The Role of Mechanical Circulatory Support in Cardiogenic Shock: When to Utilize

Presented by Nancy Scroggins ACNP, CNS-CC
CV Surgery ACNP Bayshore Medical Center

The Role of Mechanical Circulatory Support in Cardiogenic Shock: When to Utilize

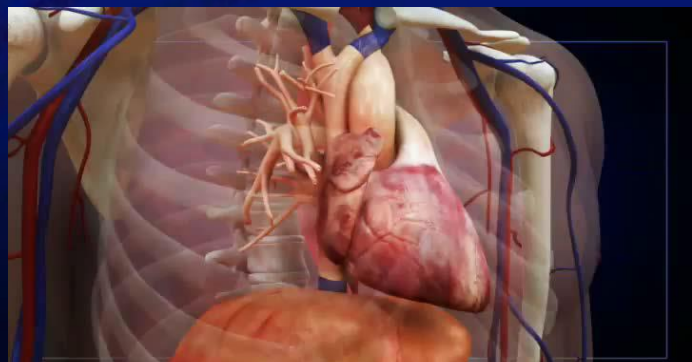
Objectives

- Define Cardiogenic Shock
- Describe Goals of MCS
- Devices Currently Available
- Understand Indications, Contraindications & Complications

The Role of pMCS in Cardiogenic Shock: When to Utilize

Cardiogenic Shock: Defined

- Systemic Tissue Hypo-perfusion Secondary to Inadequate Cardiac Output
  - CI Decreased
  - SVR Increased
  - SVO2 Decreased
  - PCWP Increased
  - Tachycardia
  - Hypotension MAP < 60mmHg
  - Skin: cold, clammy, pale, moist
  - Anxiety/Confusion
  - Oliguria UO <30cc/H

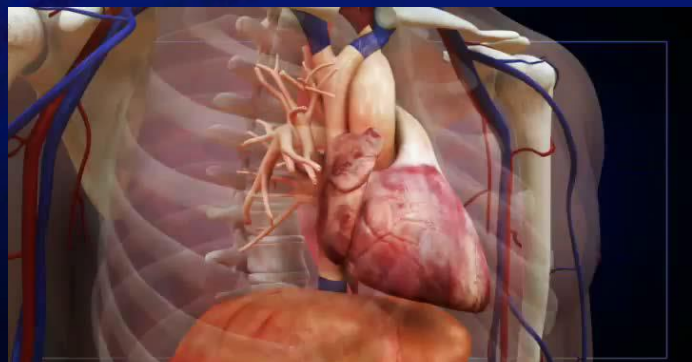


The Role of pMCS in Cardiogenic Shock: When to Utilize

Cardiogenic Shock: Defined

Interagency Registry for Mechanical Assist Circulatory Support (INTERMACS)

- Defined 7 Clinical Profiles before Implantation of a Surgical VAD
- INTERMACS 1 & 2 Patients may be Considered for pVAD as a *Bridge* to Recovery, Surgical MCS or Heart Transplantation



Rihal et al. *JACC* 2015 65 (19) e7-e226.

The Role of pMCS in Cardiogenic Shock: When to Utilize

INTERMACS

Level	Description	Time to MCS
1	“Crashing and burning”- critical cardiogenic shock	Within hours
2	“Progressive decline” – inotrope dependence with continuing deterioration	Within a few days
3	“Stable but inotrope dependent” – describes clinical stability on mild-moderate doses of intravenous inotropes (patients stable on temporary circulatory support without inotropes are within this profile)	Within a few weeks
4	“Recurrent advanced heart failure” – “recurrent” rather than “refractory” decompensation	Within weeks to months
5	“Exertion intolerant” – describes patients who are comfortable at rest but are intolerant of exercise	Variable
6	“Exertion limited” – a patient who is able to do some mild activity but fatigue results within a few minutes or any meaningful physical exertion	Variable
7	“Advanced NYHA III” – describes patients who are clinically stable with a reasonable level of comfortable activity, despite history of previous decompensation that is not recent	Not a candidate for MCS

The Role of pMCS in Cardiogenic Shock: When to Utilize

Cardiogenic Shock: Defined

(INTERMACS)

Hours

- PROFILE 1: Critical cardiogenic shock - Patients with life threatening hypotension despite rapidly escalating inotropic support, critical organ hypoperfusion, often confirmed by worsening acidosis and/or lactate levels.

Days

- PROFILE 2: Progressive decline - Patient with declining function despite intravenous inotropic support, may be manifest by worsening renal function, nutritional depletion, inability to restore volume balance “Sliding on inotropes.” Also describes declining status in patients unable to tolerate inotropic therapy.

Rihal et al. *JACC* 2015 65 (19) e7-e226.

The Role of pMCS in Cardiogenic Shock: When to Utilize

Indications

- Cardiogenic Shock
  - AMI with related mechanical complications
  - ADHF
  - Acute mycarditis
  - Post-cardiotomy shock
  - Acute rejection post-cardiac transplant with hemodynamic compromise
- High-risk Interventions
  - PCI
  - Ventricular tachycardia ablation

