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Brief reports

The influence of using antibiotic-coated peripherally inserted central catheters on decreasing the risk of central line-associated bloodstream infections

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The use of peripherally inserted central catheters (PICCs) has increased over the past few years due to their less serious insertion complications. The purpose of the present study was to determine whether patients receiving PICCs impregnated with minocycline and rifampin had a lower rate of CLABSI compared with a concurrent control group of patients receiving uncoated PICCs.

Central venous catheters (CVCs) play a fundamental role in the management of hospitalized patients because they provide reliable access for intravenous delivery of therapeutic agents, hemodynamic monitoring, and laboratory testing. The use of peripherally inserted central catheters (PICCs) has increased exponentially across the United States[1,2] because of their advantages over traditional CVCs.[3] Because of its peripheral site of entry, PICC insertion is associated with less serious mechanical complications than that of CVCs.[4]

Previously, several authors reported incidence rates of PICC-related bloodstream infections ranging from 0.4-0.8 per 1,000 catheter-days. This rate range is markedly lower than the incidence rates of traditional CVC-related bloodstream infections, which have ranged from 1.4-5.0 per 1,000 catheter-days.[1,5,6] However, recent extensive studies challenged this belief and reported higher infection rates with PICC use. For example, in a prospective cohort study, Safdar and Maki[7] found higher bloodstream infection rates with PICC use than what was previously reported, approaching 2.1 per 1,000 catheter-days. These studies raised the very important question of whether PICCs are truly safer than CVCs regarding infectious complications.

A number of investigators have searched the possibilities of decreasing the rate of infections with the use of conventional CVCs. Impregnating catheters with the antibiotic combination minocycline and rifampin (M/R) showed significant decrease in the rates of biofilm formation and bloodstream infections compared with noncoated catheters and catheters impregnated with chlorhexidine-silver sulfadiazine (CHX-SS).[8,9] We therefore compared patients who had insertion of M/R-coated PICCs with those who had uncoated PICCs and followed them for any microbiologic and mechanical complications.

MATERIAL AND METHODS

M/R-PICCs were inserted in 65 subjects as part of a quality improvement pilot project in the infusion therapy unit at The University of Texas MD Anderson Cancer Center from March 11, 2013-April 29, 2013. These patients were compared with a group of 94 concurrent control patients who received uncoated PICCs, particularly those inserted at our institute. The M/R-PICCs were power-injectable Cook Spectrum devices (Cook Inc., Bloomington, IN) and the uncoated PICCs were power injectable Bard devices (Bard Access Systems, Inc., Salt Lake City, UT). Demographic characteristics, clinical data, and information on the patients' catheters were collected.

After PICC insertion, the patients were observed for 45 days.

The primary outcome assessed was development of central line-associated bloodstream infection (CLABSI), and the secondary

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outcome was development of mechanical complications. CLABSI was defined according to the National Healthcare Safety Network–Centers for Disease Control and Prevention criteria as a bloodstream infection in a patient who has an intravascular catheter and no apparent source for the bacteremia except the catheter with either 1 positive blood culture with a recognized pathogen or 2 positive blood cultures with a common skin contaminant in the presence of clinical manifestations of infection.[10]

Statistical analysis

We used χ^2 or Fisher exact tests to compare categorical variables, as appropriate. Continuous variables were compared using Wilcoxon rank-sum test. Poisson distribution and Fisher exact tests were used to compare incidence rates of CLABSI. Competing risk analysis was used to compare the cumulative probabilities of being free from CLABSI. All tests were 2-sided tests with a significance level of 0.05. The competing risk analysis was performed using R version 2.15.0 (R Foundation for Statistical Computing, Vienna, Austria) and all other statistical analyses were performed using SAS version 9.3 (SAS Institute Inc, Cary, NC).

RESULTS

During the study period, the 65 patients in the M/R-PICC group underwent catheter placement for a total of 1,994 catheter-days, and the 94 patients in the uncoated PICC group did so for 2,960 catheter-days. The demographic and clinical characteristics of the patients are listed in Table 1.

During the observation period, CLABSIs developed in 5 patients in the uncoated PICC group (5%) for an incidence rate of 1.7 per 1,000 catheter-days. In comparison, no CLABSIs developed in the M/R-PICC group (0 per 1,000 catheter-days) ($P = .066$). The organisms causing CLABSI in the control group were *Staphylococcus aureus*, *Escherichia coli*, *Candida glabrata*, and *Candida albicans*. One of the CLABSIs was polymicrobial, caused by *Leuconostoc* and *Candida tropicalis*. None of the CLABSI episodes met the criteria for laboratory-confirmed mucosal barrier injury CLABSI.

