original article

Peripherally inserted central catheter bloodstream infection surveillance rates in an acute care setting in Saudi Arabia

Jaffar A. Al-Tawfiq,[a] Mahmoud S. Abed,[b] Ziad A. Memish[c]

From the [a]Internal Medicine Unit, [b]Infection Control Unit, Dhahran Health Center, Saudi Aramco Medical Services Organization, Saudi Aramco, Dhahran, [c]Preventive Medicine Directorate, Saudi Ministry of Health, Riyadh, Saudi Arabia

Correspondence: Dr. Jaffar A. Al-Tawfiq · Internal Medicine Unit, PO Box 76, Room A-420B, Building 61, Dhahran Health Center, Saudi Aramco, Dhahran 31311 Saudi Arabia · T: +9663-8773524, F: +9663-8773790 · jaffar.tawfiq@aramco.com · Accepted: April 2011

Ann Saudi Med 2012; 32(2): 169-173

DOI: 10.5144/0256-4947.2012.169

BACKGROUND AND OBJECTIVE: Peripherally inserted central venous catheters (PICCs) are alternatives to short-term central venous catheters and provide intravenous access in the acute hospital setting. In this study, we describe the rate of PICC-associated bloodstream infections (BSI).

DESIGN AND SETTING: Prospective cohort study using data on PICC lines reviewed from January to December 2009.

METHODS: The infection control team was responsible for prospective BSI case findings. The infection rate was calculated per 1000 device-days.

RESULTS: During the study period, 92 PICC lines were inserted with a total of 3336 device-days of prospective surveillance. The most frequent reasons for the insertion of the PICC lines were chemotherapy (n=19, 20.7%), intravenous antimicrobial therapy (n=34, 37%), and for patients in the medical intensive care unit (ICU) (n=16, 17.4%). The overall BSI rate was 4.5/1000 PICC days. The PICC line–associated BSI rates for a specific indication were as follows: chemotherapy 6.6/1000 device-days, intravenous antimicrobial therapy 1.2/1000 device-days, medical ICU 7.3/1000 device-days, surgical ICU 4.6/1000 device-days, and total parental nutrition patients 2.4/1000 device-days ($P<.001$). The rates were not adjusted for patient severity of illness.

CONCLUSIONS: Our data suggest that underlying conditions and indications for the PICC line use may play an important role in the development of BSI.

Peripherally inserted central catheters (PICCs) are being used increasingly in acute care settings to overcome risks associated with non-tunneled multiple-lumen central venous catheters (CVCs).[1] PICCs also provide prolonged intravenous access.[1] Few studies addressing PICC-associated bloodstream infections (BSIs) in hospital settings are available;[1] and one study questioned the trend toward using PICCs, instead of tunneled catheters and ports, to decrease central line–associated BSI (CLABSI).[1] Another study concluded that CVCs and PICCs had similar rates of CLABSIs providing the presence of active surveillance and intervention to remove unnecessary or high-risk CVCs.[2] In this study, we analyzed the rate of BSI related to PICC in an acute care setting. In addition, the objective of the this study was to compare CLABSI rates in patients with PICCs in the hospital setting in relation to the specific indication for the insertion of the PICC line.

METHODS

The main aim of this study was to report the incidence density of BSI in hospitalized patients with PICC lines during a 1-year period from January to December 2009. We included all patients with PICC, hospitalized at Dhahran Health Care Center, Saudi Arabia. The center is part of Saudi Aramco Medical Services Organization (SAMSO). SAMSO provides medical care for Saudi Aramco employees and their dependents, where approximately 370 000 individuals are eligible for medical care. The main hospital, Dhahran Health Center (DHC), has 380 beds. DHC has 5 intensive care units (ICUs) (cardiac, medical, surgical, pediatric, and neonatal).[3,4] PICC lines were inserted by an interventional

