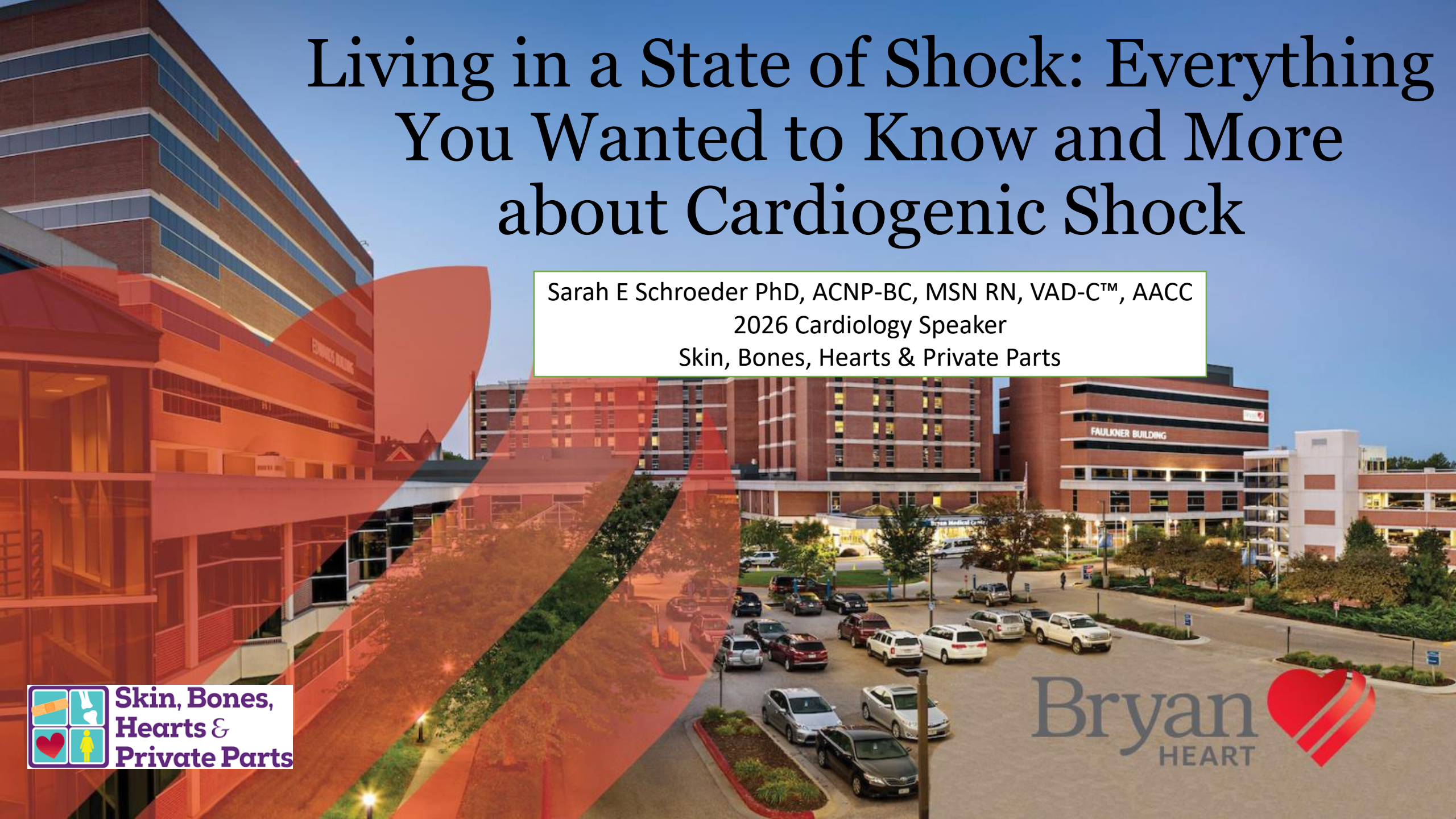
Living in a State of Shock: Everything You Wanted to Know and More about Cardiogenic Shock

Sarah E Schroeder PhD, ACNP-BC, MSN RN, VAD-C™, AACC
2026 Cardiology Speaker
Skin, Bones, Hearts & Private Parts



Disclosures

- Investigator-Driven Research Grant, Abbott Labs, 2023-2026
- VAD Coordinator Professional Development Grant, ICCAC, 2024-2026

I will occasionally discuss patient scenarios – any pictures directly of patients are displayed following consent and will be noted

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I have a paid subscription to Vecteezy

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Objectives

- What is Cardiogenic Shock?
- Why Distinguishing Shock Matters
- Stages of Shock and Clinical Presentation
- Useful Devices in Cardiogenic Shock
- Medications Used to Treat Cardiogenic Shock
- Case Study Discussions
  - Acute MI
  - PE
  - True Cardiogenic Shock secondary to depressed EF
  - Anomolies
- Final PEARLS on Cardiogenic Shock

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What is Cardiogenic Shock?

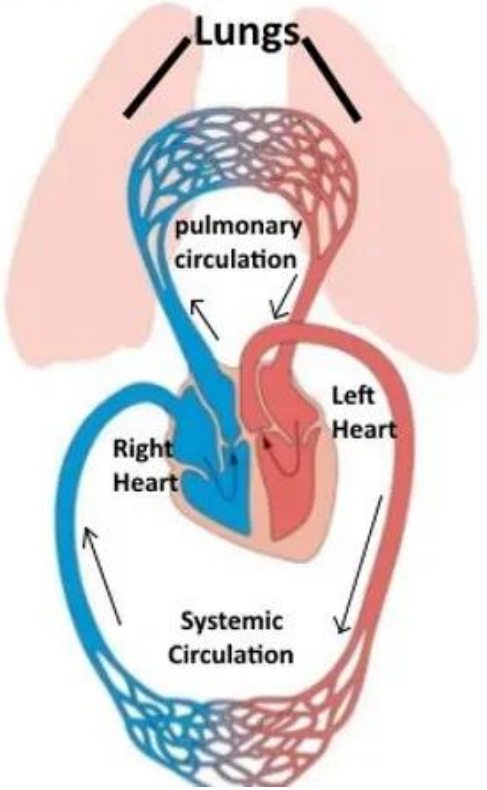
Cardiogenic Shock

as defined in the SHOCK trial

1. Persistent hypotension (SBP < 90 mmHg or MAP 30 mmHg below baseline)
2. Cardiac Index < 1.8 L/min/m^2 without support (< 2.2 L/min/m^2 with support)
3. Adequate or elevated filling pressure (LVEDP > 18 mmHg, RVEDP > 10 mmHg)

Cardiogenic Shock

- Cardiac Output
  - reduced
- PCWP
  - Increased
- CVP/RAP
  - increased
- Blood Pressure
  - Low
- Systemic Vascular Resistance
  - Increased

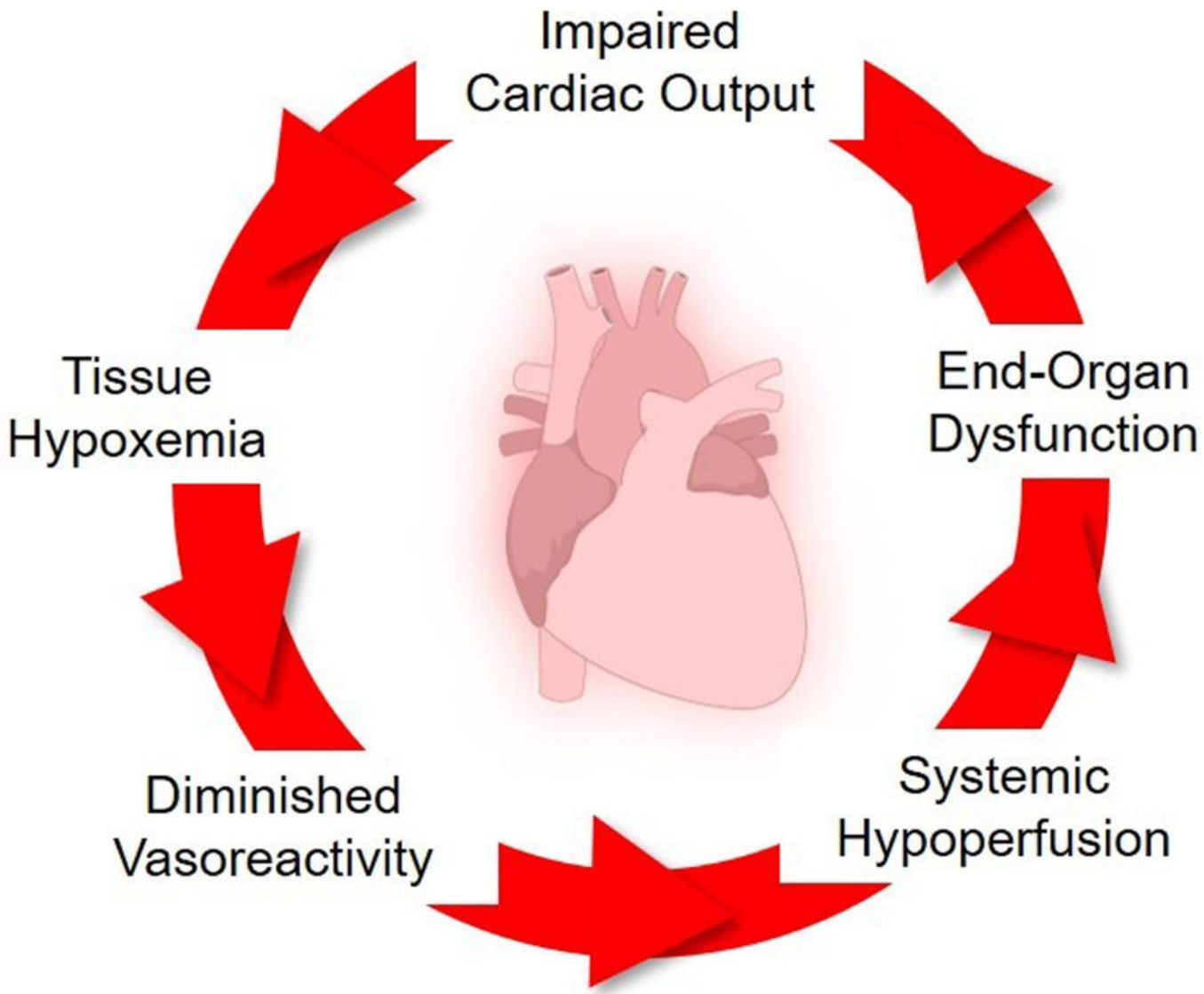


Cardiogenic Shock | Heartplace | Cardiovascular Disease Specialists & Cardiac Electrophysiologists located in Allen, Fort Worth, Arlington, Dallas, Plano, Corsicana, Garland, Glen Rose, Bedford, Burleson, Irving, Mansfield, Richardson, North Richland Hills, Granbury, Red Oak, Southlake, Frisco, Mesquite, Greenville, McKinney and Midlothian, TX

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Cardiogenic Shock… A Bit More Specific…

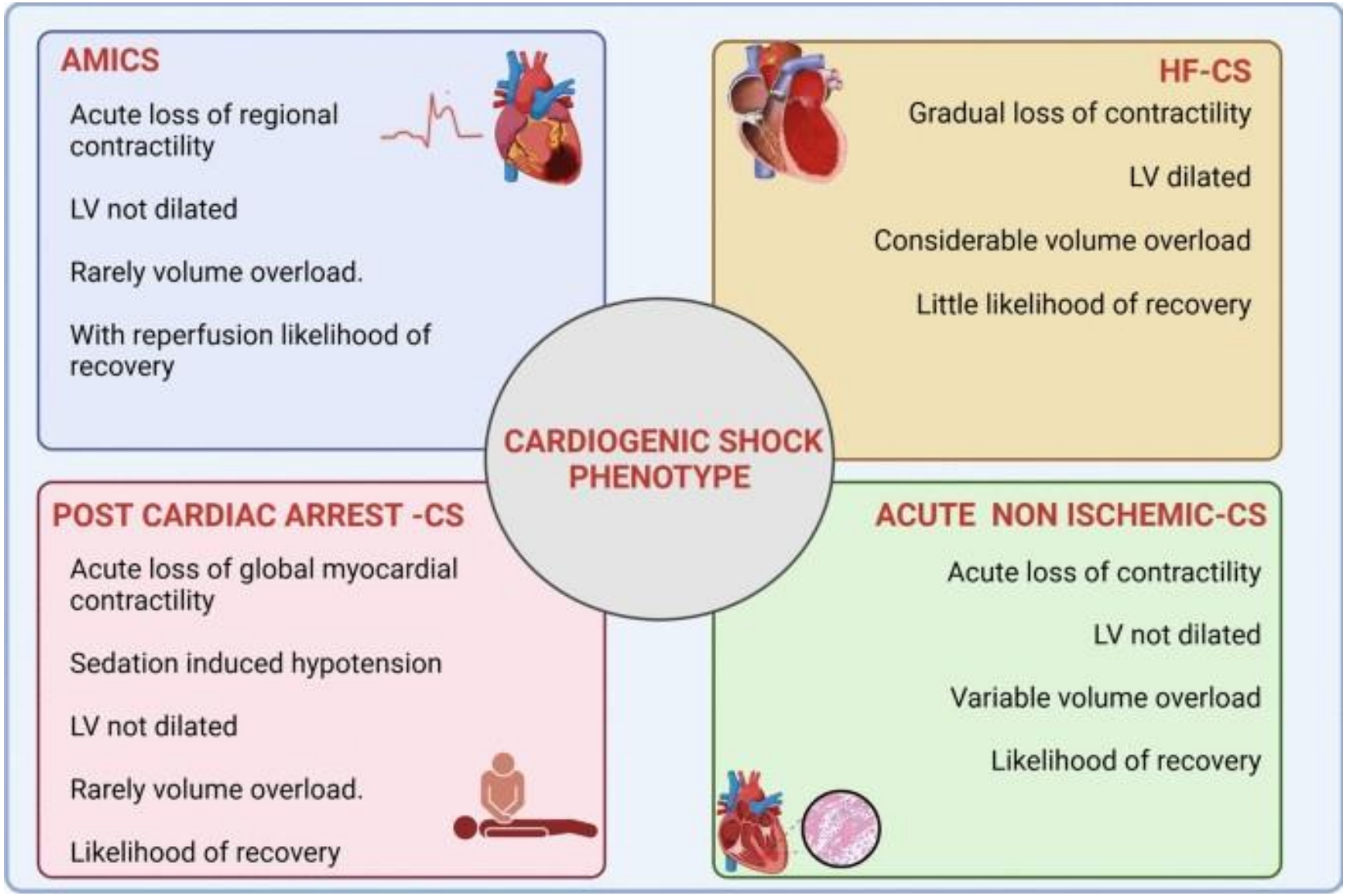


Life-Threatening Condition

Systolic BP < 90mmHg
(Myocardial Dysfunction)

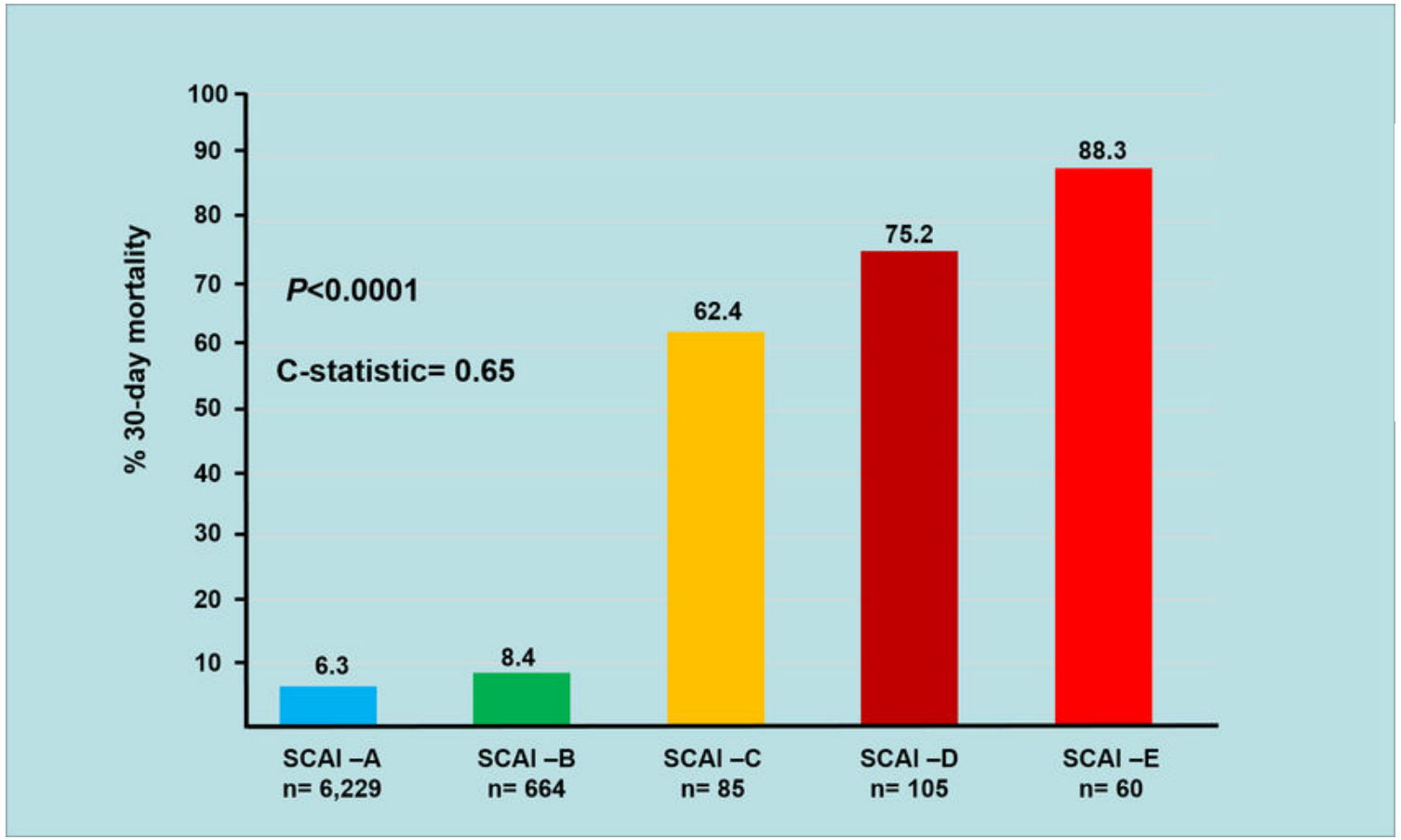
Decreased End Organ
Function

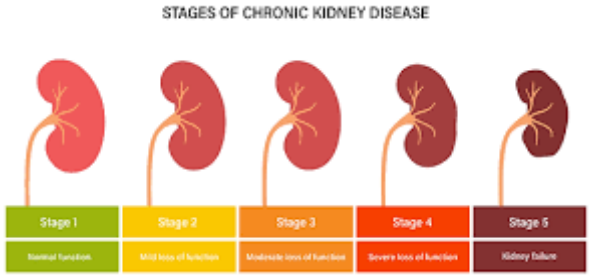
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Cardiogenic shock: diagnosis, phenotyping and management | Intensive Care Medicine

