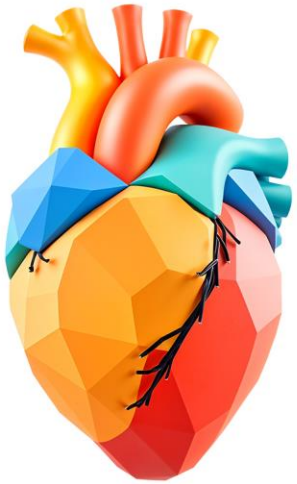

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12th Annual Tehran Heart Center Congress

7th CRITICAL CARDIOVASCULAR CARE

دوازدهمین کنگره سالیانه مرکز قلب تهران

2025

۲۵ و ۲۶ بهمن ماه ۱۴۰۳

13 & 14 February

Tehran Heart Center

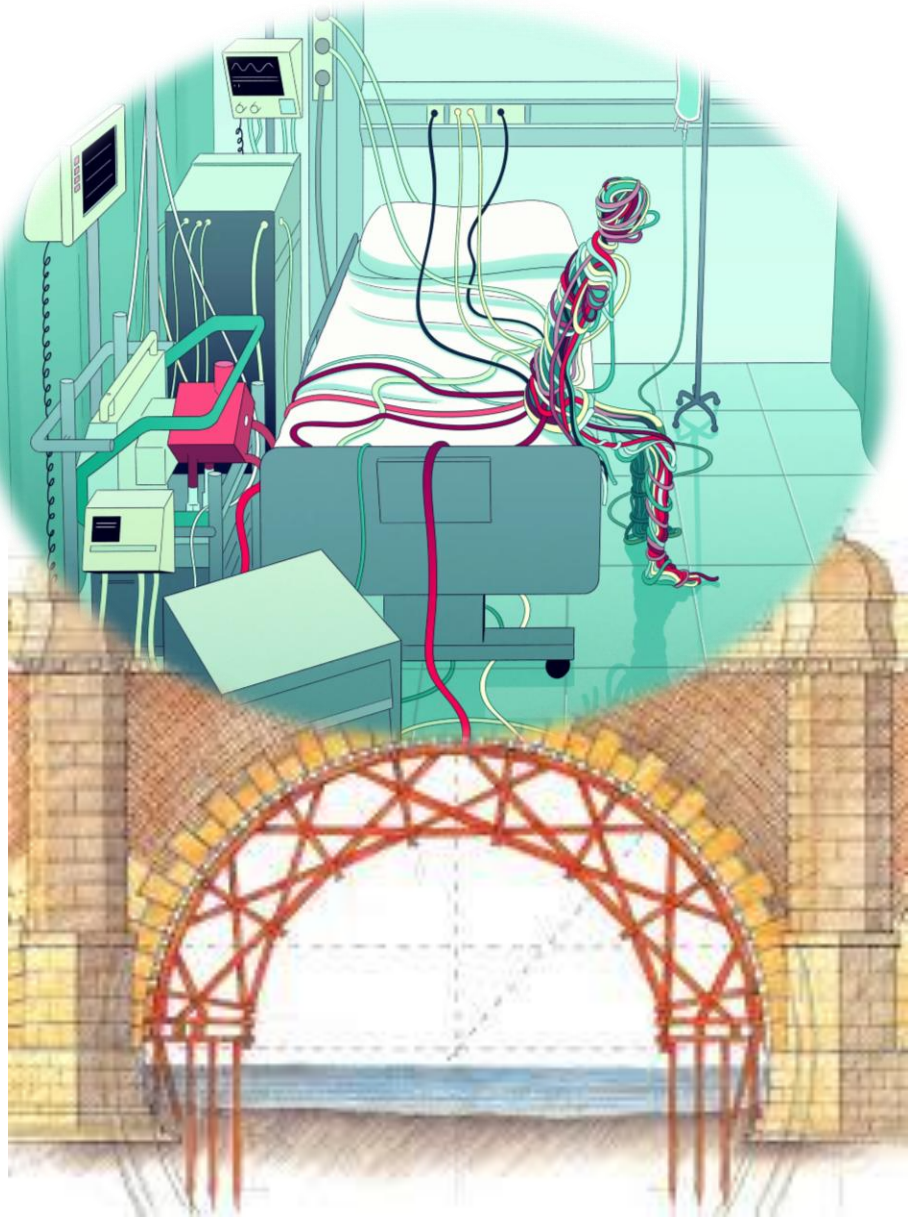
Tehran, Iran

Case presentation: Extracorporeal Membrane Oxygenation (ECMO) as a bridge in heart transplantation

Soheil Mansourian
Cardiac Surgeon

Haleh Ashraf
Fellowship of advanced heart failure and transplant

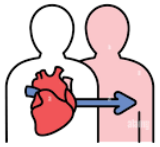
Tehran Heart Center
Tehran University of Medical Sciences



Case#1

- 39-year-old male
- Dilated cardiomyopathy (DCM)
- ICD placed to high-degree AV block (1.5 years ago).

- Frequent hospitalizations for heart failure, renal, and hepatic failure, requiring IV diuretics and inotropes.



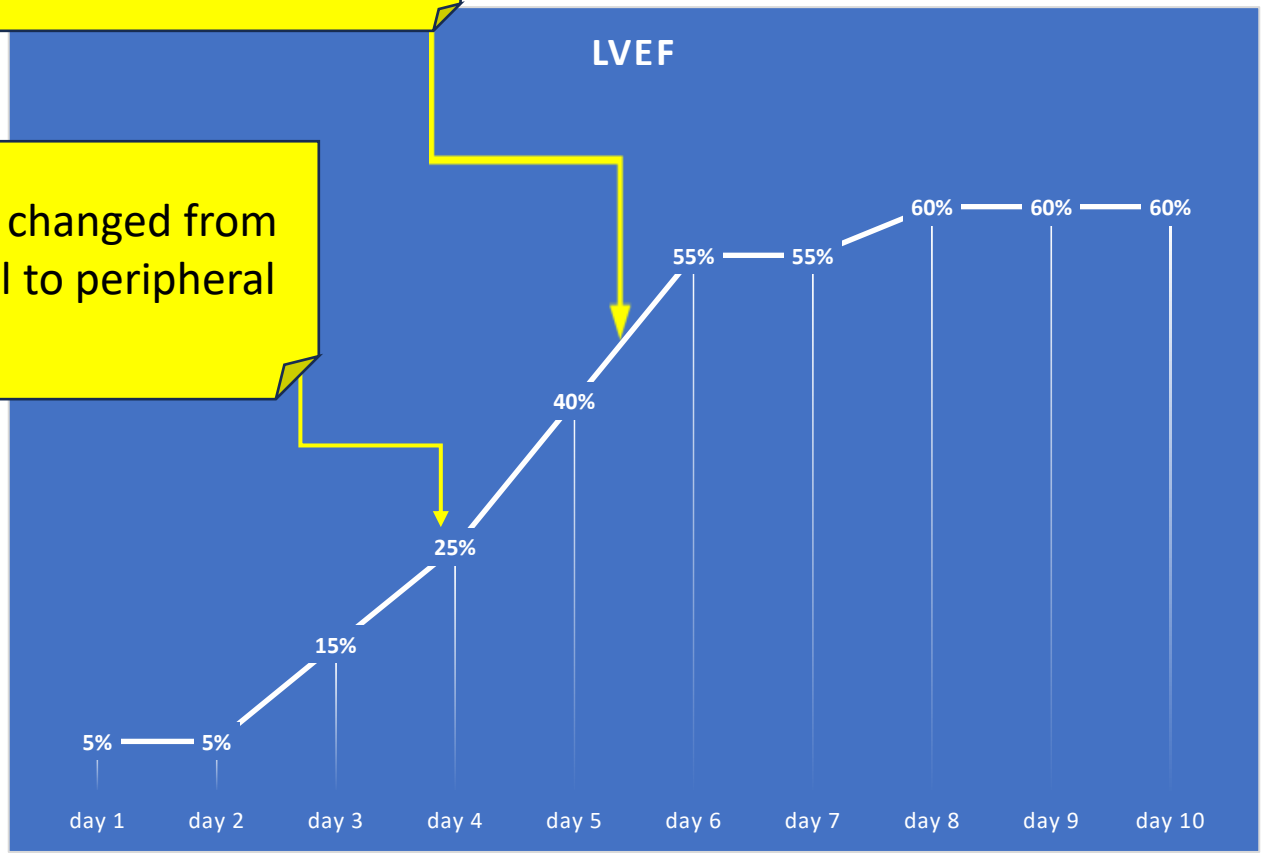
- Orthotopic heart transplant on Sep 15, 2024

