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Methods: A retrospective clinical audit was undertaken. Complications included in this study are: malposition events, thrombotic/thrombophlebitis, infection and dysfunction.

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Conclusion: This study highlights that the potential advantages of reduced expected cost- and labour- effectiveness of PICCs as traditionally perceived, may be inaccurate, and further awareness of complications associated with PICCs need to be considered.

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I. INTRODUCTION

Obtaining central venous access that is cost effective, safe and dependable is an important consideration in the management of acutely ill patients. This access is important to provide prolonged administration of intravenous medication, access for chemotherapy, parenteral nutrition, haemodialysis, and resuscitation in intensive care settings.¹

Central venous access can be achieved using two main groups of catheters, namely central venous catheters (CVCs) and peripherally inserted central catheters (PICCs). Due to the elimination of the associated risks of haemorrhage and pneumothorax with CVC insertion, and given that PICCs can be inserted at the bedside by medical and nurse-based teams, PICCs have been the favoured central catheter type. They are seen to be more cost-effective and labour efficient.

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In the past few years, there have been several studies and reviews, which have challenged whether PICCs improve overall quality of patient care. These studies argue that with increased complications such as malpositions, infections and thrombotic events associated with PICCs, they may not be as cost and labour effective as previously perceived. A recent meta-analysis has found malpositioning events (9.3% vs 3.4%); thrombophlebitis rates (78 vs 7.5 per 10 000 indwelling days); catheter dysfunction (78 vs 14 per 10,000 indwelling days) occurred more often in PICCs than CVCs respectively.² The usage of PICCs in replacement of CVCs for similar indications are reported to be increasing, and awareness that PICCs may have higher complication rate is not widespread.¹

In light of this emerging evidence, this study sets out to compare the complication rates between PICCs and CVCs electively inserted in operating theatre by the anaesthetics team at The Canberra Hospital within a six months period. The complications looked at in this study include the malposition events, rates of thrombotic/thrombophlebitis, infection and dysfunction.

II. METHODS

This study is a retrospective clinical audit of patient data using the medical record database at The Canberra Hospital. All patients, age greater than 16 years old, with central lines (PICCs and CVCs) inserted in the operating theatre by anaesthetists within six months period starting from 01/06/2011 to 31/12/2011 were included in the audit. Only non-tunnelled CVCs are included in this study. Complications included in this study are: malposition events, thrombotic/thrombophlebitis, infection and dysfunction.

Post-procedural X-ray showing the tip of the central line not being in the desirable position determines malposition event. The optimal positions of central catheter tips for most indications are recognised to be the distal portion of the Superior Vena Cava (SVC) and high right atrium.

Thrombotic/thrombophlebitis is defined to include transient superficial thrombophlebitis and phlebitis as clinical diagnosis of erythema and tenderness around the catheter exit site and thrombi, which form in the deep venous system, which are demonstrated radiologically.

Infection is defined to include local skin infection as clinical diagnosis of erythematous, oozing

skin, with/without purulent discharge at site of exit of catheter; and Catheter-Related Bloodstream Infection (CRBSI). CRBSI is defined as “the clinical manifestation of bacteremia occurring in the absence of an apparent source of infection other than the catheter, proven when the same pathogen is isolated from the involved catheter and from blood cultures”.² Dysfunction is defined as lumens being blocked for either receiving or drawing (i.e. events within the device).

The rates of complications are expressed in per 10,000 indwelling catheter days, which is calculated as the number of complication (events) over total indwelling days of the catheter multiplied by 10,000 days. Data collected was processed and analysed with Microsoft Excel 2012© for Windows. Statistics calculation was performed using MedCalc ©.

III. RESULTS

A total of 189 patients met the inclusion criteria with age ranging from 16 to 95 years old (mean age 60 years old). Gender breakdown for both central line types