Why Distinguishing Shock Matters



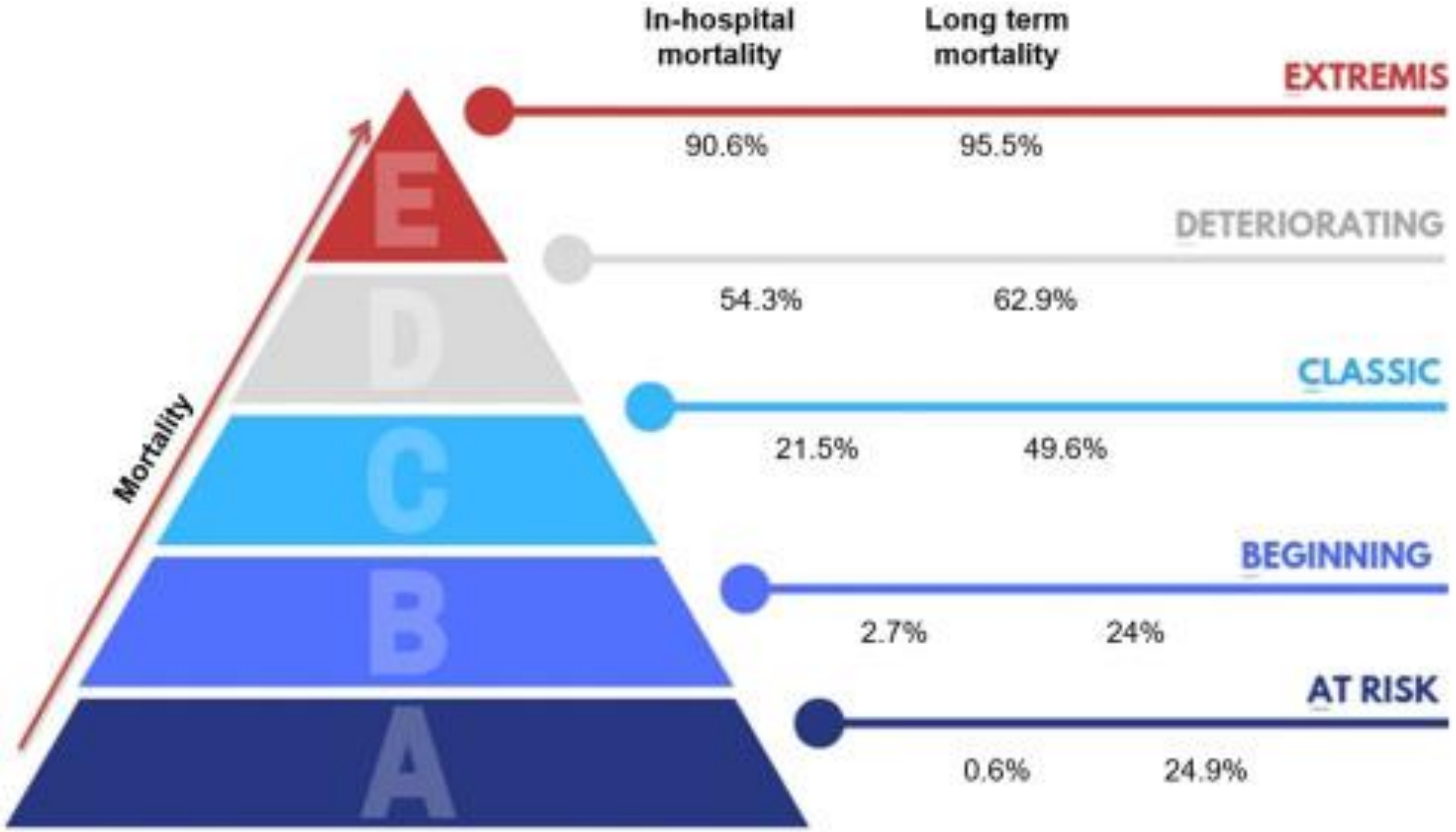






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SCAI Criteria

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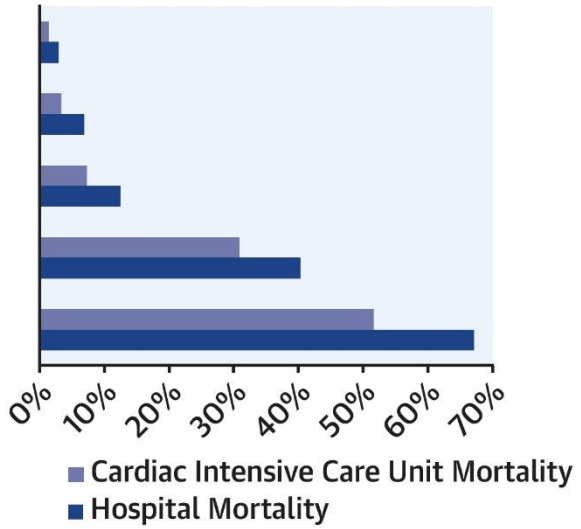
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Stages of Shock and Clinical Presentation

CENTRAL ILLUSTRATION: Definitions of SCAI Shock Stages A Through E, With Associated Cardiac Intensive Care Unit and Hospital Mortality in Each SCAI Shock Stage

Cardiogenic Shock Stage	Study Definition
Stage A ("At risk")	Neither hypotension/tachycardia nor hypoperfusion
Stage B ("Beginning")	Hypotension/tachycardia WITHOUT hypoperfusion
Stage C ("Classic")	Hypoperfusion WITHOUT deterioration
Stage D ("Deteriorating)"	Hypoperfusion WITH deterioration NOT refractory shock
Stage E ("Extremis")	Hypoperfusion WITH deterioration AND refractory shock

Observed Mortality in Overall Cohort



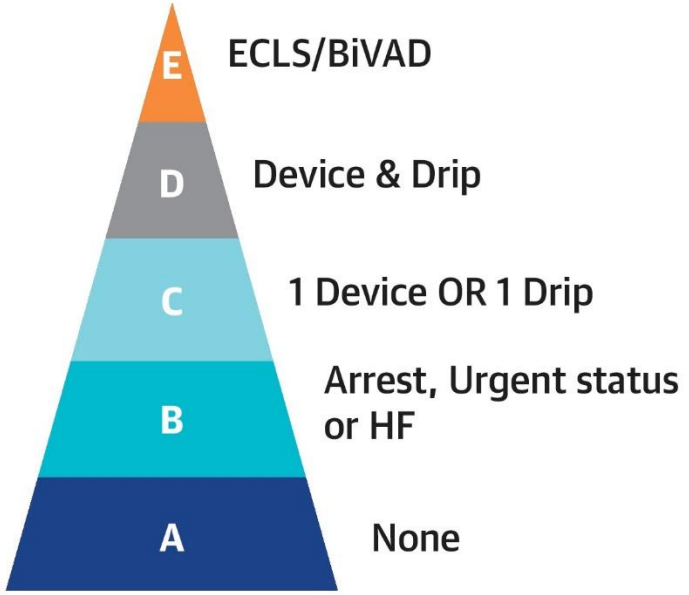
Jentzer, J.C. et al. J Am Coll Cardiol. 2019;74(17):2117-28.

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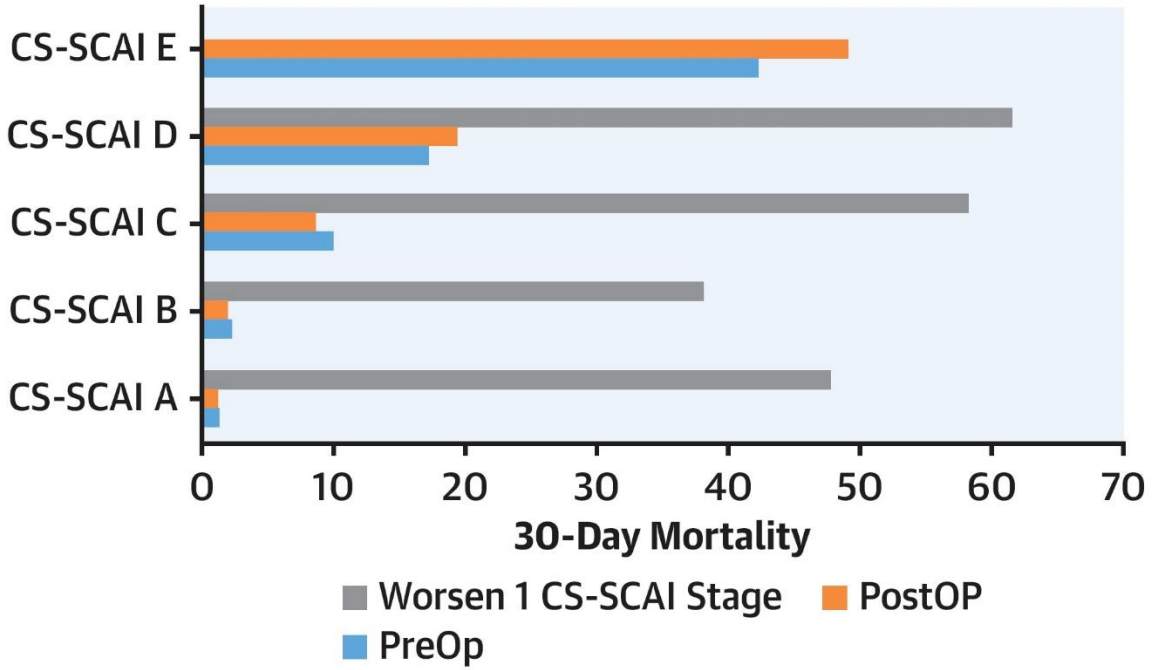
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CENTRAL ILLUSTRATION: CS-SCAI Construct and 30-Day Mortality Including the Effect of Worsening Stage

CS-SCAI Definition



CS-SCAI Stage and 30-Day Mortality

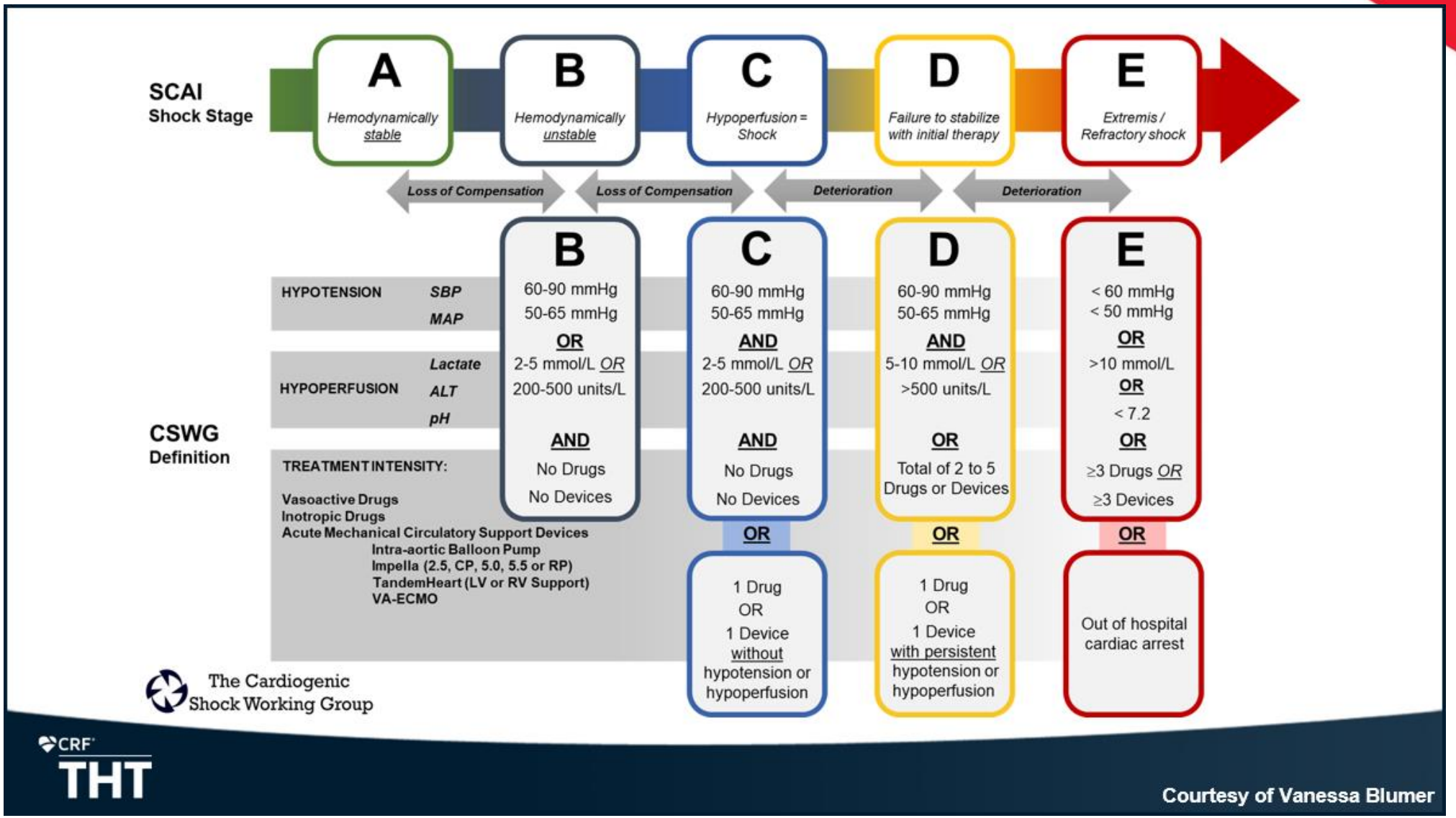


Brozzi N, et al. JACC Adv. 2025;4(8):101975.

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[Shock Stages in Cardiac Surgical Patients: Implications for Post-Cardiotomy Shock and Mortality | JACC: Advances]

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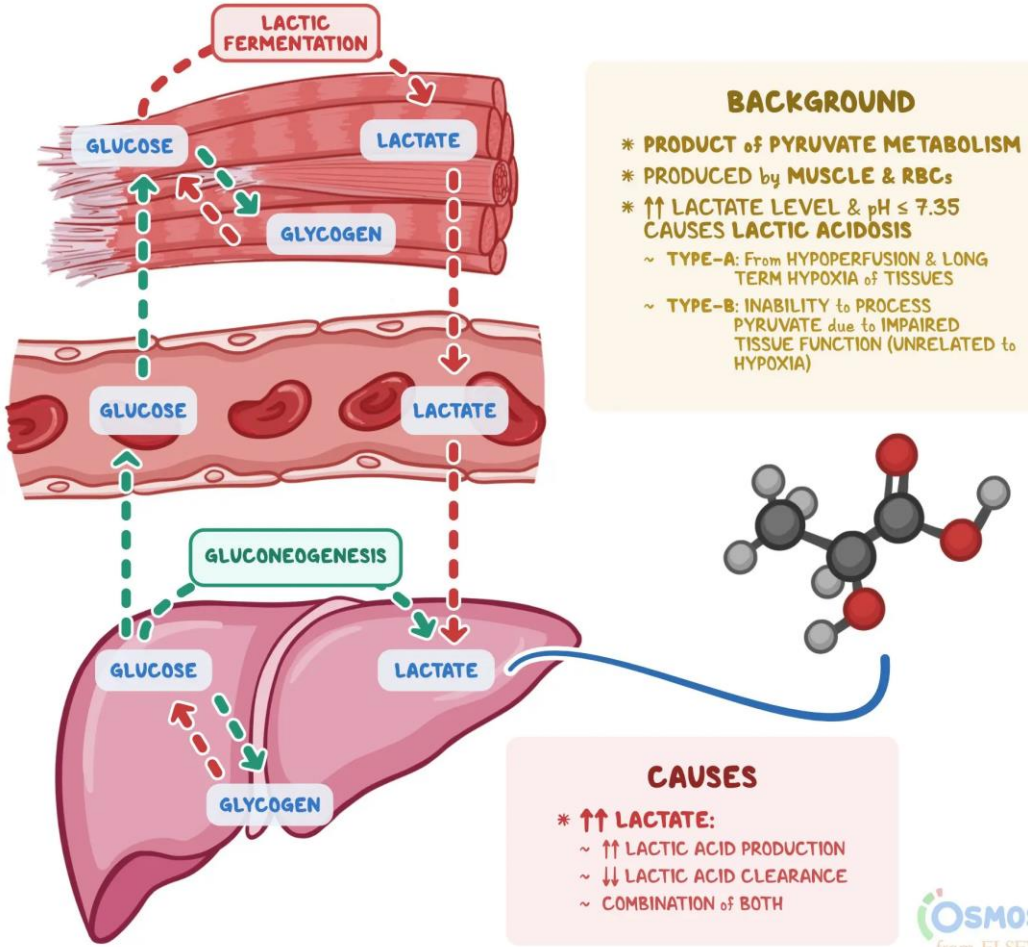


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[Cardiogenic Shock's Origins, Progression Tightly Tied to Mortality | tctmd.com]

Function of the Lactate



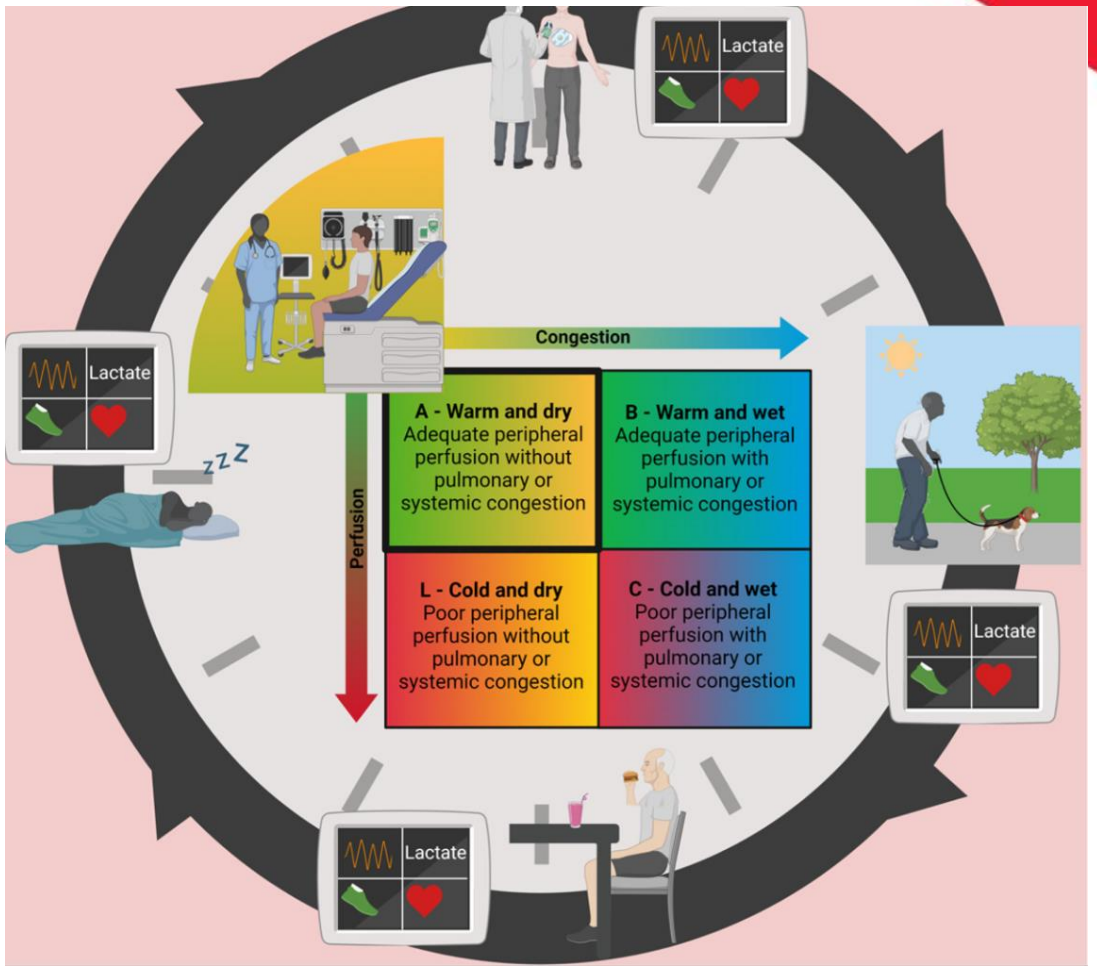
BACKGROUND

* PRODUCT of PYRUVATE METABOLISM
* PRODUCED by MUSCLE & RBCs
* ↑↑ LACTATE LEVEL & pH ≤ 7.35 CAUSES LACTIC ACIDOSIS
  - TYPE-A: From HYPOPERFUSION & LONG TERM HYPOXIA of TISSUES
  - TYPE-B: INABILITY to PROCESS PYRUVATE due to IMPAIRED TISSUE FUNCTION (UNRELATED to HYPOXIA)

CAUSES

* ↑↑ LACTATE:
  - ↑↑ LACTIC ACID PRODUCTION
  - ↓↓ LACTIC ACID CLEARANCE
  - COMBINATION of BOTH

OSMOSIS from ELSEVIER



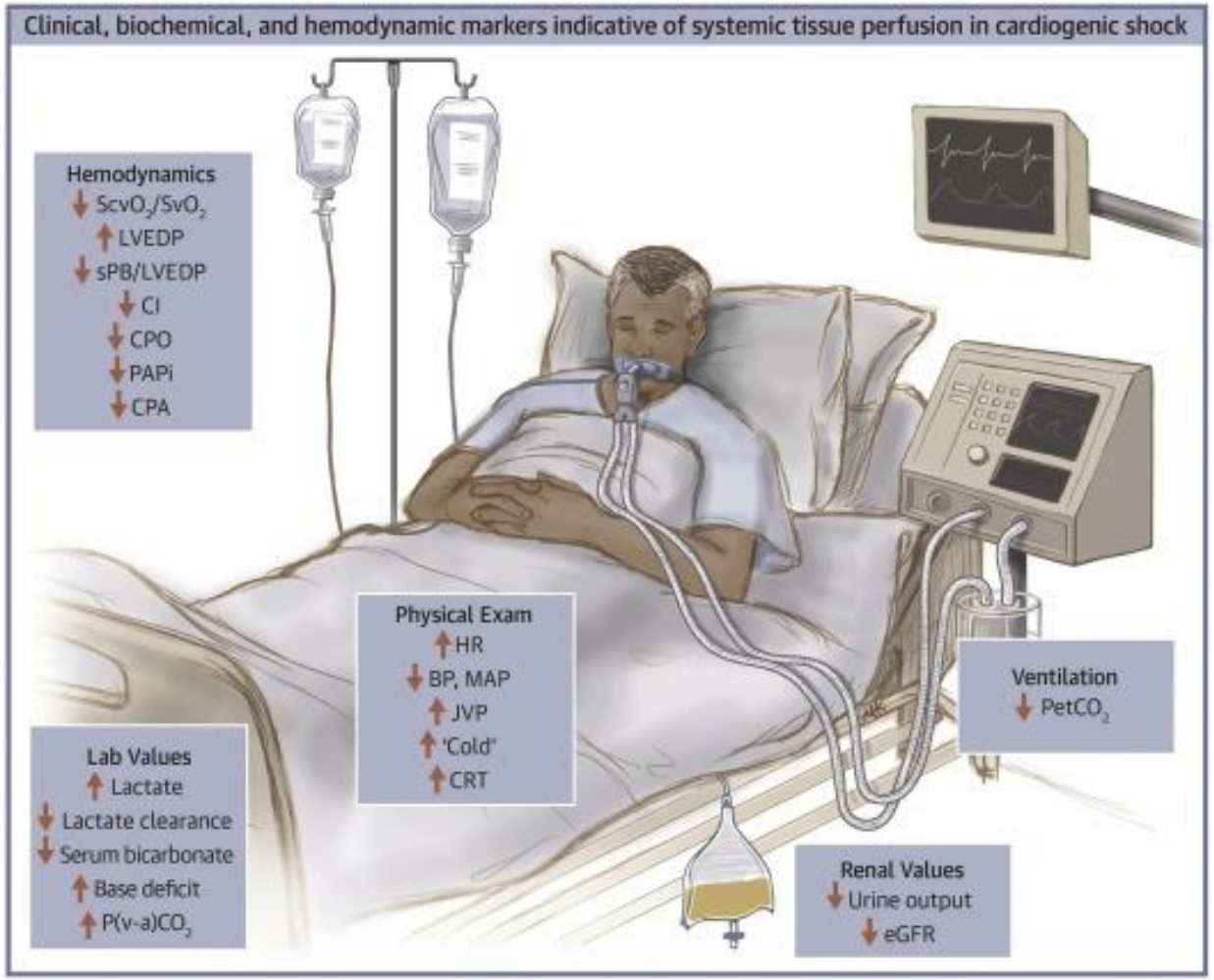
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Lactic Acid: What Is It, What Increases It, and More | Osmosis

https://doi.org/10.1016/j.cardfail.2025.01.011

CENTRAL ILLUSTRATION: Clinical, Biochemical, and Hemodynamic Variables



Mathew R, et al. JACC Adv. 2022;1(2):100034.

