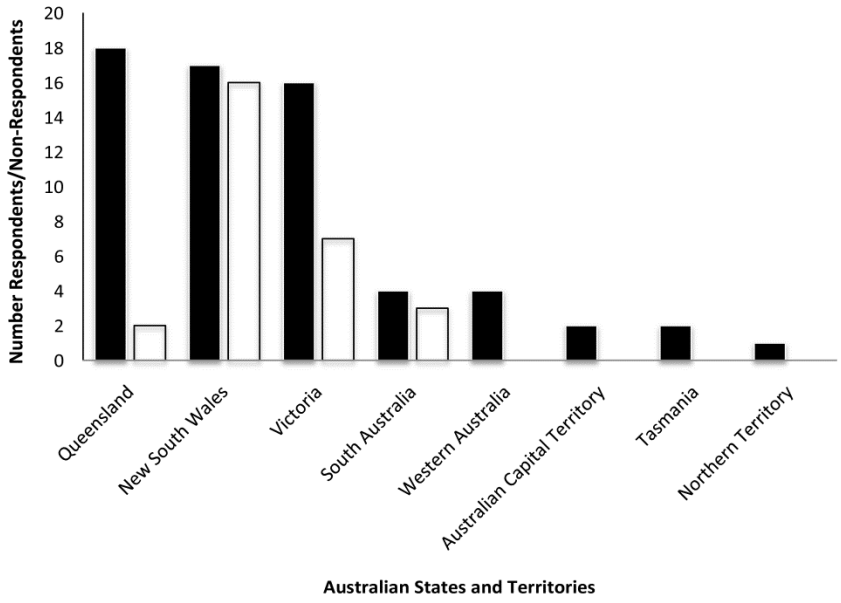

Figure 1 Geographical distribution of survey respondents (■) (n=64) and non-respondents (□) (n=28).

APPENDIX

Questionnaire