

1 A Comparison Study of Complication Rates -To PICC or to 2 CVC?

3 Krishanth Naidu¹, Hilman Harryanto² and Bella Nguyen³

4 ¹ THE CANBERRA HOSPITAL

5 Received: 15 December 2013 Accepted: 3 January 2014 Published: 15 January 2014

6

7 **Abstract**

8 Background: Cost-effective, safe and dependable central venous access is fundamental in the
9 care of anpatients. This study sets out to compare the complication rates between electively
10 insertedperipheral (PICCs) and central venous catheters (CVCs) in operating
11 theatres.Methods: A retrospective clinical audit was undertaken. Complications included in
12 this study are: malposition events, thrombotic/thrombophlebitis, infectio n and
13 dysfunction.Results: A total of 189 patients met the inclusion cr iteria. Malpositioning of the
14 catheter tips and thrombotic/thrombophlebitic events more often occurred after PICCs
15 insertion than CVCs. There was no statistical difference in the catheter associated infection
16 and dysfunctio n rate for PICCs and CVCs. The highest number of complications occured in
17 the first 7 indwelling days. Conclusion:This study highlights that the potential advantages of
18 reduced expected cost-and labour-effectiveness of PICCs as traditionally perceived, may be
19 inaccurate, and further awareness of complications associated with PICCs need to be
20 considered.

21

22 **Index terms**— central venous access, complications, picc, cvc, thrombophlebitis.

23 **1 A Comparison Study of Complication Rates -To**

24 **PICC or to CVC?**

25 Abstract-Background: Cost-effective, safe and dependable central venous access is fundamental in the care
26 of anpatients. This study sets out to compare the complication rates between electively insertedperipheral (PI
27 CCs) and centr al veno us catheters (CVCs) in operating theatres.

28 Methods: A retrospective clinical audit was undertaken.

29 Complicatio ns included in this study are: malposition events, thrombotic/thrombophlebitis, infectio n and
30 dysfunctio n.

31 Results: A total of 189 patients met the inclusion cr iteria.

32 Malpositioning of the catheter tips and thrombotic/thrombophlebitic events more often occurred after PICCs
33 insertion than CVCs. Ther e was no statistical difference in the catheter associated infection and dysfunctio n
34 rate for PICCs and CVCs. The highest number of complications occurred in the first 7 indwelling days.

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

38 In the past few years, there have been several studies and reviews, which have challenged whether PICCs
39 improve overall quality of patient care. These studies argue that with increased complications such as
40 malpositions, infections and thrombotic events associated with PICCs, they may not be as cost and labour
41 effective as previ ously perceived. A recent metaanalysis has found malpositioning events (9.3% vs 3.4%);
42 thrombophlebitis rates (78 vs 7.5 per 10 000 indwelling days); catheter dysfunction (78 vs 14 per 10,000 indwelling
43 days) occurred more often in PICCs than CVCs respectively. ?? The usage of PICCs in replacement of CVCs for

5 RESULTS

44 similar indications are reported to be increasing, and awareness that PICCs may have higher complication rate
45 is not widespread. In light of this emerging evidence, this study sets out to compare the complication rates
46 between PICCs and CVCs electively inserted in operating theatre by the anaesthetics team at The Canberra
47 Hospital within a six months period. The complications looked at in this study include the malposition events,
48 rates of thrombotic/thrombophlebitis, infection and dysfunction.

49 2 II.

50 3 Methods

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

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

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

62 Infection is defined to include local skin infection as clinical diagnosis of erythematous, oozing Introduction
63 obtaining central venous access that is cost effective, safe and dependable is an important consideration in the
64 management of acutely ill patients. This access is important to provide prolonged administration of intravenous
65 medication, access for chemotherapy, parenteral nutrition, haemodialysis, and resuscitation in intensive care
66 settings. 1 Central venous access can be achieved using two main groups of catheters, namely central venous
67 catheters (CVCs) and peripherally inserted central catheters (PICCs). Due to the elimination of the associated
68 risks of haemorrhage and pneumothorax with CVC insertion, and given that PICCs can be inserted at the bedside
69 by medical and nurse-based teams, PICCs have been the favoured central catheter type. They are seen to be
70 more cost-effective and labour efficient.

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

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

80 4 III.