Lactate

BP/HR

Urine Output

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Shock

Life-Threatening Circulatory Failure

Shock is a life-threatening condition characterized by inadequate tissue perfusion and impaired oxygen delivery relative to metabolic demand.

1 Cardiogenic Shock

Pump failure

- Caused by myocardial infarction, severe heart failure, arthythmias
- Decreased cardiac output
- Blood backs up, tissues underperfused



↓ Tissue Perfusion
↓ Oxygen Delivery
↑ Cellular Hypoxia

2 Hypovolemic Shock

Volume loss

- Hemorrhage
- Dehydration
- Burns or GI losses
- Decreased preload
  → decreased cardiac output

3 Septic Shock

Vasodilation from infection

- Severe systemic infection
- Widespread vasodilation
- Decreased systemic vascular resistance

4 Anaphylactic Shock

Severe allergic reaction

- Massive histamine release
- Vasodllation
- Increased vascular permeablity
- Hypotension

5 Neurogenic Shock

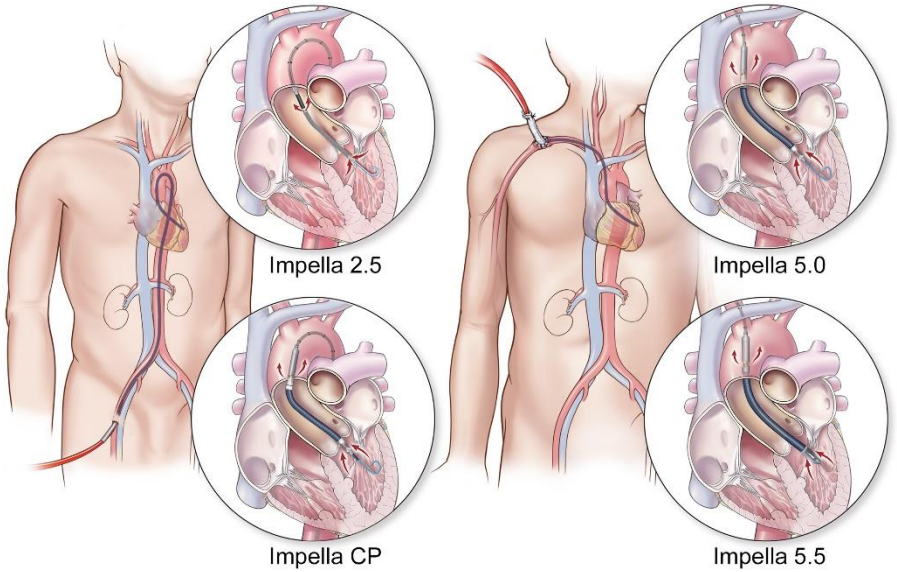
Loss of sympathetic tone

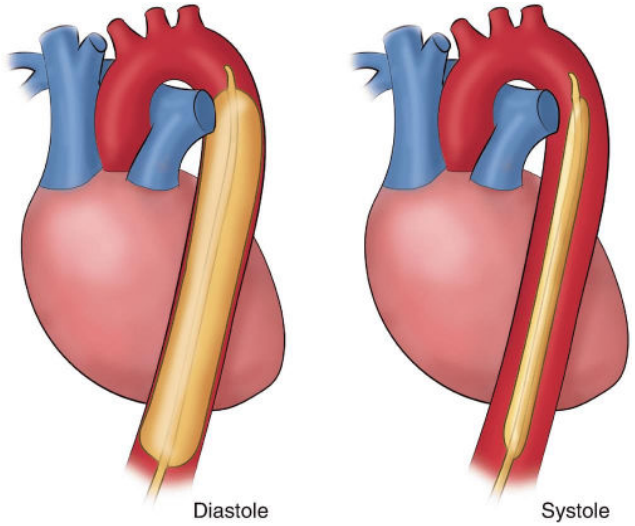
- Spinal cord injury
- Vasodilation
- Hypotension
- Bradycardia possible

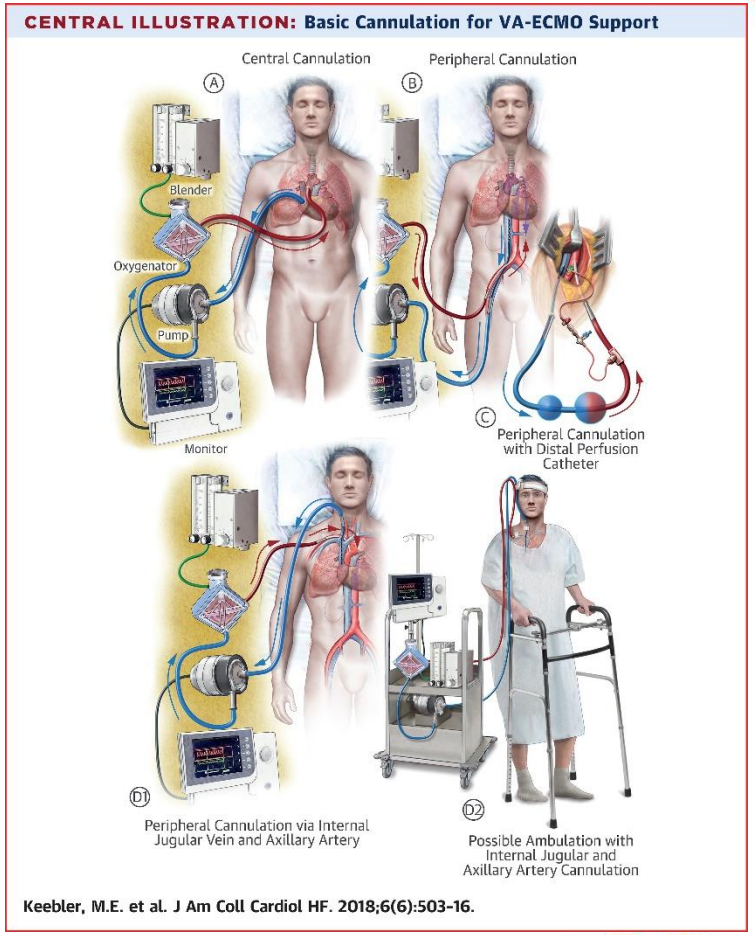
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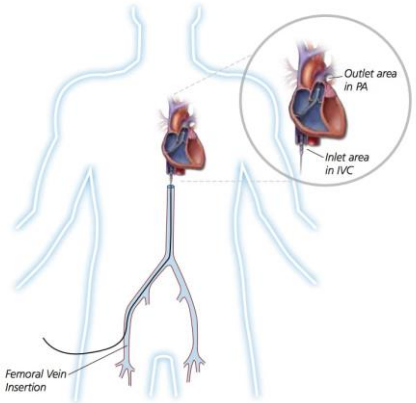
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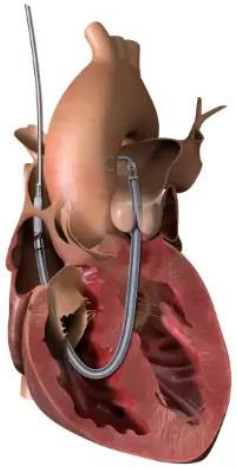
Useful Devices in Cardiogenic Shock











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[Guide to Temporary Mechanical Support in Cardiogenic Shock - Heart Failure Clinics]

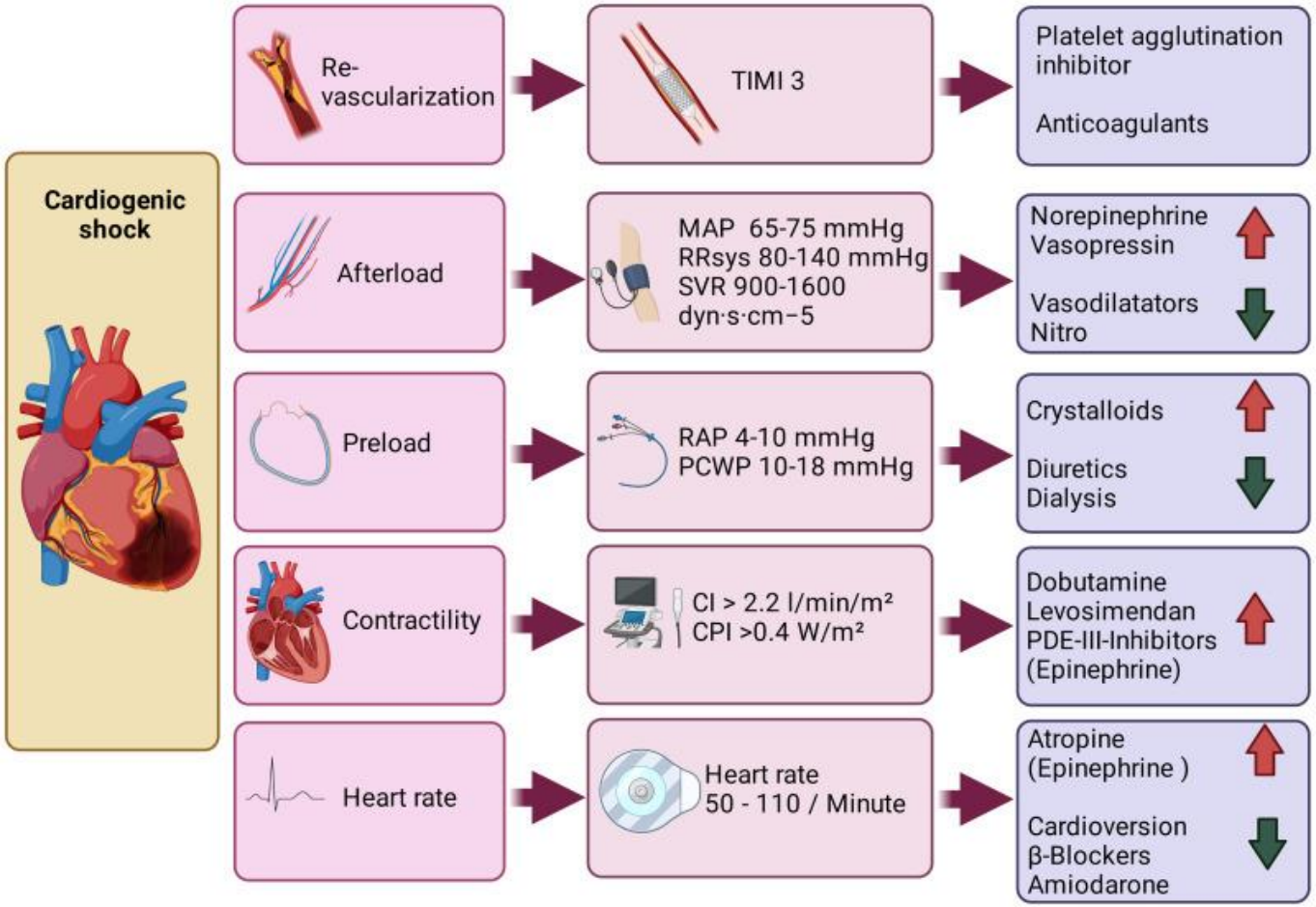
[Intra-Aortic Balloon Pump (IABP) for Heart Health]

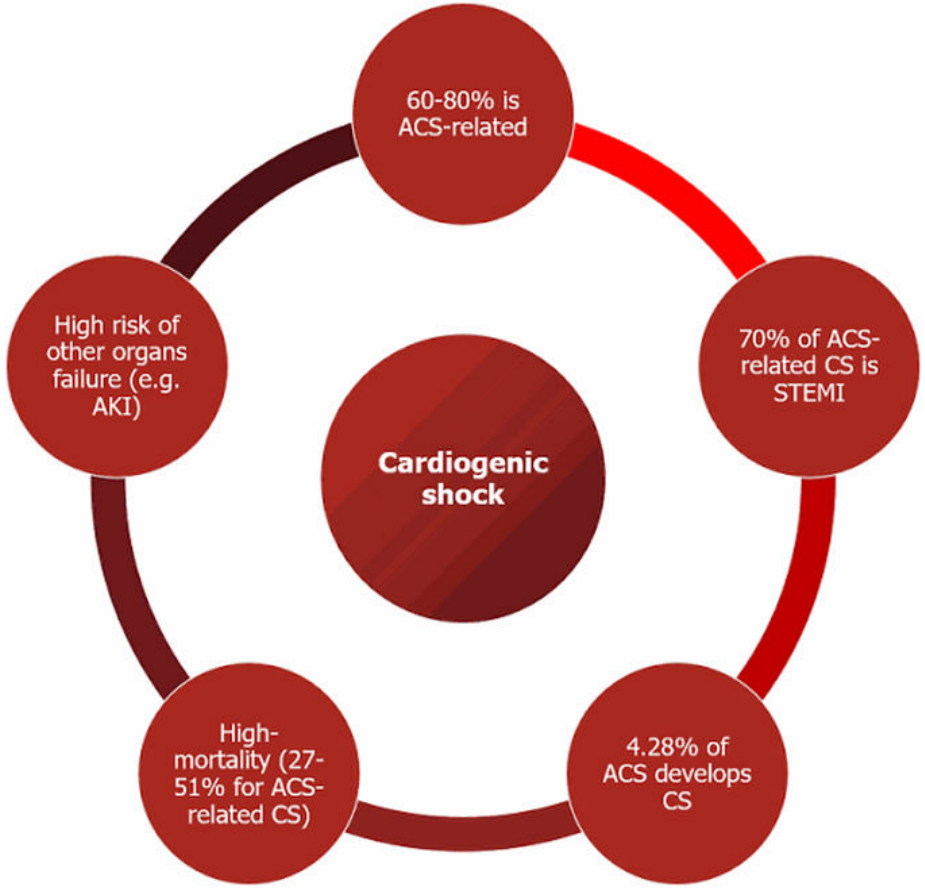
[Venoarterial Extracorporeal Membrane Oxygenation in Cardiogenic Shock | JACC: Heart Failure]

https://www.abiomed.com/en-us/about-us/news-and-media/media-kit

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Medications Used to Treat Cardiogenic Shock





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Pharmacological treatment of cardiogenic shock – A state of the art review - ScienceDirect

Causes of cardiogenic shock - MEDizzy

Patient A: Acute Myocardial Infarction CGS











73 yr old Female

PMH: Old ER Nurse
Persistent Afib + Ablation
CKD St 3a
HLP
Hypothyroidism
Hodgkins Lymphoma





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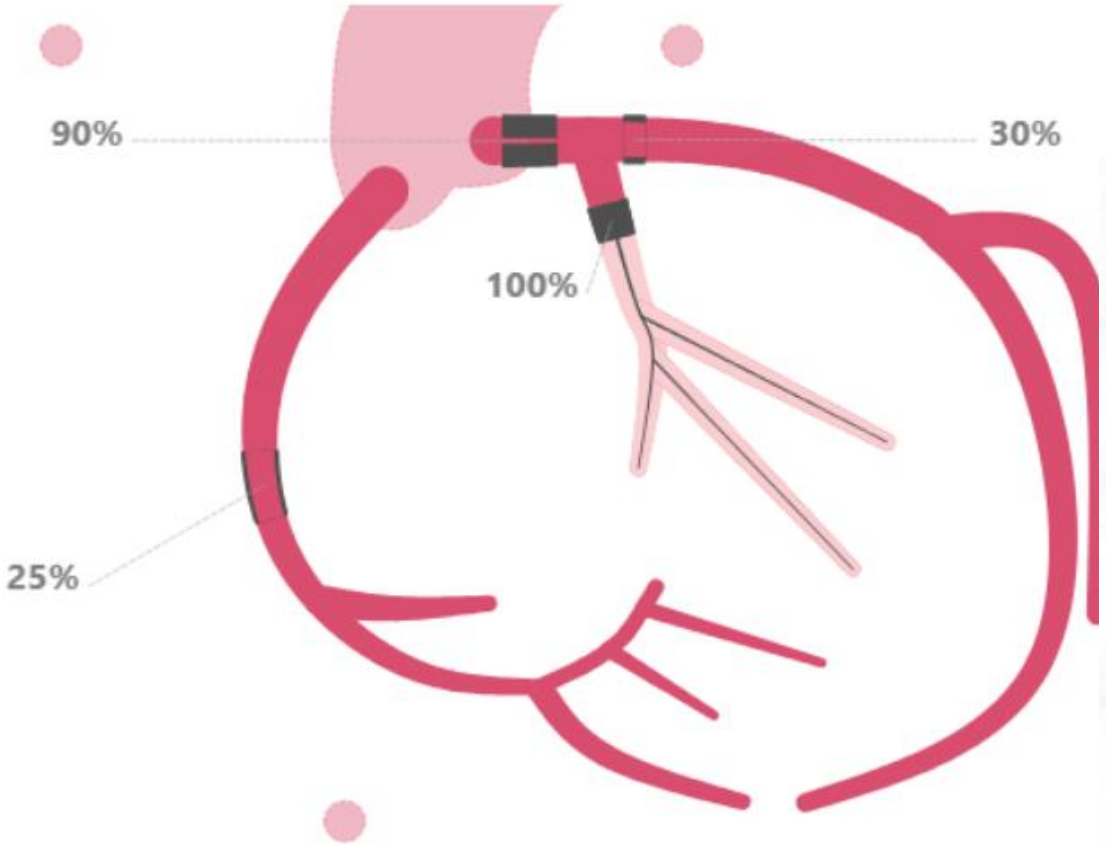
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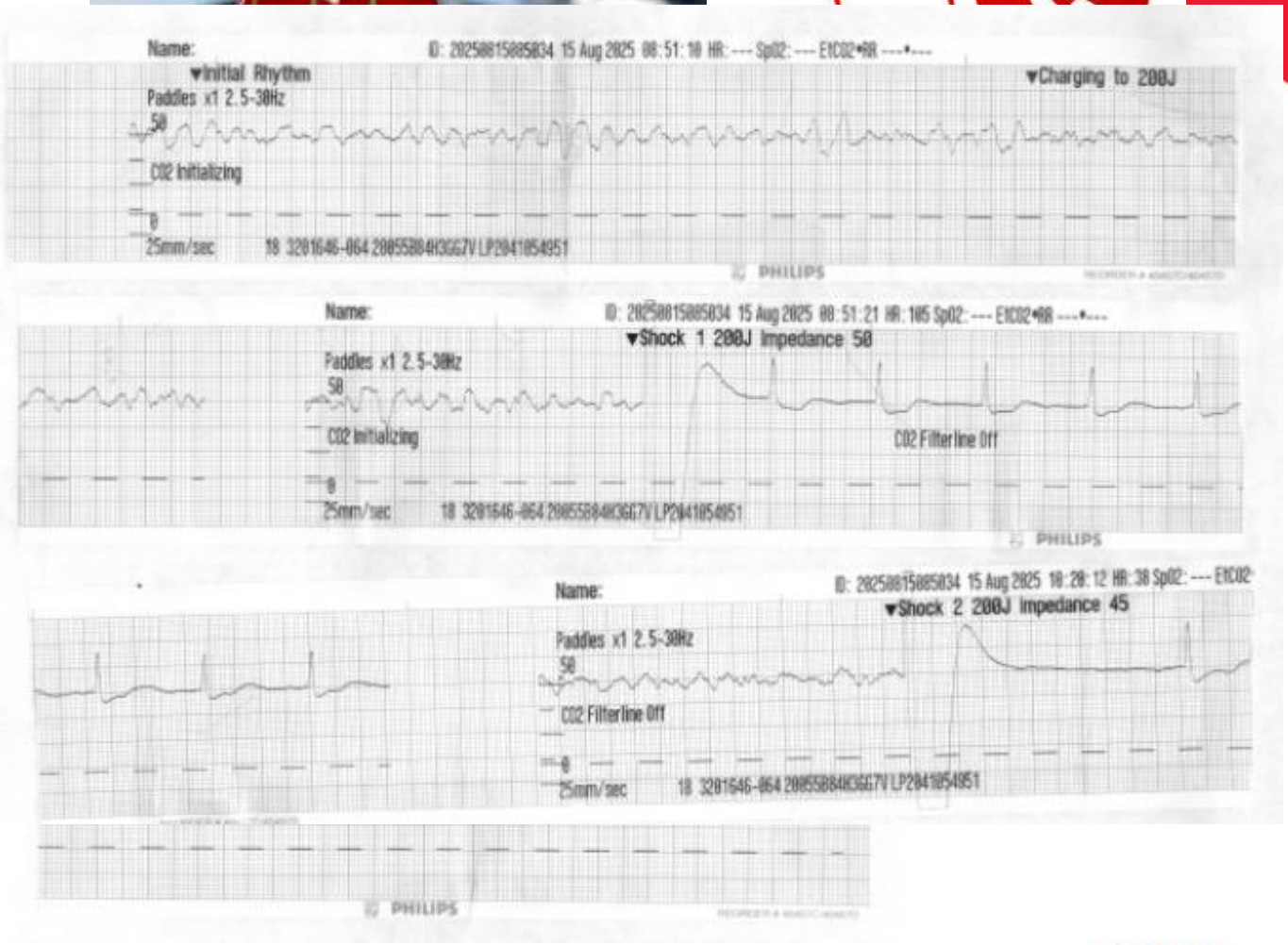
Posterior Lateral STEMI with reciprocal changes

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Diagnostic

Left Main

Ost LM to Mid LM lesion is 90% stenosed.

