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Long-term central venous access in a pediatric leukemia population



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ABSTRACT

Background: Central venous access devices (CVADs) play an important role in the management of pediatric oncology patients; unfortunately, they are also associated with potentially serious complication rates. We hypothesized that, despite the significantly different disease courses typical of acute lymphoblastic leukemia and acute myelogenous leukemia, there would be identifiable risk factors for premature CVAD removal.

Methods: We retrospectively studied clinical characteristics and procedure records for all patients admitted with a leukemia diagnosis at our institution from May 2009 to July 2014.

Results: Our observed perioperative complication rate was 6%; over 70% of lines had at least one long-term complication (thrombosis, catheter-related bloodstream infection, or unexplained line malfunction). Obesity (odds ratio [OR], 6.9; 95% CI, 1.62-29.43), preoperative dosage of packed red blood cells (in mL/kg; OR, 3.13; 1.07-9.21), bloodstream infection (OR, 5.75; 1.69-19.56) were associated with increased risk of premature catheter removal; unexplained malfunction was associated with a lower risk (OR, 0.28; 0.09-0.93).

Conclusions: Obesity, the preoperative dosage of packed red blood cells, the presence of a bloodstream infection, and unexplained line malfunction are significant predictors of premature CVAD removal in a pediatric leukemia population.

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Introduction

Central venous access devices (CVADs) are important in the management of pediatric oncology patients because they minimize the discomfort associated with frequent venipuncture for blood work and infusions while also

providing access to central veins to allow safe infusion of irritating chemotherapeutic agents. Unfortunately, CVADs are also associated with an array of known early and late complications.¹ Perioperative complications, such as pneumothorax or hemorrhage, are more generally related to technique or anatomy, whereas long-term complications, such as infection,

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dysfunction, or thrombosis, tend to be related to patient disease or maintenance of the intravascular device.

Children with acute leukemia, including acute lymphoblastic leukemia (ALL) and acute myelogenous leukemia (AML), represent a large proportion of the population of pediatric patients who undergo CVAD placement. Although ALL and AML are both hematologic cancers, they require very different approaches to therapy. ALL has a long duration of treatment which is less intense, whereas AML has a shorter duration but much more intense therapy. Each diagnosis therefore represents a unique risk profile, and the requested CVAD (port versus external-tunneled line) is generally determined by the diagnosis. More important, this entire group is particularly fragile as they all are immunosuppressed during their disease course both as a result of the disease process itself and the chemotherapy regimens used for treatment. We hypothesized that, despite the significantly different disease courses typical of ALL and AML, there would be identifiable risk factors that are associated with premature removal of the CVADs. These risk factors may be modifiable and serve as targets for future interventions or study.

Material and methods

Study design

After obtaining institutional review board approval, we reviewed the charts of all patients who had a CVAD placed by a surgeon for the treatment of ALL or AML at Children's Health, Children's Medical Center, Dallas in Dallas, Texas from May 2009 to May 2014; charts were reviewed for complications through July 2014. Charts were examined for demographic data, disease-specific data, details from the surgical procedure, and complications related to the CVAD. Demographic data collected included gender, age at diagnosis, ethnicity, and race and type of CVAD inserted. Body mass index was calculated according to height and weight obtained at diagnosis and documented as either underweight, normal, overweight, obese, or infant (under 2 y) based on the classification system used by the Centers for Disease Control.² Disease-specific data included vital signs at time of diagnosis, disease diagnosis (AML or ALL), dosage of packed red blood cells (pRBCs), and platelets (PLTs) transfused before line placement. The primary outcome was premature catheter removal for any cause; secondary outcomes included reason for removal, including mortality, episodes of central line-associated blood stream infection or insertion site infection, catheter malfunction, documented DVT, and number of administrations of tissue plasminogen activator (tPA). Specifically, catheter malfunction was defined as poor aspiration or forward flush through the catheter which prompted intervention or investigation (administration of medication, patient-positioning maneuvers, or initiation of a diagnostic workup).

All CVADs were placed under general anesthesia by attending physicians using either Seldinger or cutdown techniques under ultrasound and/or fluoroscopic guidance. The decision to place a port versus a tunneled line was made by the treating oncologist based on the details of the patient's

treatment plan. Although children are admitted, CVADs are maintained according to our institutional protocol, which minimizes the frequency and number of times the line is accessed and specifies the frequency of heparin instillation to maintain line patency. For children discharged with a CVAD in place, caregivers are provided with care instructions for home use and are encouraged to contact clinic staff with any questions or concerns. All lumens of a tunneled catheter are flushed with normal saline at least once every 24 h, and caregivers are instructed on proper sterile dressing change technique. Generally, ports are not accessed among outpatients except by home nursing or clinic staff.

Statistical analysis

Demographics are analyzed for each unique patient; factors associated with both perioperative and long-term complications were analyzed per catheter placed. Continuous variables were analyzed using Student's t-test for normally distributed data and the Wilcoxon rank-sum test for nonparametric data. Categorical variables were assessed with Spearman's rank correlation coefficient, chi-square test, or Fisher's exact test as appropriate. Backward stepwise logistic regression was performed to evaluate risk factors for premature catheter removal, with the initial model including all independent variables with $P < 0.2$ on univariate analysis; variables were selected to remain in the final model based on Akaike's information criterion. For all analyses, significance was set at 0.05. All analyses were performed using R (version 3.1.1, Vienna, Austria).

Results

Demographics

Over the 5-y study period, 292 CVADs were placed in 198 pediatric patients diagnosed with ALL or AML (Table 1). These catheters remained in place for an average of 488 ± 399.8 d (range, 3-1674); a total of 142,607 catheter days are included in this study. A total of 82% of CVADs (240) were fully implanted ports, and the remainder (52 or 18%) was tunneled catheters. The average age at diagnosis was 6.2 y (range, 0.4-18.7) for patients with ALL and 5.4 y (range, 0.3-17.5 y) for those with AML. Fifty-four percent of patients were male. As expected based on the different management protocols for each disease, children with AML tended to have more devices placed than those with ALL (2.1 versus 1.4, respectively; $P = 0.009$). Similarly, based on current treatment protocols most ports (90.8%) were placed in children with ALL, whereas most tunneled catheters (76.9%) were placed in children with AML ($P < 0.0001$). Median studied time for placed CVADs was 388 d (range, 3-1674).

Perioperative complications

The overall incidence of perioperative complications was 6%; 13 events occurred during placement of a subcutaneous port and 4 events occurred during placement of a tunneled catheter. Perioperative complications included three

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