81 5 Results

82 A total of 189 patients met the inclusion criteria with age ranging from 16 to 95 years old (mean age 60 years old).
83 Gender breakdown for both central line types are roughly equal in number. One hundred and four PICCs (74.8%)
84 were placed for prolonged antibiotic therapy and 15 (10.79%) to administer TPN. Twenty PICCs (14.39%) were
85 inserted for other reasons, most commonly for patients with difficult IV access requiring blood sampling, or to
86 administer insulin or heparin infusion. Twenty-seven CVCs (54%) were placed for haemodialysis access, 10 (20%)
87 were inserted for IV antibiotics, 9 (18%) were inserted for TPN, 1 (2%) inserted for chemotherapy and 3 (6%)
88 were inserted for IV access and resuscitation. PICCs have a mean indwelling time of 18 days and total of 2486
89 indwelling days. CVCs have a mean indwelling time of 9 days, with a total of 427 total indwelling days.

90 The complication rates of CVCs and PICCs in the study are summarised in Table 1 below. The most common
91 complication in PICCs is thrombotic/thrombophlebitis events with 18 (72/10,000 indwelling days), whilst the
92 most common complication in CVCs is malpositioning events (6 events; 12%). Malpositioning of the catheter
93 tips more often occurred after PICCs insertion than CVCs (32% vs 12%; OR 3.51 (95% CI 1.39 -8.84); P-value
94 0.006). Similarly, the rates of thrombotic/thrombophlebitis events were higher in PICCs than CVCs (72 vs
95 0/10,000 indwelling days; estimated OR 4.46 (95% CI 1.49 -13.37)). There was no statistical difference in the
96 catheter associated infection rates with 32 vs 23/10,000 indwelling days (OR 2.99; 95% CI (0.36 -24.55); P-value
97 0.31) for PICCs and CVCs respectively. Similarly, the rate of dysfunction was found to be no difference between
98 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
99 CVCs respectively. These findings are summarised in Graph 1 below.

100 Graph 1 : Comparison of complications rates between PICCs and CVCs. Nil CVC tips sent to microbiology
101 returned with positive growth for any microbiology, whilst seven PICCs returned with positive microbiology,
102 namely Coagulase negative Staphylococcus (n=3); Micrococcus species (n=1); Streptococcus viridans (n=1)

103 and mixed skin type flora (n=1). Additionally, we observed one possible case of CRBSI in a patient with PICC
104 line inserted. The data was also analysed to establish the number of catheter indwelling days before complications
105 arise. The highest number of complications in both PICCs and CVCs occurred with total of 22 cases of PICCs
106 and 2 cases of CVCs occurred during the first 7 indwelling days.

107 PICCs inserted for IV antibiotics have the highest rate complications, with 11 thrombotic/thrombophlebitis
108 events (44/10,000 indwelling days) followed by 8 infections (32/10,000 indwelling days) and 5 dysfunctions
109 (20/10,000 indwelling days). PICCs inserted for TPN have the next highest rate of complications with 4
110 thrombotic/thrombophlebitis events (16/10,000 indwelling days), 3 infections (12/10,000 indwelling days) and 0
111 dysfunctions.

112 **6 IV.**

113 **7 Discussion**

114 The findings of this study are compared with other studies performed elsewhere during the period 1966 -2011
115 as described in literature review. ?? This study's complication rate of malposition is statistically significantly
116 higher in PICCs than in CVCs (32% Vs 12%), and is consistent with the finding of other studies (Table 2).
117 The malposition rate of 32% of this study is noted to be significantly higher than in other studies. 3,4 This
118 study also showed that PICCs have higher rates of thrombotic/thrombophlebitis complications than CVCs, in contrast
119 to four other studies which showed that CVCs have higher infection rates than PICCs. It was discussed
120 in a recent review, that lower infection rates in PICCs found in studies may have been due to comparison of
121 rates between stable in-patient and/or outpatient in PICC cohorts, with unstable, acutely ill ICU patients in
122 CVC cohorts. 8 It has been hypothesised that PICCs may also have lower infection rates due to the catheter
123 insertion site of antecubital fossa, a less ideal environments for bacterial growth compared to the subclavian and
124 jugular vein areas which may be contaminated by nasal and oral flora. 9 One confounding factor explaining lower
125 thrombotic/thrombophlebitis rate in CVCs in this study may be due to the predominant indication of CVCs
126 is for haemodialysis, which often include the use of prophylactic heparin. PICCs were also found to have a
127 significantly higher rate of malposition events, and it has been theorised that thrombosis could be caused by
128 initial malposition event. 1 It may be useful for future studies to consider whether thromboprophylaxis in PICCs
129 may reduce the complication rate.