- Upon declamping, the heart did not beat effectively.

- LVEF 5-10% requiring pacing and high doses of inotropes.
- Successfully weaned from the pump using ECMO.
- No evidence of rejection on endomyocardial biopsy (EMB).
- Primary graft failure

ECMO was weaned

ECMO changed from central to peripheral



Fully Recovered under ECMO after 5 days

Case#2

- 39-year-old male with DCM
- ICD placed in 2020 for syncope, PVCs, and NSVT
- Frequent ICD shocks despite VT ablation in 2021
- Amiodarone-induced liver damage (Bilirubin Total 3.45).
- Listed for heart transplant in 2023.

- Referred to me for LVAD (but Unsuitable)
- Readmitted after ICD shock Aug 25, 2024
- Refractory arrhythmia and hepatic failure (elevated bilirubin: Bil-T 3.81, Bil-D 0.38)
- Emergent heart transplant candidate

- VT/VF on 8th days of hospitalization in spite of lidocaine and esmolol
- Amiodarone administered
- RUQ Pain with amiodarone, better with dose reduction

- Bil-T 3.72, Bil-D 0.98 → Bil-T 14.11, Bil-D 9.54

Amiodarone cardiotoxiciy

- Hx of hepatic side effect to amiodarone
- RUQ pain
- no change in hemodynamiccs after arrest
- Normal levels of, PH, Lactate & Cr

Organ failure due to cardiac arrest

- Cardiac arrest
- Low output state

Case Rep Gastroenterol. 2020 Feb 20;14(1):87–90. doi: 10.1159/000506184

Amiodarone-Induced Acute Liver Injury

Rajesh Essrani [a,*], Shehriyar Mehershahi [b], Rajesh Kumar Essrani [b], Shri Jai Kirshan Ravi [c], Sajeer Bhura [d], Anuraj Sudhakaran [a], Muhammad Hossain [a], Asif Mehmood [a]

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PMCID: PMC7098330 PMID: 32231507

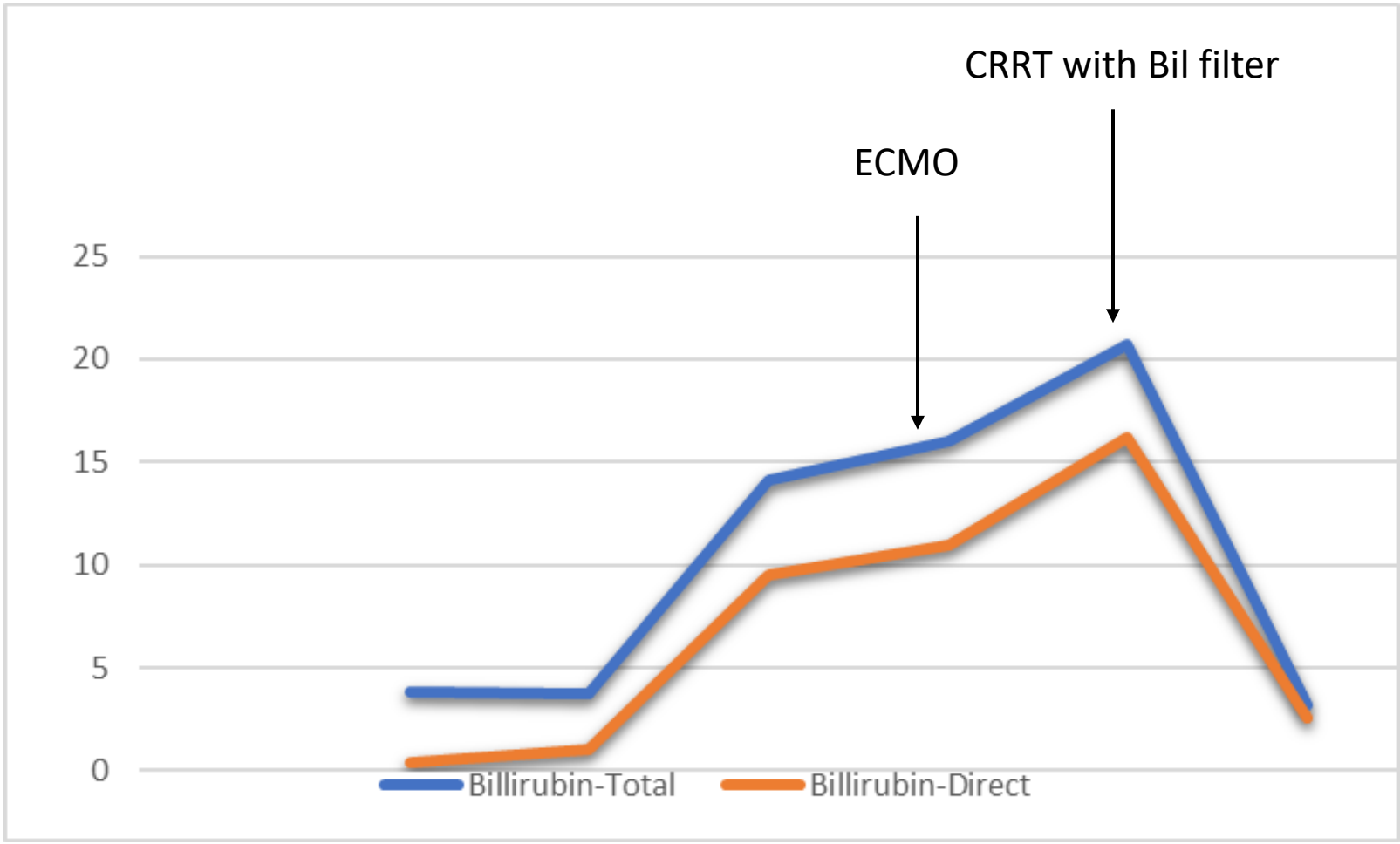
Abstract

Amiodarone is a lipophilic structure with a half-life of 25–100 days. Long-term oral amiodarone is associated with photosensitivity, thyroid dysfunction, and pulmonary and hepatic toxicity. Intravenous amiodarone can lead to sweating, heating sensation, nausea, phlebitis at the injection site, and rarely acute hepatitis. This is a compelling case of a 60-year-old male who developed acute liver injury 24–36 h after starting amiodarone. All the possible causes of acute liver injury were ruled out, and his liver enzymes improved after discontinuing amiodarone.

