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Concise Communication

Bloodstream infections in prolonged use of axillary-placed, intra-aortic balloon-pump support: A single-center study

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Abstract

Infections from prolonged use of axillary intra-aortic balloon pumps (IABPs) have not been well studied. Bloodstream infection (BSI) occurred in 13% of our patients; however, no difference in outcome was noted between those with BSI and those without. Further studies regarding protocol developments that minimize BSI risk are needed.

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Percutaneous axillary placement of intra-aortic balloon pumps (IABPs) is a recent advancement in the management of cardiogenic shock.[1] This strategy may be utilized for prolonged support to allow patients to ambulate.[2] Infections in patients with temporary mechanical circulatory support (t-MCS) devices are associated with increased morbidity and mortality.[3,4] Bloodstream infections (BSI) remain particularly problematic in this population due to risk of device seeding and recurrent bacteremia.[5] In this study, we sought to define incidence and explore risk factors associated with the development of BS, and evaluate the impact of BSI on patient outcomes in patients who received a percutaneous axillary IABP.

Methods

This retrospective cohort study was approved by the institutional review board. All patients who underwent placement of a percutaneous axillary IABP between May 2016 and June 2020 were included. Patients on concomitant extracorporeal membrane oxygenation (ECMO) were excluded. Data were collected from electronic medical records. The primary end point was incidence of BSI while on axillary IABP support. A clinically significant BSI was defined as a positive blood culture that required treatment. For blood cultures that yielded coagulase-negative staphylococci, at least 2 bottles from separate sites with the same organism were required to indicate a BSI. Secondary end points included time to first BSI, end outcome attainment as planned (LVAD/OHT/recovery), rates of BSI within 30 days of device removal, description of infecting pathogens, and use of procedural antimicrobials. Subgroup analyses were performed for planned outcome (ie, left ventricular assist device (LVAD) or orthotopic heart transplant (OHT) or cardiac recovery), use of periprocedural antimicrobials, incidence of device exchanges, and previous use of a femoral t-MCS device.

Due to increasing BSI in this patient population, an institutional protocol was developed in 2019 to administer a one-time dose of vancomycin and ceftriaxone for initial device placement, and vancomycin alone for device exchanges or manipulations needing dressing removal. The antibiotic choice was based on institutional blood cultures and sensitivity data.

Descriptive statistics including median or mean, interquartile ranges (IQR) or standard deviation (SD), counts, and percentages were used to characterize data. All categorical variables were compared using the χ^2 or the Fisher exact test. Continuous data were compared using Mann-Whitney *U* test. A 2-sided *P* value $\leq .05$ was used. All analyses were defined a priori and performed using Minitab version 16 software (Minitab, State College, PA).

Results

In total, 141 patients were included in the analysis. Baseline characteristics and outcomes are listed in Table 1. Most patients were male, with a median overall age of 53 years. Traditional BSI risk factors including central-line days, use of total parenteral nutrition, and incidence of previous positive cultures did not differ between the 2 groups.

The incidence of BSI was 13% with a mean of 4.3 infections per 1,000 device days. The median time from IABP insertion to first BSI was 19 days. The rate of femoral device use prior to axillary

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Table 1. Baseline Characteristics in Patients With Axillary IABP

Variable	All (N=141), No. (%)[a]	BSI (n=18), No. (%)[a]	No BSI (n=123), No. (%)[a]	*P* Value
Age, median y (IQR)	53 (62–66)	57 (53–66)	62 (53–66)	.60
Sex, male	105 (74)	14 (78)	91 (74)	.70
Race				.20
White	100 (71)	10 (55)	90 (73)	
Black	35 (25)	6 (33)	29 (23)	
Native American	0 (0)	0 (0)	0 (0)	
Asian	3 (2)	1 (6)	2 (2)	
Other	3 (2)	1 (6)	2 (2)	
Ethnicity				.60
Hispanic	17 (12)	3 (17)	14 (11)	
Non-Hispanic	122 (87)	15 (83)	107 (87)	
Declined	2 (1)	0 (0)	2 (2)	
Height, median inches (IQR)	69 (66–71)	71 (66–73)	68 (66–71)	.10
Weight, median kg (IQR)	85 (70–93)	89 (85–98)	83 (69–91)	.04
BMI, median kg/m^2 (IQR)	27 (24–30)	28 (27–30)	27 (23–30)	.20
BMI classification (kg/m^2)				.30
Underweight (≤18.5)	1 (1)	0 (0)	1 (1)	
Normal (18.6–24.9)	43 (30)	2 (11)	41 (33)	
Overweight (25–29.9)	55 (39)	9 (50)	46 (37)	
Obese (30–39.9)	34 (24)	6 (33)	28 (23)	
Morbidly obese (≥40)	8 (6)	1 (6)	7 (6)	
Use of inotropes at baseline	135 (96)	16 (89)	119 (97)	.10
Central line days per 100 patient days, median (IQR)	96 (67–112)	100 (75–117)	96 (66–112)	.40
Use of TPN within 72 h prior to device placement	13 (9)	2 (11)	11 (9)	.70
Previous femoral device use	69 (49)	12 (67)	57 (46)	.10
Duration of femoral device use, median d (IQR)	7 (5–11)	7 (6–10)	7 (5–11)	
Any positive cultures prior to device insertion	12 (9)	1 (6)	11 (9)	1.0
Insertion at outside institution	3 (2)	1 (6)	2 (2)	.30
Device indication				.70
Bridge to transplant	108 (77)	13 (72)	95 (78)	
Bridge to LVAD	17 (12)	2 (11)	15 (12)	
Bridge to recovery	4 (3)	1 (6)	3 (2)	
Bridge to decision	12 (8)	2 (11)	10 (8)	
Antimicrobial prophylaxis at time of insertion	100 (71)	10 (56)	90 (73)	.10
Index device exchange	71 (50)	9 (50)	62 (50)	1.0
No. of exchanges per individual, median (IQR)	2 (1–3)	2 (1–3)	2 (1–3)	
Switch to percutaneous LVAD (Impella)	17 (12)	2 (11)	15 (12)	1.0
Duration of axillary device support, median d (IQR)	28 (17–49)	49 (28–69)	26 (17–48)	.04
Antibiotic days of therapy, median (IQR)				
Per 100 days on axillary device	20 (7–38)	42 (28–56)	18 (6–33)	<.01
Per 100 inpatient days	29 (18–47)	54 (40–59)	28 (18–43)	<.01
Planned end strategy at time of device placement				.8
OHT	108 (76)	13 (72)	95 (77)	
LVAD	15 (11)	2 (11)	13 (11)	
Recovery	4 (3)	1 (6)	3 (2)	
Decision	14 (10)	2 (11)	12 (10)	