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

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

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

145 V.

146 **8 Conclusion**

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

8 CONCLUSION

1

Type of catheter	Number of cases (%) n = 189	Total indwelling days	Malposition events (%)	Events (rate per 10,000 indwelling days)	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)

Figure 1: Table 1 :

2

Catheter type (number of events)	Total indwelling day	Malposition (%)	Complications rate (rate per 10,000 indweling days)	Study
			Thrombotic/ Thrombophlebitis	Infection Dysfunction
PICC (135)	1381	4	22	0 36 (3)
CV C (135)	1056	3	0	19 0
PI CC (51)	482	10	166	41 166
CV C (51)	533	2	19	56 38

Figure 2: Table 2 :

.1 Acknowledgements

153 The authors have no information to disclose in relation to the use of any writing assistance.
154 VII.

.2 Conflict of Interest

156 The authors have no financial and personal relationships with other people or organizations that could
157 158 inappropriately influence (bias) this submission.

.3 VIII.

.4 Funding Source

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

.5 IX.

.6 Appendix

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

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

168 Table ???: Comparison of data collected in other studies with this study.

169 [central venous cannulation Anaesthesia ()] 'central venous cannulation'. *Anaesthesia* 2012.

170 [Giuffrida et al. (1986)] 'Central vs peripheral venous catheters in critically ill patients'. D J Giuffrida, C W
171 Bryan-Brown, P D Lumb, K B Kwun, H M Rhoades. 3780327. 1986/12/01. eng. *Chest* 1986 Dec. 90 (6)
172 p. .

173 [Cowl et al. (2000)] 'Complications and cost associated with parenteral nutrition delivered to hospitalized
174 patients through either subclavian or peripherally-inserted central catheters'. C T Cowl, J V Weinstock
175 , Al-Jurf, A Ephgrave, K Murray, J A Dillon, K. 10952794. /08/23. eng *Clinical nutrition* 2000 Aug.
176 2000. 19 (4) p. .

177 [Amerasekera et al. ()] 'Imaging of the complications of peripherally inserted central venous catheters'. S S
178 Amerasekera, C M Jones, R Patel, M J Cleasby. *Clinical radiology* 2009.

179 [Worth et al. ()] *Infective and thrombotic complications of central venous catheters in patients with hematological
180 malignancy: prospective evaluation of nontunneled devices. Supportive care in cancer : official journal of the
181 Multinational Association of Supportive Care in Cancer, L J Worth, J F Seymour, M A Slavin. 19096883.
182 /12/20. eng* 2009 Jul. 17 p. .

183 [Duerksen et al. (1999)] 'Peripherally inserted central catheters for parenteral nutrition: a comparison with
184 centrally inserted catheters'. D R Duerksen, N Papineau, J Siemens, C Yaffe. 10081998. *JPEN Journal of
185 parenteral and enteral nutrition* 1999 Mar-Apr. 1999/03/19. 23 (2) p. .

186 [Turcotte et al. (2006)] *Peripherally inserted central venous catheters are not superior to central venous catheters
187 in the acute care of surgical patients on the ward. World journal of surgery, S Turcotte, S Dube, G Beauchamp
188 . 16865322. /07/26. eng* 2006 Aug. 2006. 30 p. .

189 [McGee and Gould (2003)] *Preventing complications of central venous catheterization. The New England journal
190 of medicine, D C McGee, M K Gould. 12646670. 2003 Mar 20. 2003/03/21. 348 p. .*

191 [Alhimyary et al. ()] *Safety and efficacy of total parenteral nutrition delivered via a peripherally inserted central
192 venous catheter. Nutrition in clinical practice : official publication of the American Society for Parenteral
193 and Enteral Nutrition, A Alhimyary, C Fernandez, M Picard, K Tierno, N Pignatone, H S Chan. 1996.*