Left Anterior Descending

Ost LAD lesion is 30% stenosed.

Left Circumflex

Prox Cx lesion is 100% stenosed.

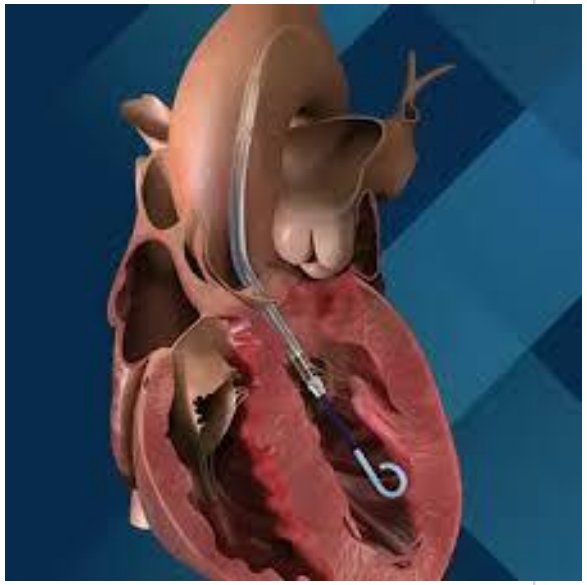
Right Coronary Artery

Mid RCA lesion is 25% stenosed.

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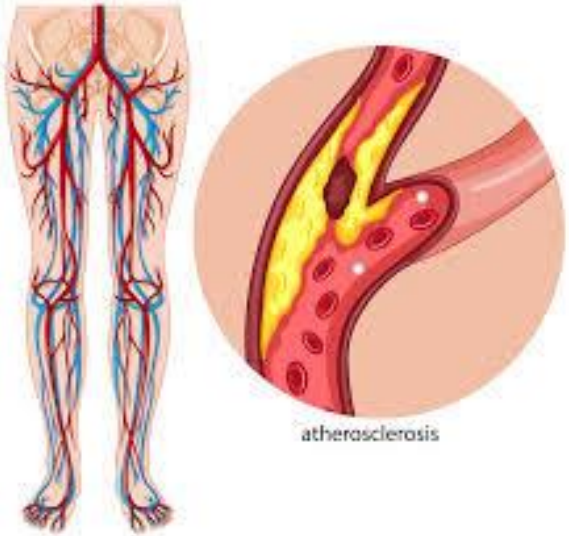
Bryan HEART

ACLS



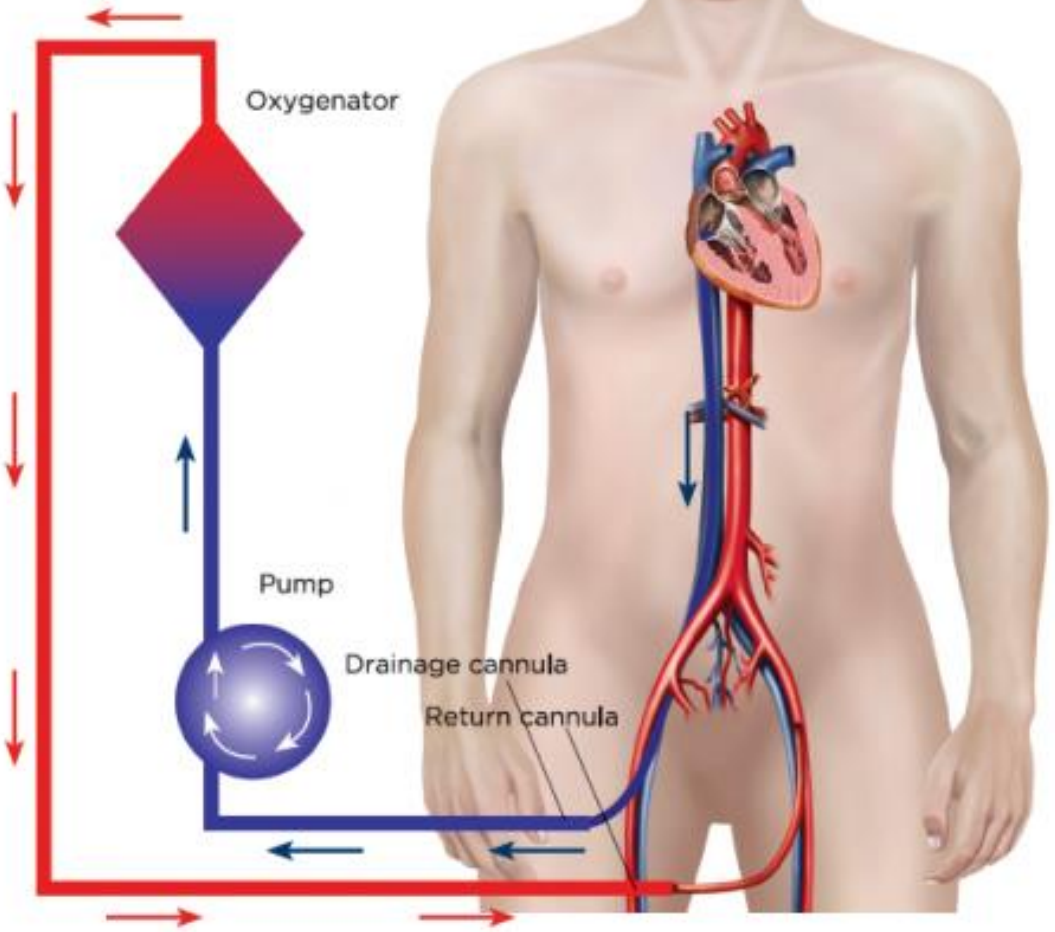


Peripheral Artery Disease



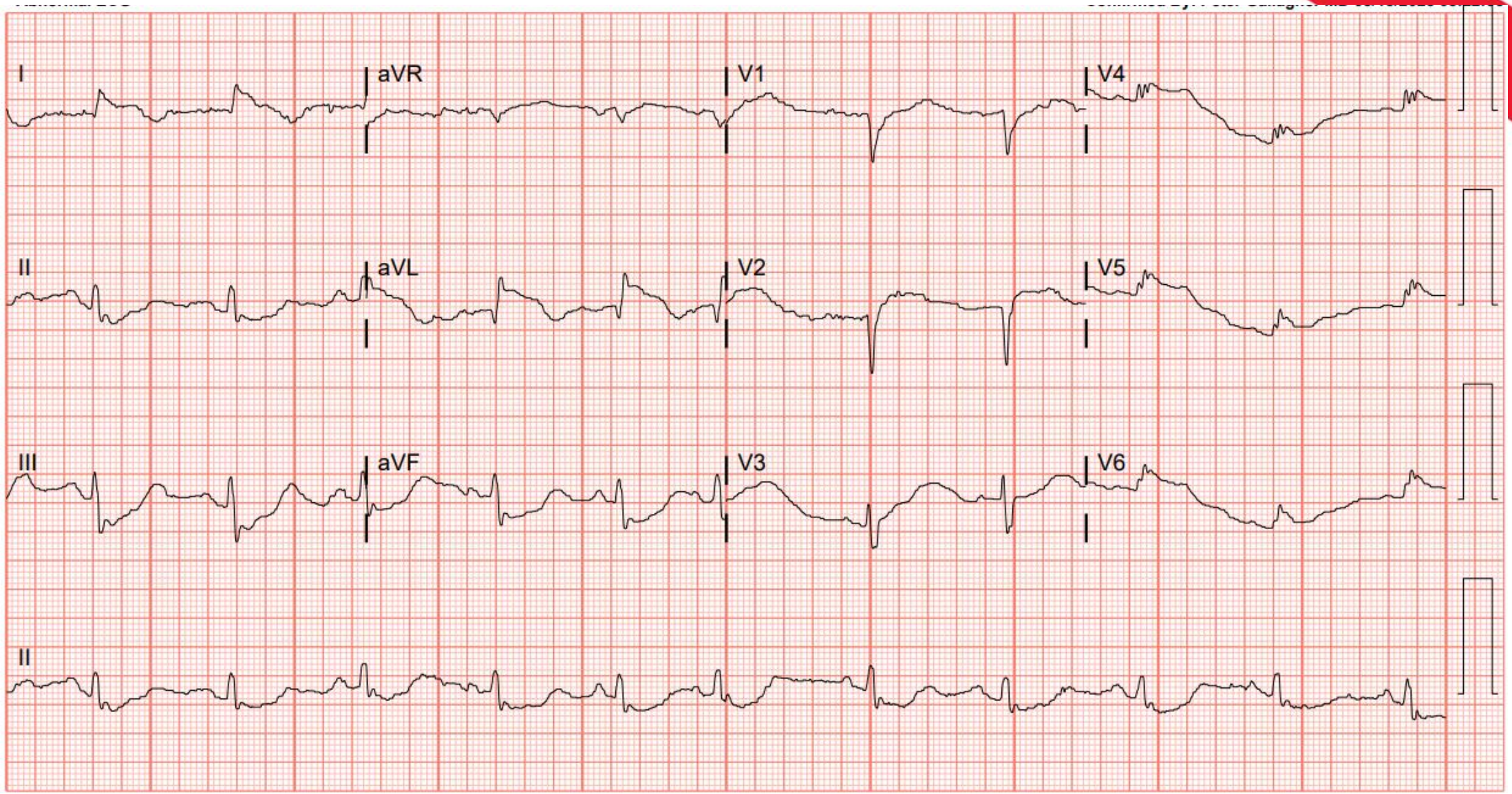
Veno-arterial (VA) ECMO

supports both heart and lungs



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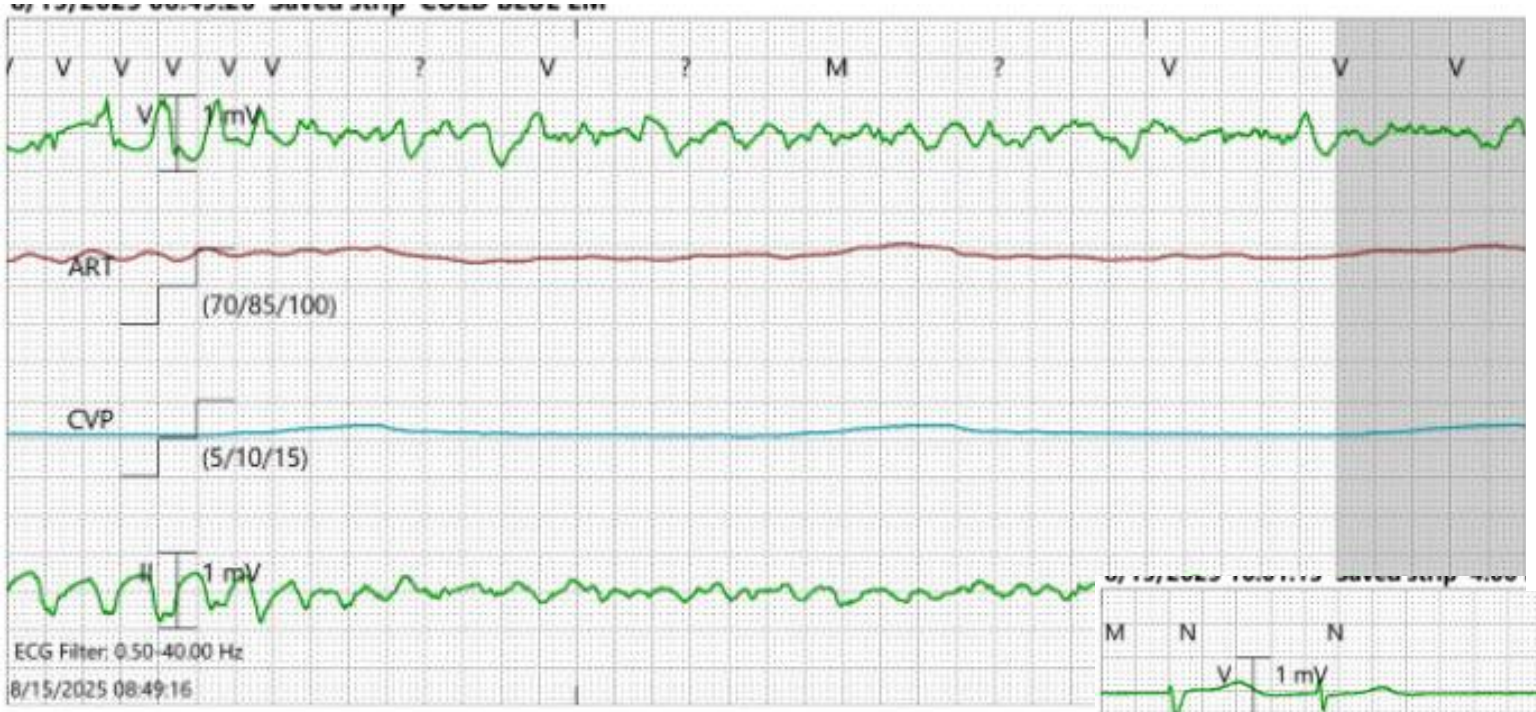
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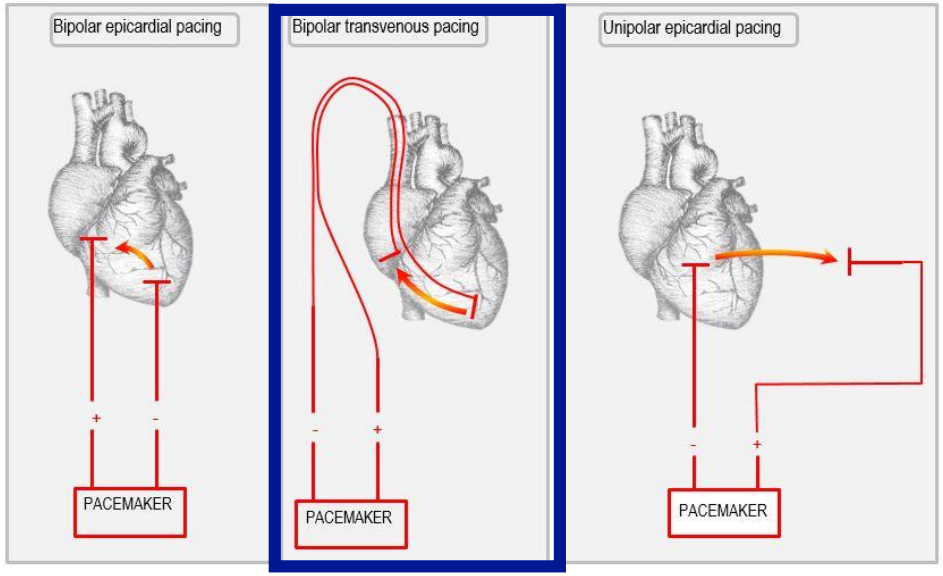


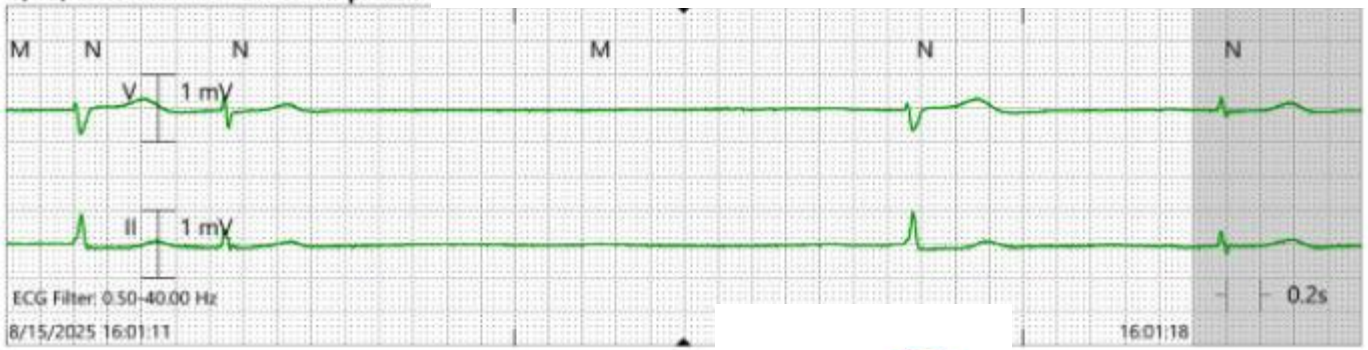
Rate	65	SINUS RHYTHM
PR		Nonspecific intraventricular conduction delay
QRSd	197	Posterolateral infarct
QT	556	Lateral leads are also involved

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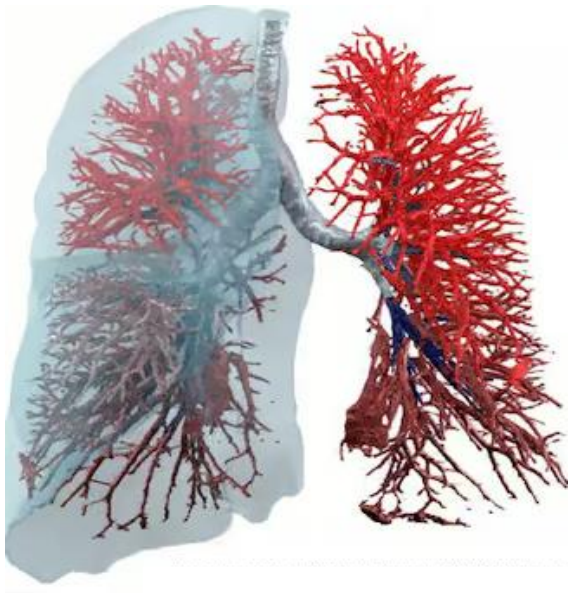
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2nd







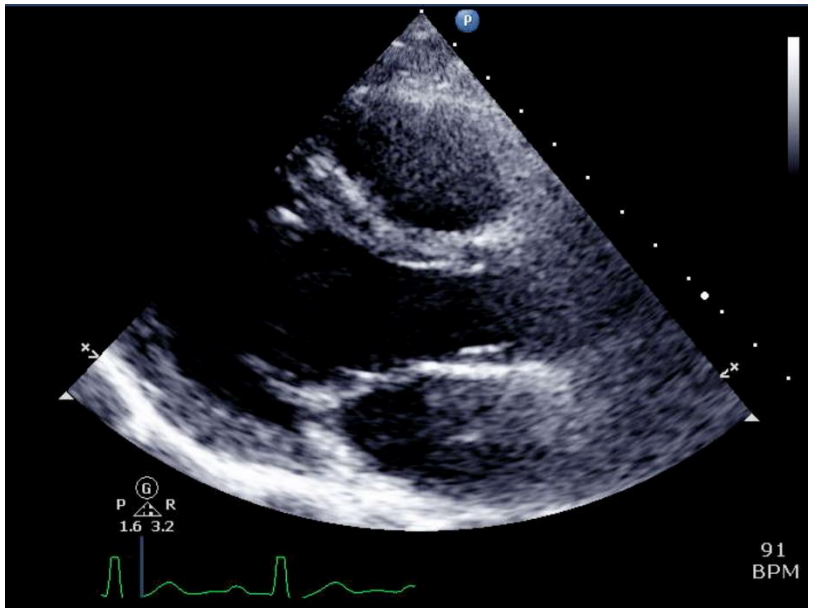
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Patient B: Post Cardiotomy CGS

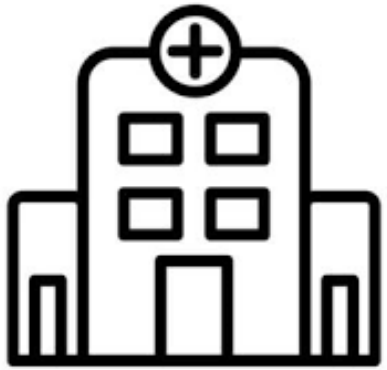






41 yr old Female

PMH:
3 months postpartum
HFrEF
MV CAD
HTN, Obesity, Smoker



Echo Results:
EF 15-20%
Abnormal Diastolic Function
Normal RV
Mild MR, No AI, Trace TR, no PI
LVIDD 5.89 cm, RVIDD 2.5cm

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Diagnostic

Left Main

The vessel is angiographically normal.