Amiodarone induced ALI

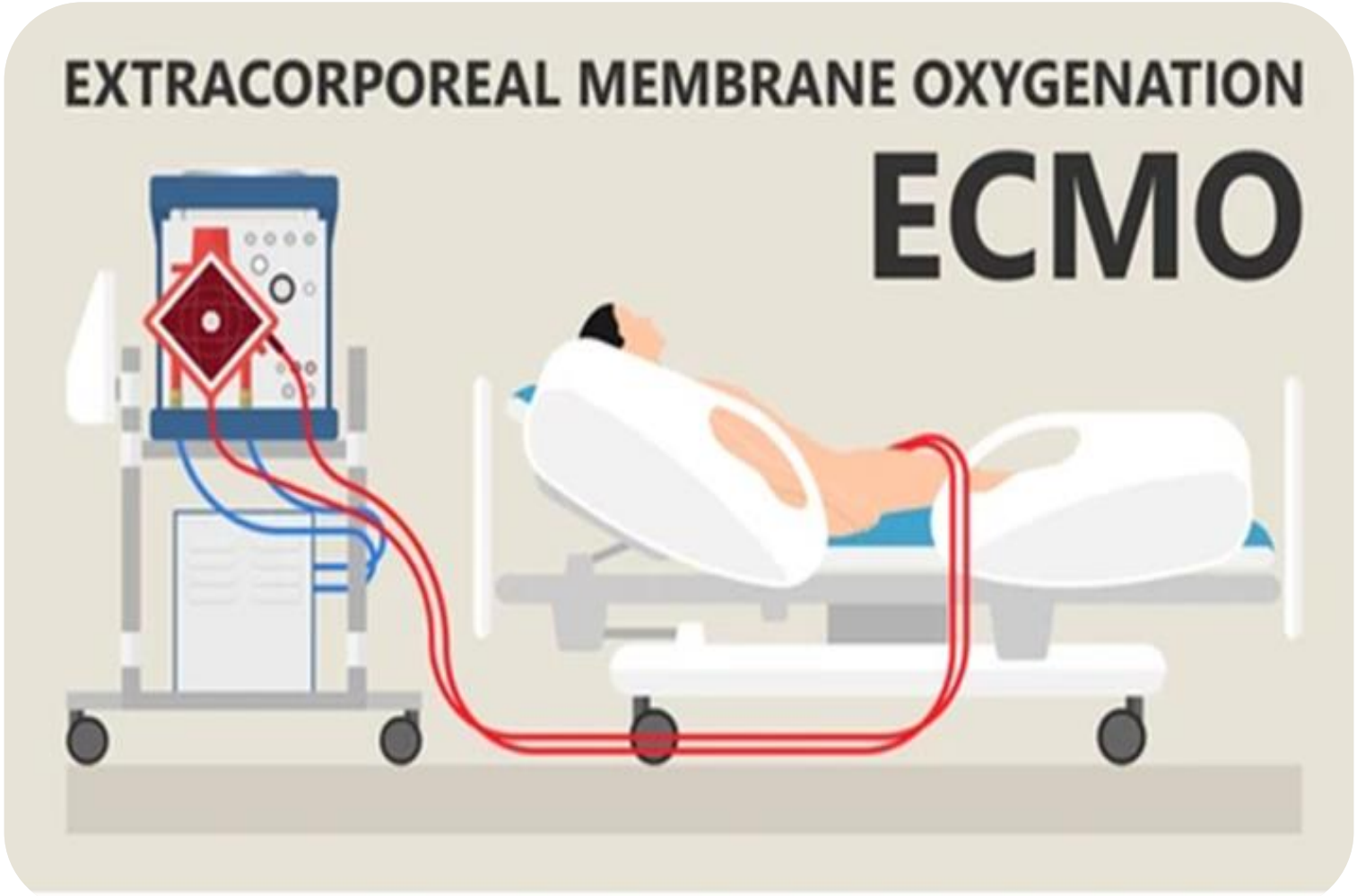
- Rare, but potentially fatal, adverse effect of intravenous amiodarone.
- Intravenous amiodarone should be stopped immediately and not be reintroduced again.
- If there is no alternative, an oral form may be used with a lower dose.

