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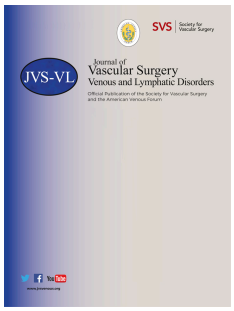

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Veno-Arterial Extracorporeal Membrane Oxygenation Is An Effective Management Strategy For Massive Pulmonary Embolism Patients.

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ARTICLE HIGHLIGHTS

Type of Research: Single-center retrospective review of a prospectively maintained registry.

Key Findings: Out of 17 consecutive patients with massive pulmonary embolism (MPE) who were placed on Veno-arterial Extracorporeal Membrane Oxygenation (VA-ECMO), 13 survived (76%). In survivors, 12 of 13 patients (92%) were discharged without evidence of neurologic insult. Median duration of VA-ECMO run for survivors was 86 hours. In survivors, the median length from ECMO cannulation to lactate clearance (<2.0mmol/L) was 10 hours and the median length from ECMO cannulation to freedom from vasopressors was 6 hours.

Take home Message: VA-ECMO as first-line adjunct therapy was effective at salvaging highly unstable patients with massive PE. Survivors had rapid reversal of multiple organ failure with ECMO as their primary therapy.

TABLE OF CONTENTS SUMMARY

Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) was effective at salvaging 13 highly unstable patients with massive pulmonary embolism (MPE) of consecutive 17 patients. These data suggest VA-ECMO should be considered as first-line treatment and therapeutic anticoagulation in MPE patients

Abstract:

Objective: Treatment of massive pulmonary embolism (MPE) is controversial, with mortality rates ranging from 25% to 65%. Patients commonly present with profound shock or cardiac arrest. Veno-arterial Extracorporeal Membrane Oxygenation (VA-ECMO) is increasingly being utilized as a form of acute cardiopulmonary support in critically ill patients. We reviewed our institutions pulmonary embolism response team (PERT) experience utilizing VA-ECMO for patients presenting with advanced shock and/or cardiac arrest from MPE.

Methods: From March 2017 to July 2019 we retrospectively reviewed seventeen consecutive patients at our institution with MPE who were placed on VA-ECMO for initial hemodynamic stabilization.

Results: Mean patient age and body mass index was 55.8 years and 31.8, respectively. Ten of 17 patients (59%) required cardiopulmonary resuscitation (CPR) prior-to or during VA-ECMO cannulation. All patients had evidence of profound shock with mean initial lactate of 8.95 mmol/L, mean pH of 7.10, and a mean serum creatinine of 1.78 mg/dl. Seventeen of 17 (100%) cannulations were performed percutaneously, with 41% (n=7) of patients placed on VA-ECMO while awake and utilizing local analgesia. Five of 17 patients (29%) required reperfusion cannulas, with 0% incidence of limb loss. Overall survival was 13 in 17 patients (76%), with causes of death resulting from anoxic brain injury (n=2), septic shock (n=1), and CPR-induced hemorrhage from liver laceration (n=1). In survivors, 12 of 13 patients (92%) were discharged without evidence of neurologic insult. Median duration of VA-ECMO run for survivors was 86 (45-218) hours. In survivors, the median length from ECMO cannulation to lactate clearance (<2.0 mmol/L) was 10 hours and the median length from ECMO cannulation to freedom from vasopressors was 6 hours. Three of 13 patients (23%) required concomitant percutaneous

thrombectomy and cathether-directed thrombolysis to address persistent right heart dysfunction, with the remaining survivors (77%) receiving VA-ECMO and anticoagulation alone as definitive therapy for their massive PE. Median ICU and hospital length of stay for survivors was 9 and 13 days, respectively.

Conclusions: VA-ECMO was effective at salvaging highly unstable patients with massive PE. Survivors had rapid reversal of multiple organ failure with ECMO as their primary therapy. Majority of survivors required ECMO and anticoagulation alone for definitive therapy of their massive PE.

Key Words: Massive pulmonary embolism (MPE); Veno-arterial Extracorporeal Membrane Oxygenation (VA-ECMO); Pulmonary Embolism Response Teams (PERTs); Reperfusion cannulas; Catheter-directed thrombolysis (CDT).

