Characteristics of Venous-Venous Extracorporeal Membrane Oxygenation Related Bloodstream Infections

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Abstract

Infectious complications have been shown to increase the morbidity of venous-venous extracorporeal membrane oxygenation (VV-ECMO) population, including the use of right ventricular assist devices. We aimed to evaluate our VV-ECMO population for ECMO related bloodstream infections (E-BSI) and characteristics that affect risk and overall outcomes. We report a low infection rate of 2.7%. We postulate our low BSI rate may be due to our use of perioperative antimicrobials as well as a majority of our cannulations occurring in the operating room. Further investigation into trends, risks, and outcomes related to E-BSI is needed.

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Infectious complications have been shown to increase the morbidity of venous-venous extracorporeal membrane oxygenation (VV-ECMO) population, including the use of right ventricular assist devices. We aimed to evaluate our VV-ECMO population for ECMO related bloodstream infections (E-BSI) and characteristics that affect risk and overall outcomes. We report a low infection rate of 2.7%. We postulate our low BSI rate may be due to our use of perioperative antimicrobials as well as a majority of our cannulations occurring in the operating room. Further investigation into trends, risks, and outcomes related to E-BSI is needed.

Case Report

A 22-year-old male presented to our emergency department following a motor vehicle accident. He was taken to the operating room (OR) for emergent surgery. Due to his condition, he was admitted to the ICU. There, he was difficult to ventilate and ultimately placed onto venous-venous extracorporeal membrane oxygenation (VV-ECMO). While on ECMO, blood cultures were obtained which were subsequently positive.

Introduction

ECMO related Bloodstream infections (E-BSI) are now separated from central venous catheters.[1] With this distinction, further understanding of the epidemiology, risk factors, and clinical significance for E-BSI is required.[1,2] Infectious complications of ECMO have been shown to increase morbidity but not necessarily mortality.[2-6] To further the understanding of E-BSI, we conducted a retrospective analysis to assess our institutional clinical characteristics and outcomes.

Methods

Retrospective data was collected from electronic medical records of 75 adult patients (>18 years of age) supported with VV-ECMO from September 2012-December 2016. Demographic information, type, site, and location of cannulation as well as antimicrobial use, and presence of bacteremia were obtained. E-BSI were defined as positive blood cultures > 24 hours after cannulation. Counts and percentages are reported for categorical variables. This study was approved by the IRB.

Results

75 patients were included for 712 ECMO days with an average duration of 9.5 days. 76.6% (n=58) of patients were male with an average age of 54.1 years. 48% (n=35) utilized a right ventricular assist device (RVAD) with in-line oxygenator which was included as a form of VV ECMO. 70.2% (n=45) of cannulations occurred in the operating room. Femoral-femoral cannulation was utilized in 38.7% (n=29), femoral-internal-jugular in 30.7% (n=23), central in 17.3% (n=13) and internal jugular only in 13.3% (n=10) of patients. 62.2% (n=46) were decannulated while 52.7% (n=39) were alive at discharge.

70.6% (n=53) of patients were on antimicrobials prior to cannulation while 56% (n=42) received perioperative antimicrobials. Blood cultures, based on clinical suspicion, were obtained in 59.6% (n=49) of patients with seven positive cultures. Five were contaminants while two were E-BSI resulting in a E-BSI rate of 2.7% (3 per 1000 ECMO days).

Escherichia Coli, Enterobacter cloacae , and *Streptococcus Pneumoniae* were identified in the patients with E-BSI. Patient characteristics are summarized in Table 1. Of the contaminants, two were*Staphylococcus epidermidis* while an unidentified Coagulase Negative staphylococcus, *Bacillus* not anthracis, and*Abiotrophia*

species comprised the other positive cultures. These were determined to be contaminants due to the organisms and review of Infectious Diseases consultation notes.

Of the two E-BSI, one patient only had positive peripheral cultures. While the peripheral cultures may not have been directly related to his ECMO, we felt the need to include it given the organism (*E. Coli)*in the setting of femoral-femoral cannulation.