The Role of MCS in Cardiogenic Shock: When to Utilize

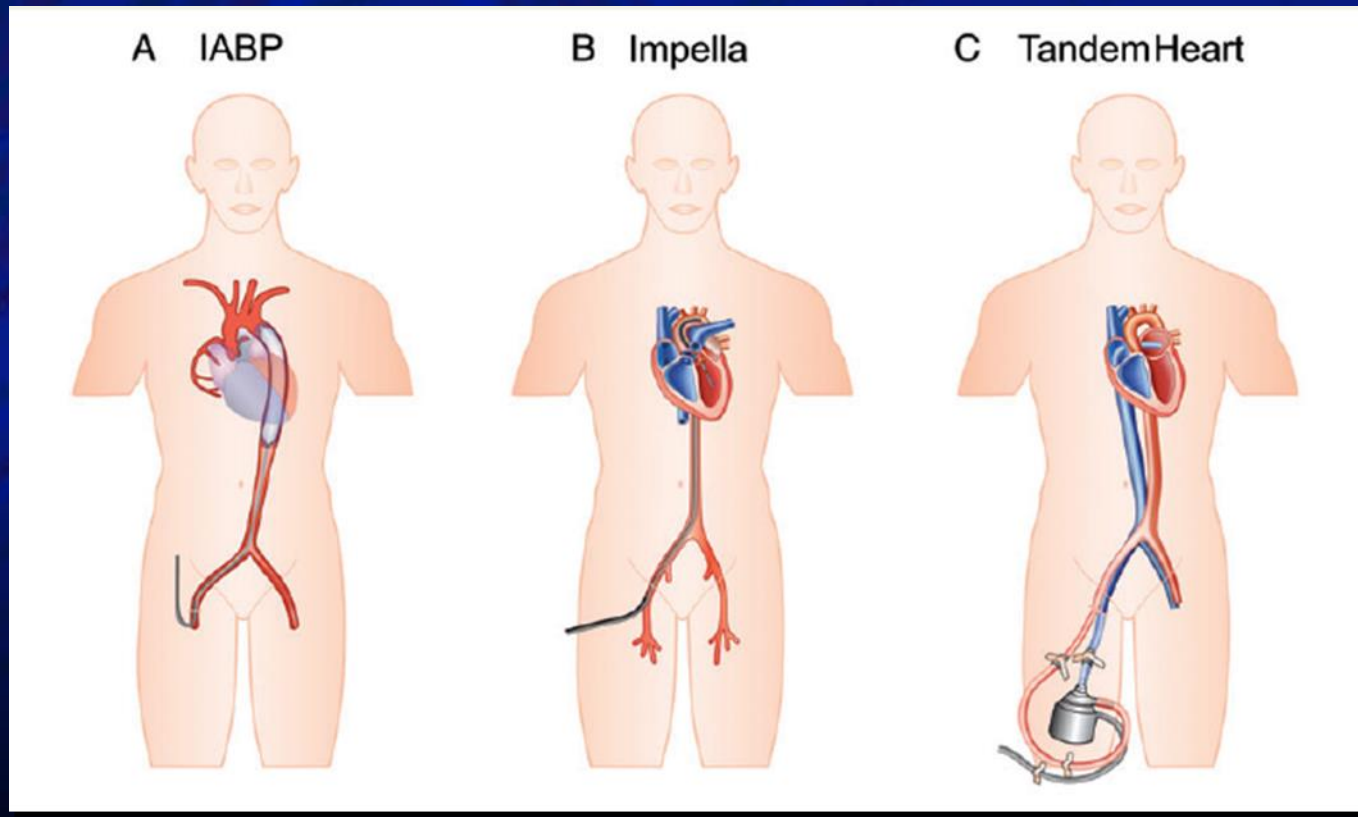
MCS: Percutaneous Ventricular Assist Devices (pVAD)

- Intra-Aortic Balloon Pump (IABP)
  - LV support by LV pressure unloading
- Percutaneous Ventricular Assist Device (pVAD) – ventricular assist device
  - LV support by LV volume unloading
    - Impella Recover LP®
    - TandemHeart

Gilotra and Stevens. *Clinical Medicine Insights: Cardiology* 2014; 8(S1):75-85.

The Role of MCS in Cardiogenic Shock: When to Utilize

MCS: Percutaneous Ventricular Assist Devices (pVAD)



The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

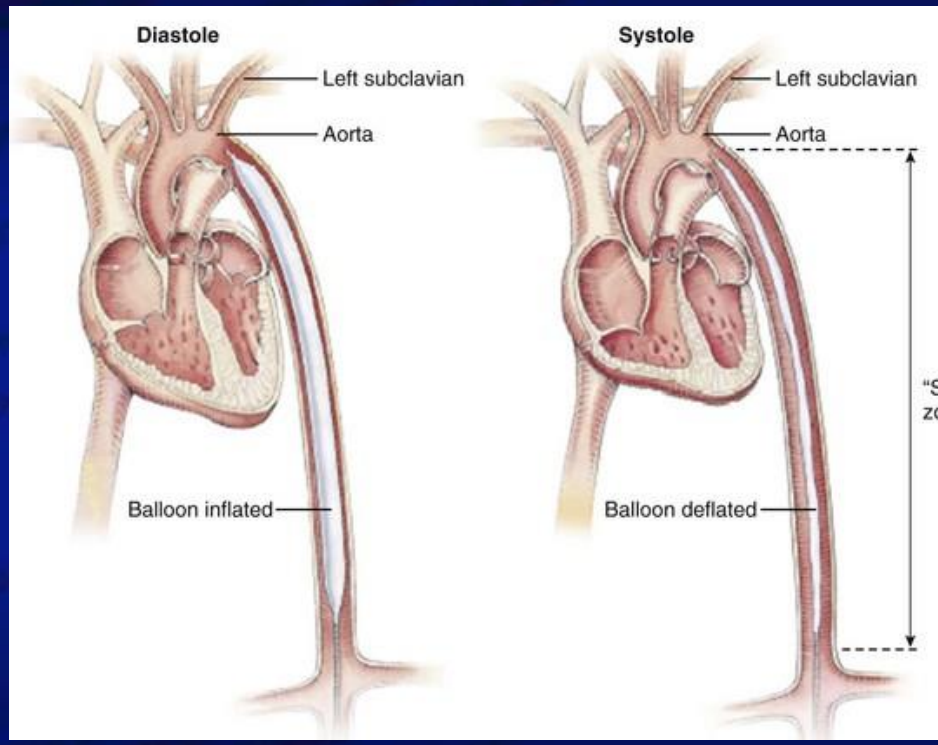
- Most Common
- 7.5 – 8Fr. Catheter
  - 2 Lumens
    - Inflation/Deflation
    - Transduce Arterial Pressure
- Helium
  - Low Viscosity
  - Absorbed in Blood Rapidly
- Trigger – EKG or Pressure
  - Inflation – Onset of LV Diastole
    - Middle of T wave
  - Deflation – Onset of LV Systole
    - Peak of R wave

Gilotra and Stevens. *Clinical Medicine Insights: Cardiology* 2014; 8(S1):75-85.