Abbreviations: MPE – massive pulmonary embolism; CPR – cardiopulmonary resuscitation; PERTs – Pulmonary Embolism Response Teams; RV- Right Ventricle; VA-ECMO - Veno-arterial Extracorporeal Membrane Oxygenation; ED – emergency department; ICU – Intensive care unit; ACLS – Advance Cardiopulmonary Life Support; NIRS – near infrared spectroscopy; CT- Computed tomography; CDT – Catheter-directed thrombolysis.

Introduction:

Massive Pulmonary Embolism (MPE) is a common cause of sudden death. MPE is a term used to designate patients with sustained hypotension (systolic blood pressure <90mmHg for at least 15 minutes or requiring inotropic support), pulselessness, or persistent profound bradycardia. Although accounting for only 5% of total pulmonary embolisms, MPEs have a mortality ranging from 25-60%.[1,2] However, optimal treatment for MPEs remains controversial. Patients that survive to receive medical care commonly present in hemodynamic extremis after undergoing cardiopulmonary resuscitation (CPR).[1-4] Multiple organ failure on initial presentation is likewise typical.

Over the past several years, there has been a focus at our institution in the development of multidisciplinary Pulmonary Embolism Response Teams (PERTs) that has been spear-headed by the Vascular Surgery Division and Department of Critical Care. Our institutions PERT objectives is to optimize care for patients with submassive and massive PE through medical management, catheter-based therapy, and/or circulatory support using Veno-arterial extraocorporeal membrane oxygenation (VA-ECMO).[5-6] Submassive PE refers to patients with acute PE without systemic hypotension but with evidence of either right ventricle (RV) dysfunction or myocardial necrosis.

ECMO is a form of acute cardiopulmonary support. Its use for pulmonary embolism has more recently been advocated by several centers.[7-11] Advantages of ECMO include providing immediate right ventricular decompression and augmenting cardiac output in patients with advanced organ dysfunction. Cannulations for ECMO can likewise be performed percutaneously and with minimal sedation in the emergency department (ED) or intensive care unit (ICU).

In many cases, ECMO has been reserved as "last resort", when the patient remains in extremis despite anticoagulation, thrombolytic therapy, mechanical ventilation, and vasopressor therapy. However, mortality rates were high with VA-ECMO as salvage therapy for MPE.[12-17] The primary objective of this current study was to review our institutional experience of a PERTs utilizing an "ECMO First" management algorithm in patients presenting with advanced shock and/or cardiac arrest from MPE. Therefore, all patients at our institution with a clinical diagnosis of a MPE were candidates for VA-ECMO cannulation as initial adjunct intervention and started on therapeutic anticoagulation.

Methods:

Study Design:

Institutional review board approval was obtained for the study. According to the research ethics board policy, patient informed consent was not required. This study is a single center retrospective review of a prospectively maintained registry of consecutive 17 patients who were placed on VA-ECMO for MPE from March 2017 to July 2019. Our PERT protocol used for patient selection at our institution is summarized in Figure 1. All patients with hypotension in the setting of a pulmonary embolism are screened for suitability of VA-ECMO cannulation. During this timeframe all MPE patients who met inclusion criteria were treated with ECMO. Inclusion criteria to proceed with ECMO for MPE patient were based upon: 1) Pre-procedure diagnosis of PE is made typically with computed tomography (CT) imaging demonstrating pulmonary clot burden or bedside echocardiography (transthoracic or transesophageal) demonstrating evidence of pulmonary hypertension compromising right ventricular function in the setting of hypotension and shock or 2) Our institution also practices an ECMO-based

Advanced Cardiopulmonary Life Support (ACLS) program where selective cardiac arrest patients are placed on VA-ECMO if suspicion of a reversible cause of their arrest (such as pulmonary embolism) exists. These patients then receive CT imaging after ECMO cannulation for confirmation of diagnosis. Common alternative causes of these arrests include coronary events. In these scenarios, patients at our institution proceed to the cardiac catheterization lab for coronary revascularization. Exclusion criteria include intracranial bleed within last 3 months (n=1), metastatic malignancy, and age greater than 75 years old (n=1).

ECMO Cannulation strategy and PE management:

If patients are maintaining a natural airway at time of diagnosis, they are preferentially cannulated utilizing local analgesia alone to avoid hemodynamic decline associated with mechanical ventilation. Veno-arterial configuration of ECMO is used in all patients. Ultrasound guidance was used for the placement of 25 Fr venous drainage cannula into the common femoral vein and a 15 – 17 Fr arterial return cannula into the common femoral artery. In awake patients, after cannulation a focused neuromotor exam is performed of the lower extremities to identify patients that require reperfusion cannulas. Conversely intubated patients are monitored utilizing serial physical exam and near infrared spectroscopy (NIRS) placed on lower extremities to detect asymmetric limb perfusion.

