

Abstract

Introduction: The use of extracorporeal membrane oxygenation (ECMO) in children continues to increase nationally, including patients with methicillin-resistant *Staphylococcus aureus* (MRSA) infection. Survival of pediatric patients with MRSA sepsis has not improved over the last 20 years. We sought to review our institutional experience and outcomes of ECMO support among children with MRSA sepsis.

Case Description: Children aged 0-19 years who received ECMO support from October 2014 to June 2021 were reviewed retrospectively, and patients with laboratory confirmed MRSA infections were identified using ICD-9 and ICD-10 codes. In addition, demographics, diagnosis, ventilator settings, vasoactive infusions, ECMO indications and characteristics, and patient outcomes were collected. Out of 88 unique pediatric patients requiring ECMO support, 8 patients had documented MRSA infections. Three patients had a primary diagnosis of congenital cardiac defects. Only 2 patients had a prior known history of MRSA infection or colonization. Half of the patients had MRSA positive blood culture, and 7 of 8 patients had MRSA isolated from the respiratory tract. Five out of 8 patients developed sepsis during ECMO support. Five patients were initially cannulated to veno-venous (VV) - ECMO, 1 to veno-arterial (VA) -ECMO, 1 was converted from VA to VV-ECMO, and 1 was cannulated via extracorporeal cardiopulmonary resuscitation (ECPR). The duration of mechanical ventilation prior to ECMO initiation was an average of 7 days (range 0.7 to 21.8 days). The median ECMO duration was 648.1 hours (range 15.5 to 1580.5 hours). Five patients were successfully decannulated; however, only 2 patients survived to discharge. The two surviving patients were both cannulated via VV-ECMO. Mechanical ventilation prior to ECMO was 4.5 and 21.8 days in these cases with run durations of 18.9 and 29.9 days, respectively.

Discussion: Our institutional survival of patients with MRSA on ECMO is lower than what has been reported in recent database studies, but notably, 62.5% were successfully decannulated. As it has been reported in the literature, we have seen increased utilization of ECMO in patients with MRSA, with the majority of our cases occurring in the last 4 years. While both surviving patients were supported with VV-ECMO, there was no other clear trend in factors that contributed to survival.

Conclusion: MRSA continues to be a source of significant morbidity and mortality among pediatric patients, including at our own institution. On-going investigation of outcomes and factors contributing to survival in patients with MRSA infection on ECMO is warranted.

Introduction

Staphylococcus aureus is a significant source of morbidity and mortality in children with a mortality of 18% despite decreased rates of hospital-associated MRSA. [1] The use of ECMO in pediatrics has been increasing internationally over the past 20 years [2] and has been reported in the treatment of MRSA sepsis [3] and pneumonia [4, 5]. Survival among pediatric patients with MRSA sepsis requiring ECMO support has been reported to be 39.8%. [6] As the largest tertiary children's hospital in the state and the primary provider of pediatric ECMO services, we sought to review our own institutional experience and outcomes among children with MRSA sepsis requiring ECMO.