The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

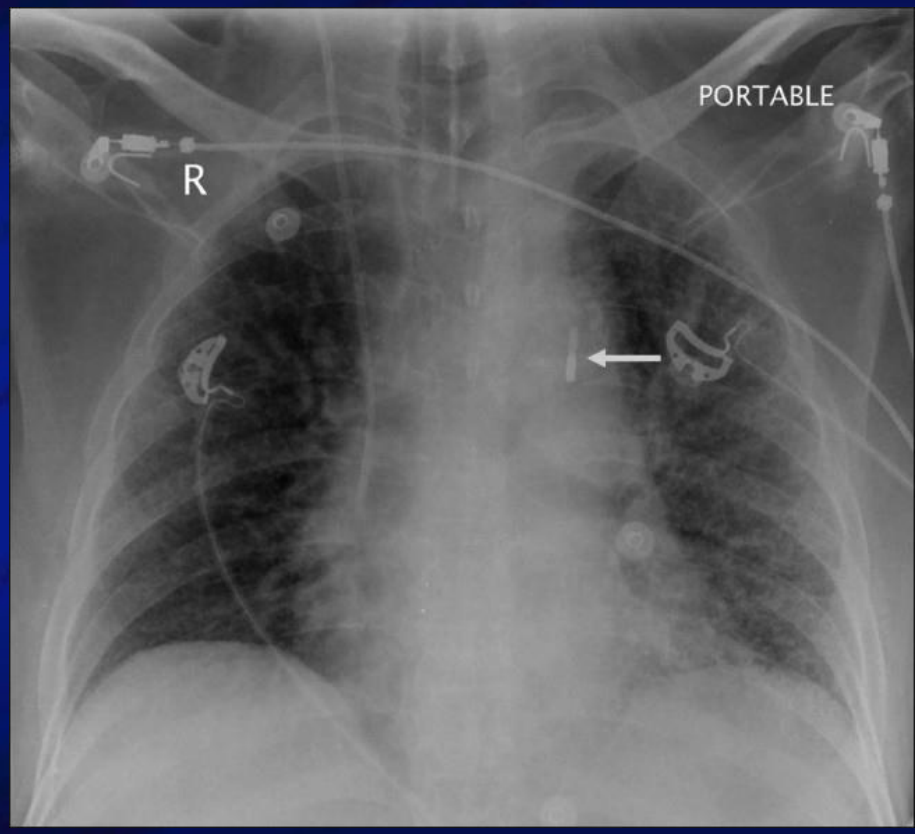
- Placement
- Descending Aorta
  - Tip Distal Left Subclavian Artery
  - Proximal to Renal Arteries
  - Small Linear Metallic Marker



The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

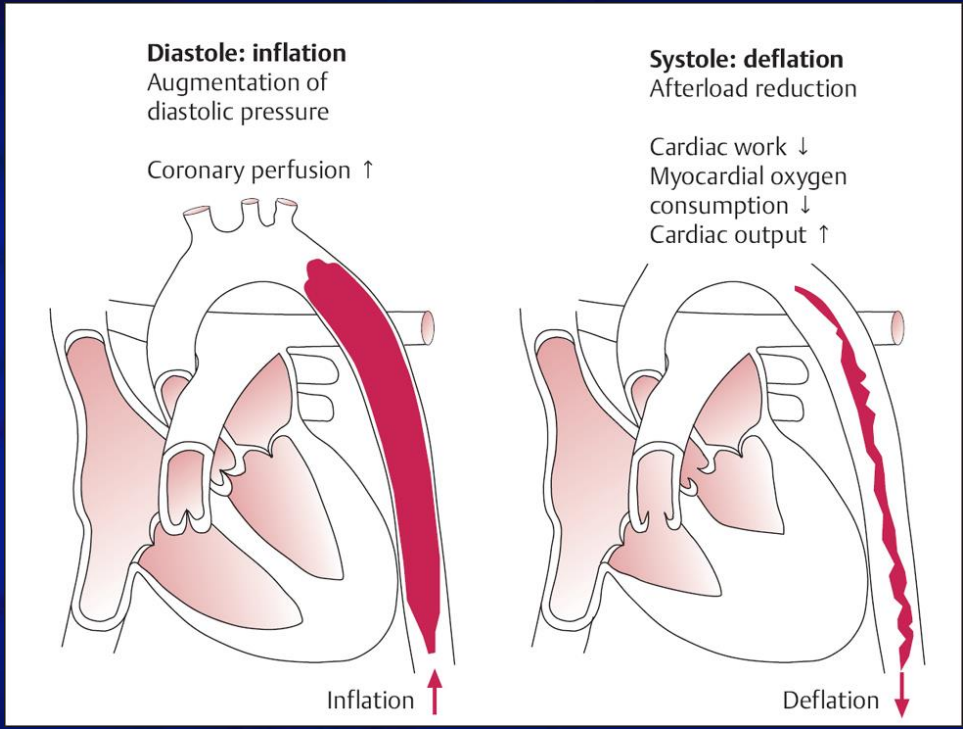
- Placement
- Descending Aorta
  - Tip Distal Left Subclavian Artery
  - Proximal to Renal Arteries
  - Small Linear Metallic Marker



The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

– Hemodynamic Effects
  - Increases (Augments) DBP
  - Increases MAP
  - Increases Coronary Perfusion
  - Decreases Afterload (SVR)
  - Decrease Myocardial Oxygen Consumption (Mv02)
  - Modestly Improves CO

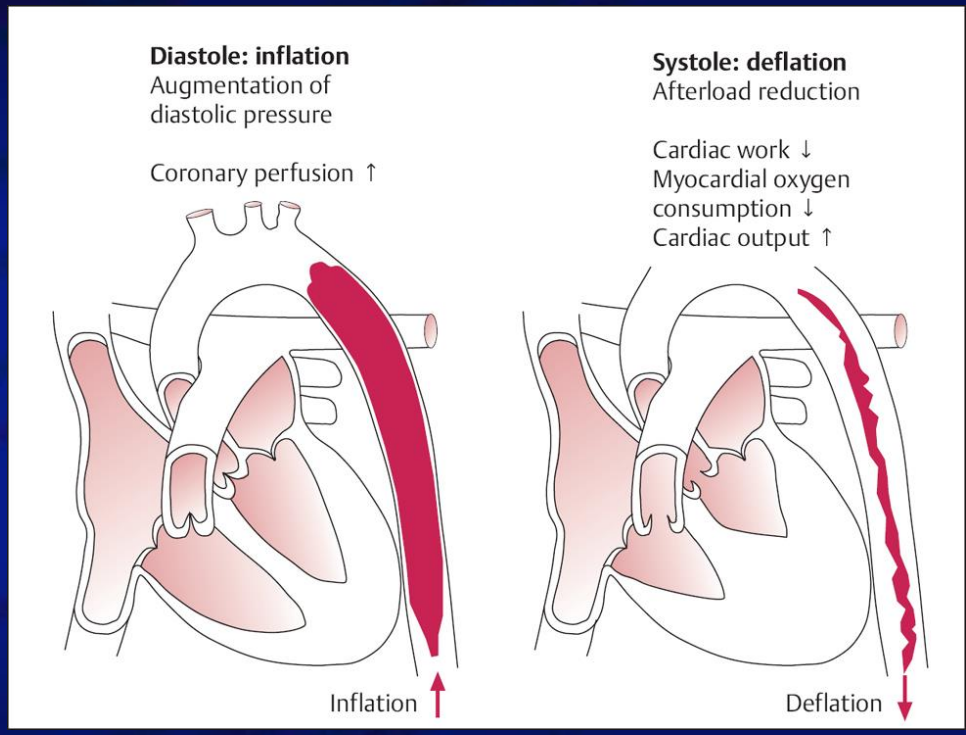


Gilotra and Stevens. *Clinical Medicine Insights: Cardiology* 2014; 8(S1):75-85.