radiologist under sterile techniques according to a standardized policy. The policy provides clinical guidelines for the nurse assisting with insertion and maintenance of central vascular access devices or central intravenous lines. The policy addresses the maintenance of the central lines and the care of patients who develop fever in the presence of central lines. In addition, maintenance and daily access of PICC lines follow a standardized protocol. The policy addresses pertinent maintenance issues (accessing, changing tubing, changing connectors, changing dressing, and the use of biopatch). Only professional nurses care for central lines including PICC lines. They will assess the insertion site for infection, leakage, and need for dressing change every shift and document findings on the appropriate flow sheet. Central line insertion sites were dressed with a transparent semipermeable membrane and were changed every 7 days or when the dressing integrity has been compromised. Chlorhexidine gluconate 2% solutions were used to cleanse the site before insertion and with each dressing changes and site care.

The PICC line duration was defined as days from line insertion until the development of CLABSI or until the removal of the PICC line once the line was no longer needed, whichever was shorter. The first CLABSI was included for a patient who developed multiple CLABSIs from the same PICC line. The data were collected as a part of the daily activity of the infection control staff. The infection control practitioner prospectively identified CLABSIs according to the Centers for Disease Control and Prevention's National Healthcare Safety Network (NHSN) definition for CLABSI.[5] CLABSI was defined as the clinical manifestation of bacteremia occurring in the absence of an apparent source of infection other than the catheter, with or without isolation of the same pathogen from the involved catheter and from blood cultures.[5,6] The list of patients with PICC lines was obtained from the interventional radiology section. The infection preventionists reviewed both electronic and paper medical records for the development of BSI. In addition, we collected data on gender, age, date of PICC line insertion, date of the development of BSI, and date of PICC line removal. PICC line–associated BSI was defined as a primary BSI in a patient with PICC who met the NNIS (currently known as NHSN) criteria for CLABSI.[6]

The incidence density of CLABSI was expressed per 1000 device-days and was calculated as the number of CLABSI divided by the total number of PICC line-days. Statistical analyses were performed using SPSS version 10.0 (IBM Corp., Armonk, NY USA). The trend of BSI rates over time was determined using the linear trend analysis method, and to show that a trend was statistically valid, the *P* value of the χ^2 for association had to be significant (<.05). For multiple comparisons, we performed Bonferroni correction to the level of significance based on multiple comparison proportion tests. Thus, we accepted *t* tests as being significant only if the *P* value was <.008.

RESULTS

During the study period, 92 PICC lines were inserted with a total of 3336 device-days of prospective surveillance. The most frequent reason for the insertion of the PICC lines were chemotherapy (n=19, 20.7%), intravenous antimicrobial therapy (n=34, 37%), and for patients in the medical ICU (n=16, 17.4%). The mean and median duration of PICC utilization were 36.3 and 22.0 days, respectively. The overall BSI rate was 4.5/1000 PICC days. The PICC line–associated BSI rates for specific indications are shown in (**Table 1**) (*P*<.001). PICC lines were used mainly for TPN in 12 cases with a total of 413 device-days and an infection density of 2.4/1000 PICC line-days. The rates were not adjusted for patient severity of illness; however, the rate of CLABSI seemed to show a 2-peak curve in relation to the duration of the PICC line (**Figure 1**). The data did not show a linear trend (χ^2 value for the rates over

Table 1. Incidence of central line–associated blood stream infections in the different indications.

	Chemotherapy	Intravenous antimicrobial therapy	Medical ICU	Surgical ICU	TPN	Antibiotic
No. of events	7	1	3	2	1	1
No. of catheters	19	34	16	7	12	7
No. of catheter-days	1067	858	412	435	413	103
Incidence density per 1000 catheter-days	6.6[a]	1.2[a]	7.3[a]	4.6[a]	2.4[a]	0.9[a]

ICU: intensive care unit; TPN: total parental nutrition. [a]*P*<.001.

time was 7.48, *P*=.2789). However, a bimodal increase in the infection rate was observed over time. The highest rate of infection was during days 11 to 20 and 51 to 60 (R2=0.0005). A comparison between those who developed BSI and those who did not is shown in **Table 2**. Patients with BSI had a higher mean (SD) duration of PICC line-days (53.2 [42.6] vs 32.9 [33.7], *P*=.044) and were more likely to have chemotherapy (46.6% vs 15.5%; *P*=.012).[7] On the other hand, those without CLABSI were more likely to have been on intravenous antimicrobial therapy (42.8% vs 6.7%; *P*=.008). The microbiology of the 15 CLABSIs identified included *Pseudomonas aeruginosa* (n=4), coagulase-negative staphylococci (n=4), *Escherichia coli* (n=2), and other organisms (n=5).

