A Multimodal Approach to Post Cardiotomy Distributive Shock

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INTRODUCTION

- Pre-Operative Course
  - Admitted to outside hospital 6 days prior to surgery for headache, chest pain, palpitations for several days
  - Transferred to our hospital 5 days prior to surgery, admitted to step-down unit.
  - Transferred to Intensive Care Unit (ICU) day prior to surgery for increased work of breathing.
- Past Medical History
  - Intravenous Drug Use (IVDU), Hepatitis B, Hepatitis C, Current smoker (15 pack year)
  - Body Mass Index (BMI): 23.98 kg/m^2
- Diagnostics
  - Transesophageal Echo:
    - Left ventricular ejection fraction: 55-60%, normal right ventricular systolic function
    - Severe mitral regurgitation, mobile heterogeneous echo density on the anterior leaflet (A2) of the mitral valve consistent with mitral valve vegetation measuring 1.17 x 0.88 cm with flow through the vegetation suggestive of perforation
    - Severe aortic valve regurgitation with perforation of the left coronary cusp.
    - Mobile echo density on the septal leaflet of the tricuspid valve measuring 0.3 x 0.7 cm, consistent with tricuspid valve vegetation (partially healed). Regurgitant jet associated with tricuspid valve suggestive of possible perforation
  - Computed Tomography (CT) Scan
    - Chest/Abdomen/Pelvis: Small bilateral pleural effusions; Hepatosplenomegaly
  - Magnetic Resonance Imaging (MRI)
    - Brain: Several areas concerning for scattered embolic infarcts
    - Spine: L2-L3 discitis osteomyelitis without evidence of epidural abscess
  - Culture results
    - Pre-operative blood cultures: *Enterococcus faecalis*
    - Intra-operative fungus culture: 1+ Rare *Candida glabrata*
- Pre-Operative Medication Regimen (including but not limited to)
  - Antibiotics: Vancomycin
  - No vasopressors or inotropes
  - Diuretics: daily Furosemide
  - No supplemental oxygen
- Operative Procedure:
  - Urgent aortic valve replacement (23 mm Trifecta) and pericardial patch of root abscess
  - Complex mitral valve repair (26 mm CG Future) annuloplasty and pericardial leaflet repair
  - Tricuspid valve repair (28 mm Contour 3D) annuloplasty
  - Drainage of bilateral pleural effusions

	Arrival from OR	Start VA ECMO	Methylene Blue		Start PLEX	45 minutes Post-PLEX		POD 1	VA to VV ECMO
Time out of OR (Hour, Min)	0	1H, 20M	1H, 50M	3H, 5M	3H, 50M	6H, 50M	7H, 50M	24H, 5M	24H, 50M
Epinephrine (mcg/kg/min)	0.1	0.08	0.13	0.08	0.06	0.02	0	0.03	0.03
Norepinephrine (mcg/kg/min)	0.15	0.08	0.12	0.07	0.01	0	0	0.02	0
Vasopressin (units/hour)	0.08	0	0.08	0	0.08	0	0	0	0

METHODS

1. On-pump cardiopulmonary bypass during the operative procedure with successfully wean off with moderate dose epinephrine. Pulmonary edema noted that was suctioned without bronchoscopy.
2. Transported to ICU intubated, on Epinephrine, Norepinephrine, Vasopressin, and inhaled nitric oxide (iNO) at 40 Parts Per Million (PPM).
3. Maximal ventilator support, severe pulmonary edema on X-Ray and rapidly increasing vasopressor requirements, decision was made to cannulate for Veno-Arterial-Extracorporeal-Membrane-Oxygenation (VA-ECMO) in the setting of immediate post-cardiotomy.
4. Vasopressor requirements were initially decreased post-cannulation, but then continued to increase, Methylene Blue administered (1.5 mcg/kg).
5. With some improvement in vasopressor requirements, and a White Blood Cell Count of 55, Therapeutic Plasma Exchange (TPE) was completed 75% Plasma, 25% Albumin.
6. All vasopressors were weaned off within 2 hours of the end of the TPE treatment.
7. Patient was taken back to the operating room POD#1 for transition from VA-ECMO to (Veno-Venous) VV-ECMO.

RESULTS

1. Patient was extubated Post-Operative Day (POD) 2
2. Patient decannulated from VV-ECMO POD 8
3. Patient transferred out of the ICU to the Step-down unit POD 9
4. Patient signed out prior to completing antibiotic therapy regimen at POD 15

HYPOTHESES

1. Inhaled nitric oxide provided right ventricular support in the setting of Acute Respiratory Distress Syndrome (ARDS) in addition to pulmonary vasodilation assisting with oxygen delivery.
2. VA-ECMO provided support while determining primary source of shock in the setting of immediate post-cardiotomy
3. Methylene Blue aided in the reversal of the patient's vasoplegic syndrome
4. TPE terminated the (presumed) cytokine storm leading to patient's cardiovascular and respiratory compromise
5. Transition of VA-ECMO to VV-ECMO with continuation of therapy to support lungs during exudative phase of ARDS

CONCLUSIONS

Distributive shock is a condition that has gained an increased amount of attention in relation to the Surviving Sepsis campaign. Literature states that roughly 5-50% of patients are at risk of developing distributive shock in the post-operative period with an associated high risk of morbidity and mortality.[3] However, information related to its treatment and in particular presence after cardiac surgery, is lacking. This case used a multimodal approach to combat the patient's distributive shock and ARDS in the immediate post-cardiotomy period.

Vasoplegic syndrome, synonymous with distributive shock, is characterized by end-organ hypoperfusion due to markedly low systemic vascular resistance (SVR) despite normal or supranormal cardiac output. Common after cardiac surgery secondary to pharmacologically-induced vasoplegia, vasopressors combined with inotropic support are the first line intervention. A combination of catecholamines (Norepinephrine and Epinephrine) and noncatecholamines (Vasopressin) can help to increase Mean Arterial Pressure (MAP). Methylene Blue (noncatecholamine) has also proven to rapidly improve MAP in severe vasoplegia.[3]

Inhaled Nitric Oxide (iNO) is a potent pulmonary vasodilator that can help provide circulatory support in the setting of ARDS by dilating the pulmonary vessels to improve oxygen delivery. This also assists with forward blood flow and reducing the workload of the right ventricle, decreasing the risk of acute-decompensated right heart failure.

Extracorporeal Membrane Oxygenation can be used to provide solely pulmonary support in the Veno-Venous approach or a combination of cardiopulmonary support with Veno-Arterial cannulation. With the factors of this particular case study, VA ECMO provided the most support as providers were able to navigate the origin and severity of shock, to the heart in the immediate post-cardiotomy period, and the lungs in the setting of ARDS.

TPE serves beneficial for the removal of circulating injurious molecules, specifically inflammatory cytokines, by removing the patient's plasma and replacing with allogeneic or autologous plasma.[1,2] A meta-analysis by Rimmer et. Al. (2014) discussed four-randomized control trials and found a reduced mortality in adults with TPE in sepsis, (95% confidence interval 0.42 to 0.96).[1] Although current evidence for TPE in septic shock is rated as moderate-quality with a weak recommendation, it was initiated due to a lack of complete resolution with the other conventional therapies aforementioned.[2]

A key highlight in this case scenario was the prompt recognition and quick action of the healthcare providers with the immediate accessibility to these resources. This allowed for better management of the precipitating factors negatively impacting the patient and prescribing of the best targeted therapies.

REFERENCES

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