The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

- Achieving Optimization
  - Level of Intrinsic LV Function (CI 1.2-1.4)
  - Electrical Stability
    - Tachycardia, AF
  - Balloon Position
  - Blood Displacement Volume – Max Inflate
  - Proper Timing

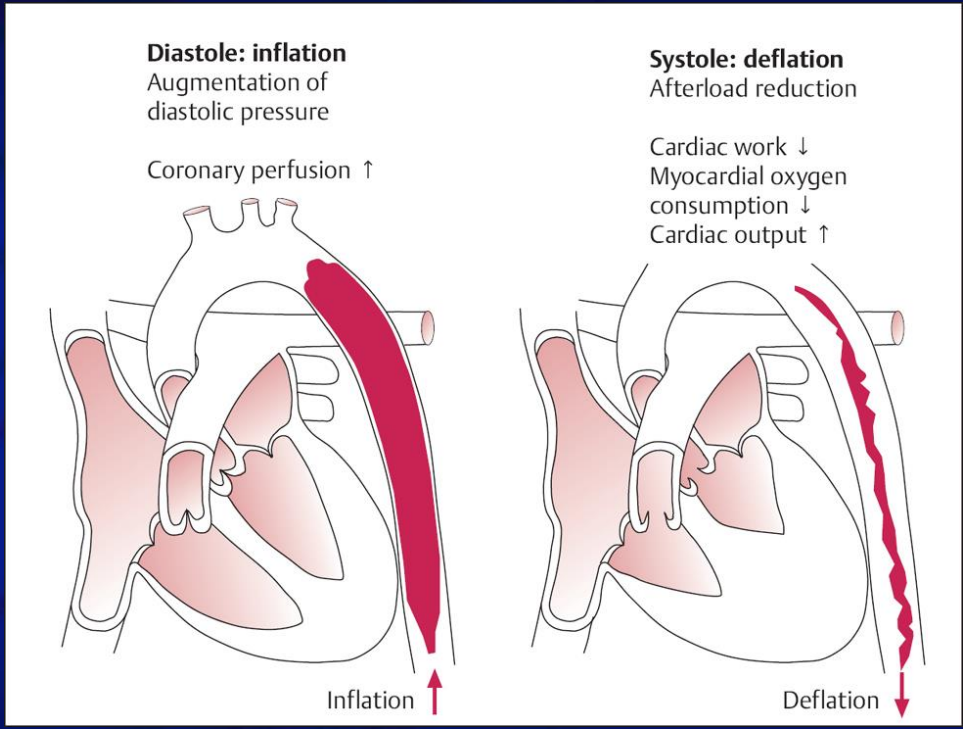


Gilotra and Stevens. *Clinical Medicine Insights: Cardiology* 2014; 8(S1):75-85.

The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

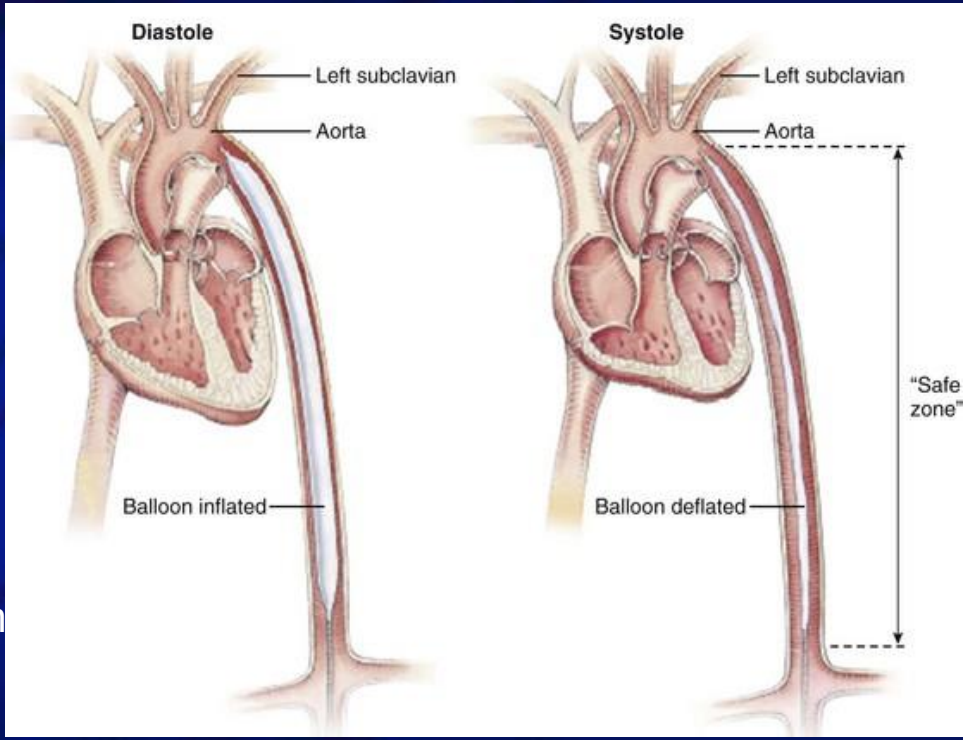
- Contraindications
  - Moderate Aortic Regurgitation
  - Severe PAD or Aortic Disease
  - Aortic Dissection
  - Aortic Aneurysm
  - Prosthetic Aortic Grafts
  - Local Sepsis
  - CI < 1.2 or Refractory Tachyarrhythmias
  - Severe Coagulopathy