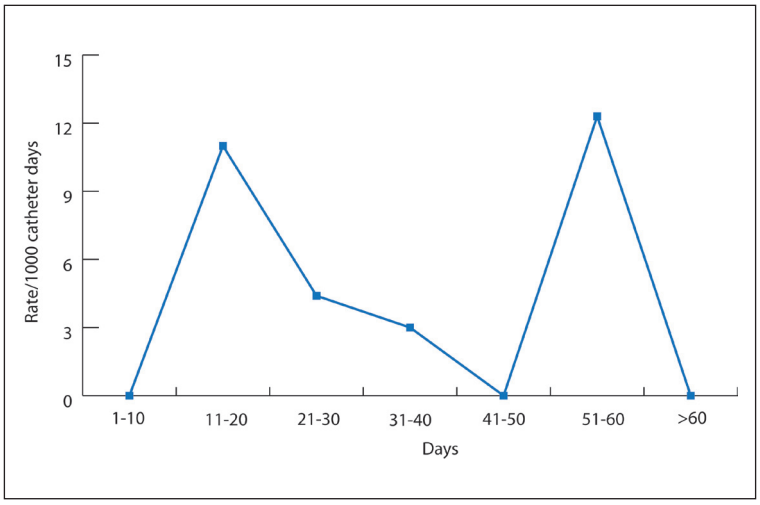

Figure 1. Incidence of central line-associated bloodstream infections over 10-day time intervals since peripherally inserted central catheter insertion.

DISCUSSION

Traditionally, CVCs are used as venous access in the ICU setting, but the use of PICCs is becoming more popular in ICUs.[8] PICCs were thought to be associated with a lower risk of BSI. The lower risk is related to the exit site on the arm, making it less prone to contamination by nasal and oral secretions.[9] In that analysis, including 48 articles published between 1979 and 2004, no clear evidence was available that PICCs were superior to CVC in acute care settings. In a meta-analysis, it was concluded that there was no difference in the infectious complications between CVC and PICC lines. The rates of CLABSIs were 1.2 to 14.7 per 1000 catheter-days for CVC and 1.1 to 2.5 per 1000 catheter-days for PICC.[10]

Many factors may contribute to the development of CLABSI. Host-related risk factors include age, immunity, and severity of the underlying disease.[2] In this study, we found that the highest risk of CLABSI was in patients with malignancy with a rate of 6.6/1000 device-days. Similarly, in a previous study of PICC-related complications in oncology patients, the rate of BSI was 5.7%.[11] In a pediatric study of PICC lines in oncology patients, the incidence density of CLABSI was 0.42 per 1000 catheter-days.[12] The reported incidence of PICC-associated BSI ranges from 0.46 to 3.4 per 1000 catheter-days.[13-18] It was reported that the rate of BSI was relatively low in TPN patients compared with the rate of BSI in ICU patients and patients receiving chemotherapy. In a retrospective study of PICC line infections, there was no BSI in adult inpatients when catheters were used exclusively for TPN.[19] The patient's disease is an important factor in the predisposition to BSI. For example, patients with lymphomas and acute leukemias are usually at higher risk.[20,21] In addition, this observation may be related to the number of times those lines were accessed daily. Adjusting the BSI rate to the number of times a PICC line is accessed may provide a better estimate of the risk. This adjustment may reflect the risk related to catheter hub and lumen contamination for catheters used for longer durations.[22]

We found a bimodal increase in the infection rate over time. In a study of the rate of hospital-wide PICC line infections, the rate of BSI was 2.1/1000 catheter-days in patients with catheters in place for 1 to 5 days, compared with 10.2/1000 catheter-days in patients

Table 2. Blood stream infections and those without blood stream infections.