Bilirubin

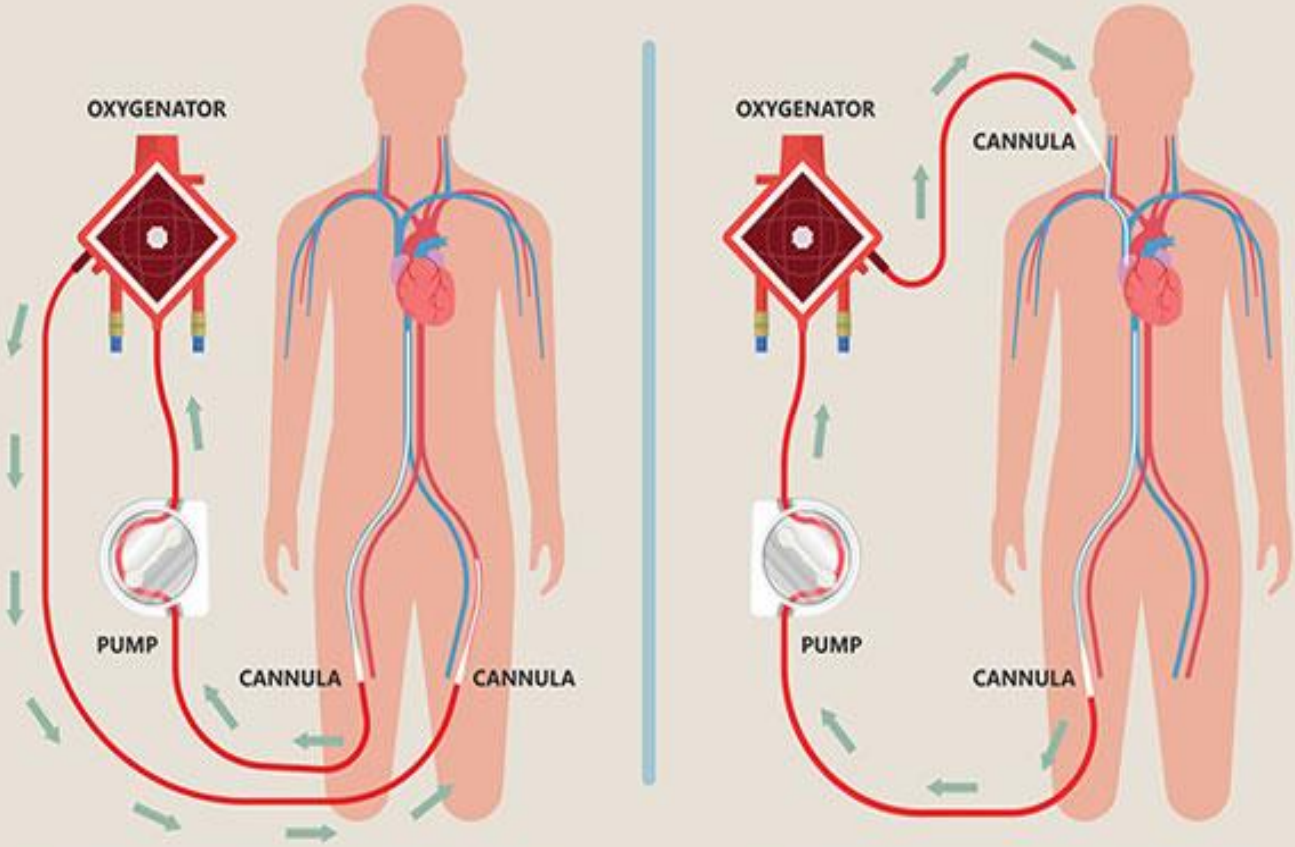

CRRT with Bil filter
ECMO
25
20
15
10
5
0
Billirubin-Total
Billirubin-Direct

- Fever
- ECMO was weaned
- No positive culture
- Fever stopped
- Heart Transplantation in 13 Sep, 2024
- ICD was removed
- Weaned successfully from pump

- ICD lead culture (Klebsiella positive)
- ECMO catheter vascular complications
- Discharged after 2 months


EXTRACORPOREAL MEMBRANE OXYGENATION
ECMO

EXTRACORPOREAL MEMBRANE OXYGENATION



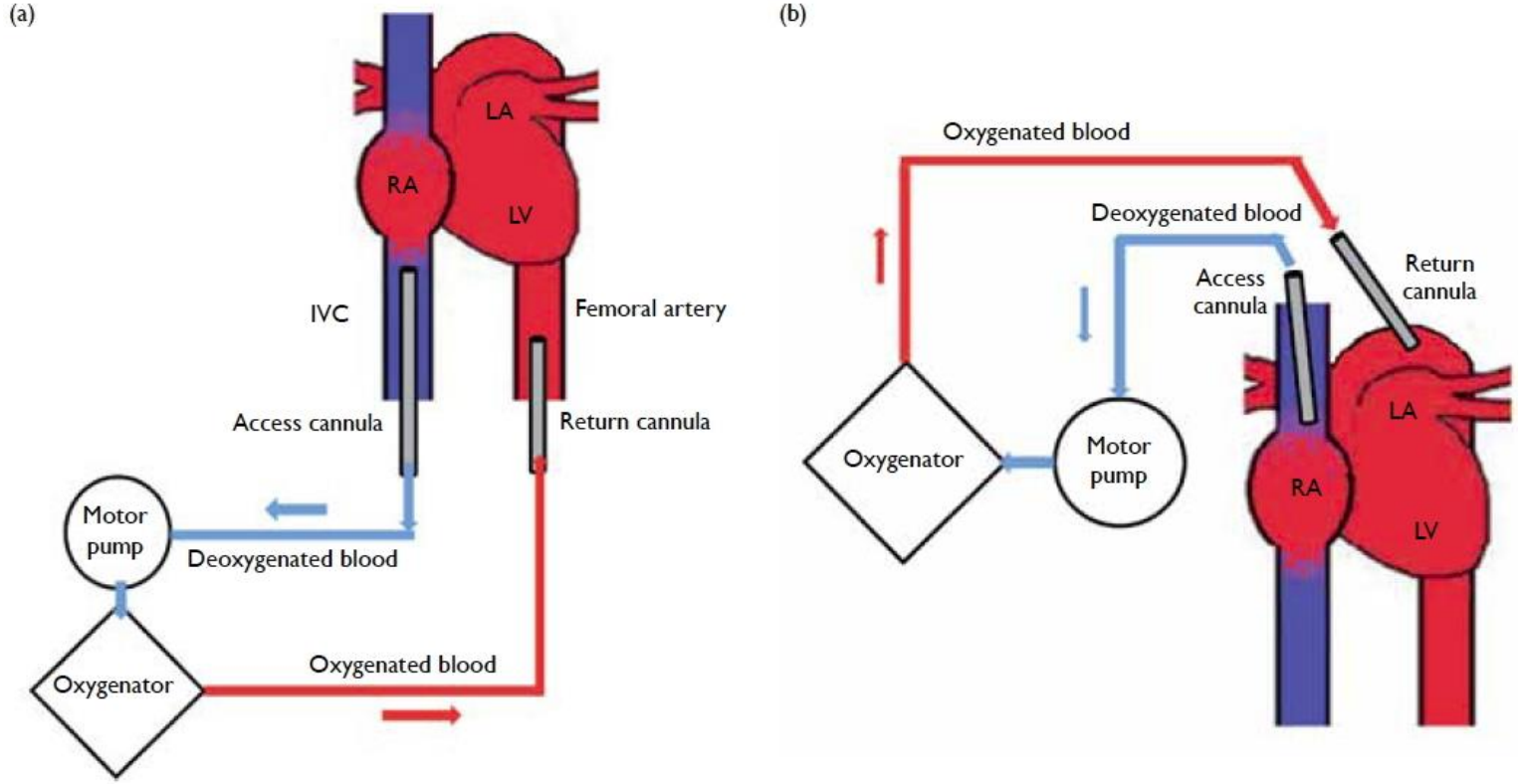


FIG 1. Two different configurations of venoarterial extracorporeal membrane oxygenation (VA-ECMO)
(a) Peripheral and (b) central VA-ECMO

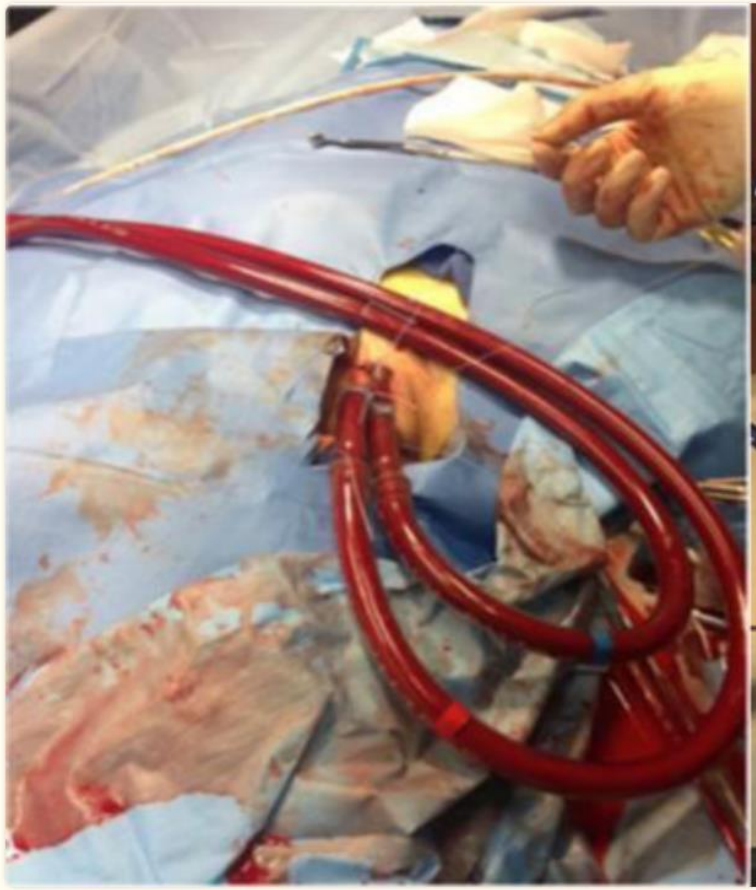


Table 66.2 Indications for Veno-Arterial Extracorporeal Membrane Oxygenation

Cardiogenic shock due to:

- Acute myocardial infarction
- Acute fulminant myocarditis
- Post-cardiotomy failure to wean off CPB
- Acute RV failure secondary to massive pulmonary embolism
- Progression of congenital heart disease with acute decompensated heart failure
- Progression of cardiomyopathy, ischemic or non-ischemic
- Sepsis-associated cardiomyopathy
- Refractory ventricular arrhythmias
- Primary graft failure post heart transplantation
- Acute allograft rejection post heart transplantation
- RV failure secondary to pulmonary hypertension

Provide RV support post LVAD placement

As a bridge to durable LVAD

As a bridge to heart transplantation

As a component of extracorporeal cardiopulmonary resuscitation (ECPR)

CPB, Cardiopulmonary bypass; *LVAD*, left ventricular assist device; *RV*, right ventricle.

Table 66.3 Indications for Veno-Venous Extracorporeal Membrane Oxygenation

Acute Respiratory Distress Syndrome

- Severe bacterial/viral pneumonia, including COVID-19 pneumonia
- Aspiration syndrome
- Alveolar proteinosis

To Provide Lung Rest

- Pulmonary contusion
- Smoke inhalation

Conduct of Complex Thoracic Procedures

- Airway surgery
- Difficulty with single-lung ventilation
- Mediastinal masses
- Advanced pulmonary and esophageal resections

Lung Transplantation

- As a bridge to transplant
- Primary graft dysfunction
- Intraoperative stabilization

Pulmonary hemorrhage or massive hemoptysis

Congenital diaphragmatic hernia

Meconium aspiration syndrome

Sabiston Sabiston Textbook of Surgery ,2024

Table 66.1 Differences Between Veno-Arterial and Veno-Venous Extracorporeal Membrane Oxygenation

VA-ECMO	VV-ECMO
Provides cardiac as well as respiratory support	Provides isolated respiratory support
Requires arterial and venous cannulation	Requires only venous cannulation
Bypasses the pulmonary circulation, thereby reducing pulmonary artery pressure	Maintains pulmonary blood flow
Provides the heart with rest	Needs a well-functioning heart to ensure systemic distribution of oxygenated blood
Runs in parallel with the heart and lungs	Runs in series with the heart and lungs
Requires lower perfusion rates	Requires higher perfusion rates
Complication—harlequin syndrome	Complication—recirculation phenomenon

ECMO, Extracorporeal membrane oxygenation; *VA*, veno-arterial; *VV*, veno-venous.

Sabiston Sabiston Textbook of Surgery ,2024

Table 66.5 Contraindications to Extracorporeal Membrane Oxygenation

Absolute

- End-stage heart disease, not a candidate for a durable ventricular assist device, total artificial heart, or heart transplantation
- End-stage lung disease, not a candidate for lung transplantation
- Anoxic brain injury
- Disseminated malignancy
- Unrepaired aortic dissection
- Severe aortic regurgitation
- Severe chronic organ dysfunction (liver cirrhosis, renal failure)

Relative

- Severe coagulopathy or contraindication for anticoagulation
- Limited vascular access
- Severe peripheral vascular disease
- Age >75 years old
- Institutional criteria, depending on resource availability

Discussion

PGD

- Despite advances in HTx management, a devastating and poorly understood complication.
- 2 to 26%
- The main cause of early mortality after transplantation

- Risk factors :
  - Donor age
  - Cause of donor brain death
  - Organ preservation technique
  - Ischemia–reperfusion injury
  - Ischemic time
  - gender mismatch
  - Preoperative presence of recipient VAD

Transpl Int 2022, 35: 10176

Classification of PGD after heart transplantation

PGD-LV	Mild - meets one of the following criteria:	Echocardiography: LVEF < 40% OR Hemodynamics: CVP > 15 mmHg, PCWP > 20 mmHg, CI < 2 L/min/m^2 lasting for 1 hour and requiring low-dose inotropes
	Moderate - meets one criterion from 1 and another criterion from 2:	1. Echocardiography: LVEF < 40% OR Hemodynamics: CVP > 15 mmHg, PCWP > 20 mmHg, CI < 2 L/min/m^2, hypotension with MAP < 70 mmHg 2. Inotrope score > 10 or intra-aortic balloon pump
	Severe	Dependence on mechanical circulatory support, excluding intra-aortic balloon pump
PGD-RV	Requires 1 + 2, or 3 alone	1. CVP > 15 mmHg, PCWP < 15 mmHg, CI < 2 L/min/m^2 2. TPG < 15 mmHg AND/OR SBP < 50 mmHg 3. Requirement of right circulatory assistance

PGD-LV: Left ventricular primary graft dysfunction; LVEF: Left ventricular ejection fraction; CVP: Central venous pressure; PCWP: Pulmonary capillary wedge pressure; CI: Cardiac index; MAP: Mean arterial pressure; PGD-RV: Right ventricular primary graft dysfunction; TPG: Transpulmonary pressure gradient; SBP: Systolic blood pressure.

ISHLT, 2024

- Preventive strategies:
  - Better donor choice and maintenance
  - Heart preservation methods
  - Better myocardial protection during implantation
- Little progress in prevention
- Advances in the treatment and management may save many lives.
- MCS is the only effective treatment for severe PGD

Ann Thorac Surg 2024;90:1541– 47

Prompt ECMO initiation

- Within the first few hours of surgery, and ideally before leaving the operating room.
- Poor outcomes if delayed beyond 24 hours.