The Role of MCS in Cardiogenic Shock: When to Utilize

IABP

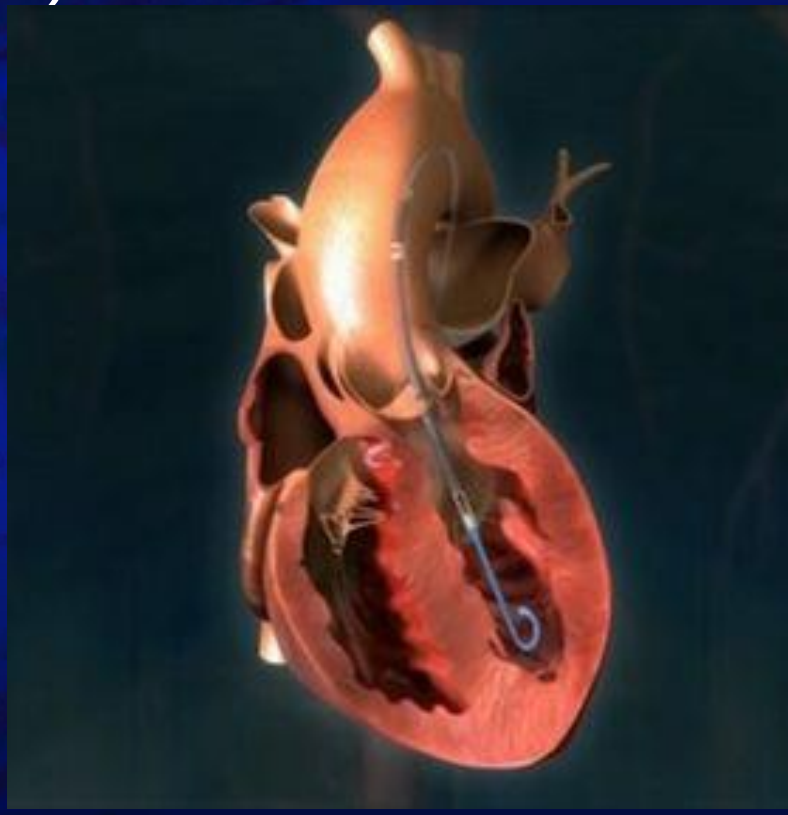
- Complications
  - Stroke
  - Limb Ischemia
  - Vascular Trauma
    - Atheroembolism
    - Acute Kidney Injury
  - Thrombocytopenia
    - Platelet deposition on balloon
    - Use of Heparin (Variable)
  - Infection
  - Complications of Immobility



The Role of MCS in Cardiogenic Shock: When to Utilize

Impella 2.5 (12 Fr.) & 5.0 (21Fr.)

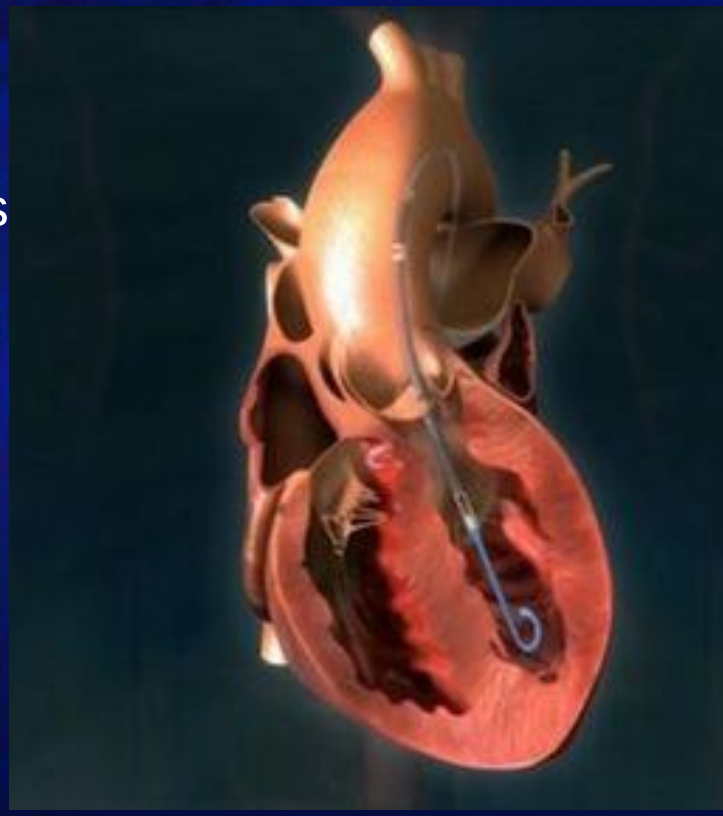
- Left Ventricle - Aorta
  - Femoral Artery Insertion
    - 2.5 Device Percutaneous Approach
    - 5.0 Device Surgical Cutdown
  - Flexible Pigtail Loop in LV
    - Stabilizes in LV
    - Decreases Likelihood Perforation
    - Connects to Cannula that Contains
      - Inlet (LV) Area
      - Outlet (Aorta) Area
      - Motor Housing
      - Pump Pressure Monitor



The Role of MCS in Cardiogenic Shock: When to Utilize

Impella 2.5 (12 Fr.) & 5.0 (21Fr.)

- Left Ventricle - Aorta
  - Non-Pulsatile Axial Flow Screw Pump
    - Blood LV to Ascending Aorta in Series
    - Impella 2.5 – 2.5 L/min CO
    - Impella 5.0 – 5.0 L/min CO



The Role of MCS in Cardiogenic Shock: When to Utilize

The Role of MCS in Cardiogenic Shock: When to Utilize

Impella

- Hemodynamic Effects
  - LV & Pump Contribute to Flow
    - Redirection From LV to Aorta
      - Reduces LV Preload
      - Reduces LV Filling Pressures
      - Decreases Mv02
    - Increases BP & CO
    - Reduction LV Wall Stress
      - Unknown
  - IV Heparin
      - Can be used up to 7 days

The Role of MCS in Cardiogenic Shock: When to Utilize

Impella

- Contraindications
  - Mechanical Aortic Valve
  - LV Thrombus
  - AS or AR (Relative)
  - Severe PAD
  - Severe Coagulapathies
  - VSD
    - Worsen Right to Left Shunting & Hypoxemia

The Role of MCS in Cardiogenic Shock: When to Utilize

Impella

- Complications
  - Limb Ischemia
  - Vascular Injury
  - Bleeding Requiring Blood Transfusion
  - Local Transfemoral Complications
    - Hematoma
    - Pseudoaneurysm
    - Arterial – Venous Fistula
    - Retroperitoneal Hemorrhage
  - Hemolysis – Mechanical Shearing
    - 5 – 10% of Patients within 1st 24H
    - Persistant Hemolysis with AKI – Indication for Device Removal