Table 1
Characteristics of the patients receiving minocycline and rifampin- (M/R) coated and uncoated peripherally inserted central catheters (PICCs)

Characteristic	M/R-PICC (n = 65)	Uncoated PICC (n = 94)	*P* value
Age, y	60 (22-83)	59 (20-83)	.370
Male sex	41 (63)	49 (52)	.170
Cancer type			.560
Hematologic malignancy	34/63 (54)	54/92 (59)	
Solid tumor	29/63 (46)	38/92 (41)	
No cancer	2 (3)	2 (2)	
BMT within 1 year	2 (3)	7 (7)	.310
Type of BMT			
Autologous	1/2 (50)	3/7 (43)	
Allogeneic	1/2 (50)	4/7 (57)	
GI–GVHD	1 (2)	3 (3)	.650
Neutropenia	17 (26)	44 (47)	.009
Catheter use*			
Total parenteral nutrition	3 (5)	5 (5)	>.99
Drug	48 (74)	76 (81)	.29
Transfusion	18 (28)	47 (50)	.005
Catheter lumen			.008
Single	22 (34)	14 (15)	
Double	43 (66)	78 (83)	
Triple	0 (0)	2 (2)	
Catheter side			.400
Right	43 (66)	56 (60)	
Left	22 (34)	38 (40)	

NOTE. Values are presented as n (%) or median (range).
BMT, bone marrow transplant; *GI–GVHD*, gastrointestinal–graft-versus-host disease.
*Many patients used catheters for >1 reason.

Table 2
Outcomes of patients receiving minocycline and rifampin- (M/R) coated and uncoated peripherally inserted central catheters (PICCs)

Outcome	M/R-PICC (N = 65)	Uncoated PICC (N = 94)	*P* value
Central line-associated bloodstream infection*	0	1.7	.066
Catheter-related mechanical complications	12 (18)†	9 (10)	.100
Failure of insertion	7 (11)	2 (2)	.033
Malposition	3 (5)	3 (3)	.690
Thrombosis	4 (6)	4 (4)	.720
Death within 45 d after catheter insertion	6 (9)	9 (10)	.940
Cause of death			
Underlying disease	3/6 (50)	8/9 (89)	—
Respiratory failure	—	1/9 (11)	—
Unknown	3/6 (50)	—	—

NOTE. Values are presented as n (%).
*Per 10^3 catheter-days.
†Some patients had >1 catheter-related mechanical complication.

Overall, the rates of mechanical complications were comparable in both groups (18% in the M/R-PICC group and 10% in the uncoated PICC group; $P = .1$) (Table 2). However, the rate of failure to thread the PICC line was significantly higher in the M/R-PICC group (11% vs 2%; $P = .033$).

A competing risk analysis using death as a competing event demonstrated that patients with M/R-PICCs tended to remain CLABSI-free for longer durations than did patients with uncoated PICCs ($P = .068$) (Fig 1).

Although the group using uncoated PICCs had more patients with neutropenia than the group using coated PICCs (47% vs 26%; $P = .009$), there was no significant difference in outcomes between patients with and without neutropenia. For CLABSI, 1.6% of patients with neutropenia vs 4.1% of patients without neutropenia developed CLABSIs ($P = .65$). For mortality, 9.8% of patients with neutropenia versus 9.2% of patients without neutropenia died during the study period ($P = .89$).

DISCUSSION

Our data demonstrated that placement of uncoated PICC lines in patients with cancer was associated with a high incidence of nonmucosal barrier injury CLABSI of 1.7 per 1,000 catheter-days despite the fact that all elements of aseptic bundles, including barrier precautions, were applied during insertion and follow-up of the PICC lines. This infection rate was almost 2-fold higher than that reported for insertion of regular CVCs in high-risk, critically ill patients.[11] However, the use of M/R-PICCS in patients with cancer with similar demographic and patient characteristics did not result in any CLABSI and tended to be associated with a significantly decreased CLABSI incidence ($P = .066$).

Traditionally, use of PICC lines has been associated with lower rates of CLABSI than has use of conventional CVCs in the subclavian and jugular veins.[1,5,6] However, more recent studies demonstrated that, when used in a high-risk patient population, PICC lines had a rate of CLABSI similar to or higher than that with conventional CVCs placed in the internal jugular or subclavian vein, ranging from 1-5 per 1000 catheter-days.[7,12]

In the present study, we demonstrated that use of conventional uncoated PICCs in cancer patients, particularly those with hematologic malignancies, was associated with a relatively high rate of CLABSI of 1.7 per 1,000 catheter-days. Meanwhile, the concurrent