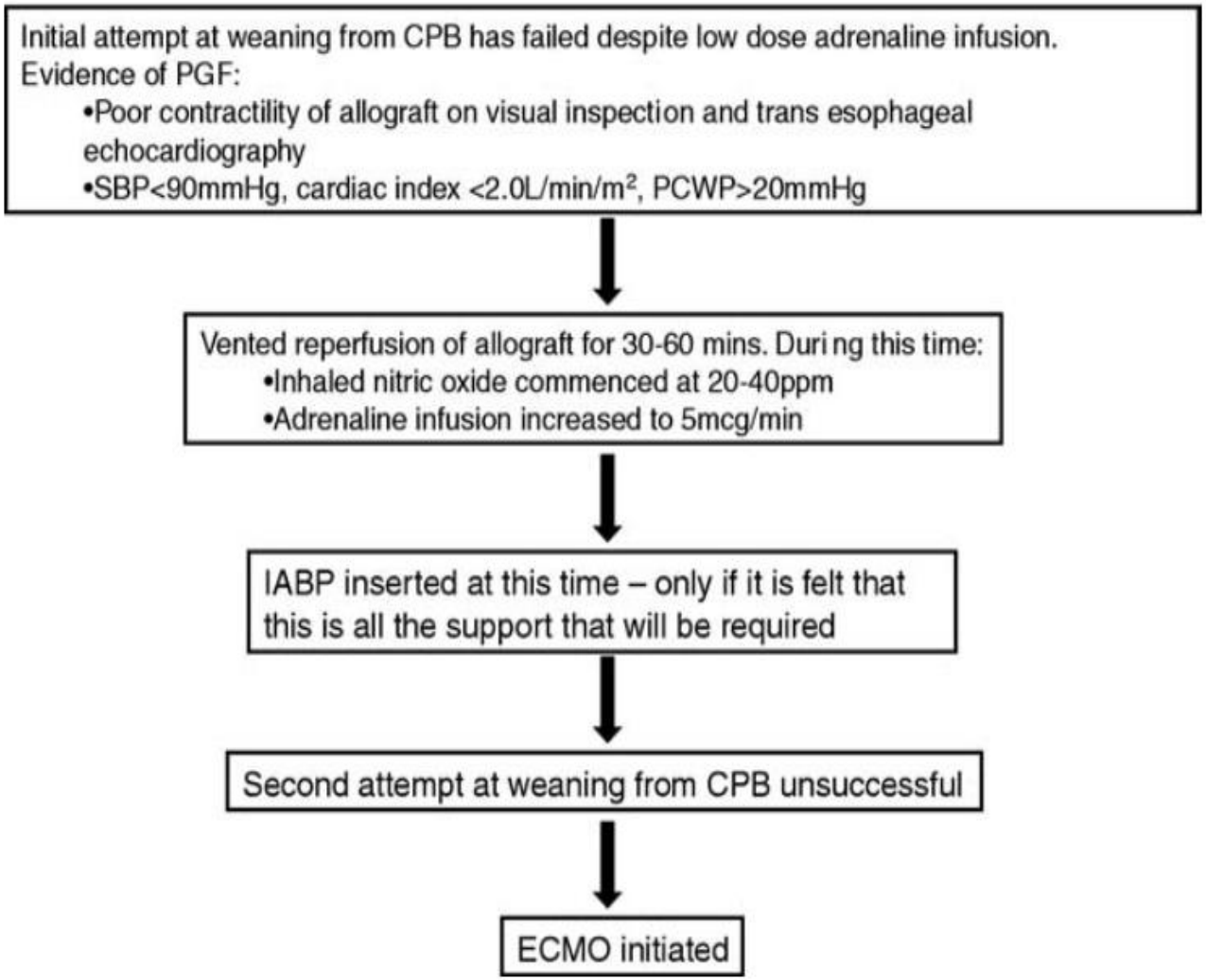
Prompt implementation of MCS

- Adequate end-organ perfusion
- Allowing the transplanted heart time to recover

- Avoiding exposing transplanted heart to a period of significant hemodynamic strain and a self-perpetuating cascade of injurious and inflammatory mediators.

- Avoid of large doses of inotropic or vasoactive agents

Ann Thorac Surg 2024;90:1541– 47



Ann Thorac Surg 2024;90:1541– 47

- Monitoring during and after surgery with a Swan-Ganz continuous cardiac output catheter
- Real-time hemodynamic parameters
- Intraoperative transesophageal
- Bedside echocardiography

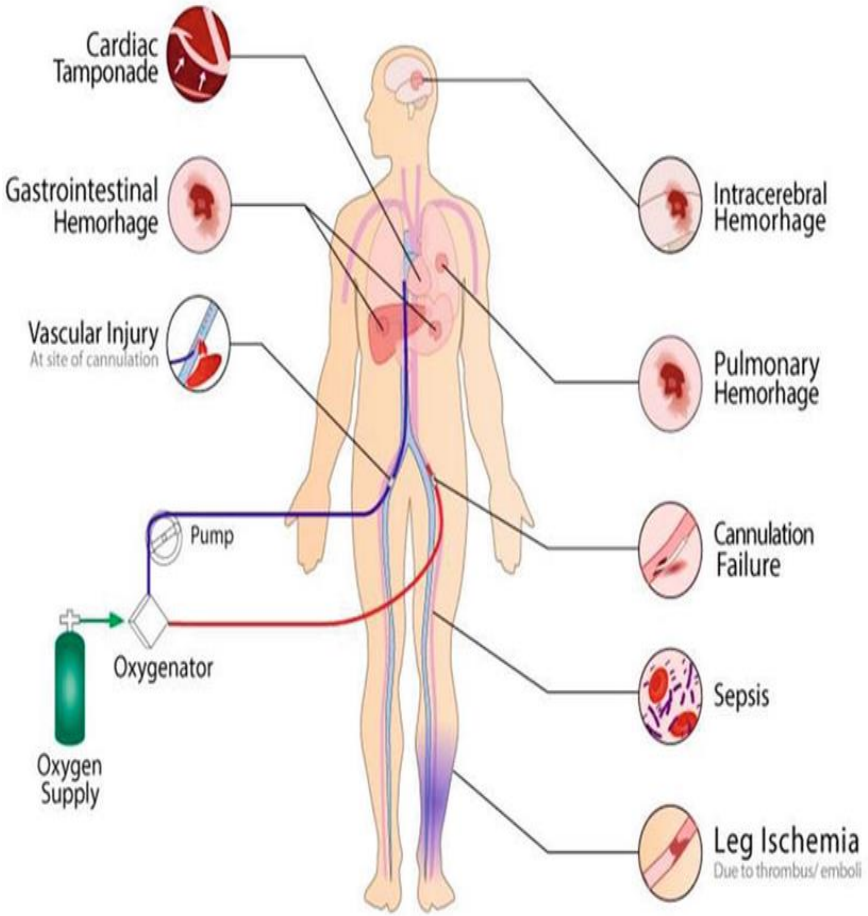
Ann Thorac Surg 2024;90:1541– 47

Criticism

- Too aggressive
- Overuse of ECMO
- Expose to ECMO complication

Complicating factors

- Recent heart surgery
- Presence of shock with hepatic dysfunction
- DIC
- Excessive use of blood products
- Pulmonary hypertension



PROC (BAYL UNIV MED CENT) 2018;31(4):482–486

How to reduce the complication rate of ECMO?

- Advances in the management of patients on ECMO
- Changes in the physical components of the ECMO circuit
- Use of heparin-coated circuits
- Maintenance of hemodynamic stability with systemic venous decompression
- Partial hemodynamic support with peripheral ECMO cannulation.