The Role of MCS in Cardiogenic Shock: When to Utilize

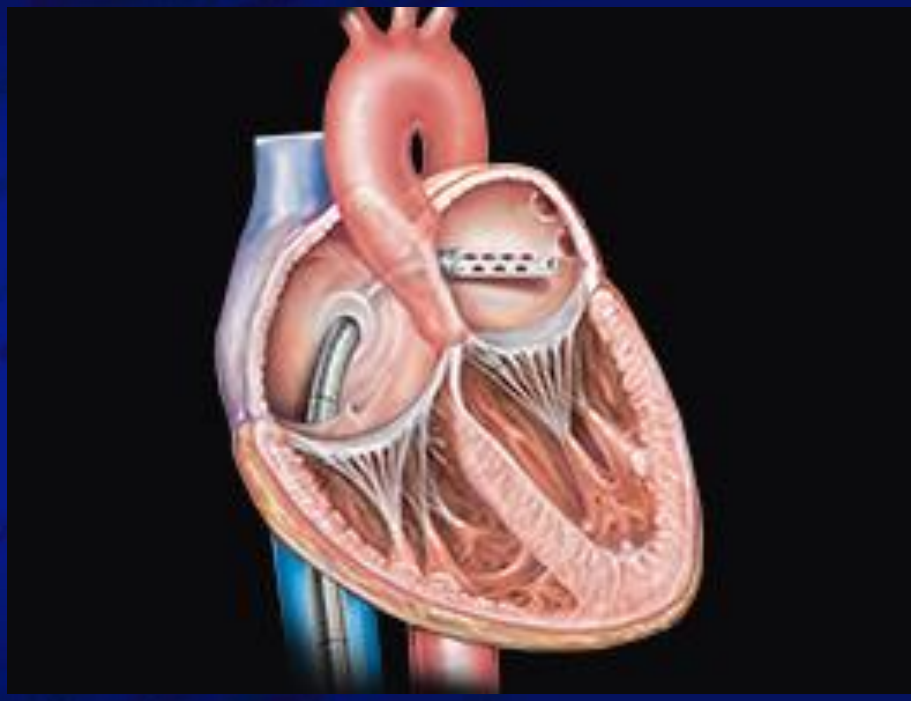
Impella

- Complications
  - Profound Coagulopathies
    HIT
    DIC
  - History of HIT – No Heparin
    Alternatives – Bivalirudin or Argatroban

The Role of MCS in Cardiogenic Shock: When to Utilize

Tandem Heart

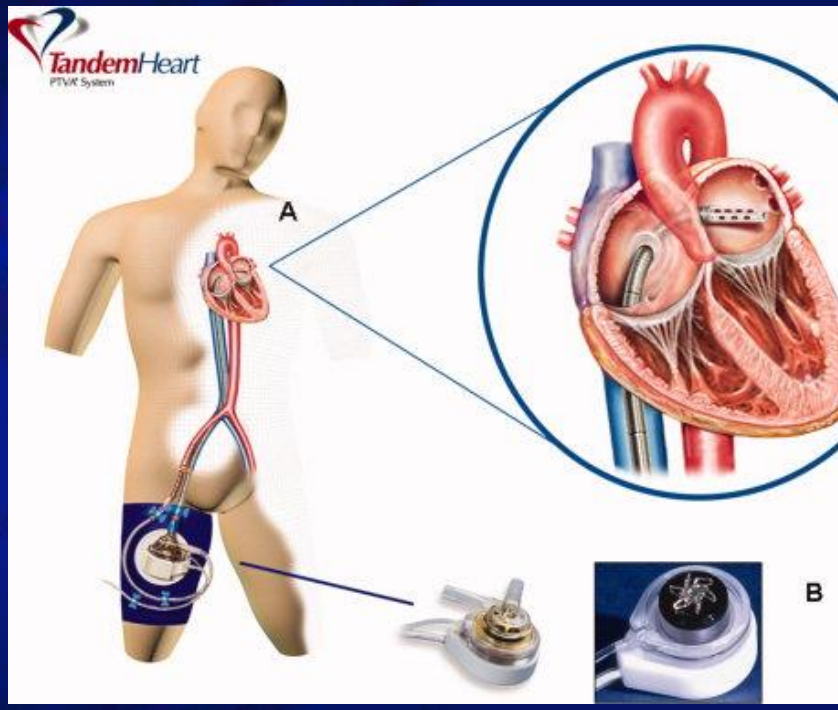
- Left Atrial - Aorta
  - Percutaneous Insertion
    - 21 Fr. Transeptal Cannula - LA
    - Centrifugal Pump
    - Femoral Arterial Cannulation
    - Control Console
  - Transeptal Cannula
    - Large End Hole
    - 14 Side Holes
    - Aspiration of Left Atrial Blood
  - Arterial Perfusion Cannula
    - 15 - 19 Fr.
    - Determinant of Flow 3.5 - 5L/min



The Role of MCS in Cardiogenic Shock: When to Utilize

Tandem Heart

- Left Atrial - Aorta
  - Centrifugal Blood Pump
    - Centrifugal Pump
    - 3,000 – 7,500 RPM
    - IV Heparin
      - Prevents Thrombus Formation
  - Option to add Oxygenator
    - LV Unloading & Oxygenation

