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ORIGINAL ARTICLE

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Catheter-associated bloodstream infection incidence and outcomes in congenital cardiac surgery

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Abstract

Objective: Catheter-associated bloodstream infections complicate and prolong hospitalizations. The incidence of catheter-associated bloodstream infections in children undergoing congenital cardiac surgery has not been reported. This study sought to define the incidence of catheter-associated bloodstream infections after congenital cardiac surgery in neonates and infants ≤12 months old and compare hospital outcomes and costs to those who underwent surgery and did not have a catheter-associated bloodstream infections.

Design: Retrospective review of hospital admissions between October 2013 and November 2015 for neonates and infants ≤12 months old at admission with ICD-9 codes for congenital cardiac surgery from discharge data from Vizient Clinical Data Base/Resource Manager (formerly University HealthSystem Consortium), an analytic platform for performance improvement. Hospitals were included if they had >100 congenital cardiac surgery admissions during the study period. Admissions were stratified by age at admission: Neonates (<1 month) and Infants (1-12 months). Established database flags for catheter-associated bloodstream infections were utilized. Length of stay, mortality, and direct costs were compared between admissions with and without catheter-associated bloodstream infections using t test or χ^2, as appropriate.

Results: Catheter-associated bloodstream infections incidence after congenital cardiac surgery was higher in Neonates than Infants (1.5 vs 0.8%, P = .024). Length of stay and direct costs were significantly higher for patients with catheter-associated bloodstream infections in both groups. Mortality was higher in the Infant group with catheter-associated bloodstream infections compared to those without catheter-associated bloodstream infections.

Conclusions: Neonates develop catheter-associated bloodstream infections at nearly twice the rate of older infants. For those who develop infection, mortality is 2-8-fold greater and hospital costs are 4-6-fold higher, which further highlight the importance of catheter-associated bloodstream infections prevention in this population.

KEYWORDS
complications, congenital heart disease, infection

1 | INTRODUCTION

Severe forms of congenital heart disease often require multiple surgical procedures with prolonged management in intensive care units (ICU). Bloodstream infections are one of the most common causes of nosocomial complications, particularly in the ICU.[1] While surgical intervention is a risk factor in and of itself, it is known that the use of central line catheters in children increase their risk of catheter associated bloodstream infections (CABSI) by 1.0%-3.9%.[2] Additionally, it has been shown that CABSI can prolong length of stay (LOS) by up to 24 days.[3] Prior studies have shown that each additional hospital day after surgery costs approximately $500.[4] While CABSI is definitively prevented by not having central access, this is not always possible, and studies have highlighted the importance of standardized methods for prevention.[5]

There are limited published data on the incidence of CABSI in children with congenital heart disease undergoing congenital cardiac surgery (CCS). However, it is known that this population of critically ill children is predisposed to immunodeficiency with a breakdown of natural barriers to infection.[6] Additionally, patients that have non-elective procedures are noted to have increased propensity for CABSI.[7] Prior studies have shown that postoperative infection is a risk factor for prolonged LOS, but have not quantified the effect. The primary aim of this study was to define the incidence of CABSI in neonates and infants undergoing CCS. The secondary aim was to define the hospital outcomes and costs associated with CABSI in this population.

2 | METHODS

The Vizient Clinical Data Base/Resource Manager is an analytic platform for performance improvement populated by 350 health systems and community hospitals nationwide, including nearly all academic medical centers. The database includes comparative benchmarks such as demographic, mortality, length of stay, complication rates, readmission rates, diagnosis, procedure, resource utilization, and other information. We performed a retrospective review from October 2013 to November 2015 for inpatient admissions of patients ≤12 months old with ICD-9 codes for any diagnosis of congenital heart disease and a primary procedure code for CCS. Only hospitals with >100 CCS during the study period were included to minimize the potential biases of including low-volume surgical centers. Admissions were stratified by age at admission: Neonates (<30 days) and Infants (1-12 months). Data obtained included demographics, LOS, in-hospital mortality rate, and direct hospital costs.

Because of the importance of CABSI, Vizient has an established data field for the presence of catheter-associated infection during an admission, which was used to identify admissions with CABSI from the data query. Incidence of CABSI after CCS was calculated for both age groups. Normally distributed data were compared using *t* test, non-normally distributed data with Mann-Whitney U test and categorical data using χ^2.