Left Anterior Descending

The vessel is angiographically normal. Dist LAD is angiographically normal.

Collaterals

Dist LAD filled by collaterals from RPDA.

Prox LAD lesion is 99% stenosed.

Mid LAD lesion is 100% stenosed.

Ramus Intermedius

Ramus lesion is 80% stenosed.

Left Circumflex

Prox Cx lesion is 100% stenosed.

Second Obtuse Marginal Branch

Collaterals

2nd Mrg filled by collaterals from 1st Diag.

Collaterals

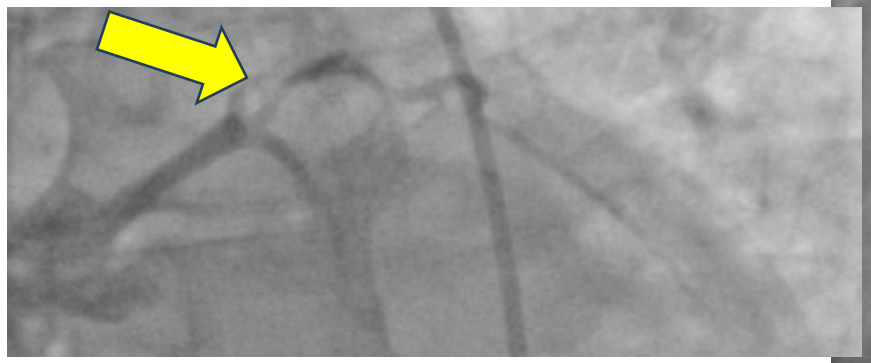
2nd Mrg filled by collaterals from RPDA.

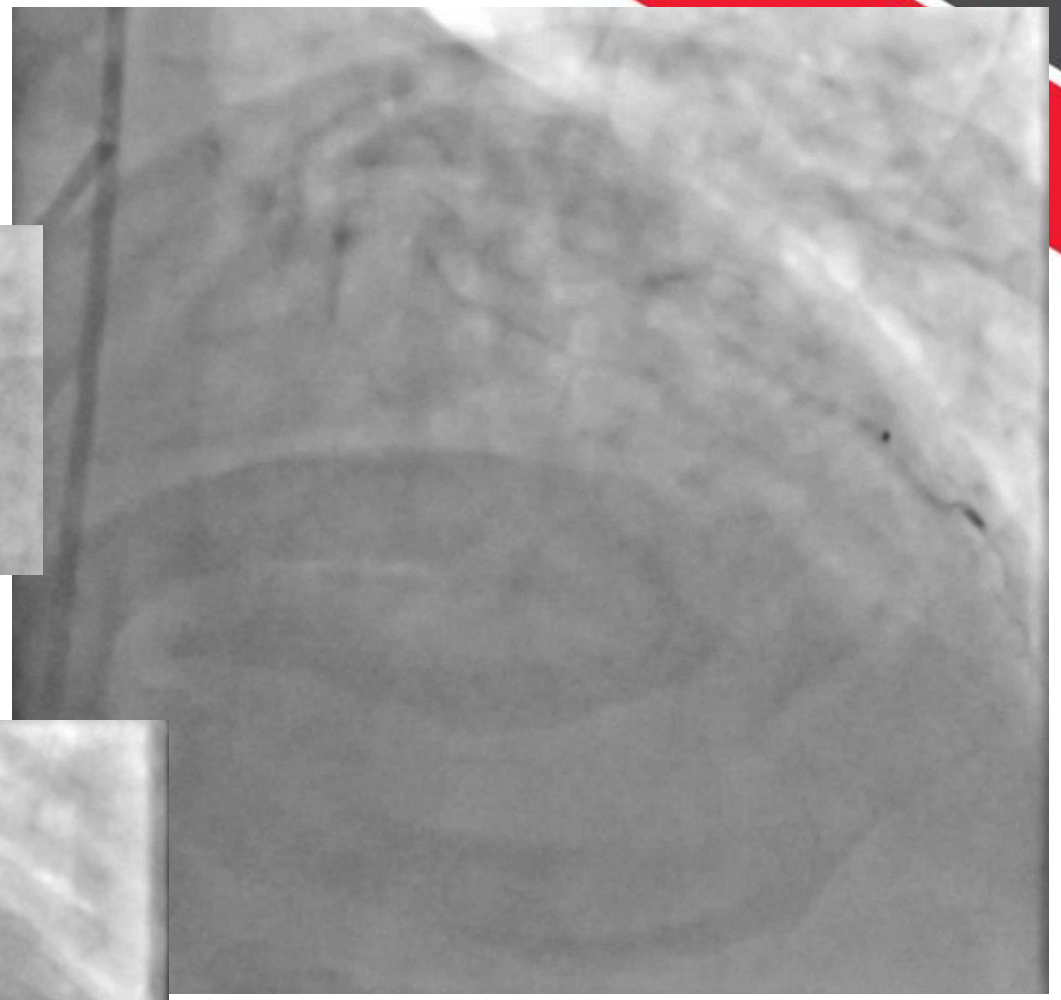
Right Coronary Artery

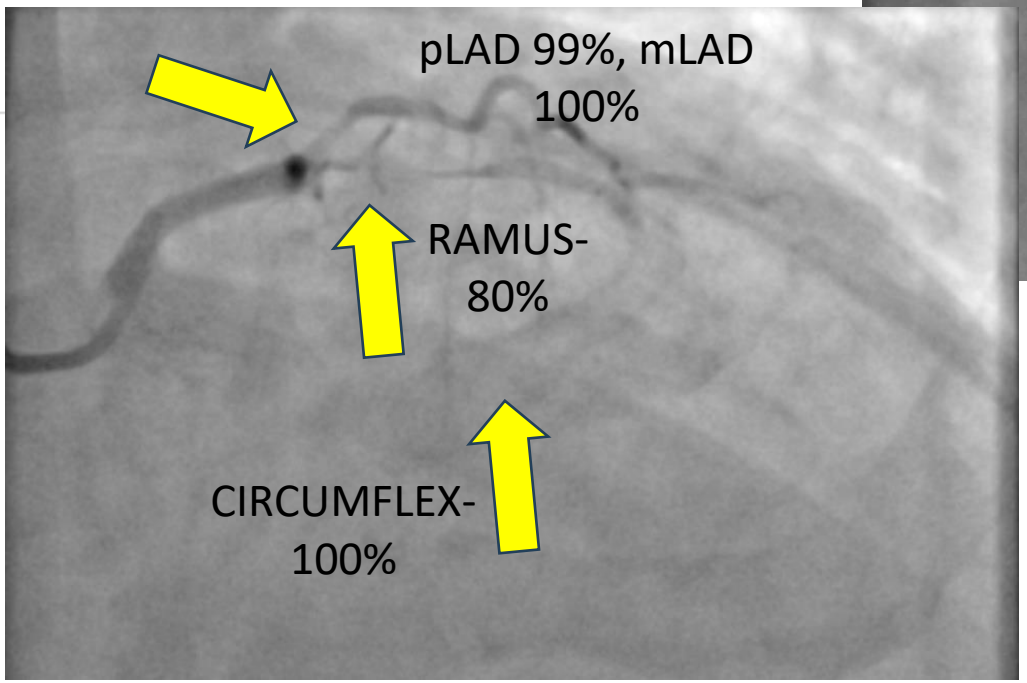
Mid RCA lesion is 60% stenosed.

Intervention

No interventions have been documented.



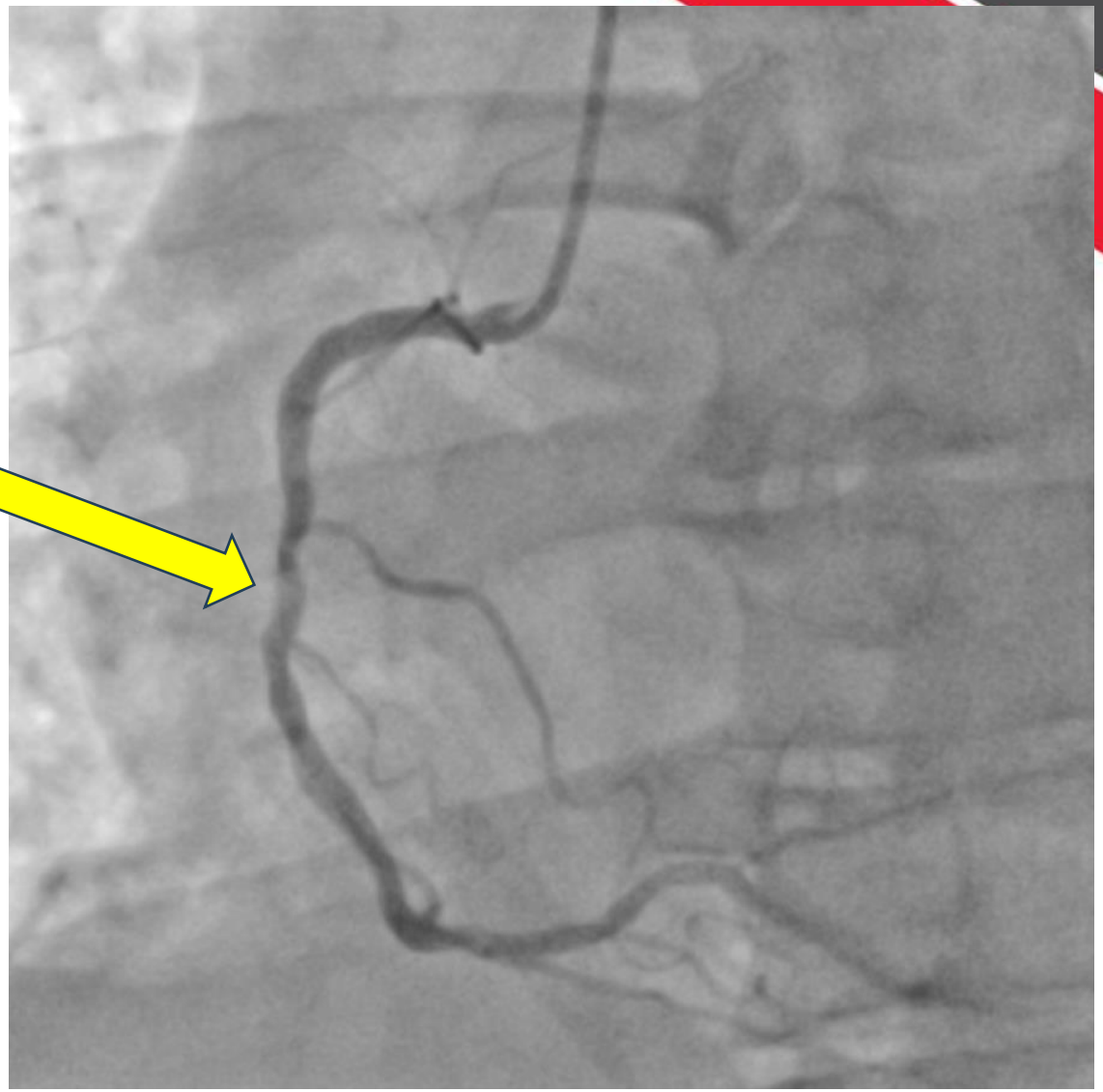




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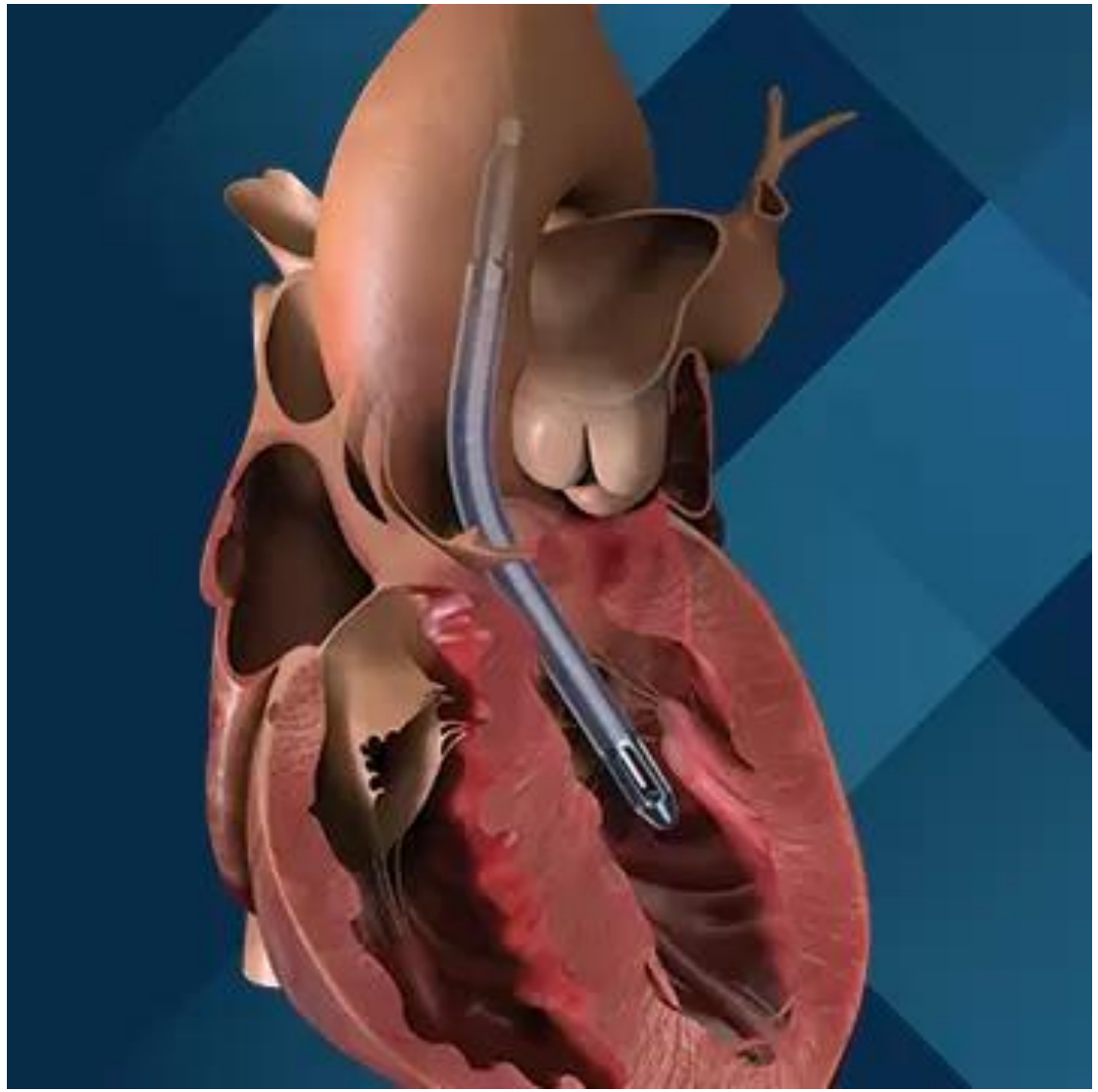
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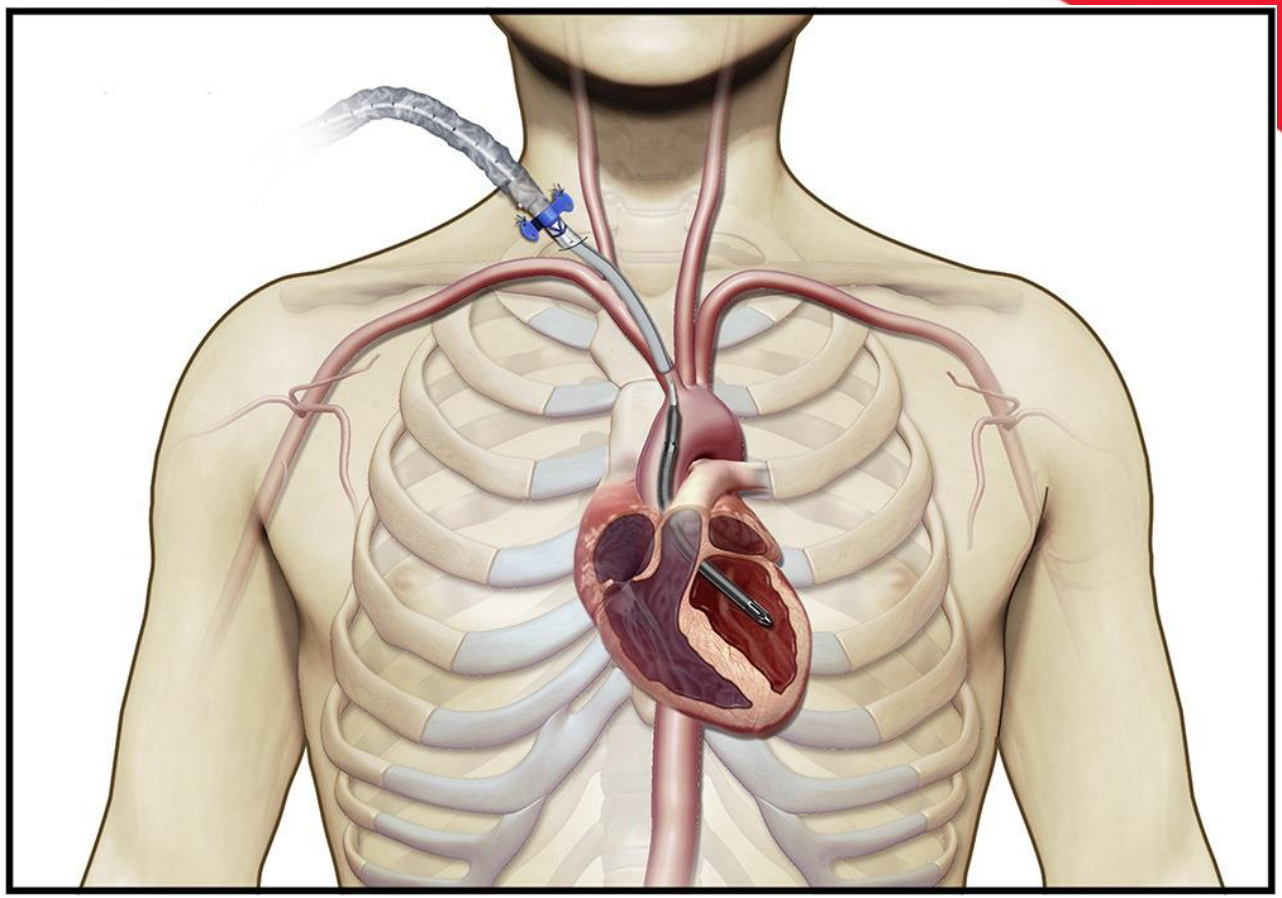


Skin, Bones, Hearts & Private Parts

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3 days of Impella Support – Removed at the Bedside