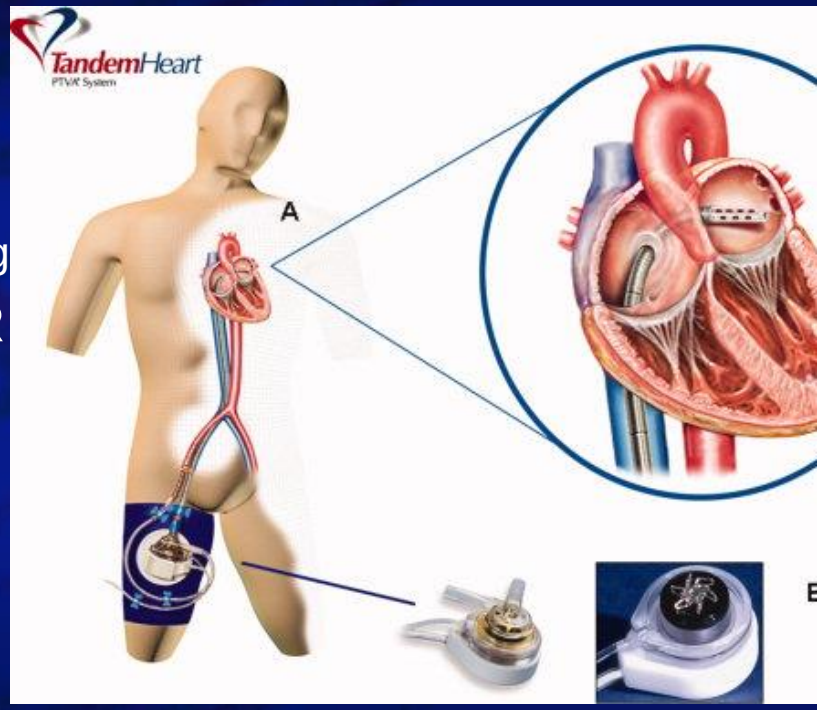


Can be Used for up to 14 Days

The Role of MCS in Cardiogenic Shock: When to Utilize

Tandem Heart

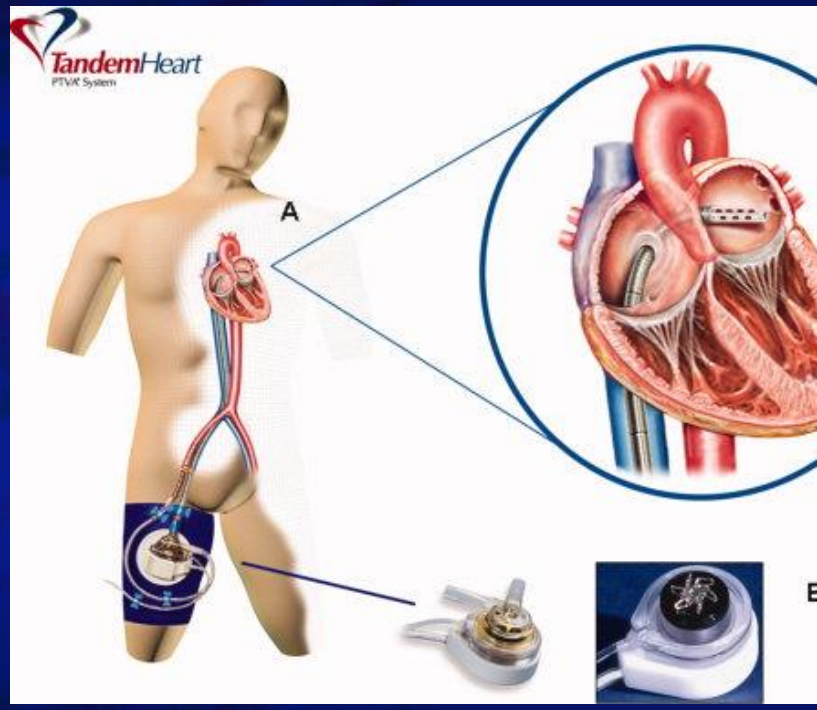
- Contraindications
  - RV Failure or Insufficiency
    - Normal RV Function - LA Filling
  - Limited Use in VSD or Severe AR
  - Severe PAD
  - Profound Coagulopathies
    - HIT
    - DIC
  - History of HIT – No Heparin
    - Alternatives – Bivalirudin or Argatroban



The Role of MCS in Cardiogenic Shock: When to Utilize

Tandem Heart

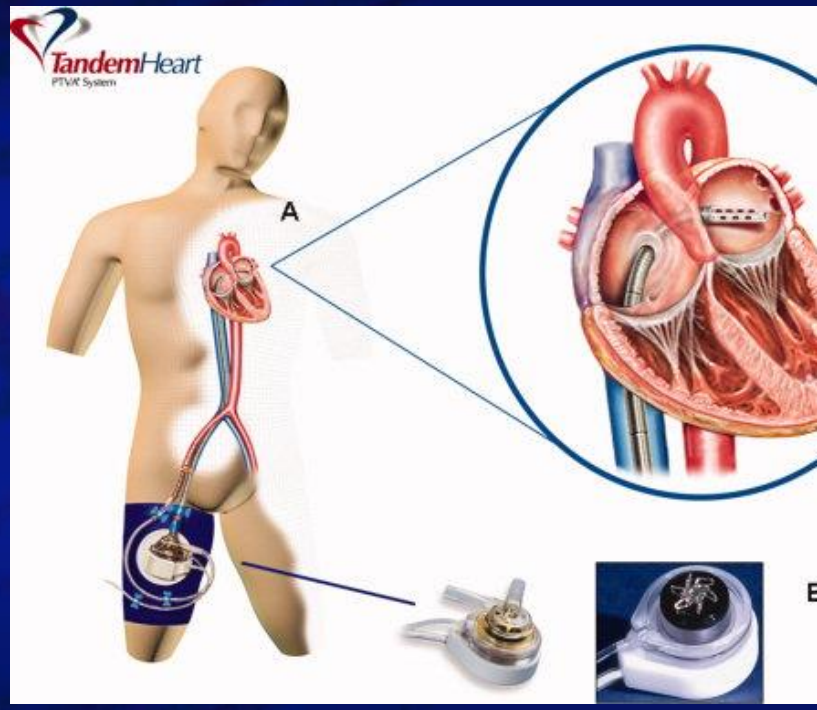
- Hemodynamic Effects
  - LV & Pump Contribute to Flow
    - Redirection From LA to Aorta
      - Reduces LV Preload
      - Reduces LV Filling Pressures
      - Reduces LV Wall Stress
      - Decreases Mv02
    - Increases BP & CO
    - Improves Perfusion
      - Not Uncommon LV Contraction Ceases
      - Systemic Perfusion becomes Pump Dependent



The Role of MCS in Cardiogenic Shock: When to Utilize

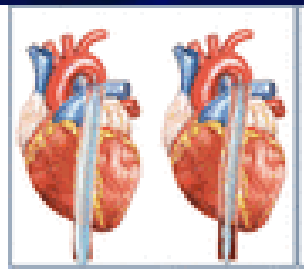
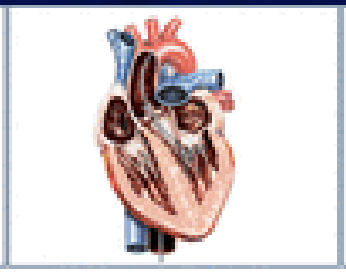
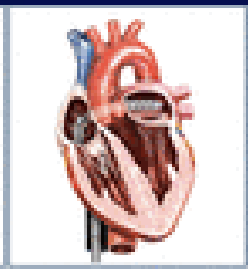
Tandem Heart