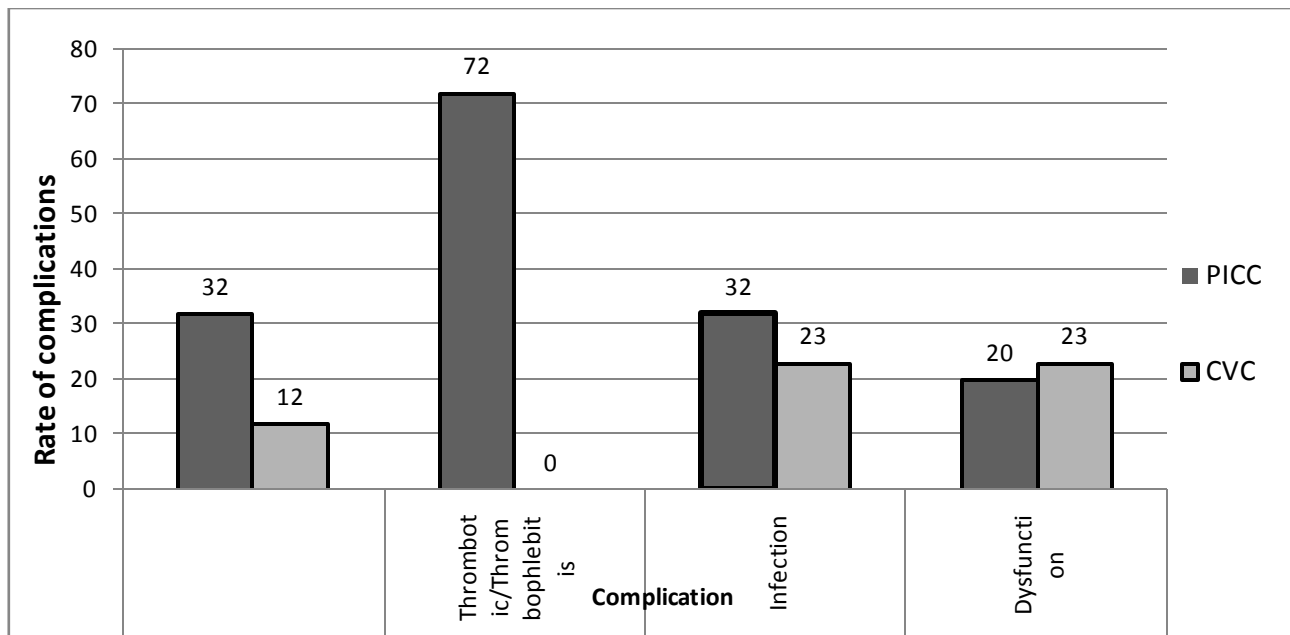
are roughly equal in number. One hundred and four PICCs (74.8%) were placed for prolonged antibiotic therapy and 15 (10.79%) to administer TPN. Twenty PICCs (14.39%) were inserted for other reasons, most commonly for patients with difficult IV access requiring blood sampling, or to administer insulin or heparin infusion. Twenty-seven CVCs (54%) were placed for haemodialysis access, 10 (20%) were inserted for IV antibiotics, 9 (18%) were inserted for TPN, 1 (2%) inserted for chemotherapy and 3 (6%) were inserted for IV access and resuscitation. PICCs have a mean indwelling time of 18 days and total of 2486 indwelling days. CVCs have a mean indwelling time of 9 days, with a total of 427 total indwelling days.

The complication rates of CVCs and PICCs in the study are summarised in Table 1 below. The most common complication in PICCs is thrombotic/thrombophlebitis events with 18 (72/10,000 indwelling days), whilst the most common complication in CVCs is malpositioning events (6 events; 12%).

Table 1 : Summary of complication rates in PICCs and CVCs inserted in 189 patients in operating theatre at The Canberra Hospital (between 1st June 2011 and 31st December 2011). * OR is estimated using the null hypothesis where there is 0 variable and regular OR unable to be calculated

Type of central catheter	Number of cases (%) n = 189	Total indwelling days	Malposition events (%)	Events (rate per 10,000 indwelling days)		
				Thrombotic/Thrombophlebitis	Infection	Dysfunction
PICC	139 (74%)	2486	45 (32%)	18 (72)	8 (32)	5 (20)
CVC	50 (26%)	427	6 (12%)	0 (0)	1 (23)	1 (23)
Odds ratio (95% CI)			3.63 (1.44 – 9.14)	4.46 (1.49 – 13.37)*	2.99 (0.36 – 24.55)	1.83 (0.21 – 16.04)

Malpositioning of the catheter tips more often occurred after PICCs insertion than CVCs (32% vs 12%; OR 3.51 (95% CI 1.39 – 8.84); P-value 0.006). Similarly, the rates of thrombotic/thrombophlebitis events were higher in PICCs than CVCs (72 vs 0/10,000 indwelling days; estimated OR 4.46 (95% CI 1.49 – 13.37)). There was no statistical difference in the catheter associated infection rates with 32 vs 23/10,000 indwelling days (OR 2.99; 95% CI 0.36 – 24.55); P-value 0.31) for PICCs and CVCs respectively. Similarly, the rate of dysfunction was found to be no difference between the two types of central lines (20 vs 23/10,000 indwelling days (OR 1.83; 95% CI 0.21 – 16.04)) for PICCs and CVCs respectively. These findings are summarised in Graph 1 below.