DC Medications: Amiodarone, ASA, Lipitor, Plavix (NSTEMI), Lasix, Toprol XL

Labs: Creatinine 1.02 (DC)
HS Troponin peak 2535

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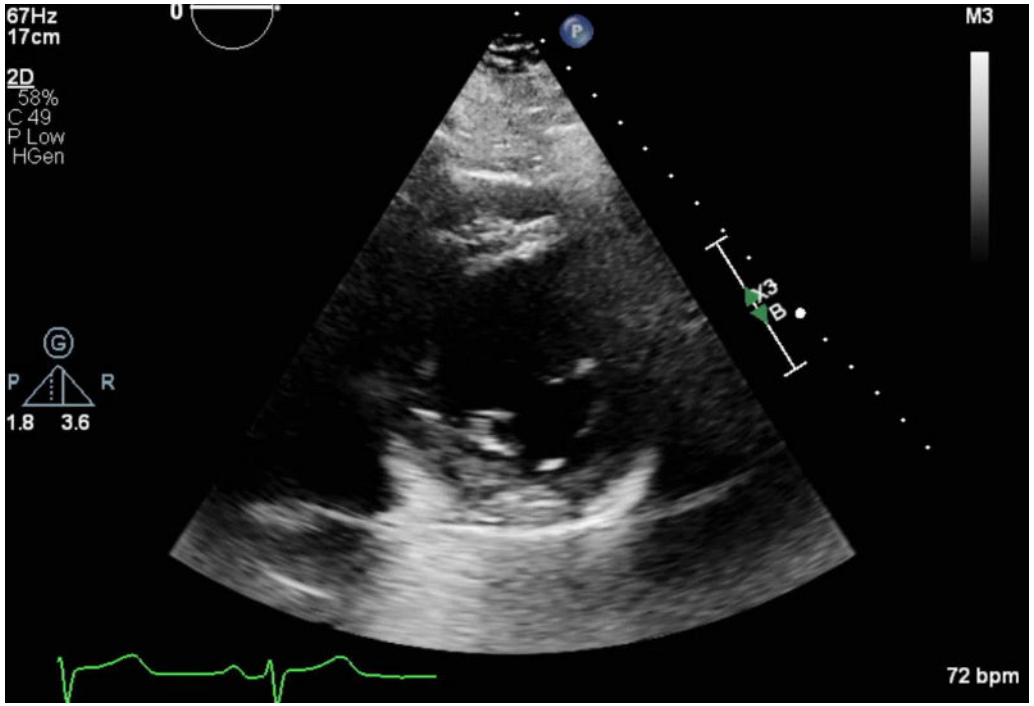
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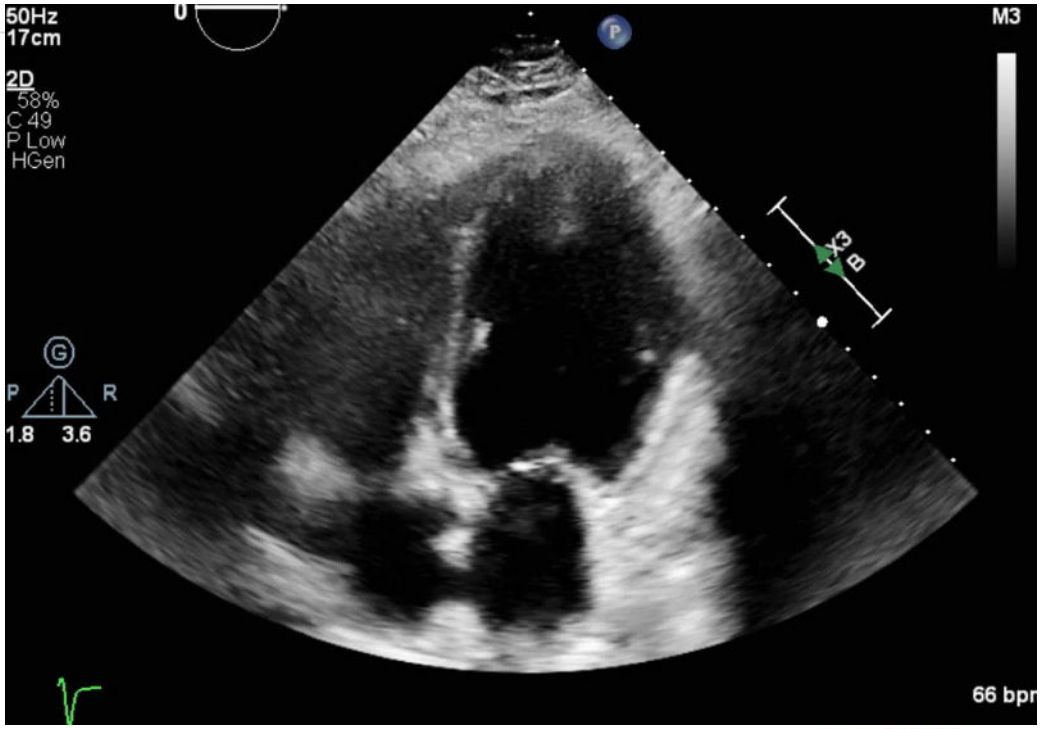
Transinnominate Impella 5.5 insertion as a bridge to transplantation in a pediatric patient in refractory cardiogenic shock - JTCVS Techniques

Myocardial Findings

Left Ventricle	Ejection fraction is 45%. Mildly reduced systolic function. Chamber is normal in size. Normal wall thickness observed. No wall motion abnormalities were noted.
Right Ventricle	The right ventricle is normal in size. The systolic function is normal.
Right Atrium	Normal chamber size.
Mitral Valve	Normal valve structure.
Aortic Valve	Normal valve structure.
Tricuspid Valve	The tricuspid valve is normal.
Pulmonic Valve	Normal valve structure.
Aorta	Normal aortic root, ascending aorta and sinus of Valsalva.
IVC/SVC	The IVC is normal in size with normal respiratory collapse. This is consistent with a normal right atrial pressure (3 mmHg).
Pericardium	No pericardial effusion. Pericardium is normal.





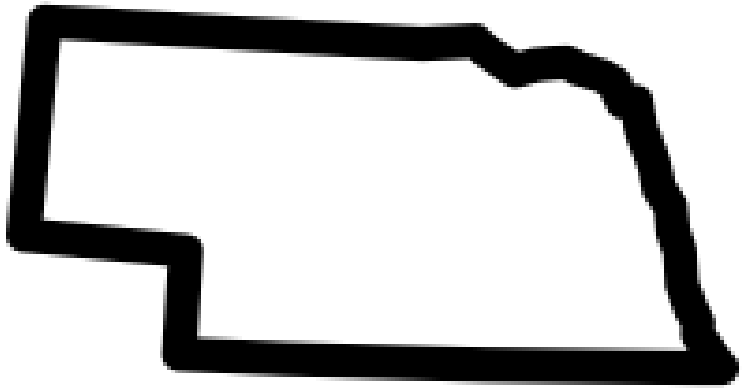


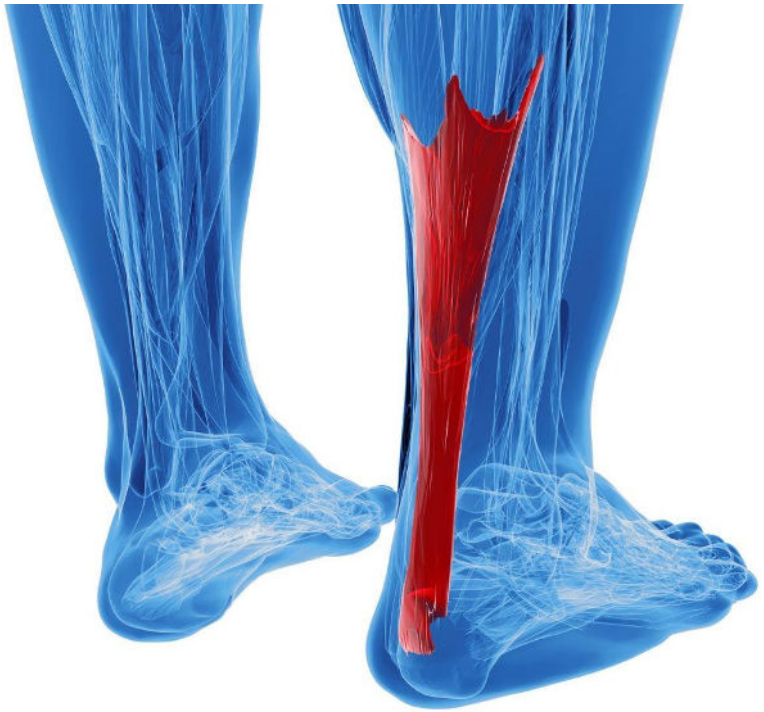
Skin, Bones, Hearts & Private Parts

Bryan HEART

Patient C: Nothing Is Ever As It Seems: Acute PE with Cardiopulmonary Compromise







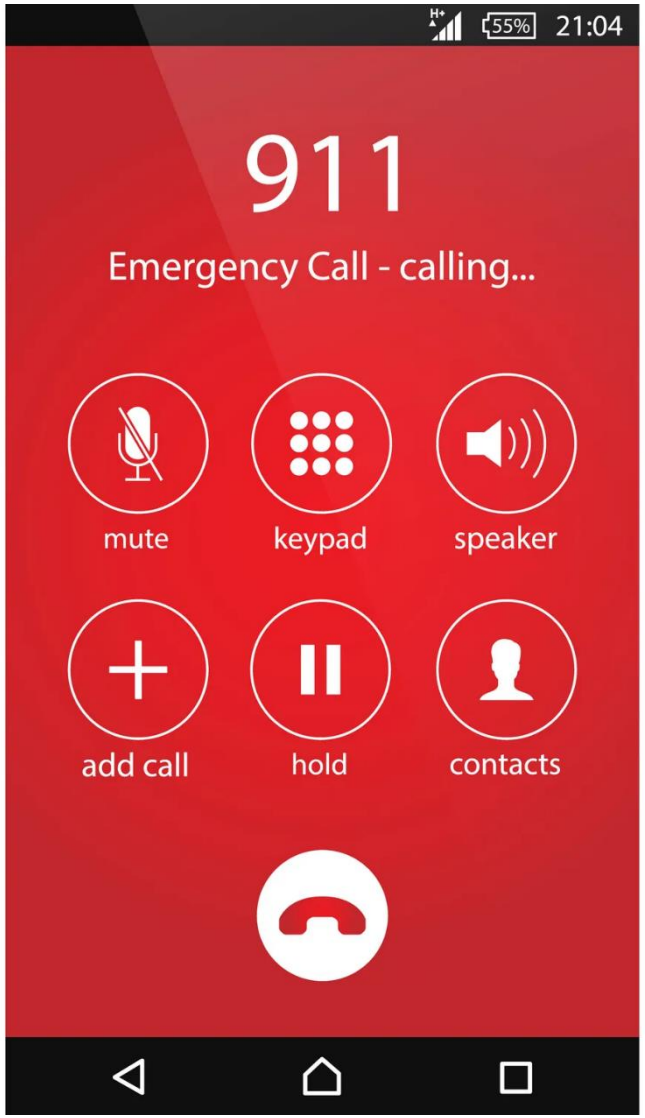
34 yr old Female

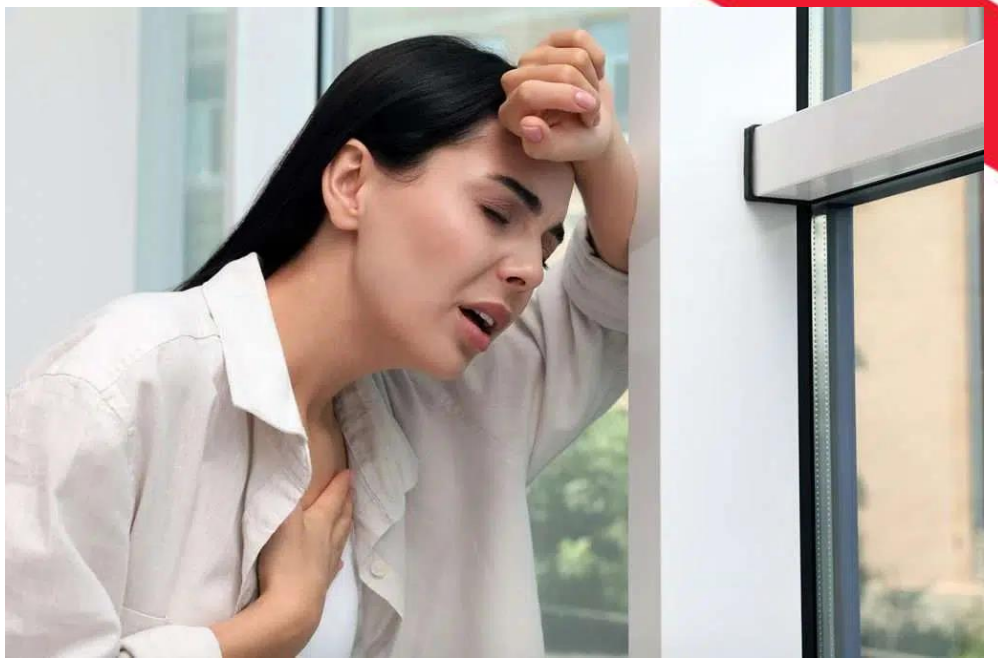
PMH:
Clotting Disorder =
"Factor V Leiden"
Mild Obesity

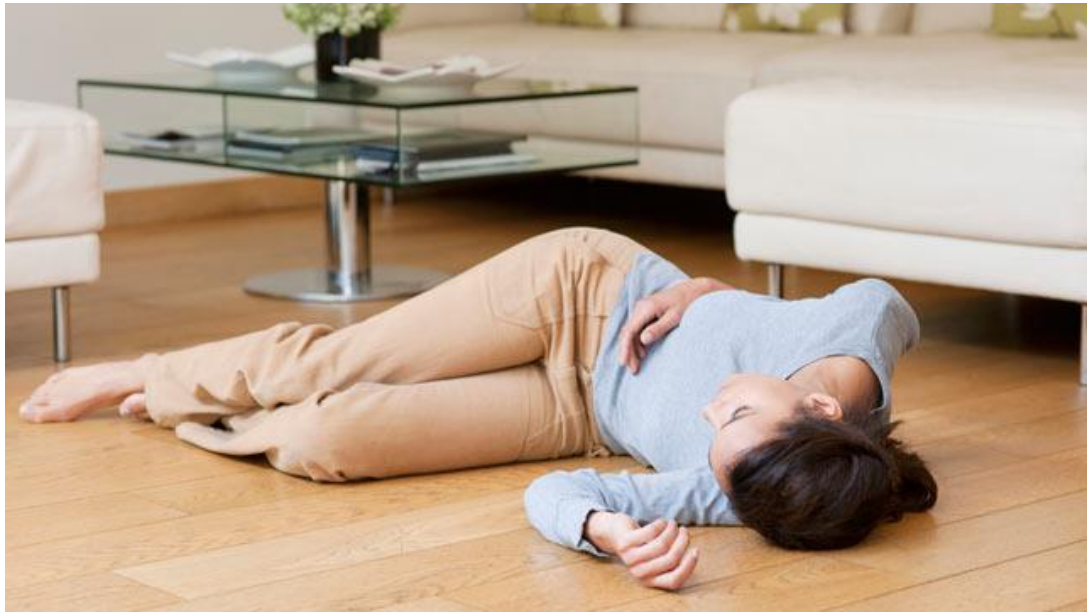


Skin, Bones, Hearts & Private Parts

Bryan HEART







Skin, Bones, Hearts & Private Parts

Bryan HEART









Skin, Bones, Hearts & Private Parts

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8 Rounds of CPR in the field (24 minutes roughly)

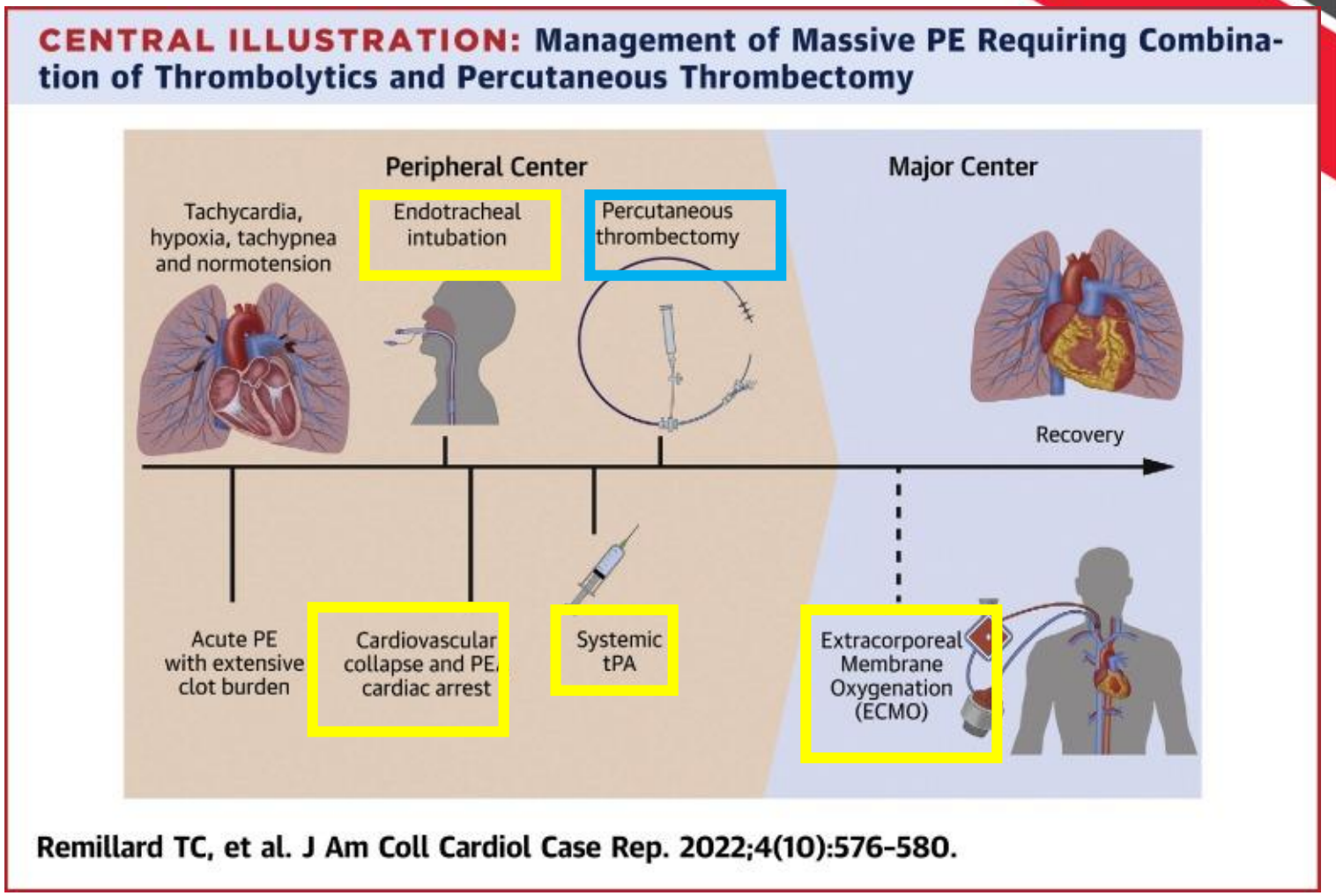
Came in as active code in ER

Kept Lucas Device in place

Went to CT scanner for CTA > > >

"Saddle embolus with bulky bilateral occlusive PE at the distal main PA"

"Small pneumomediastinum was also identified, as well as rib fractures and sternal fracture"



NPS NEBRASKA PULMONARY SPECIALTIES

nho Nebraska Hematology Oncology



GSA GENERAL SURGERY ASSOCIATES

Bryan HEART

Skin, Bones, Hearts & Private Parts

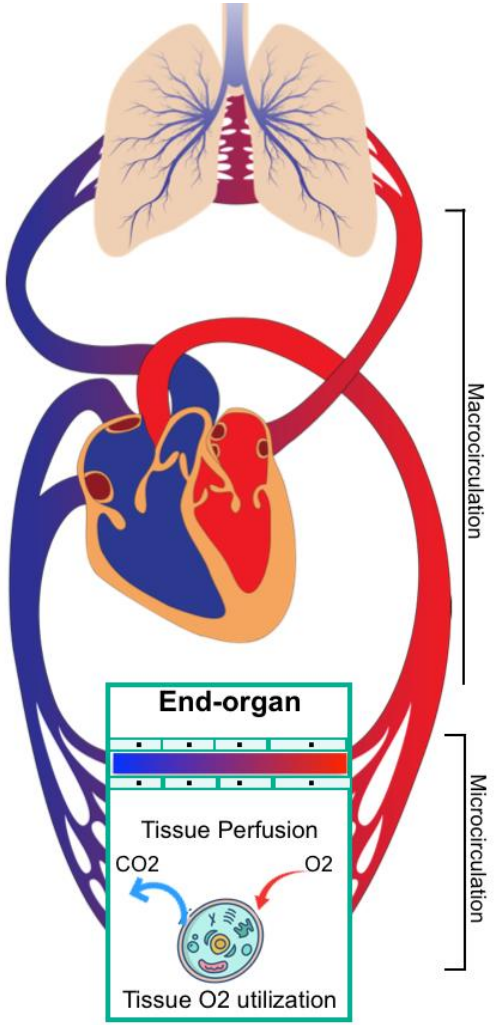
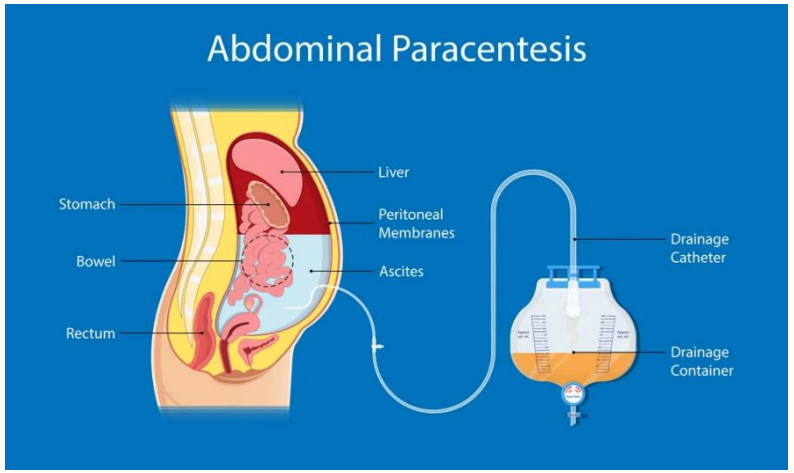


Illustration showing circulatory compartments.
Cardiovascular system works to provide adequate tissue perfusion and appropriate organs function. The performance of circulatory system can be assessed by evaluating end-organs function, or alternatively by evaluating several circulatory indices which give insight to performance of circulatory system.