Systemic thrombolytic is administered in patients with cardiac arrest while ECMO cannulation is being arranged. Anticoagulation strategy for pulmonary embolism utilizes Factor Xa levels for heparin drip and is titrated to a level between 0.3 to 0.7 IU/ml. When patients are placed on VA-ECMO, their anticoagulation is titrated to a PTT level of 60 to 110 seconds. Patients are monitored for improvement in their end organ function and hemodynamics as well

as clarity in their neurologic status (if post cardiac arrest). After 3-5 days of ECMO support, an attempt is made to wean ECMO flows and observe hemodynamic tolerance of this. Interval echocardiography is additionally performed to assess recovery of right ventricular function. Patients that are able to tolerate minimal ECMO flows with reasonable residual right ventricular function are decannulated from ECMO via a groin cutdown and cannula removal in the operating room. De Patients still dependent upon ECMO support after 3-5 days of therapy receive pulmonary CT imaging to further characterize residual clot burden and to plan for clot removal therapies while on ECMO. At this time the patients are candidates for either (CDT) catheter-directed thrombolysis via EkoSonic catheters (EKOS Corporation, Bothell, WA) and/or mechanical thrombectomy via Penumbra (Penumbra Inc, Alameda, CA) to reduce thrombus burden while on ECMO. Post-cannulation, CDT or Penumbra is performed only for evidence of residual severe right heart failure while on ECMO or inability of the patient to tolerate weaning of the ECMO circuit. Patients who underwent CDT and/or mechanical thrombectomy were continued on heparin and continued on VA-ECMO circulation. The patients are transported from the ICU to our hybrid OR and CDT was initiated via left or right common femoral vein access. Pulmonary angiography was then performed using a pigtail catheter and placement of either Unilateral or bilateral EKOS catheters.

For our single center retrospective review of our 17 patients who were placed on VA-ECMO for MPE from March 2017 to July 2019 an univariate 1-tail distribution and 2-sample equal variance *T*-test was used for statistical analysis. A p value of less than 0.05 was considered statistically significant.

Results:

Seventeen patients were treated with VA-ECMO for MPE by our PERT since the initiation of our program in 2016. Mean age was 55.9 years, with 9 of 17 patients (53%) being male. Mean body mass index (BMI) of patients was 31.8. Two of the 17 patients (12%) had a prior history of deep venous thrombosis (DVT) or PE. Eight of 17 patients (47%) had an identifiable inciting case of their PE such as recent travel (n=1), recent hospitalization, trauma or surgery (n=5), recent immobility (n=1), or oral contraception (n=1). There were no modifiable risk factors (ie.missed prophylactic anticoagulation doses) in this subgroup to suggest a preventable event.

Mean heart rates of patients on admission was 111 beats per minute. Three of 17 patients had unrecordable initial blood pressures with the remaining 14 patients having a median systolic and diastolic blood pressure of 81 mmHg and 53 mmHg, respectively. Ten of the 17 patients (59%) required cardiopulmonary resuscitation (CPR) either prior to or during ECMO cannulation. Sixteen of 17 patients were either hypotensive or requiring vasopressors at the time of cannulation, with 1 of 17 patients having episodic hypotension and refractory hypoxia as the indication for ECMO cannulation. Mean initial troponin was 1.66 ng/ml, and mean initial Brain natriuretic peptide (BNP) was 10575.6 pg/ml. The cohort of patients presented with advanced multiple organ failure, with a mean lactate of 8.95 mmol/L, mean pH of 7.14 and mean creatinine of 1.78 mg/dl. Ten of 17 patients (65%) were cannulated after CT confirmation of pulmonary embolism, with the remainder placed on ECMO first after either presenting with cardiac arrest or with bedside echocardiography suspicious for acute PE in the setting of profound hemodynamic instability. Mean overall RV/LV ratio on initial CT imaging was 1.96. The mean time to initiate ECMO from initial presentation was unable to be recorded.