- Femoral vessels via surgical cut-down
  - without the need to reopen for decannulation
  - simplifies the decannulation process
  - patients can be extubated on ECMO support

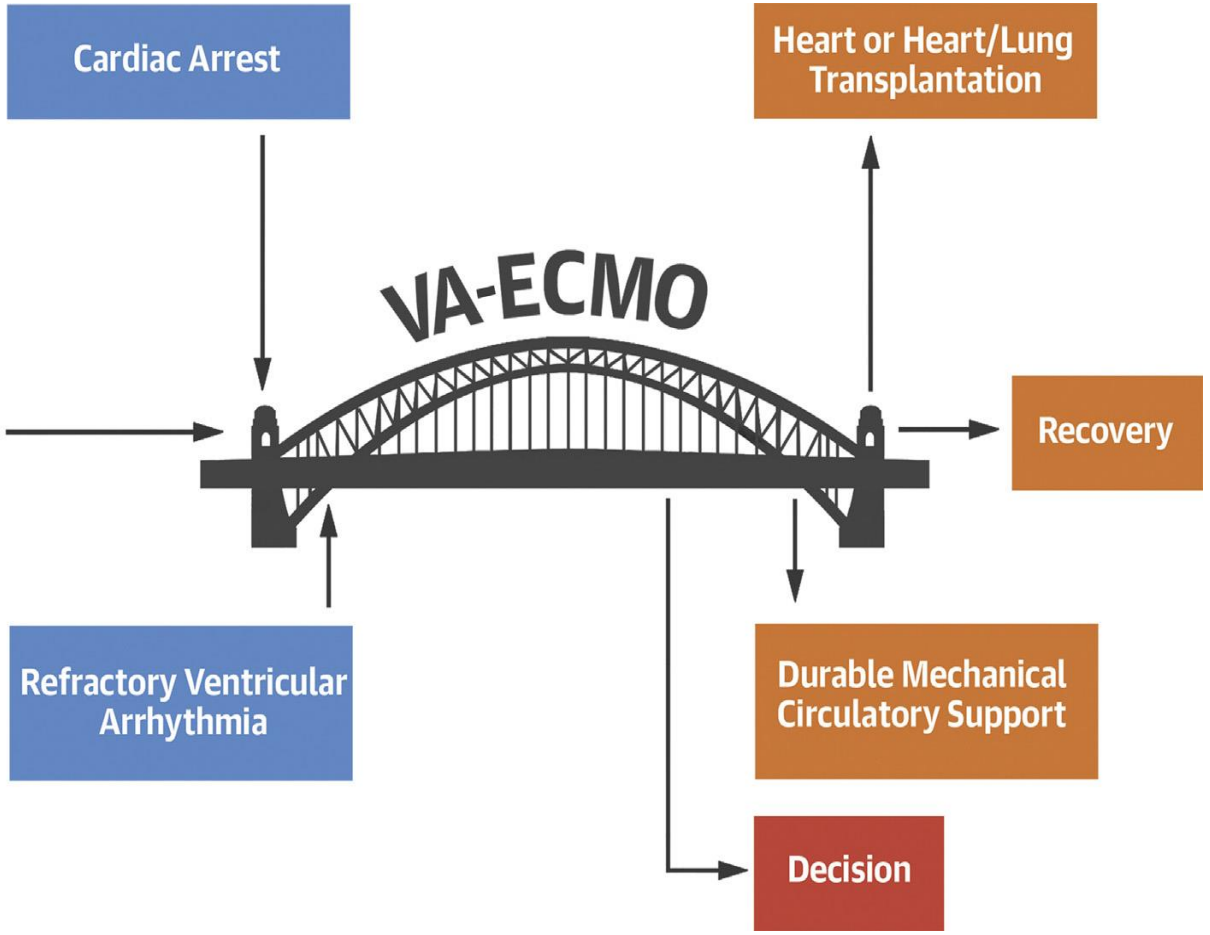
PROC (BAYL UNIV MED CENT) 2018;31(4):482–486

- Allograft function generally starts improving within the first 24 to 48 hours of partial ECMO support.
- Average duration of ECMO support: 5 days in the post-2015 cohorts.
- Use of prompt ECMO for PGD, but with the goal of recovery and weaning rather than urgent retransplant.

PROC (BAYL UNIV MED CENT) 2018;31(4):482–486

Cardiogenic Shock

- Acute myocardial infarction
- Acute or chronic heart failure due to left ventricle or biventricular
  - Myocarditis
  - Chronic cardiomyopathy
  - Septic cardiomyopathy
  - Graft failure after heart transplantation
- Chronic right ventricle (RV) failure
- Pulmonary embolism with RV failure
- Postcardiotomy syndrome