Our organism profile is similar to that reported in ECMO patients.[1,2,4,6] Amongst VV-ECMO, common isolates include gram negative rods, candida species, and*Staphylococcus/Streptococcus* species.[2,7,8]Compared to central venous catheter associated infections, the ECMO population microbiological spectrum shifts toward gram-negatives and fungi rather than *Staphylococcus* species.[7] This shift appears to be multifactorial including exposure to antimicrobials, complexity of illness, and complications from secondary infections.[2,7]

Inherent differences exist between VV and Venous-Arterial (VA) ECMO patients. VV-ECMO patients require support longer with more exposure to antimicrobials.[2] Cannulation sites may also differ with VA-ECMO patients undergoing higher rates of central cannulation and open chests.[7] Within our cohort, 17% of VV patients were cannulated centrally by way of RVAD and nearly 70% of cannulations occurred in the OR. These factors may influence the rate of E-BSIs and therefore we chose VV patients exclusively.

The current rate of E-BSI ranges from 9.7%-35%.[2,5,7,8] Amongst VV patients only, an incidence of 13.1%-17% as been reported.[2,7] Notably, Menaker et al. reported a BSI incidence of 5.7% amongst their VA-ECMO population. Per their institutional protocols, only VA-ECMO would receive routine antimicrobial prophylaxis.[7]

The use of antimicrobials in the pre-, peri-, or post-cannulation settings is not standardized and the routine use of prophylactic antimicrobials is currently discouraged by the Extracorporeal Life Support Organization.[3,5] Despite this, many ECMO centers utilize a prophylactic antimicrobial regimen.[3,5]

We postulate our institutional use of antimicrobials in the perioperative setting may have decreased our overall rate. The majority of cannulations occurring within the OR likely also contributed to our low rate. Both E-BSI patients were cannulated in non-OR settings. Improving our rate of antimicrobial use in the perioperative setting may help reduce our overall institutional E-BSI incidence. Although E-BSI has not been linked with increased mortality, it is reasonable to assume that a correlation might emerge in a large cohort and this remains an open question.

The current study has several limitations including the retrospective nature, single institution, and an older data set. Duration of support has been suggested as a contributing risk factor for E-BSI, however, our cohort was not large enough to further study this. In the era of COVID-19, in which patients may have prolonged periods of VV-ECMO, an analysis including duration of support might be revealing. Our low E-BSI rate did not allow for further analysis into risk factors and effect on morbidity and mortality.

Conclusion

In summary, we report a E-BSI incidence of 2.7%. Further research is needed to continue to evaluate the incidence and factors such as prophylactic antimicrobials, duration of support, and site and location of cannulation that contribute to E-BSI and its effect on morbidity and mortality. Future directions would include expanding data collection to VA-ECMO to identify differences in risk factors and outcomes compared to the VV-ECMO.

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Patient Characteristics for E-BSI

	Patient A	Patient B
Sex	Female	Male
Reason for ECMO	Right Ventricular Failure s/p valve replacement	Respiratory Failure s/p Trauma
CPR in progress?	No	No
Hospital days until ECMO	12 days	1 day
Type of cannulation	RVAD Femoral-Internal Jugular	Femoral-Femoral
Location of cannulation	Cath lab	Bedside
Hospital days on ECMO	4 days	3 days
ECMO day cultures drawn	4 days	2 days
Organism Identified	*Escherichia coli Enterobacter Cloacae*	*Escherichia coli Streptococcus Pneumoniae*
Multi-drug resistant?	No	No
Antibiotics prior to cannulation?	No	No
Perioperative antibiotics?	No	No
Cultures drawn from line?	Yes, Arterial + Central	No, peripheral x2

Table 1. Patient characteristics for E-BSI

(ECMO: Extracorporeal Membrane Oxygenation, RVAD: Right Ventricular Assist Device)