Graph 1 : Comparison of complications rates between PICCs and CVCs

Nil CVC tips sent to microbiology returned with positive growth for any microbiology, whilst seven PICCs returned with positive microbiology, namely Coagulase negative Staphylococcus (n=3); Micrococcus species (n=1); Streptococcus viridians (n=1) and mixed skin type flora (n=1). Additionally, we observed one possible case of CRBSI in a patient with PICC line inserted.

The data was also analysed to establish the number of catheter indwelling days before complications arise. The highest number of complications in both PICCs and CVCs occurred with total of 22 cases of PICCs and 2 cases of CVCs occurred during the first 7 indwelling days.

PICCs inserted for IV antibiotics have the highest rate of complications, with 11 thrombotic/thrombophlebitis events (44/10,000 indwelling days) followed by 8 infections (32/10,000 indwelling days) and 5 dysfunctions (20/10,000 indwelling days). PICCs inserted for TPN have the next

highest rate of complications with 4 thrombotic/thrombophlebitis events (16/10,000 indwelling days), 3 infections (12/10,000 indwelling days) and 0 dysfunctions.

IV. DISCUSSION

The findings of this study are compared with other studies performed elsewhere during the period 1966 – 2011 as described in literature review.² This study's complication rate of malposition is statistically significantly higher in PICCs than in CVCs (32% Vs 12%), and is consistent with the finding of other studies (Table 2). The malposition rate of 32% of this study is noted to be significantly higher than in other studies.^{3,4} This study also showed that PICCs have higher rates of thrombotic/thrombophlebitis complications than CVCs, in contrast to four other studies which showed that CVCs have higher infection rates than PICCs.

Table 2 : Comparison of data collected in other studies with this study

Catheter type (number of events)	Total indwelling day	Malposition (%)	Complications rate (rate per 10,000 indwelling days)			Study
			Thrombotic/ Thrombophlebitis	Infection	Dysfunction	
PICC (135)	1381	4	22	0	36	(3)
CVC (135)	1056	3	0	19	0	
PICC (51)	482	10	166	41	166	(4)
CVC (51)	533	2	19	56	38	
PICC (209)	2209	10	113	9	131	(5)
CVC (285)	3597	2	33	22	14	
PICC (472)	2313	NA*	246	9	151	(6)
CVC (713)	4421	NA*	41	0	149	

PICC (75)	1815	NA*	77	66	NA*	(7)
CVC (31)	583	NA*	34	103	NA*	
PICC (139)	2486	32%	72	32	36	This
CVC (50)	247	12%	0	23	23	study

*NA: Data not reported

It was discussed in a recent review, that lower infection rates in PICCs found in studies may have been due to comparison of rates between stable in-patient and/or outpatient in PICC cohorts, with unstable, acutely ill ICU patients in CVC cohorts.⁸ It has been hypothesised that PICCs may also have lower infection rates due to the catheter insertion site of antecubital fossa, a less ideal environments for bacterial growth compared to the subclavian and jugular vein areas which may be contaminated by nasal and oral flora.⁹

One confounding factor explaining lower thrombotic/thrombophlebitis rate in CVCs in this study may be due to the predominant indication of CVCs is for haemodialysis, which often include the use of prophylactic heparin. PICCs were also found to have a significantly higher rate of malposition events, and it has been theorised that thrombosis could be caused by initial malposition event.¹ It may be useful for future studies to consider whether thromboprophylaxis in PICCs may reduce the complication rate.

Traditional ICU literature recommends approximately 1 week of indwelling time for CVCs, whilst there is a big range of recommended time of stay for PICCs in the literature. It is often assumed that for indications with longer indwelling time; PICCs would be the preferred choice to CVCs.⁹ Our study shows that most complication arise within 7 days of catheter insertion, for both PICCs and CVCs. A review has also shown that 30-40% of PICC have to be removed before completion of therapy.¹ These findings suggest that PICCs may not necessarily have a lower rate of complications for indications, which require longer indwelling time.

There are limitations of this study that must be taken into consideration. Firstly, this was a retrospective study, the definition of complication cannot be standardised and relied solely on recorded documentations. Additionally, the study has limited sample size, particularly in CVCs with short indwelling days, and multiple zero for data collected in complication rates, making statistical analysis difficult.