CICU Management of Cardiogenic Shock

Serial Assessment

- Lactate
- Fick + thermodilution CO/CI
- CPO and PAPi

and if MCS

- Serial echocardiograms
- Assess for hemolysis
- Neurovascular assessments

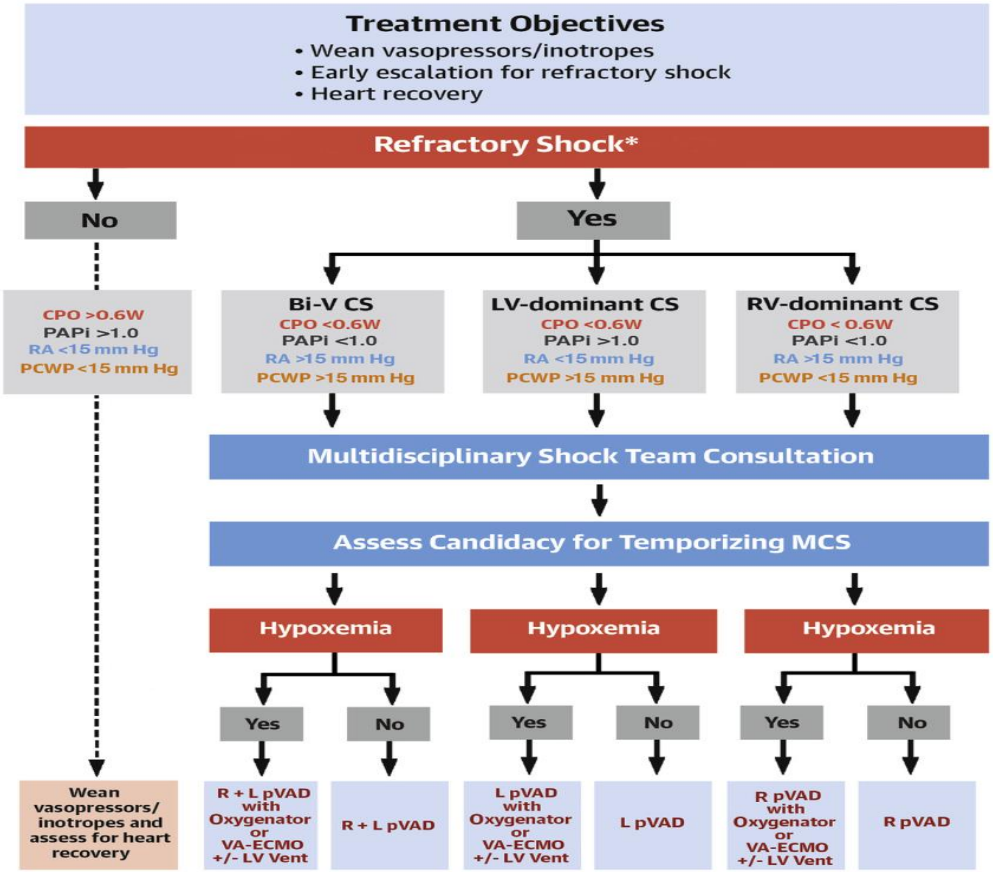
*Criteria for Refractory Shock

- CPO <0.6W
- CI <2.2 l/min/m²
- ↑ Lactate

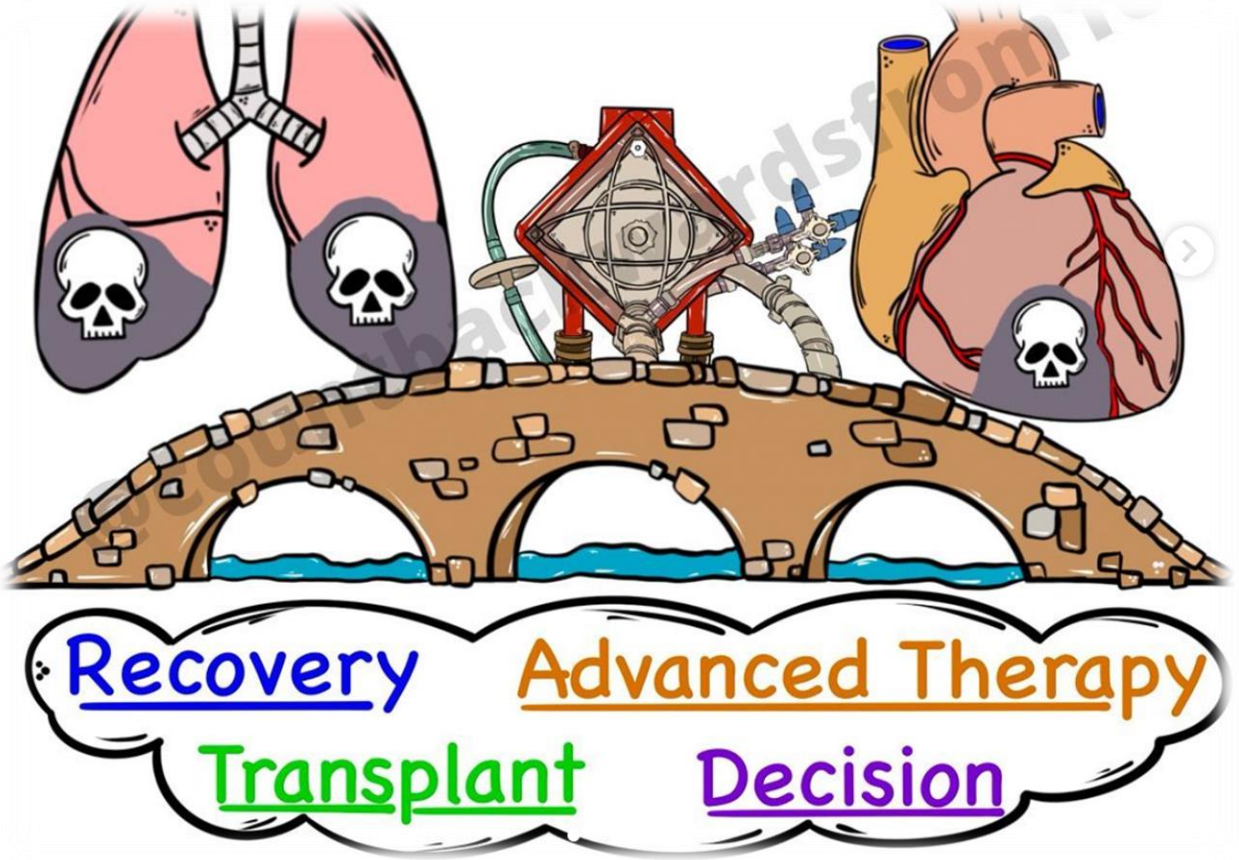
Contraindications To MCS

- Anoxic brain injury
- Irreversible end organ failure
- Prohibitive vascular access
- DNR

CPO = MAP x CO/451
PAPi = (sPAP-dPAP)/RA



This schematic illustrates the longitudinal and multidisciplinary care pathways for cardiogenic shock (CS) care in a contemporary level 1 cardiac intensive care unit (CICU). CI = cardiac index; CO = cardiac output; CPO = cardiac power output; DNR = Do Not Resuscitate order; dPAP = diastolic pulmonary arterial pressure; L = left; MAP = mean arterial pressure; MCS = mechanical circulatory support; PAPi = pulmonary arterial pulsatility index; PCWP = pulmonary capillary wedge pressure; pVAD = percutaneous ventricular assist device; R = right; sPAP = systolic pulmonary arterial pressure; other abbreviations as in **Figure 2**.



Using ECMO as a bridge to heart transplantation was generally associated with increased mortality.

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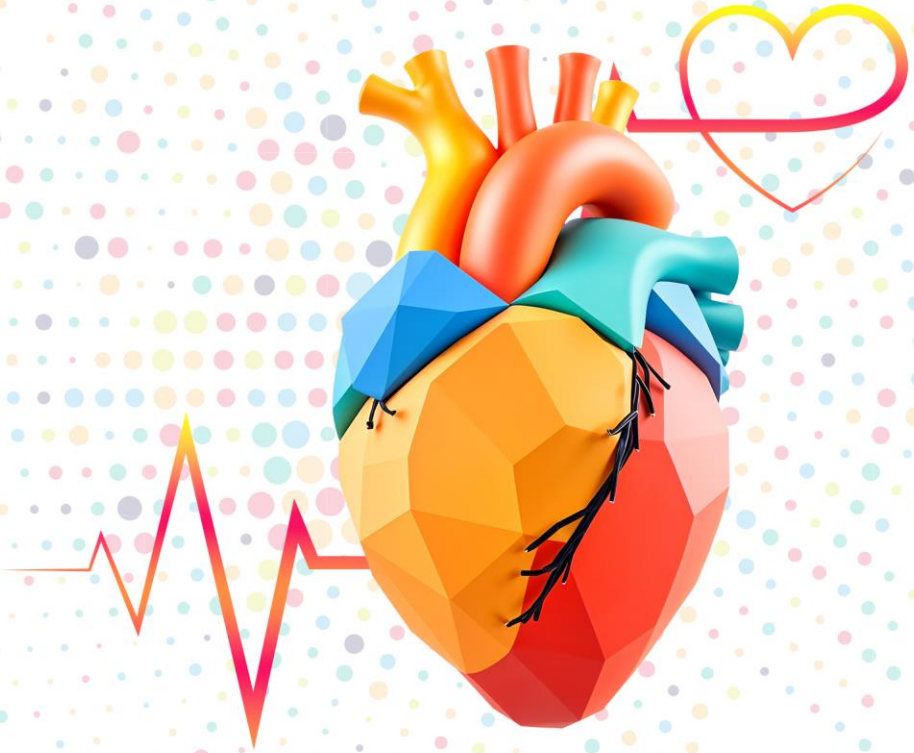
Critical Cardiovascular Care



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