Case Description

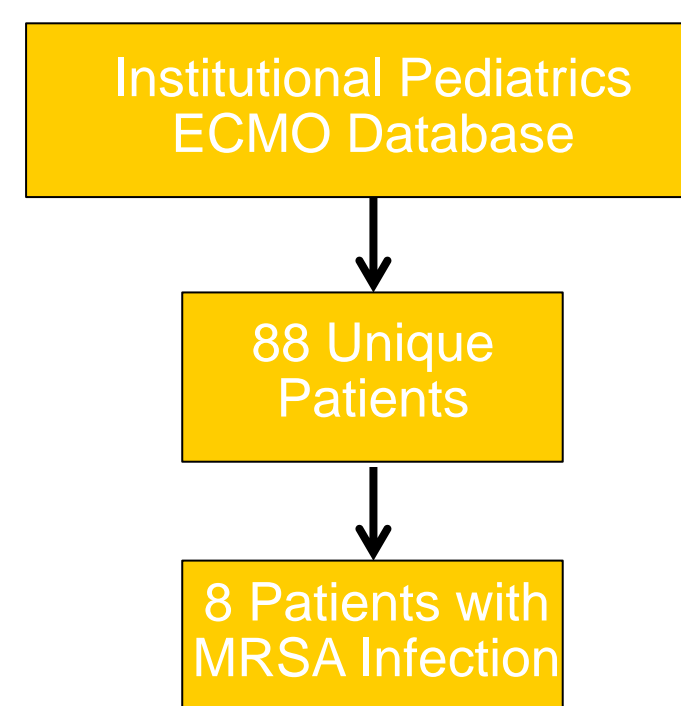


Figure 1. Identification of patients with MRSA infection requiring ECMO support. Children aged 0-19 years who received ECMO support from October 2014 to June 2021 were reviewed retrospectively, and patients with laboratory confirmed MRSA infections were identified using ICD-9 and ICD-10 codes in addition to manual review of all culture results, including blood and respiratory cultures. During the period of October 2014 to June 2021, 88 pediatric patients were placed on ECMO support. Of those patients, 8 patients had a documented MRSA infection.

Case Description

Patient	Age (M)	Sex	Weight (Kg)	Medical History	Principle Diagnosis	PIM3 Score	Ventilation Type	OI	MRSA Blood Culture	MRSA from Other Source
1	152	Female	70	None	H1N1 influenza	-3.28	HFOV	48.9	No	Respiratory
2	215	Female	49.1	Pulmonary and aortic stenosis; Aortic coarctation; Cerebellar astrocytoma	Abscess of aortic root homograft, endocarditis	-4.96	Conventional	6.2	Yes	---
3	142	Male	104.1	Asthma	MRSA septic arthritis of right ankle, MRSA sepsis, MRSA necrotizing pneumonia	-0.47	Conventional	33.6	Yes	Respiratory, Right hip, Right ankle, Left knee, Left hip
4	6	Male	8.1	VSD; Hypertrophic cardiomyopathy; Pulmonary hypertension; Trisomy 21	Hypertrophic cardiomyopathy, MRSA pneumonia	-2.15	Conventional	27.3	No	Respiratory
5	7	Female	9.9	None	Septic shock, MRSA pneumonia	-2.32	HFOV	19.44	Yes	Respiratory
6	229	Male	138.5	Asthma	Trauma related to abdominal gun shot wound	-4.81	HFOV	28.4	Yes	Respiratory
7	23	Male	11.9	None	pARDS with RV failure and cor pulmonale; systemic JIA	-2.48	APRV	42.5	No	Respiratory
8	54	Male	20.1	HLHS s/p Fontan	Acute on chronic systolic and diastolic heart failure with failed Fontan physiology	-2.85	Conventional	37.2	No	Respiratory

Table 1. Patient characteristics and pre-ECMO factors. Prior to ECMO cannulation, all patients were mechanically ventilated, and all but one patient meet criteria for severe pediatric acute respiratory distress syndrome (pARDS). The duration of mechanical ventilation prior to ECMO initiation was an average of 7 days (range 0.7 to 21.8 days). OI: oxygenation index, VSD: ventricular septal defect, HLHS: hypoplastic left heart syndrome, HFOV: high frequency oscillatory ventilation, APRV: airway pressure release ventilation

Patient	ECMO Indication	Duration of Mechanical Ventilation prior to ECMO (Days)	Mode of ECMO	Other Organisms Cultured	Successful ECMO Decannulation	ECMO Duration (Hours)	Survival to Discharge	Total Number of Hospital Days
1	Respiratory	1.38	VV converted to VA	---	No	718.23	No	31
2	Cardiac	0.85	VA	---	Yes	15.5	No	31
3	Respiratory	5.69	VV	<i>Pseudomonas aeruginosa</i>	No	1030.95	No	48
4	Cardiac	1.48	VA converted to VV	--	Yes	385.5	No	231
5	Respiratory	4.52	VV	--	Yes	455.5	Yes	49
6	Respiratory	21.75	VV	--	Yes	717.5	Yes	76
7	Respiratory	19.77	VV	Methicillin-resistant <i>Staphylococcus epidermidis</i>	No	1580.45	No	68
8	ECPR	0.69	VA	---	Yes	281.5	No	27

Table 2. ECMO characteristics and patient outcomes. The median ECMO duration was 648.1 hours (range 15.5 to 1580.5 hours). Five patients were successfully decannulated; however, only 2 patients survived to discharge. Half of patients in our series had MRSA positive blood cultures during their hospital stay, and 7 of 8 patients had MRSA isolated from the respiratory tract. MRSA positive culture occurred prior to ECMO cannulation in 6 of 8 patients. ECPR: extracorporeal cardiopulmonary resuscitation, VV: venovenous, VA: venoarterial