	CLABSI (n=15)	No CLABSI (n=77)	*P*
Mean age, (SD)	46 (26.3)	54.7 (20.5)	.15
Gender (M:F)	6:9	41:36	.45
Mean (SD) duration (day)	53.2 (42.6)	32.9 (33.7)	.044
Median duration (day)	35	21	
Reason (n %)			
Chemotherapy	7 (46.6)	12 (15.5)	.012
Medical ICU	3 (20)	13 (16.9)	.72
Murgical ICU	2(13.3)	5 (6.4)	.32
Intravenous antimicrobials	1 (6.7)	33 (42.8)	.008
TPN	2 (6.7)	11 (14.3)	.682

CLABSI: central line–associated blood stream infections; M: male; F: female. ICU: intensive care unit; TPN: total parental nutrition.

with catheters in place for 16 to 30 days.[23] Similarly, a bimodal increase in the rate of PICC-associated BSI was observed in neonates with PICC lines.[24] These differences are likely related to the study population or the small number in the included study.

It is important to mention some limitations of our study. Although only professional nurses care for central PICC lines, we did not evaluate the level of education of those providing care. Second, we included only the rate of PICC-associated BSI in this study. However, the rate of PICC-associated BSI was about half the rate of CVC-associated BSI that was published from the same institute previously (4.5 compared with 8.2/1000 device-days).[4] It is worth noting that the CLABSI rate was zero for the first 10 days indicating that CLABSI is not related to placement, but more to line access. Unfortunately, the numbers are small, and the study had insufficient power to study this point. A confounder that may not have been addressed is that different patient populations were using PICCs for different durations. So, it could be that those who had the PICC for a shorter period of time have higher acuity/severity of illness and they may have had more access to the PICC per day compared with those on intravenous antibiotics that may have access once a day. In addition, we cannot extrapolate from the findings the risks for PICC-BSI. We did not look at other factors including the duration of stay in the hospital, use of steroids, and transfusions. Without adjusting for severity of illness or having a large cohort, it may be difficult to generalize from the data.

In conclusion, our data suggest that underlying conditions such as malignancy and TPN may play an important role in the development of BSI. The use of PICCs to reduce CLABSI is thought be a nonevidence-based strategy.[25] In a recent study, the incidence rates of BSI were 6.0/1000 catheter-days for CVCs and 2.2/1000 for PICCs.[26] Thus, understanding factors contributing to the development of PICC associated BSI is important to further decrease the rates of BSI.

Acknowledgments

The authors wish to acknowledge the use of SAMSO facilities for the data and study, which resulted in this article. Opinions expressed in this article are those of the authors and not necessarily of SAMSO. The study was approved by the public relations department in accordance with our institution requirement.