Sh.Lahoute@RECAPEM





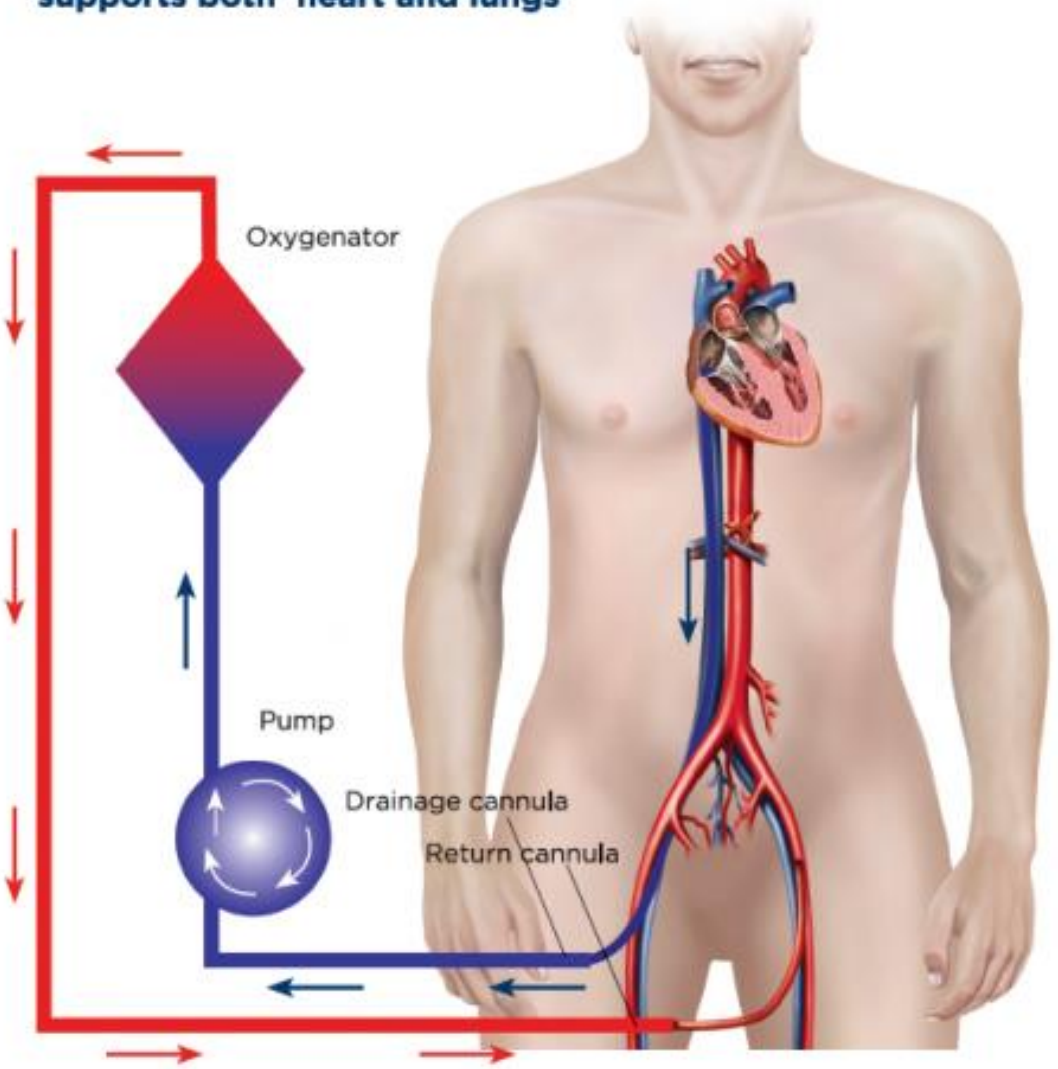


Skin, Bones, Hearts & Private Parts

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Veno-arterial (VA) ECMO

supports both heart and lungs









Skin, Bones, Hearts & Private Parts

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44 units + pRBCs

20 units + FFP

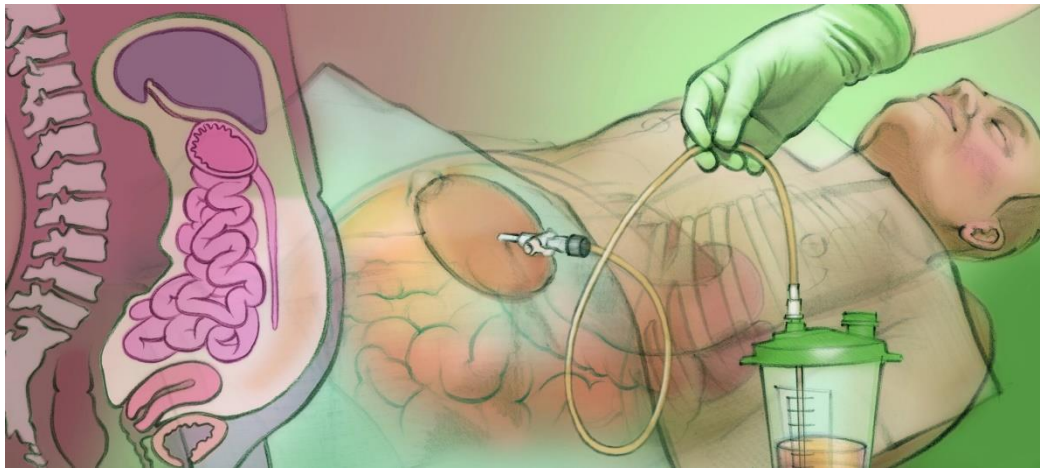
So many products…



4 units + Platelets

5 units Cryo

Bryan HEART







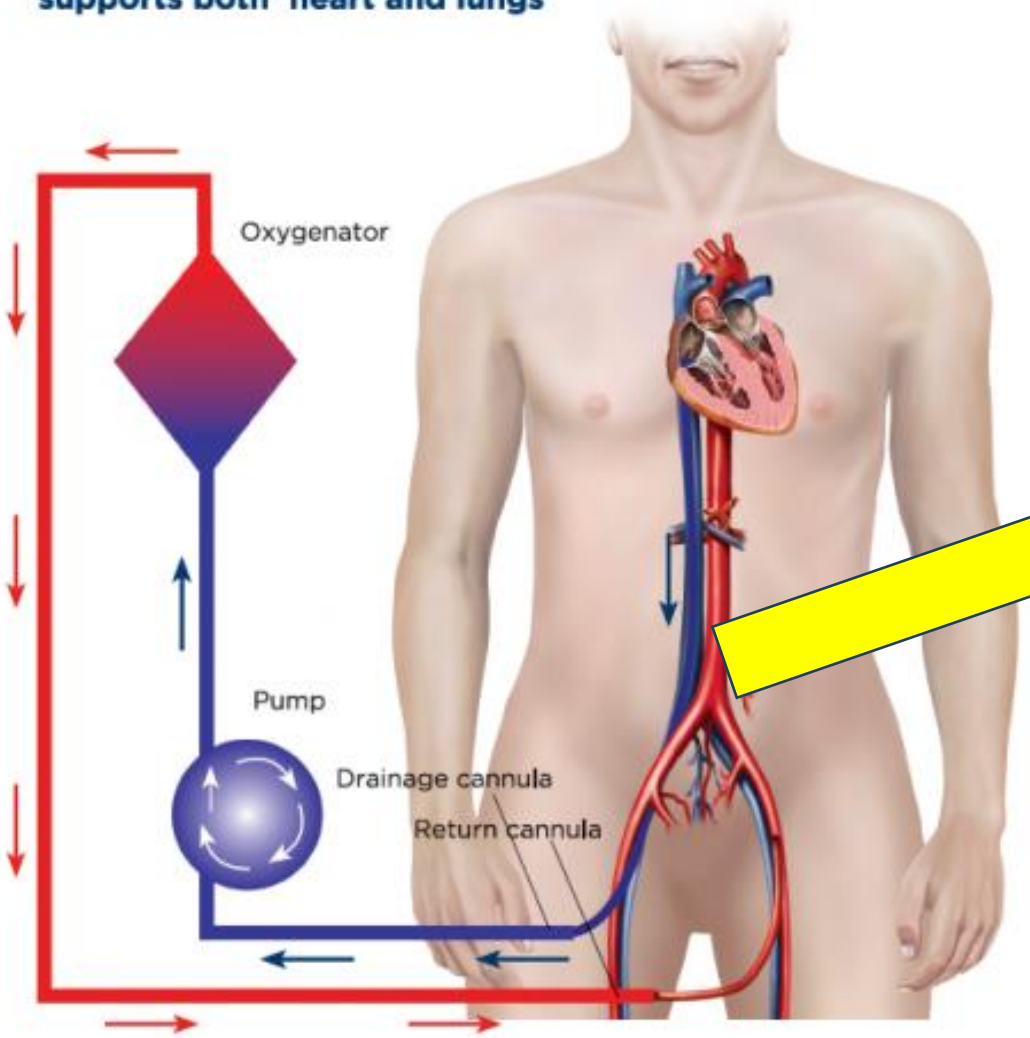
- Unable to visualize right common femoral, popliteal and gastroc veins due to ECMO. Other veins visualized appear patent.
- There is acute thrombus present in the left distal femoral vein.
- There is acute thrombus present in one or both of the left distal posterior tibial veins.
- There is acute thrombus present in one or both of the left proximal peroneal veins.

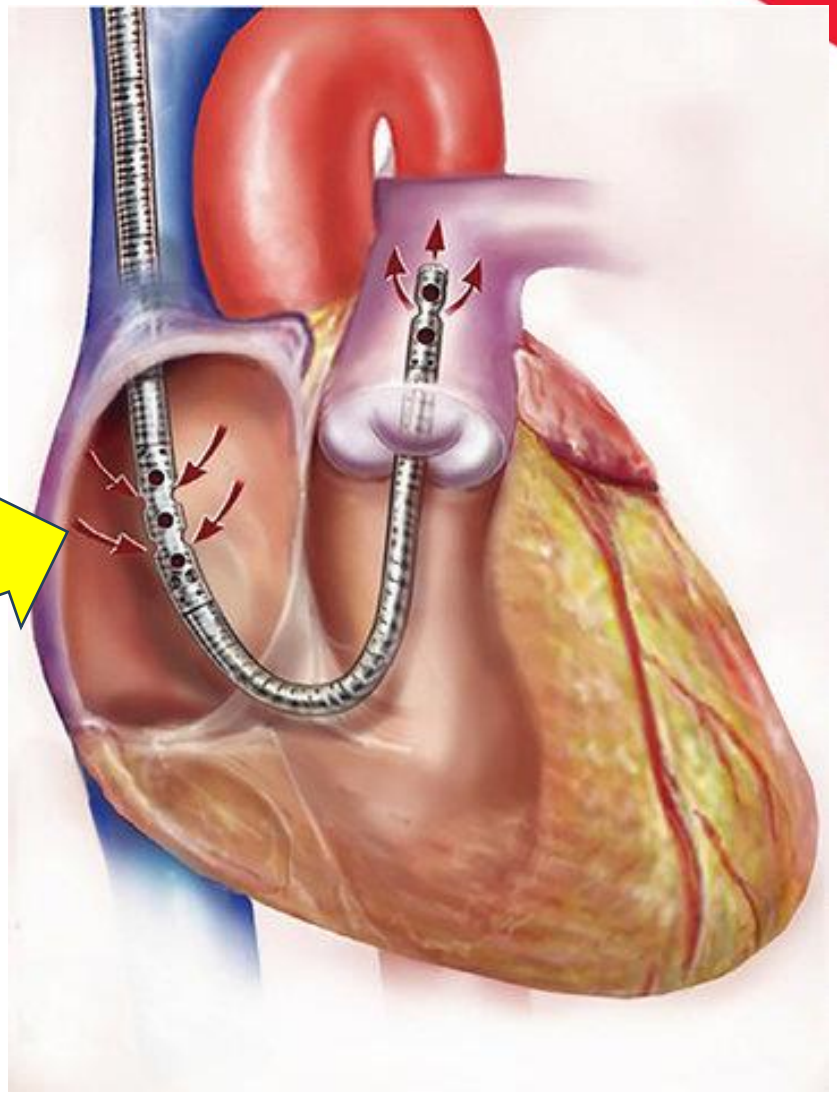
Skin, Bones, Hearts & Private Parts

Bryan HEART

Veno-arterial (VA) ECMO

supports both heart and lungs



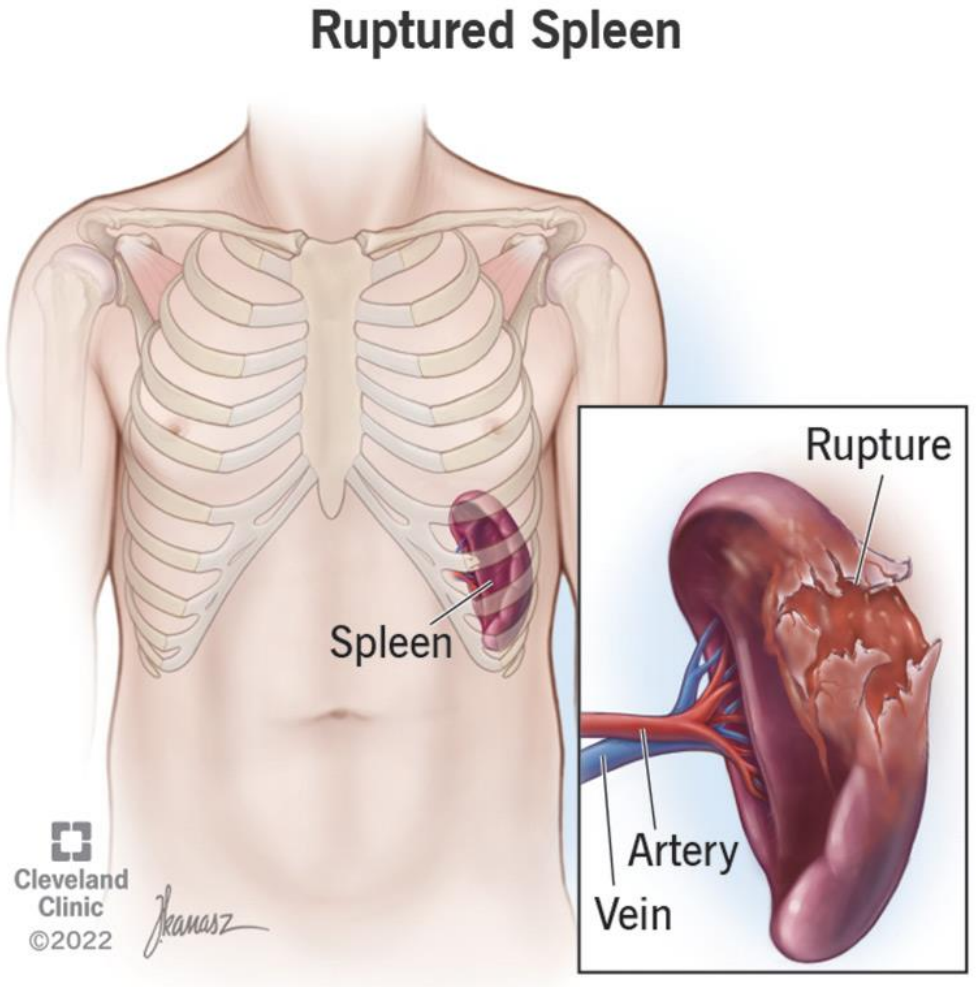


Skin, Bones, Hearts & Private Parts

Bryan HEART

Image references[2, 30, 31]





1. SPLEEN WITH CAPSULAR DETACHMENT AND SUBCAPSULAR HEMORRHAGE.
2. NO DYSPLASIA OR MALIGNANCY IDENTIFIED.

Skin, Bones, Hearts & Private Parts

Bryan HEART

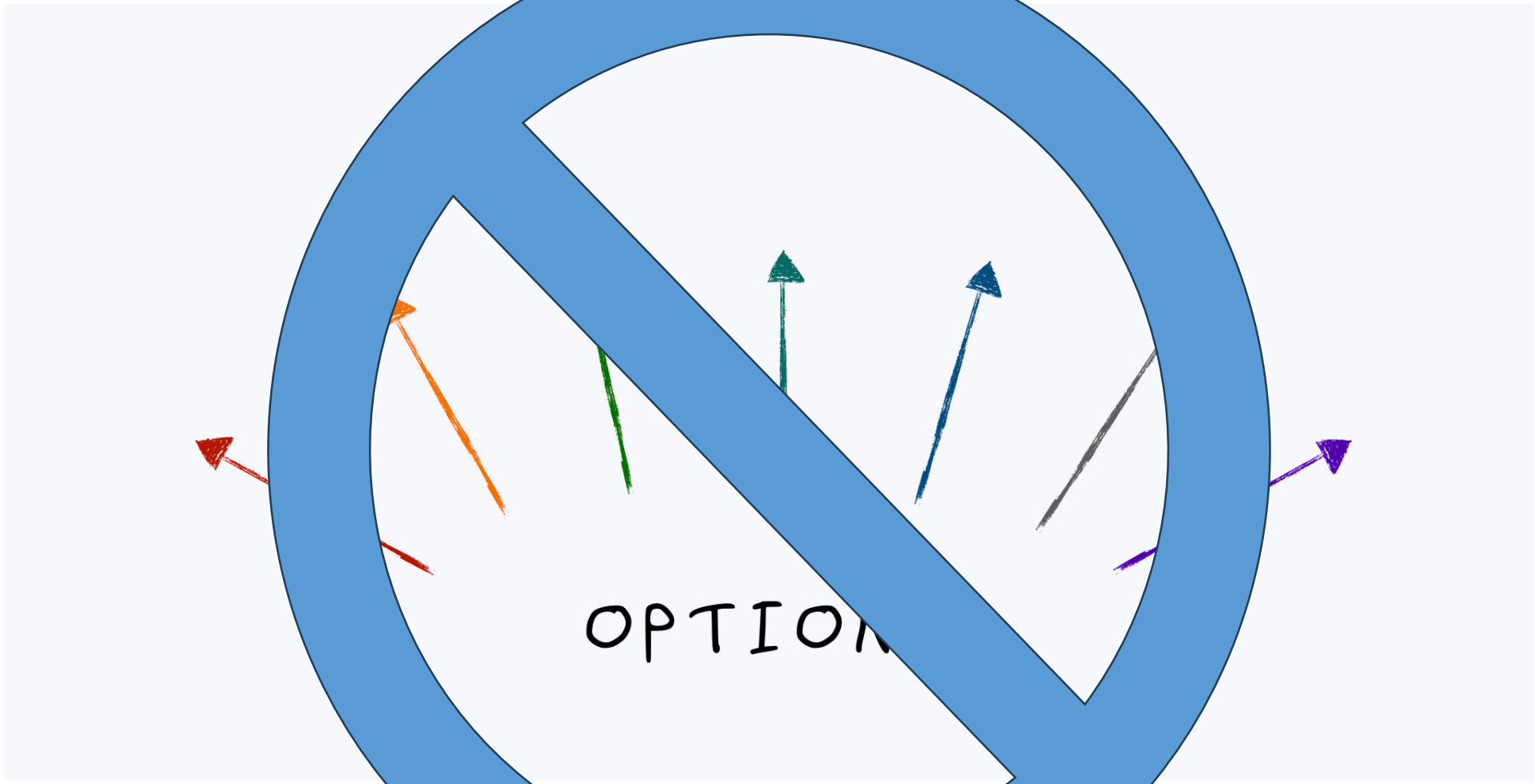
- Not able to image right and left external iliac arteries to proximal femoral arteries due to bandages.
- The right middle superficial femoral artery is **occluded.**
- The right distal superficial femoral artery re-canalized more distally by collateral flow with low flow in the popliteal artery.
- The right anterior tibial artery is **occluded or heavily calcified.**
- The right posterior tibial artery is **occluded or heavily calcified.**
- The right peroneal artery is **occluded or heavily calcified.**
- No hemodynamically significant stenosis with minimal plaque formation and multiphasic waveforms in the left artery vessels imaged from mid femoral to distal ankle.