Case Description

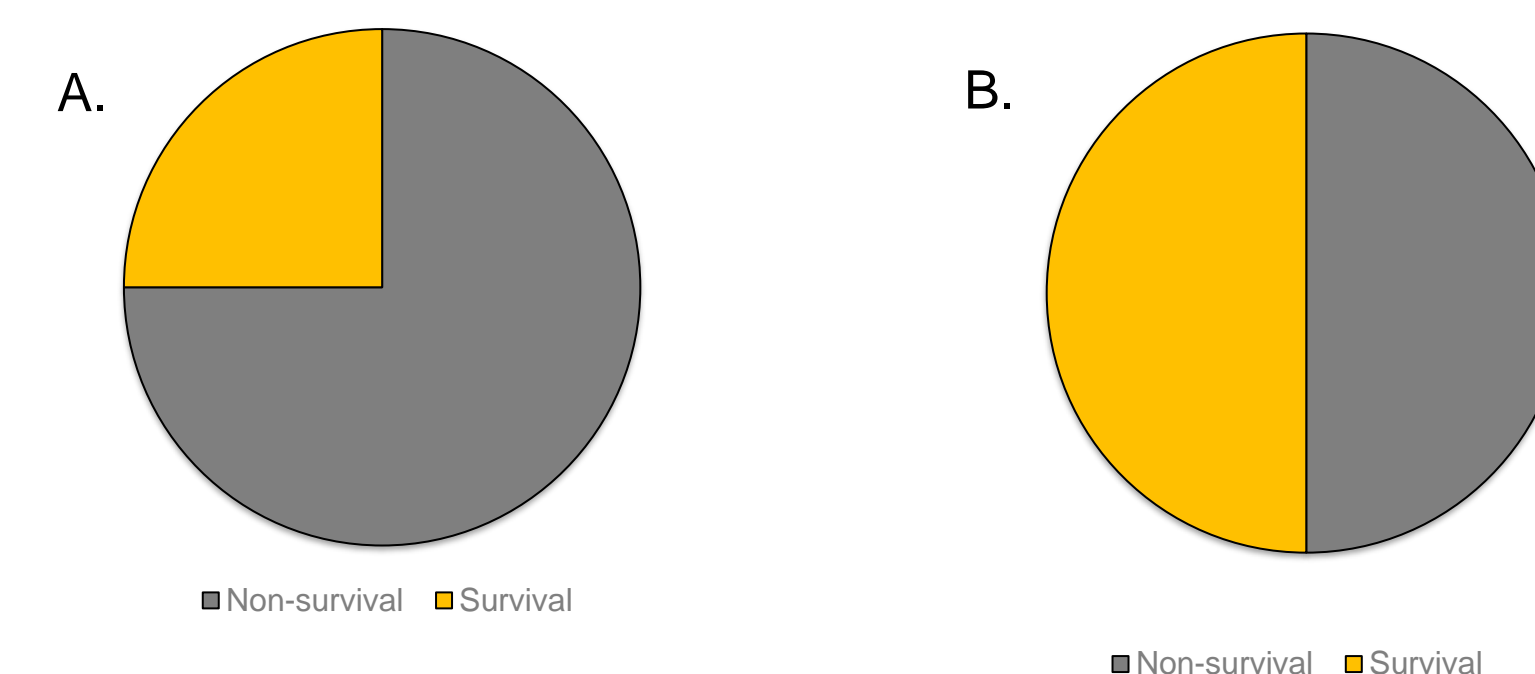


Figure 2. Survival after ECMO. In our series of 8 patients, two patients survived to discharge. However, among the 4 patients who developed MRSA sepsis, survival was 50%.

Discussion

Within our cohort, survival to discharge was 25%; however, 62.5% were successfully decannulated from ECMO. While both patients who survived to discharge were cannulated from VV-ECMO secondary to respiratory failure, there are few other similarities between them. Survival among pediatric patients with MRSA sepsis requiring ECMO has been reported to be 39.1 – 49%. [6, 3] Review of our own institutional data reveals similar rates of survival among patients with MRSA sepsis. Our case series is limited by the small number of patients, which precludes the ability to conduct any meaningful statistical analysis.

Conclusions

MRSA continues to be a source of significant morbidity and mortality among pediatric patients, including at our own institution. On-going investigation of outcomes and factors contributing to survival in patients with MRSA infection on ECMO is warranted.

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