

Balloon Atrial Septostomy During Extracorporeal Membrane Oxygenation For Refractory Pediatric Shock

Sloan Rhodes¹, BS, Mathew Gregoski², PhD, Laura Hollinger³, MD

¹Medical University of South Carolina, College of Medicine, Charleston, SC 29425, United States; ²Department of Public Health Sciences, Medical University of South Carolina, Charleston, 29425, United States; ³Division of Pediatric Surgery, Department of Surgery, Medical University of South Carolina, Charleston, SC 29425, United States.

Background

- Pediatric patients who require Extracorporeal Membrane Oxygenation (ECMO) for refractory shock can experience cardiac stun manifested as progressive left atrial dilation and distention.
- Percutaneous Transcatheter Balloon Atrial Septostomy (BAS) is an interventional catheterization with the purpose of widening the atrial communication to allow for future surgical intervention, enhanced atrial mixing, or as in during ECMO, left ventricular decompression by permitting left to right shunting.¹
- BAS has proven to be efficacious during ECMO for cardiogenic shock in positively influencing hemodynamic balance and preventing further complications.²
- MUSC Shawn Jenkins Children's Hospital's multidisciplinary ECMO team has extensive experience over recent years with performing transcatheter BAS in neonatal and pediatric patients on ECMO who experience cardiac stun, however our understanding of patient outcomes and complications is limited.
- This study aims to identify early risk factors that may be associated with the need for BAS in neonatal and pediatric patients on ECMO to allow for earlier intervention.

Method

- Retrospective cohort study collecting Extracorporeal Life Support Organization (ELSO) registry data for all neonatal and pediatric patients cannulated for ECMO at Medical University of South Carolina from 01/2017 to 12/2023.
- Only first runs included in this study.
- Patients were placed into two categories: patients without BAS and patients with BAS.
- Differences between the two groups were examined with Mann-Whitney *U* tests, *X*² analyses, or Fisher's exact tests as appropriate.

Results

- Of the 170 neonatal and pediatric patients cannulated for ECMO at MUSC during this time, 13 received a BAS with only 15% being neonatal.
- 77% of the BAS group had primary cardiac failure, while 23% were on ECMO for non-cardiac diagnoses, such as respiratory failure (Figure 1).
- BAS patients had significantly reduced admission-to-ECMO and intubation-to-ECMO times and were more commonly admitted to the PCICU (Table 1).
- BAS patients had an increased median ECMO run length, but a decreased median decannulation-to-extubation time (Figure 2).
- Cardiac complications were more frequent in the BAS group (23%), while hemorrhagic, metabolic, and neurologic complications were less prevalent.
- ECMO and hospital survival rates did not significantly differ between patients with and without BAS (Table 2).

Figure 1. BAS Diagnoses.