Overall survival was 13 in 17 patients (76%), with four deaths resulting from anoxic brain injury (n=2), bacteremia with septic shock (n=1), and CPR-induced liver laceration causing abdominal compartment syndrome (n=1). The most common cause of death was anoxic brain injury secondary to prolong CPR. Seven of 17 patients (42%) were cannulated while awake and maintaining a natural airway. In this subgroup, overall survival was seven of seven patients (100%), with no patient requiring subsequent mechanical ventilation in the intensive care unit after being placed on ECMO. Technical success for ECMO cannulation was 17 of 17 patients (100%). Ten of the 17 patients (59%) required cardiopulmonary resuscitation (CPR) either prior to or during ECMO cannulation. Three cardiac arrests occurred while the patients were out of the hospital and one in three patients survived. Five of 17 patients (29%) required reperfusion cannulas for limb ischemia. There was a 0% incidence of limb loss in the study group.

Ten of 13 patients (77%) required ECMO and anticoagulation alone for definitive PE management, with the remainder undergoing catheter-directed thrombolysis while on ECMO. Mean tPA dose in these 3 patients was 37.6 mg. One of these three patients required transfusion while receiving CDT secondary to a large volume ileostomy bleed in a recent post-operative patient. The remaining two patients experienced no complications while receiving CDT and ECMO concurrently.

Three of the 13 surviving patients (23%) received tracheostomy for prolonged ventilator dependence. Median ICU and hospital length of stay for survivors was nine and 13 days, respectively. Twelve of 13 survivors (92%) were discharged neurologically normal with one patient sustaining an anoxic brain injury and another patient suffering a paradoxical embolic stroke with neurologic deficits resolving by time of discharge on hospital day 19. This same patient initially developed a CPR-associated liver laceration requiring emergent laparotomy for

hemorrhage control, but was ultimately discharged hospital day 19. Two of the 2 patients (100%) that progressed to brain death went on to organ donation while on ECMO. Six of 13 survivors (46%) were discharged home, with the remainder discharged to a rehab facility or long-term care facility. Nine of 13 survivors (69%) received surveillance echocardiograms six weeks following discharge. In these 9 patients, RV function was normal (n=7, 78%), borderline reduced (N=1, 11%), and moderately reduced (n=1, 11%). No survivor required discharge on home oxygen.

Table I summarizes the comparison of the survival group versus the non-survival group. Compared to non-survivors, surviving patients had on admission lower lactates (6.14 vs 18.10 mmol/L, p<.0001), higher systolic blood pressure (89.3 vs 68.7 mmHg, p = 0.03), higher diastolic blood pressure (59.6 vs 44.7 mmHg, p<.03), less acidotic (pH 7.22 vs 6.88, p<.0004), and a lower rate of CPR (46% vs 100%, p<.03). Table II summarizes the findings for the survival group (n=13). In survivors, the median length from ECMO cannulation to lactate clearance (<2.0 mmol/L) was 10 hours and the median length from ECMO cannulation to freedom from vasopressors was 6 hours. Median duration of VA-ECMO run for survivors was 86 hours. In patients that survived to decannulation, mean HR (118.8 vs 82.7 bpm, p <.0009), lactate (6.14 vs 0.75 mmol/L, p< .0008), systolic BP (89.3 vs 122.7 mmHg, p <.002), diastolic BP (59.6 vs 67.4 mmHg, p <.013), and pH (7.22 vs 7.43, p<.0001) were all statistically significantly improved at time of decannulation.

Table III summarizes our complications in the survival (n = 13) and non-survival (n = 4) groups. We had n=4 (31%) patients in the survival group who required transfusion for bleeding; n = 1 (CPR – induced liver laceration), n = 1 (bleeding ileostomy), and n = 2 (groin hematomas). One (8%) vascular injury was noted in the survival group as a patient underwent a Perclose

ProGlide (Abbott Vascular, Santa Clara, CA) with an expanding groin hematoma. The patient went to the operating room for decannulation and required a bovine pericardium patch for repair of the common femoral artery. No cannulas required relocation after initial placement due. There was no correlation between ECMO duration time and ECMO-related complications. The majority of complications, bleeding requiring transfusion, occurred in the first 24 hours.