Note. BMI, body mass index; BSI, bloodstream infection; IABP, intra-aortic balloon pump; IQR, interquartile range; LVAD, left ventricular assist device; OHT, orthotopic heart transplant; TPN, total parenteral nutrition.
[a]Units unless otherwise specified.

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IABP placement was numerically higher in those who developed BSI (67% vs 46%; $P = .10$). Median duration of axillary IABP support was significantly higher in patients who developed BSI (49 vs 26 days; $P = .04$). The incidence of BSI was numerically higher in patients who did not receive antibiotics at the time of device insertion (19% vs 10%; $P = .20$) and was also higher in those with a previously placed femoral t-MCS device (17% vs 8%; $P = .10$).

Rates of OHT, LVAD, and death in those who developed BSI were 61%, 6%, and 22%, respectively, compared to 70%, 14%, and 9% in those without BSI. In patients with BSI, 72% reached their originally planned exit strategy, compared to 88% without a BSI. The most frequently isolated pathogen was *Staphylococcus epidermidis* followed by *Enterococcus faecalis*.

Of the 100 patients who received antimicrobial prophylaxis, 71% of patients received both vancomycin and ceftriaxone while 11% of patients received vancomycin alone. Median time to BSI was significantly longer in those who received antimicrobial prophylaxis compared to those who did not use antimicrobials (22 vs 7 days). All patients who developed BSI received appropriate antibiotic treatment. Death occurred in 9% of patients prior to IABP removal. Mortality was numerically, but not significantly, higher in those who developed BSI (22% vs 9%; $P = .15$). Also, 3 patients developed a BSI within 30 days after axillary device removal.

Discussion

To our knowledge, this is the largest study to report details of BSI in end-stage heart-failure patients supported with an axillary IABP. Our study demonstrated that 13% of patients with an axillary IABP developed a BSI. We did not detect any difference in the prevalence of traditional BSI risk factors at baseline including median central-line days, previous positive cultures, and use of total parenteral nutrition between those who developed BSI and those who did not.[6,7] The use of femoral t-MCS devices was numerically higher in the BSI group in our study. In a subgroup analysis, patients with previous femoral device use had twice the rate of BSI compared to patients without. Further studies are needed to evaluate the potential role of femoral t-MCS devices in acting as a source of infection for those individuals transitioning to an axillary approach. Further opportunities exist to explore interventions, such as periprocedural antimicrobials, to optimize BSI risk in patients who may transition to longer-term indwelling axillary IABP in the future.

In our study, patients who received antimicrobials at the time of axillary IABP insertion had a lower rate of BSI. Although this difference was not statistically significant, the use of periprocedural antimicrobials for index axillary IABP placement should be considered. Furthermore, there is no consensus regarding the use of periprocedural antimicrobials at the time of t-MCS device placement, and data are also lacking regarding patients with axillary t-MCSs that allow for prolonged use and ambulation.[6,7] Our average infection rate of 4.3 infections per 1,000 device days was 5-fold higher than the general ICU patient population rate of 0.8 infections per 1,000 central-line days.[8] Importantly, the device days metric of lifesaving cardiac support is different than the central-line days metric. As implemented for ECMO, it might be relevant to consider axillary t-MCS devices for exclusion from central-line–associated BSI reporting in order to not penalize institutions that are working with these complex cardiogenic shock patients needing prolonged t-MCS support. Despite such BSI risk, no patients were permanently disqualified from OHT or LVAD solely for bacteremia, and only 2 patients developed a recurrent BSI within 30 days after OHT, making this strategy feasible for life-saving therapy.

Our study had several limitations. Given the novelty of axillary placement, we were unable to find any comparator groups with a similar BSI risk profile where IABP was left for an extended time. Furthermore, to mitigate the concern for overinflated BSI rates due to treatment out of an abundance of caution, we required a minimum of 2 positive bottles for coagulase-negative staphylococci to avoid reporting contaminants. Despite these limitations, this is the largest report of percutaneous axillary IABP support.

In conclusion, as the use of axillary-placed t-MCS devices continues to rise, consideration should be given to risk factors and prevention strategies for BSI. Specific infection prophylaxis protocols and future device-specific innovations adapted for prolonged support could mitigate the occurrence of BSI in this patient population. Further research is needed to evaluate the role of antimicrobial prophylaxis in this patient population.

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