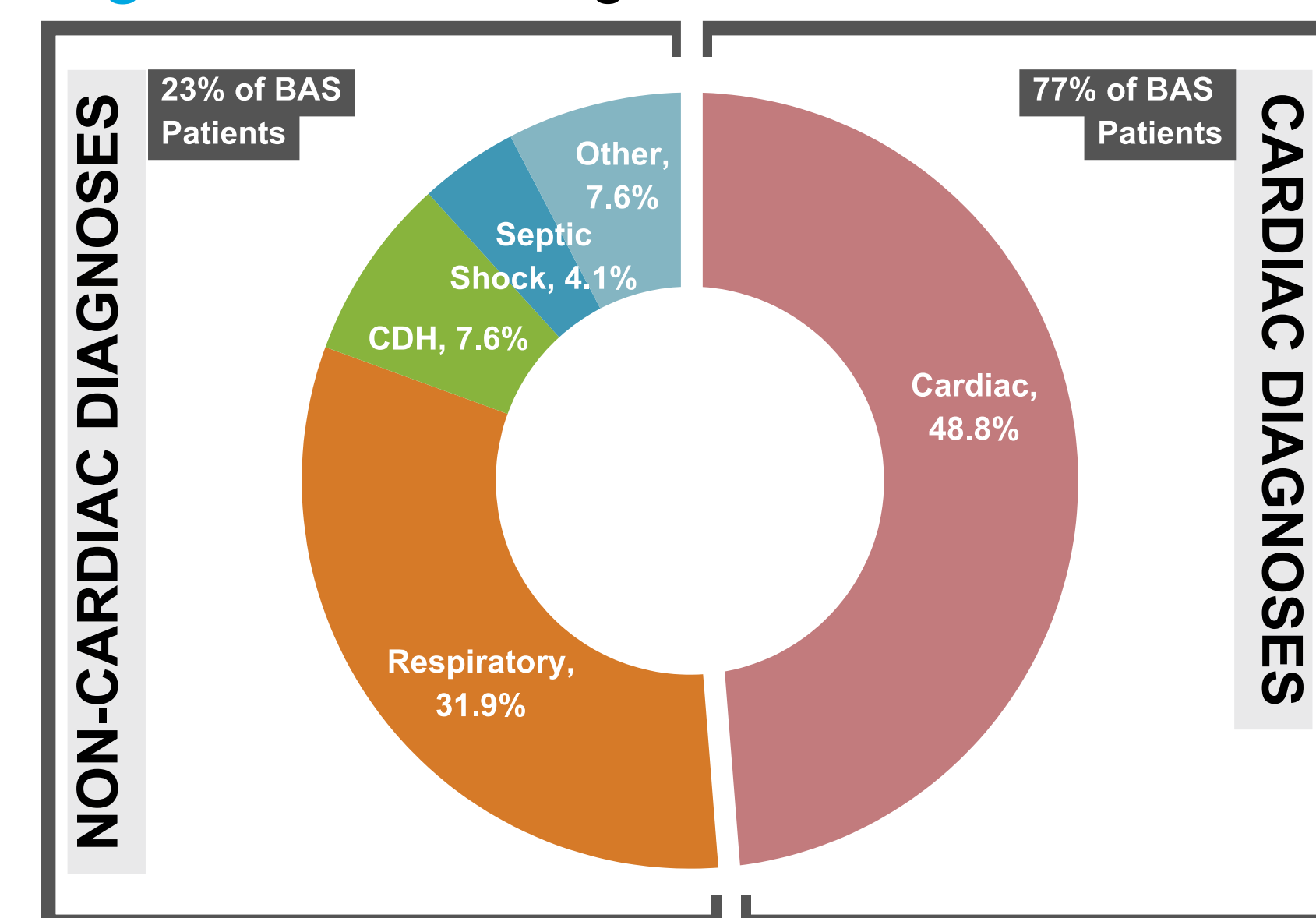


Table 1. Pre-ECMO Patient Characteristics.

	All Patients	Patients Without BAS	Patients With BAS	P Value
Patients (n)	170	157	13	
Support Type (n, %)				0.133 ^c
Cardiac	87, 51%	77, 49%	10, 77%	
ECPR	18, 11%	17, 11%	1, 8%	
Pulmonary	65, 38%	63, 40%	2, 15%	
Mode (n, %)				0.059 ^c
VA	138, 81%	125, 80%	13, 100%	
VV	32, 19%	32, 20%	0, 0%	
Pre-ECMO Arrest (yes) (n, %)	39, 23%	37, 24%	2, 15%	0.390 ^c
Admission-to-ECMO time, hours (median, IQR*)	39 (152-10)	46 (173-10)	24 (48-3)	0.023 ^a
Intubation-to-ECMO time, hours (median, IQR*)	16 (49-6)	17 (53-7)	3 (20-1)	0.002 ^a
Pre-ECMO pH (median, IQR*)				
pH at cannulation	7.23 (7.33-7.09)	7.21 (7.33-7.09)	7.31 (7.34-7.11)	0.277 ^a
pH 24-hrs after cannulation	7.41 (7.45-7.37)	7.41 (7.45-7.37)	7.45 (7.48-7.36)	0.266 ^a
Pre-ECMO lactate (median, IQR*)				
Lactate at cannulation	5.4 (10.0-2.3)	5.5 (10.2-2.3)	4.5 (7.7-1.5)	0.392 ^a
Lactate 24-hrs after cannulation	1.6 (2.6-1.0)	1.6 (2.5-1.0)	1.6 (3.7-0.7)	0.903 ^a
ICU ECMO Received (n, %)				0.033 ^c
NICU	44, 26%	44, 28%	0, 0%	
PCICU	80, 47%	70, 45%	10, 77%	
PICU	46, 27%	43, 27%	3, 23%	

*Mann-Whitney *U* test for significance; ^aFisher's exact test for significance; *IQR (Q3-Q1)

Results Continued

Table 2. ECMO and Hospital Survival.

Variable (n, %)	All Patients (n=170)	Patients without BAS (n=157)	Patients with BAS (n=13)	P-Value
ECMO Survival	137, 81%	126, 80%	11, 85%	0.520 ^c
Hospital Survival	120, 71%	109, 69%	11, 85%	0.205 ^c

^cFisher's exact test for significance

Conclusions

- Pediatric ECMO patients requiring BAS for left atrial decompression during ECMO experience rapid demise, with brief time intervals between admission to ECMO cannulation.
- Patients cannulated to ECMO for non-cardiac primary diagnoses may develop cardiac stun requiring BAS.
- Patients who received BAS experienced less frequent hemorrhagic and neurologic complications.
- Neonates underwent BAS less frequently due to conditions such as persistent patent foramen ovale and other cardiac shunts from fetal circulation.
- Vigilant echocardiogram monitoring of at-risk patients identified in this study could prompt earlier BAS intervention on ECMO, potentially hastening recovery.
- We hope to further identify early risk factors by analyzing transthoracic echocardiography reports from patients within the BAS group.

References

1. Cinteza E, Carminati M. Balloon atrial septostomy - almost half a century after. *Maedica (Bucur)*. Sep 2013;8(3):280-4.
2. Zampi JD, Alghanem F, Yu S, et al. Relationship Between Time to Left Atrial Decompression and Outcomes in Patients Receiving Venoarterial Extracorporeal Membrane Oxygenation Support: A Multicenter Pediatric Interventional Cardiology Early-Career Society Study. *Pediatr Crit Care Med*. Aug 2019;20(8):728-736. doi:10.1097/PCC.0000000000001936