Discussion:

Massive pulmonary embolism has historically had a high morbidity and mortality. In a multicenter registry study, Kasper et al showed a mortality of 25% in MPE patients presenting in cardiogenic shock, which increased to 65% in patients requiring CPR.[18] In a review of their experience with open pulmonary embolectomy, Dauphine et al likewise noted a particularly high mortality of 75% in their study population when MPE was associated with CPR.[19]

The use of ECMO for the initial stabilization and therapeutic anticoagulation for MPE patients is a more recent treatment approach.[7-11] In a study evaluating the protocolized use of ECMO for massive PE, Pasrija et al demonstrated an overall survival of 95% in 20 patients.[7] In 32 MPE patients receiving ECMO, George et al showed of 53% survival with a high portion of the deaths (73%) occurring in patients who had received CPR.[20] Corsi et al likewise noted a survival of 47% in their review of 17 highly unstable massive PE patients treated with ECMO despite a high portion of patients (41%) being cannulated during ongoing CPR.[21] Al-Bawardy et al had an established PERTs with 13 patients treated with ECMO had a thirty-day mortality was 31%.[8]

The significant findings of our study are: 1) an “ECMO First” cannulation protocol was effective at salvaging highly unstable patients with MPE; and 2) survivors had rapid reversal of

multiple organ failure with ECMO as their primary therapy. Other noteworthy findings were that patients who did not require CPR prior to cannulation had excellent outcomes from this management approach and that majority of survivors required ECMO and anticoagulation alone for definitive therapy of their massive PE. At our institution, we practice selective reperfusion cannula placement if evidence of limb ischemia post-cannulation exits. Our group is planning on a manuscript submission regarding our guidelines for placement of reperfusion cannula in the setting of ECMO.

Despite a high portion of our patient population requiring CPR during their initial presentation (59%), our study demonstrates a reasonable overall survival of 76% in this patient population. It is notable that amongst patients that did not require CPR prior to cannulation that overall survival was excellent (7 of 7 patients, 100%). This suggests that an early cannulation policy in hypotensive PE patients is an effective approach to prevent further cardiopulmonary deterioration. In our experience, most patients typically have a rapid improvement in their cardiopulmonary and mental status immediately after cannulation. VA-ECMO support likewise mitigates the consequences of potentially fatal arrhythmias that are a common observation within the first 24-hours of hospitalization.

Although advanced multiple organ failure was a common presentation in our patient population, ECMO was highly effective at rapid reversal of multiple organ dysfunction in survivors. The median duration from ECMO cannulation to lactate clearance (<2.0 mmol/L) in survivors was 10 hours. Likewise the median duration from ECMO cannulation to freedom from vasopressor requirement in survivors was 34.3 hours. Mean lactate on presentation in non-survivors was significantly higher than survivors (6.14 vs 18.10 mmol/L, P<.0001), suggesting that these patients may have presented in a non-survivable shock state. Time to lactate clearance

is a potential marker for the effectiveness of ECMO in reversing multiple organ dysfunction, as well as a marker of likelihood of survival. Lactate as a marker for success of therapy is mentioned in several of the ECMO PE papers we have cited.[7,11] It is notable that both patients that died of anoxic brain injury subsequently had viable organs for transplantation. Overall 15 of 17 patients (88%) that received ECMO either survived or went on to be organ donors.

Our study builds on the findings of other major centers in demonstrating that optimizing end-organ function first via ECMO is an effective treatment strategy for massive PE.[8-12,21] This represents a shift in the management of this disease, which historically linked rapid clot retrieval with improved survival.[22-25] Majority of survivors (77%) in our study notably did not require any subsequent clot-removal for resolution of acute right heart failure. No patient likewise required pulmonary embolectomy to achieve liberation from ECMO. In survivors, 7 of 9 patients that received 6-week follow up echocardiograms had normal RV function, with no survivor requiring discharge on home oxygen.

At our institution the median procedural cost of VA-ECMO was $70,000. In addition to ICU expenses, an additional expense of $5,000 to $10,000 per day was required for perfusionist, circuit maintenance, ECMO related labs and imaging. That being said, since starting an ECMO for MPE our institutional has seen a significant improvement on survival rate. The year prior to starting a PERT for MPE our institutional survival rate was 20% (n=2) compared to 76% now after institutional implement of VA-ECMO for MPE.

Limitations of this study include that it is a single-center retrospective review, which inherently may be prone to bias. Our sample size is also small and is thus underpowered. Larger studies evaluating this therapy are warranted. Our institution likewise has an aggressive ECMO-

first policy so there is not a comparable non-ECMO group to compare our results to during the same time period.