There are multiple confounding factors identified in this study including patients' co-morbidities and immune status; and differences in indications between CVCs and PICCs mean that CVCs already have a biased of shorter indwelling time and therefore less possibility of having complications developing. The study also did not differentiate the complication differences in tunnelled versus non-tunnelled, jugular or subclavian inserted CVCs, which are widely reported in literature to have difference in complications rates.

V. CONCLUSION

Our study found that PICCs line has higher rate of complications, especially malposition events and thrombotic/thrombophlebitis, in comparison to CVCs. Serious complication, such as CRBSI, might also arise with insertion of PICC line. This study highlights that the potential advantages of reduced expected cost- and labour-effectiveness of PICCs as traditionally perceived, may be inaccurate, and further awareness of complications associated with PICCs need to be considered. Clinicians should carefully take into account patient factors such as immune status, co-morbidities, and gender prior to deciding which central venous access to use.

VI. ACKNOWLEDGEMENTS

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VII. CONFLICT OF INTEREST

The authors have no financial and personal relationships with other people or organizations that could inappropriately influence (bias) this submission.

VIII. FUNDING SOURCE

The authors have no extra or intra-institutional funding to declare.

IX. APPENDIX

Table 1: Summary of complication rates in PICCs and CVCs inserted in 189 patients in operating theatre at The Canberra Hospital (between 1st June 2011 and 31st December 2011). * OR is estimated using the null hypothesis where there is 0 variable and regular OR unable to be calculated.

Graph 1: Comparison of complications rates between PICCs and CVCs.

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REFERENCE RÉFÉRENCES REFERENCIAS

1. Turcotte S, Dube S, Beauchamp G. Peripherally inserted central venous catheters are not superior to central venous catheters in the acute care of surgical patients on the ward. World journal of surgery. 2006 Aug;30(8):1605-19. PubMed PMID: 16865322. Epub 2006/07/26. eng.
2. Pikwer A, Akeson J, Lindgren S. Complications associated with peripheral or central routes for

- central venous cannulation. *Anaesthesia*. 2012 Jan;67(1):65-71. PubMed PMID: 21972789. Epub 2011/10/07. eng.
3. Alhimyary A, Fernandez C, Picard M, Tierno K, Pignatone N, Chan HS, et al. Safety and efficacy of total parenteral nutrition delivered via a peripherally inserted central venous catheter. *Nutrition in clinical practice : official publication of the American Society for Parenteral and Enteral Nutrition*. 1996 Oct;11(5):199-203. PubMed PMID: 9016135. Epub 1996/10/01. eng.
 4. Cowl CT, Weinstock JV, Al-Jurf A, Ephgrave K, Murray JA, Dillon K. Complications and cost associated with parenteral nutrition delivered to hospitalized patients through either subclavian or peripherally-inserted central catheters. *Clinical nutrition (Edinburgh, Scotland)*. 2000 Aug;19(4):237-43. PubMed PMID: 10952794. Epub 2000/08/23. eng.
 5. Duerksen DR, Papineau N, Siemens J, Yaffe C. Peripherally inserted central catheters for parenteral nutrition: a comparison with centrally inserted catheters. *JPEN Journal of parenteral and enteral nutrition*. 1999 Mar-Apr;23(2):85-9. PubMed PMID: 10081998. Epub 1999/03/19. eng.
 6. Giuffrida DJ, Bryan-Brown CW, Lumb PD, Kwun KB, Rhoades HM. Central vs peripheral venous catheters in critically ill patients. *Chest*. 1986 Dec;90(6):806-9. PubMed PMID: 3780327. Epub 1986/12/01. eng.
 7. Worth LJ, Seymour JF, Slavin MA. Infective and thrombotic complications of central venous catheters in patients with hematological malignancy: prospective evaluation of nontunneled devices. *Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer*. 2009 Jul;17(7):811-8. PubMed PMID: 19096883. Epub 2008/12/20. eng.
 8. Amerasekera SS, Jones CM, Patel R, Cleasby MJ. Imaging of the complications of peripherally inserted central venous catheters. *Clinical radiology*. 2009 Aug;64(8):832-40. PubMed PMID: 19589422. Epub 2009/07/11. eng.
 9. McGee DC, Gould MK. Preventing complications of central venous catheterization. *The New England journal of medicine*. 2003 Mar 20;348(12):1123-33. PubMed PMID: 12646670. Epub 2003/03/21. eng.