

Long-Term Central Venous Access in Pediatric Patients at High Risk: Conventional versus Antibiotic-Impregnated Catheters

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ABSTRACT

Purpose: To study selective use of antibiotic-impregnated catheters in children at increased risk of venous catheter-related infections (CRIs).

Materials and Methods: From December 2008 to June 2009, 428 peripherally inserted central catheters (PICCs) were placed by the interventional radiology service of a large metropolitan children's hospital. This retrospective study analyzed demographic and outcome data for the 125 patients in this group at high risk for venous CRI. Patients at high risk were those with active systemic infection, previous complicated central venous access, intensive care unit (ICU) admission, intestinal failure, transplantation, complex congenital heart disease, or renal failure. Patients (age, 7.6 y \pm 7.0; 73 male and 52 female) received a conventional or antibiotic-impregnated PICC, with 17 receiving more than one catheter.

Results: Of the 146 of 428 qualifying patient encounters (34%), 53 patients received an antibiotic-impregnated PICC and 93 received a conventional PICC, representing 5,080 total catheter-days (CDs). The rates of CRIs per 1,000 CDs, including catheter exit site infections and catheter-related bloodstream infections, were 0.86 for antibiotic-impregnated PICCs and 5.5 for conventional PICCs ($P = .036$). A propensity-based model predicts 15-fold greater infection-free survival over the lifetime of the catheter in patients who receive an antibiotic-impregnated PICC ($P < .001$). Antibiotic-impregnated PICC recipients with active infection or ICU admission at the time of insertion had no catheter-associated infections, compared with 3.42 and 9.46 infections per 1,000 CDs, respectively, for patients who received conventional PICCs. Patients with intestinal failure had 1.49 and 10 infections per 1,000 CDs with antibiotic-impregnated versus conventional PICCs, respectively.

Conclusions: Antibiotic-impregnated long-term PICCs significantly improve infection-free catheter survival in pediatric patients at high risk.

ABBREVIATIONS

CD = catheter-day, CDC = Centers for Disease Control and Prevention, CLABSI = central line-associated bloodstream infection, CRI = catheter-related infection, CVC = central venous catheter, PICC = peripherally inserted central catheter

Central venous catheter (CVC)-related infections have been identified as a major source of risk and cost. In fact, catheter-related infections (CRIs) are the most common

source of health care-associated infections in children, adding as much as \$36,000–\$50,000 to the costs of care per event (1). Although these risks exist for every patient who requires a CVC, a number of predisposing factors may substantially elevate risk, including the patient's disease state, immune competence, acuity of illness, venous history, and presence of active infection at the time of CVC insertion.

Numerous reports in the literature have described the potential advantages of rifampin-impregnated CVCs to reduce the frequency of CRIs and related morbidity and mortality, as well as the significant cost savings that may accrue with use of these catheters in patients with an increased risk of CRI (2), although only two of these reports studied long-term catheters (3,4). In view of the recent introduction of minocycline/rifampin-impregnated

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long-term peripherally inserted central catheters (PICCs), no reports are available regarding their use in pediatric populations at risk. Our experience with use of these catheters in children at high risk for CVC complications was reviewed, and outcomes related to use of these catheters compared to the use of conventional PICCs in similar children over the same time period, were evaluated. The purpose of the present study was to determine whether there are significant advantages to the selective use of these catheters in children with increased risk of venous CRIs.

MATERIALS AND METHODS

Inclusion Criteria

Interventional radiology physicians placed all catheters used in the present study during the time period of December 15, 2008, to June 17, 2009. Patients were included in the study if they were identified with one or more of the following risk factors: active systemic infection at the time of catheter insertion (contemporaneous positive bloodstream culture findings or systemic signs and symptoms of infection); history of complicated central venous access (at least one documented stenosis or occlusion in a major central venous pathway or previous CRI); admission to an intensive care unit (ICU) at the time of insertion; intestinal failure; small bowel, liver, multivisceral, or bone marrow transplantation; complex congenital heart disease; or renal failure. A total of 428 patient encounters were identified from the prospectively maintained interventional radiology procedural database during which the patient received a PICC during the study period, and each was evaluated for inclusion by reviewing the hospital electronic medical record for evidence of qualifying risk factors.

There were 146 of 428 patient encounters (34%) that qualified for the study; 53 received a minocycline/rifampin-impregnated PICC and 93 received a conventional PICC. Catheters were inserted by using standard radiologic technique (5), and prophylactic antibiotic agents were not used. Patients (mean age, 7.6 y \pm 7.0) included 73 male and 52 female patients, with 17 patients receiving two or more catheters during the course of the study. Descriptive statistics for the patients included in the study are provided in [Table 1](#), and patient characteristics by catheter type are summarized in [Table 2](#).

Minocycline/rifampin antibiotic-impregnated catheters (Spectrum; Cook, Bloomington, Indiana) were employed in the antibiotic-impregnated PICC group. The conventional PICC group included Turbo-Flo (Cook), Vaxcel (Navilyst, Marlborough, Massachusetts), Morpheus (AngioDynamics, Latham, New York), and PowerPICC catheters (Bard Access Systems, Salt Lake City, Utah). Catheter characteristics are summarized in [Table 3](#).

Table 1. Patient Characteristics

| Characteristic | Value |
|---|-----------------|
| Sex | n = 125 |
| Male | 73 (58) |
| Female | 52 (42) |
| Parameter at time of PICC insertion | |
| Age (y) | 7.6 \pm 7.0 |
| Weight (kg) | 27.9 \pm 25.4 |
| Acuity (ASA Class) | n = 105 |
| 1 | 10 (9.5) |
| 2 | 37 (35.2) |
| 3 | 52 (49.5) |
| 4 | 6 (5.7) |
| Diagnostic group | n = 146 |
| Intestinal failure | 22 (15) |
| Transplantation | 22 (15) |
| Complex congenital heart disease | 15 (10) |
| Renal insufficiency | 10 (7) |
| ICU admission | 50 (34) |
| History of complicated access | 20 (14) |
| Active infection (at time of insertion) | 102 (70) |
| Indication | |
| Antibiotic administration | 100 (68) |
| Parenteral nutrition | 33 (23) |
| Blood product administration | 9 (6) |
| Chemotherapy | 1 (1) |
| Other medication administration | 62 (42) |

Values in parentheses are percentages. Values presented as mean \pm standard deviation where applicable.

ASA = American Society of Anesthesiologists, ICU = intensive care unit, PICC = peripherally inserted central catheter.

Data Acquisition

Data from procedure notes, intraoperative medical imaging, and hospital electronic medical records were reported according to the standards and definitions of the Society of Interventional Radiology (SIR) (6) and the Infectious Diseases Society of America (7). If information was incomplete as a result of essential components of care that were delivered outside the hospital setting, missing data elements were obtained by direct query of parents or primary care providers. The study was approved by the university institutional review board and hospital quality assurance committee after expedited review, and a requirement for informed consent related to the retrospective study was waived. Data were complete for 143 of 146 qualifying patient encounters (98%).

Definition of Independent Variables

The following additional independent variables were recorded: type of catheter (antibiotic-impregnated or conventional PICC), site of insertion (brachial vein, basilic vein, or other), side of insertion, catheter diameter, number of lumens, patient acuity at the time of

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