- Complications
  - Vascular Trauma
  - Limb Ischemia
  - Transeptal Puncture Techniques
    - Cariac Tamponade
  - Thrombo or Air-Embolism
  - Hemolysis
  - Migration of LA Cannula – PV
    - Device Malfunction
  - Dislodgement LA Cannula – RA
    - Severe Systemic Desaturation



The Role of MCS in Cardiogenic Shock: When to Utilize

In Summary

	IABP	IMPELLA	TANDEMHEART
Cardiac Flow	0.3-0.5 L/ min	1-5L/ min (Impella 2.5, Impella CP, Impella 5)	2.5-5 L/ min
Mechanism	Aorta	LV → AO	LA → AO
Maximum implant days	Weeks	7 days	14 days
Sheath size	7-8 Fr	13-14 Fr Impella 5.0 - 21 Fr	15-17 Fr Arterial 21 Fr Venous
Femoral Artery Size	>4 mm	Impella 2.5 & CP - 5-5.5 mm Impella 5 - 8 mm	8 mm
Cardiac synchrony or stable rhythm	Yes	No	No
Afterload	↓	↓	↑
MAP	↑	↑↑	↑↑
Cardiac Flow	↑	↑↑	↑↑
Cardiac Power	↑	↑↑	↑↑
LVEDP	↓	↓↓	↓↓
PCWP	↓	↓↓	↓↓
LV Preload	—	↓↓	↓↓
Coronary Perfusion	↑	↑	—
Myocardial oxygen demand	↓	↓↓	↔↓

The Role of MCS in Cardiogenic Shock: When to Utilize

In Summary

- Device Selection
  - Availability of Device
  - Patient Anatomy, Level of Support Needed
  - Operator Experience
  - Comorbid Conditions
  - Support Team Experience

The Role of MCS in Cardiogenic Shock: When to Utilize

Assessment Questions

pMCS is indicated in patients with Cardiogenic Shock or High Risk PCI

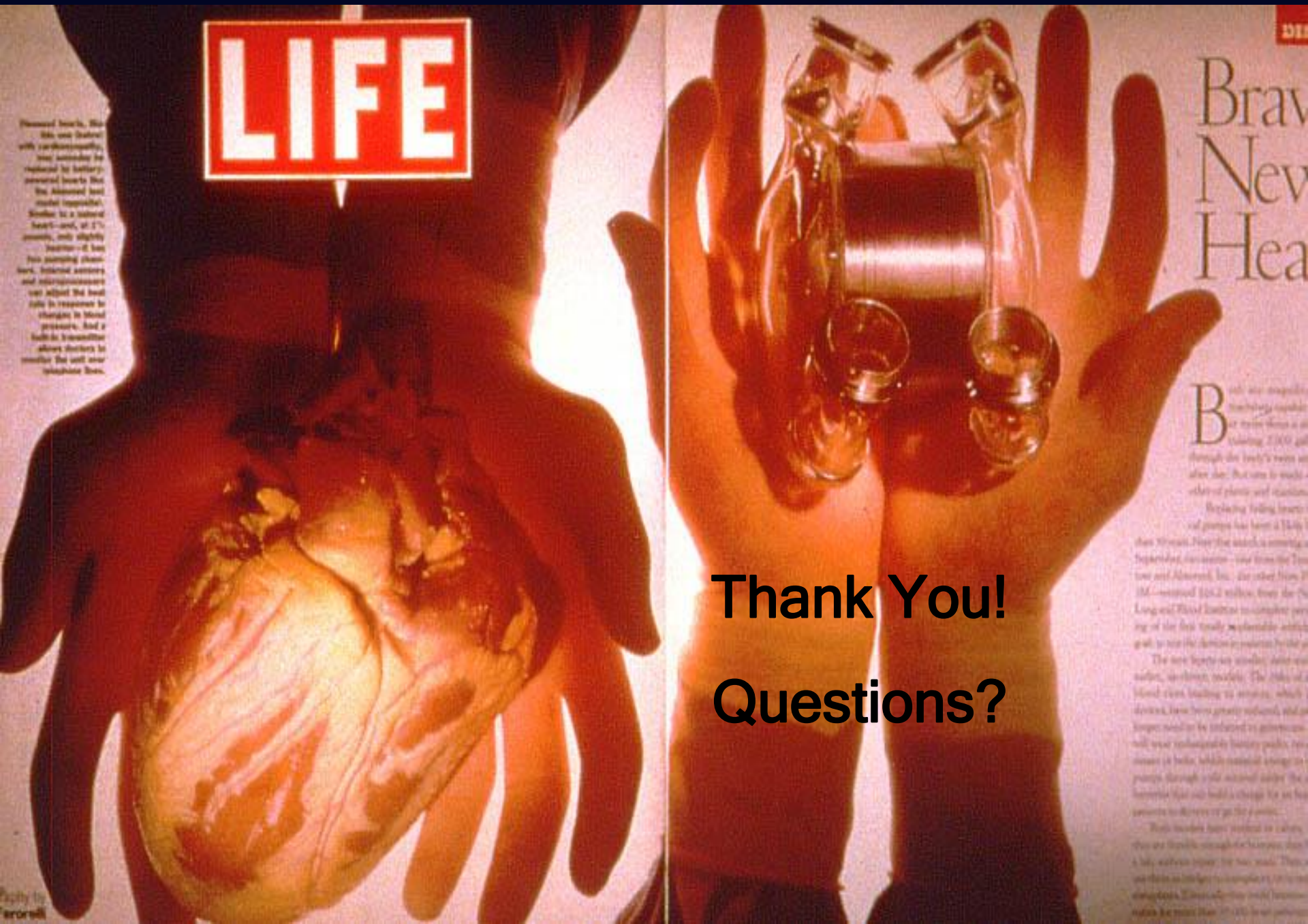
1. True
2. False

The Role of MCS in Cardiogenic Shock: When to Utilize

Assessment Questions

Which of the pVADs provide the most hemodynamic support (CI) in patients with Cardiogenic Shock

1. IABP
2. Impella 2.5
3. Tandem Heart



Thank You!

Questions?