REFERENCES

1. Safdar N, Maki DG. Risk of catheter-related bloodstream infection with peripherally inserted central venous catheters used in hospitalized patients. Chest 2005;128:489-95.
2. Al Raiy B, Fakih MG, Bryan-Nomides N, Hopfner D, Riegel E, Nenninger T, et al. Peripherally inserted central venous catheters in the acute care setting: A safe alternative to high-risk short-term central venous catheters. Am J Infect Control 2010;38:149-53.
3. Al-Tawfiq JA. Distribution and epidemiology of Candida species causing fungemia at a Saudi Arabian hospital, 1996-2004. Int J Infect Dis 2007;11:239-44.
4. Al-Tawfiq JA, Abed MS. Prevalence and antimicrobial resistance of health care associated bloodstream infections at a general hospital in Saudi Arabia. Saudi Med J 2009;30:1213-8.
5. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter-related infections. Centers for Disease Control and Prevention. MMWR Recomm Rep 2002;51:1-29.
6. Edwards JR, Peterson KD, Mu Y, Banerjee S, Allen-Bridson K, Morrell G, et al. National Healthcare Safety Network (NHSN) report: Data summary for 2006 through 2008, issued December 2009. Am J Infect Control 2009;37:783-805.
7. Rello J, Ochagavia A, Sabanes E, Roque M, Mariscal D, Reynaga E, et al. Evaluation of outcome of intravenous catheter-related infections in critically ill patients. Am J Respir Crit Care Med. 2000;162(3 pt 1):1027-30.
8. Fearonce G, Faraklas I, Saffle JR, Cochran A. Peripherally inserted central venous catheters and central venous catheters in burn patients: A comparative review. J Burn Care Res 2010;31:31-5.
9. Ryder M. Peripheral access options. Surg Oncol Clin N Am 1995;4:395-427.
10. Turcotte S, Dubé 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 J Surg 2006;30:1605-19.
11. Yap YS, Karapetis C, Lerose S, Iyer S, Koczwara B. Reducing the risk of peripherally inserted central catheter line complications in the oncology setting. Eur J Cancer Care (Engl) 2006;15:342-7.
12. Matsuzaki A, Suminoe A, Koga Y, Hatano M, Hattori S, Hara T. Long-term use of peripherally inserted central venous catheters for cancer chemotherapy in children. Support Care Cancer 2006;14:153-60.
13. Cardella JF, Cardella K, Bacci N, Fox PS, Post JH. Cumulative experience with 1,273 peripherally inserted central catheters at a single institution. Vasc Interv Radiol 1996;7:5-13.
14. Cheong K, Perry D, Karapetis C, Koczwara B. High rate of complications associated with peripherally inserted central venous catheters in patients with solid tumours. Intern Med J 2004;34:234-8.
15. Merrell SW, Peatross BG, Grossman MD, Sullivan JJ, Harker WG. Peripherally inserted central venous catheters. Low-risk alternatives for ongoing venous access. West J Med 1994;160:25-30.
16. Ng PK, Ault MJ, Ellrodt AG, Maldonado L. Peripherally inserted central catheters in general medicine. Mayo Clin Proc 1997;72:225-33.
17. Skiest DJ, Abbott M, Keiser P. Peripherally inserted central catheters in patients with AIDS are associated with a low infection rate. Clin Infect Dis 2000;30:949-52.
18. Tokars JI, Cookson ST, McArthur MA, Boyer CL, McGeer AJ, Jarvis WR. Prospective evaluation of risk factors for bloodstream infection in patients receiving home infusion therapy. Ann Intern Med 1999;131:340-7.
19. 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. Clin Nutr 2000;19:237-43.
20. Adler A, Yaniv I, Steinberg R, Solter E, Samra Z, Stein J, et al. Infectious complications of implantable ports and Hickman catheters in paediatric haematology-oncology patients. J Hosp Infect 2006;62:358-65.
21. Hall K, Farr B. Diagnosis and management of long-term central venous catheter infections. J Vasc Interv Radiol 2004;15:327-34.
22. Tokars JI, Klevens RM, Edwards JR, Horan TC. Measurement of the impact of risk adjustment for central line-days on interpretation of central line-associated bloodstream infection rates. Infect Control Hosp Epidemiol 2007;28:1025-9.
23. McLaws ML, Berry G. Nonuniform risk of bloodstream infection with increasing central venous catheter-days. Infect Control Hosp Epidemiol 2005;26:715-9.
24. Sengupta A, Lehmann C, Diener-West M, Perl TM, Milstone AM. Catheter duration and risk of CLA-BSI in neonates with PICCs. Pediatrics 2010;125:648-53.
25. Marschall J, Mermel LA, Classen D, Arias KM, Podgorny K, Anderson DJ, et al. Strategies to prevent central line–associated bloodstream infections in acute care hospitals. Infect Control Hosp Epidemiol 2008;29:S22-30.
26. Gunst M, Matsushima K, Vanek S, Gunst R, Shafi S, Frankel H. Peripherally Inserted Central Catheters May Lower the Incidence of Catheter-Related Blood Stream Infections in Patients in Surgical Intensive Care Units. Surg Infect (Larchmt) 2010 Jul 14. [Epub ahead of print]