3 | RESULTS

There were 4749 admissions identified during the study period, 1836 (39%) Neonates and 2913 (61%) Infants. Demographics, outcomes, and costs for Neonates and Infants are shown in the Table 1. The incidence of CABSI was higher in Neonates compared to Infants (1.5 vs 0.8%, $P = .024$).

Baseline demographics were not different between the groups, but LOS and direct costs were significantly higher for patients with CABSI in both groups (Table 1). Mortality was 1.8 times higher in Neonates with CABSI and 8.6 times higher in Infants with CABSI, but only the Infant group reached statistical significance (Table 1).

4 | DISCUSSION

In this retrospective review of a large administrative database, we have defined the incidence of catheter-associated blood stream

TABLE 1 Demographics, hospital outcomes, and costs for Neonates and Infants undergoing congenital cardiac surgery with and without catheter-associated bloodstream infections (CABSI)

	Neonates (<1 month) (n = 1836)		
	CABSI (n = 28)	No CABSI (n = 1808)	P
Admission age (months)	0 (0, 0)	0 (0, 0)	1.000
Female (*n*, %)	13 (46.4)	733 (40.5)	.564
Length of stay (days)	135.39 ± 95.48	42.63 ± 48.45	<.001
Mortality (%)	17.86	9.73	.188
Direct costs (mean ± SD)	$439 015 ± 320 839	$112 736 ± 132 601	<.001
	Infants (1-12 months) (*n* = 2913)		
	CABSI (*n* = 24)	**No CABSI (*n* = 2889)**	***P***
Admission age (months)	4 (3.2, 6)	5 (3, 7)	.695
Female (*n*, %)	10 (41.7)	1380 (47.8)	.683
Length of stay (days)	87.67 ± 70	16.08 ± 27.15	<.001
Mortality (%)	16.67	1.94	.001
Direct costs (mean ± SD)	$347 270 ± 340 611	$53 672 ± 94 793	<.001

Note: Data from the Vizient Clinical Data Base/Resource Manager used by permission of Vizient.

infections after congenital cardiac surgery in neonates and infants ≤12 months old. Neonates develop CABSI at nearly twice the rate of older infants. For those who develop infection, mortality is greater and hospital costs are significantly higher, which further highlight the importance of CABSI prevention in this population.

Neonates and infants are at high risk for many medical complications. Those with congenital heart disease requiring CCS are at even higher risk for medical complications due to early invasive procedures and associated prolonged hospitalizations. In the population requiring CCS, reducing complications is key to decreasing poor outcomes.[8] Defining the incidence of CABSI in this population allows for evaluation of current CABSI prevention practices and outcomes in addition to encouraging novel developments in catheter care and utilization.

Resource management is also a key aspect to inpatient hospital care. Defining the additional costs that CABSI can impose on a hospitalization highlights the importance of rapid treatment and, ideally, primary prevention. This not only emphasizes the importance of prevention, but also prompts further evaluation of post-CABSI care.

Our data show that in-hospital mortality rates for patients with CABSI after CCS are similar for neonates and infants, around 17%. Neonates have a higher baseline morbidity and mortality after CCS because of higher complexity of many of the surgical interventions, long-in-hospital recovery time, and increased fragility of neonates compared to older infants. Considering this high mortality rate, and the relatively low number of deaths in the current study, the increase from 9.73% to 17.86% was not statistically significant.

There are several limitations to this study. Databases rely on accurate ICD-9 code documentation and correct flagging of information, however, the potential for coding errors during entry is possible. Given the large number of admissions analyzed in this study, it is unlikely that a small number of coding errors would affect our findings. Additionally, we were unable to identify additional patient-specific comorbidities that could have been causes of the CABSI or mortality.

The findings of the current study further quantify the importance of CABSI in neonates and infants undergoing congenital cardiac surgery. The observed increases in length of stay, direct cost, and mortality in the population who develop CABSI highlight the role of CABSI prevention in neonates and infants undergoing CCS. Future prospective studies to develop and evaluate novel prevention methods for CABSI in this population will be vitally important. These findings also provide benchmark data for future quality improvement interventions for hospitals aiming to decrease length of stay, costs, and mortality.

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The authors confirm they had freedom of investigation and full control of the design of the study, methods used, outcome parameters and results, analysis of data, and production of the written report.

CONFLICT OF INTEREST

The authors have no conflicts of interest relevant to this article to disclose.

AUTHOR CONTRIBUTIONS

Conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript: Haughey and White

Conceptualized and designed the study, coordinated and performed the data collection, and critically reviewed and revised the manuscript: Seckeler

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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