Conclusions:

In summary, VA-ECMO first policy was effective at salvaging highly unstable patients with MPE. Survivors typically have rapid reversal of multiple organ failure with ECMO as their primary initial therapy. The majority of survivors in our study required ECMO and anticoagulation alone for definitive therapy of their massive PE. Given these experiences, VA-ECMO should be considered as first-line treatment in massive pulmonary embolism patients.

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Figure(s) Legend:

Figure 1: Our institutions Pulmonary Embolism Response team criteria on selection of patient's with massive PE and candidates for VA-ECMO.

Table(s) Legend:

Table I: Survival group (n=13) versus the non-survival group (n=4)

Table II: Survival group outcomes (n=13)

Table III: ECMO and ICU complications

Table I: Survival group versus the non-survival group

	Survival group (N = 13)	Standard Deviation	Non-Survival group (N = 4)	Standard Deviation	T-Test (P-value)
Demographics					
BMI (kg/m^2)	30.5 (19.7-43.8)	6.6	37.4 (33-44.2)	6.0	0.058
Age (years)	55.9 (34-72)	13	55.7 (43-65)	9.2	0.491
Previous PE/DVT: N and (%)	2 (15.4%)		0%		0.218
CPR prior to cannulation: N and (%)	6 (46%)		4 (100%)		**0.030**
CPR during cannulation: N and (%)	2 (15.4%)		4 (100%)		NA
Admission Vitals					
Heart Rate (BPM)	118.8 (86-154)	21.1	85.75 (60-115)	24.0	**0.009**
SBP (mmHG)	89.3 (71-125)	15.8	68.7 (56-76)	11.0	**0.029**
DBP (mmHG)	59.6 (47-86)	11.6	44.7 (33-52)	10.2	**0.034**
Admission Labs					
Lactate	6.14 (1.2-18.8)	4.79	18.10 (16.3-20.5)	1.77	**0.0001**
pH	7.22 (6.96-7.37)	0.13	6.88 (6.6-7.01)	0.19	**0.0004**
Creatinine	1.70 (1.09-3.35)	0.59	2.05 (1.86-2.29)	0.18	0.1303
Initial CT imaging (RV/LV ratio)	1.92 (1.4-2.6)	0.31	2.10 (1.4-2.9)	0.76	0.2558

BMI – body mass index; CPR – cardiopulmonary resuscitation; BPM – beats per minute; RV – right ventricle; LV – left ventricle; NA – not available

An univariate 1-tail distribution and 2-sample equal variance T-test. Significant $P < 0.05$.

Table II: Survival group outcomes (n=13)			
		Standard Deviation	T-Test (P-value)
Lactate clearance (<2 mmol/L) in hours (median)	10 (0-31)	10.5	
Freedom from vasopressors in hours (median)	6 (1-166)	60.5	
Duration on ECMO in hours (median)	86 (45-218)	48.4	
ICU in days (median)	9 (4-44)	12.1	
Hospital Length of stay in days (median)	13 (8-52)	14.6	
Heart Rate (BPM)			
Initial	118.8 (86-154)	21.1	**0.0009**
Decannulation	82.7 (56-112)	18.0	
Lactate (mmom/L)			
Initial	6.14 (1.2-18.8)	4.79	**0.001**
Decannulation	0.75		
Systolic Blood Pressure (mmHg)			**0.002**
Initial	89.3 (71-125)	15.8	
Decannulation	122.7 (75-168)	24.2	
Diastolic Blood Pressure (mmHg)			**0.013**
Initial	59.6 (47-86)	11.6	
Decannulation	67.4 (56-85)	9.2	
pH			**0.0001**
Initial	7.22 (6.96-7.37)	0.13	
Decannulation	7.43 (7.36-7.54)	0.07	
Discharge disposition (n=13)			
Home	6		46.2%
Rehab or long-term care facility	7		53.8%
6-week Echocardiogram follow-up (n =9)			
Normal RV function	7		78%
Borderline Reduced	1		11%
Moderately Reduced	1		11%

An univariate 1-tail distribution and 1-sample equal variance T-test. Significant $P < 0.05$

Table III: ECMO and ICU complications		
	Survival group (n=13)	Non-survival group (n=4)
Acute Kidney Injury (AKI)	8 (62%)	3 (75%)
AKI requiring dialysis	1 (8%)	0
Stroke	1 (8%)	0
Bleeding (Requiring transfusion)	4 (31%)	1 (25%)
Vascular Injury	1 (8%)	0
Values are in N (%)