Skin, Bones, Hearts & Private Parts

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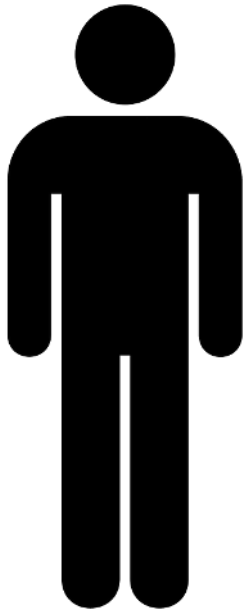


Skin, Bones, Hearts & Private Parts

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Patient D: True Depressed Ejection Fraction

HF Since 2024

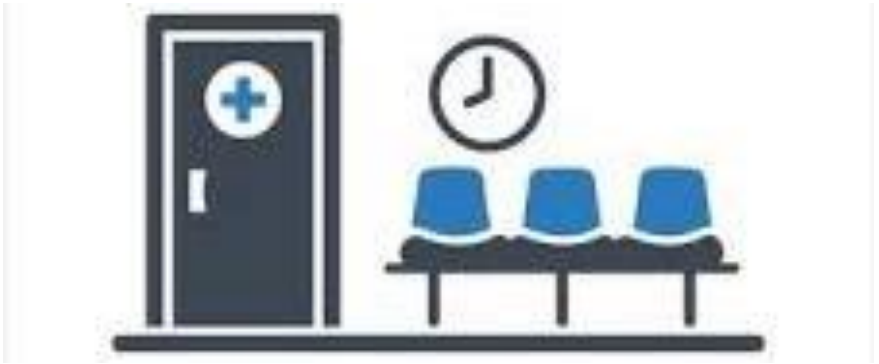


76 yr old Male

PMH: NICM, HFrEF, T2DM, CKD St 3a

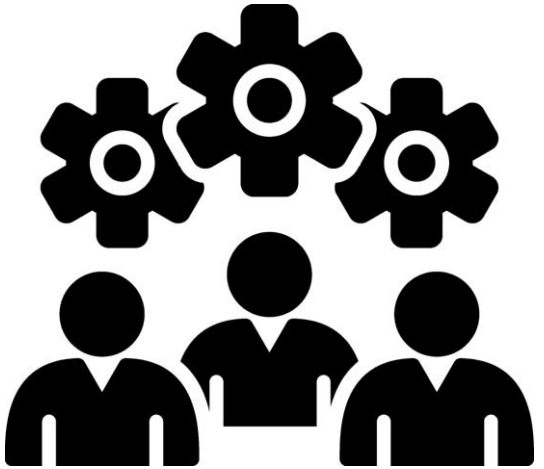
Recent Admission for A/C HF











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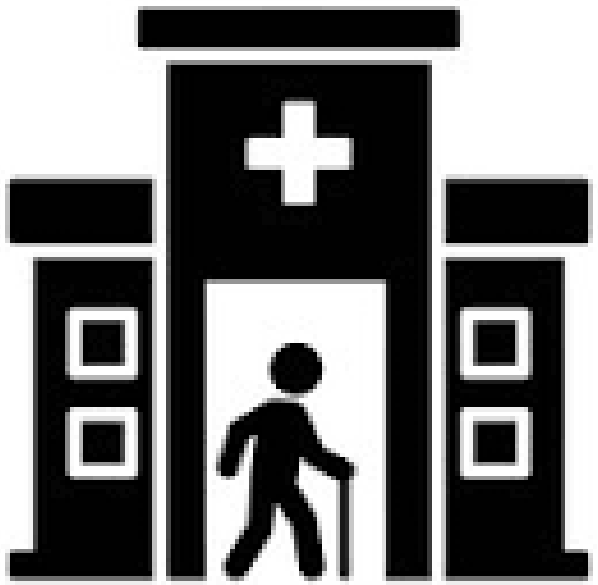


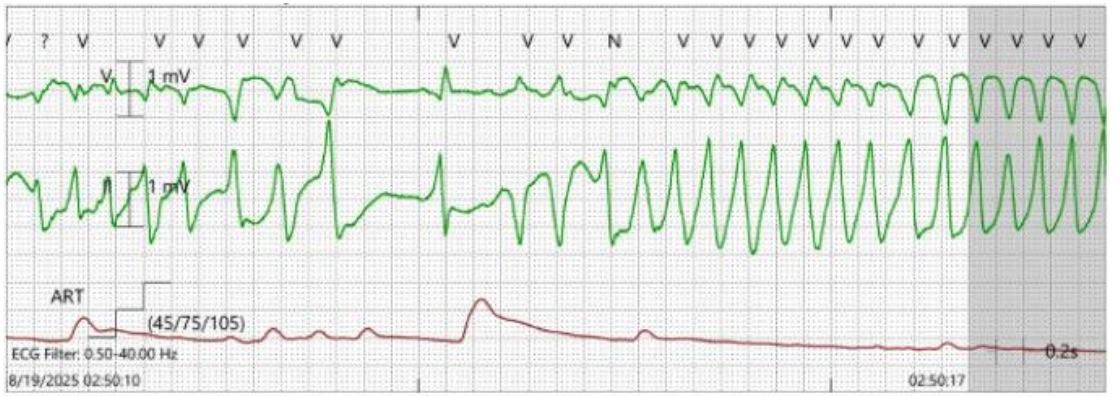










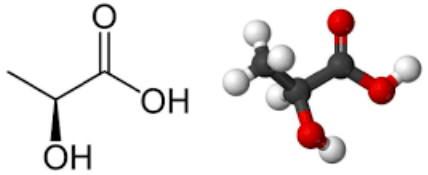




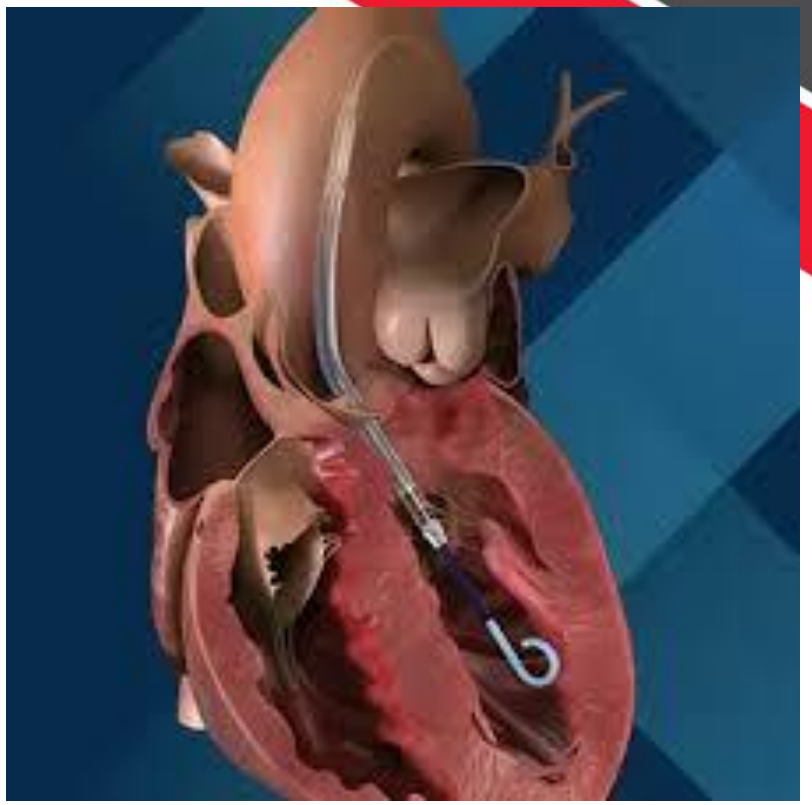
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Cardiogenic shock/sepsis syndrome

- Maps in the 50s Levophed at 0.1, adding epinephrine goal to keep MAP greater than 65
- Junctional, accelerated rhythm
- Ongoing Cheyenne stroke breathing 0-45 bpm
- Repeating lactate and BMP
- Remains on Amio at 1 mg/min
- Anuric, gave 40 of Lasix with minimal urine output 50 cc



Lactic Acid

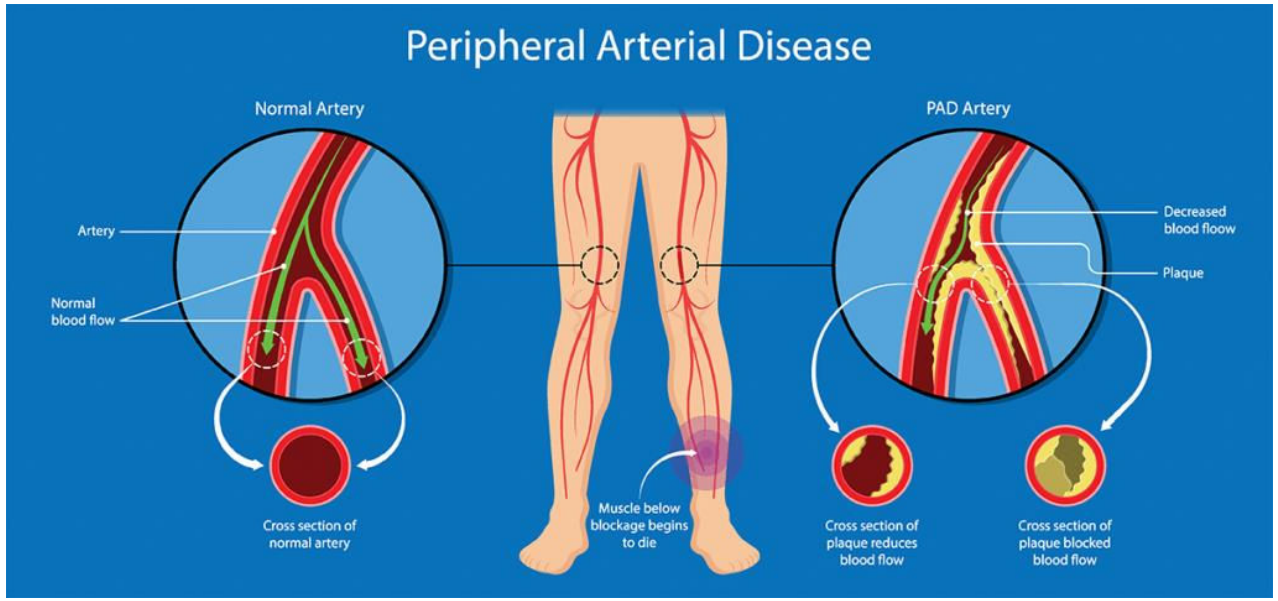


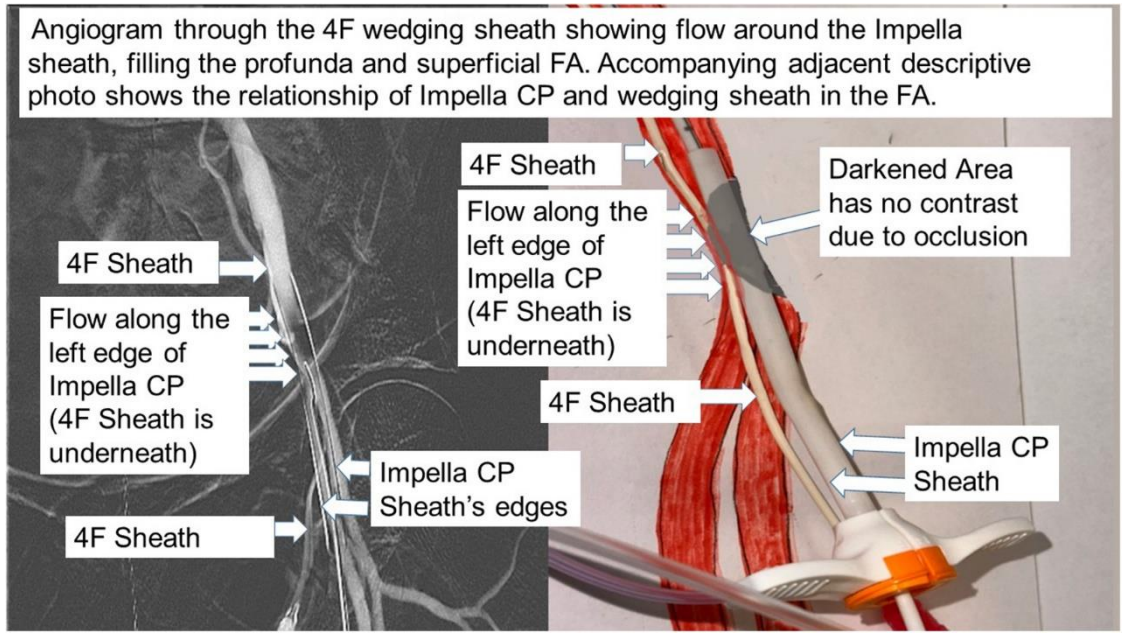


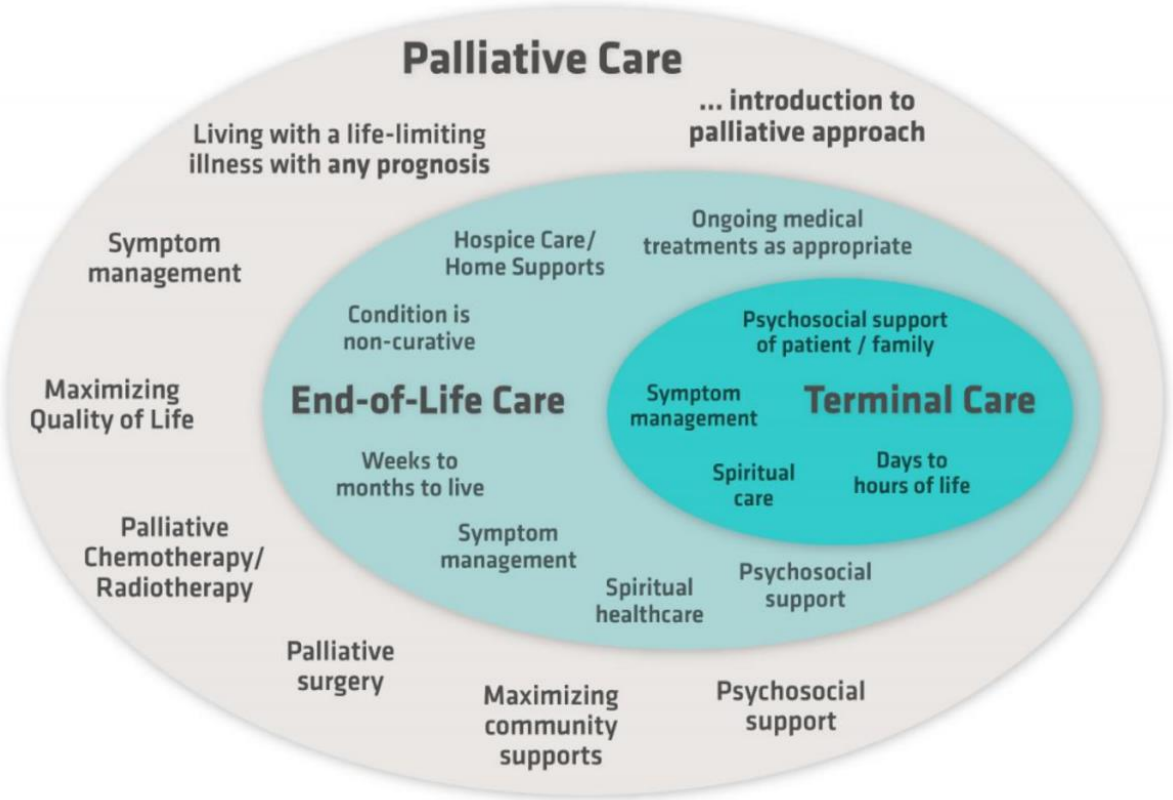
Flow: 3.2 LPM
Impella setting: P7
Impella AO pressure: 96/63/73
LV pressure: 101/13
Motor current: 753/651/691
Purge flow: 16.8 mL/h with a purge pressure of 392 and with sodium bicarb infusion
Alarm Status: No alarms currently initiated
Impella Position status: No malposition alarms noted.
Ability to Wean: NA, just placed today

Skin, Bones, Hearts & Private Parts

Bryan HEART



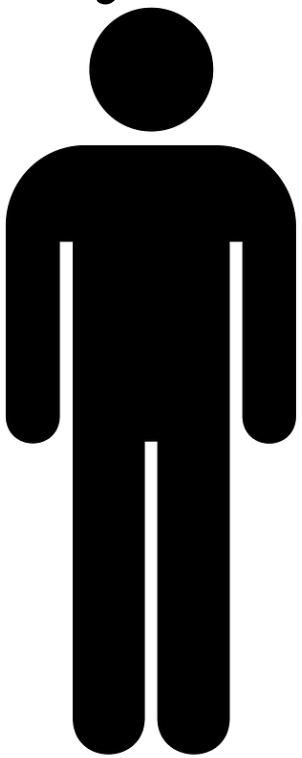




Skin, Bones, Hearts & Private Parts

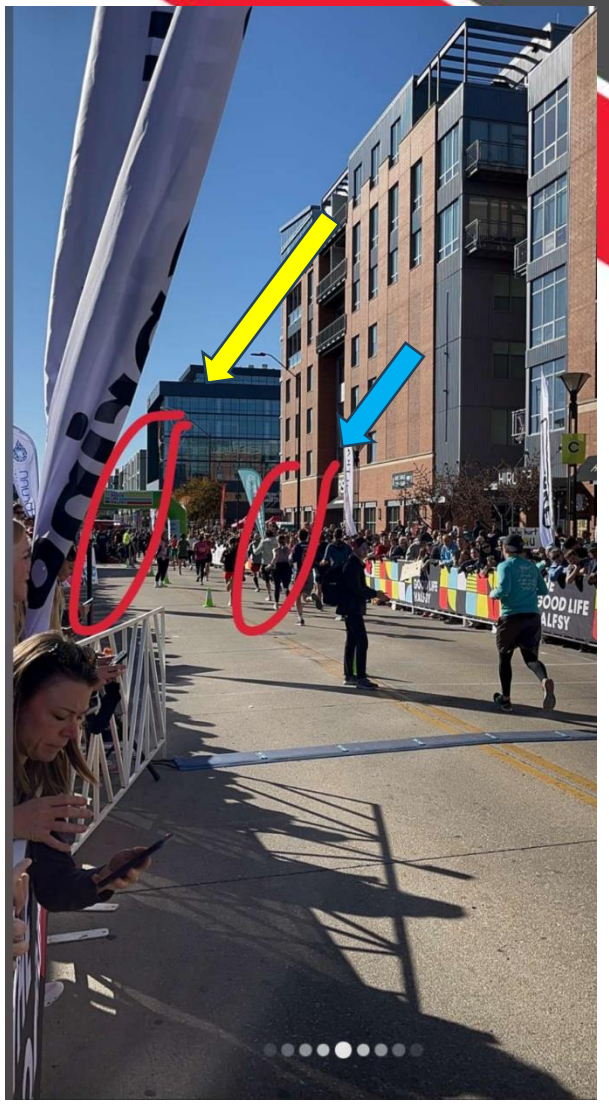
Bryan HEART

Patient E: A Happy Ending- Always an Anomaly









35 yr old Male
Married
3 Daughters (10, 7, 3)



PMH:
NONE

Skin, Bones, Hearts & Private Parts

Bryan HEART





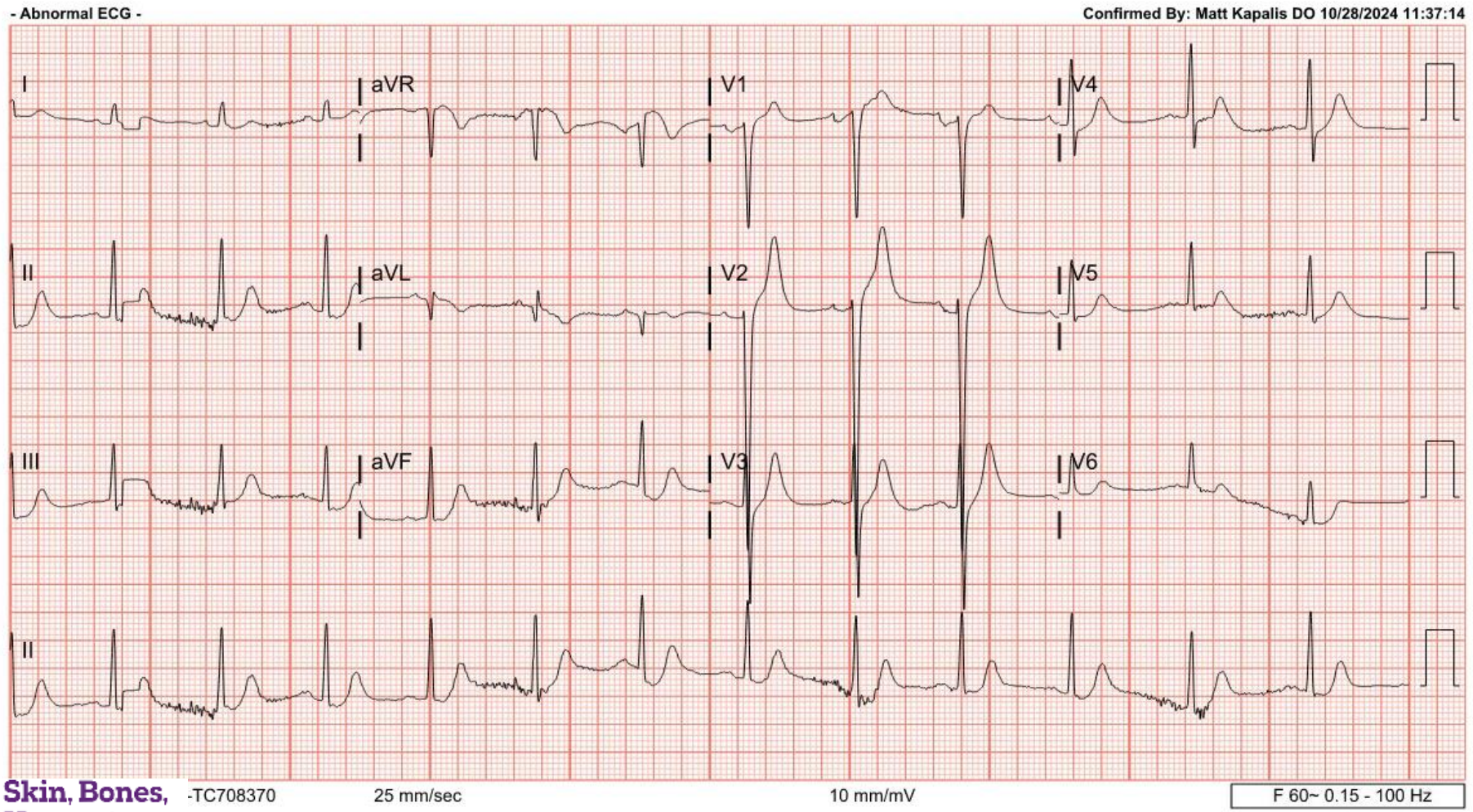






Skin, Bones, Hearts & Private Parts

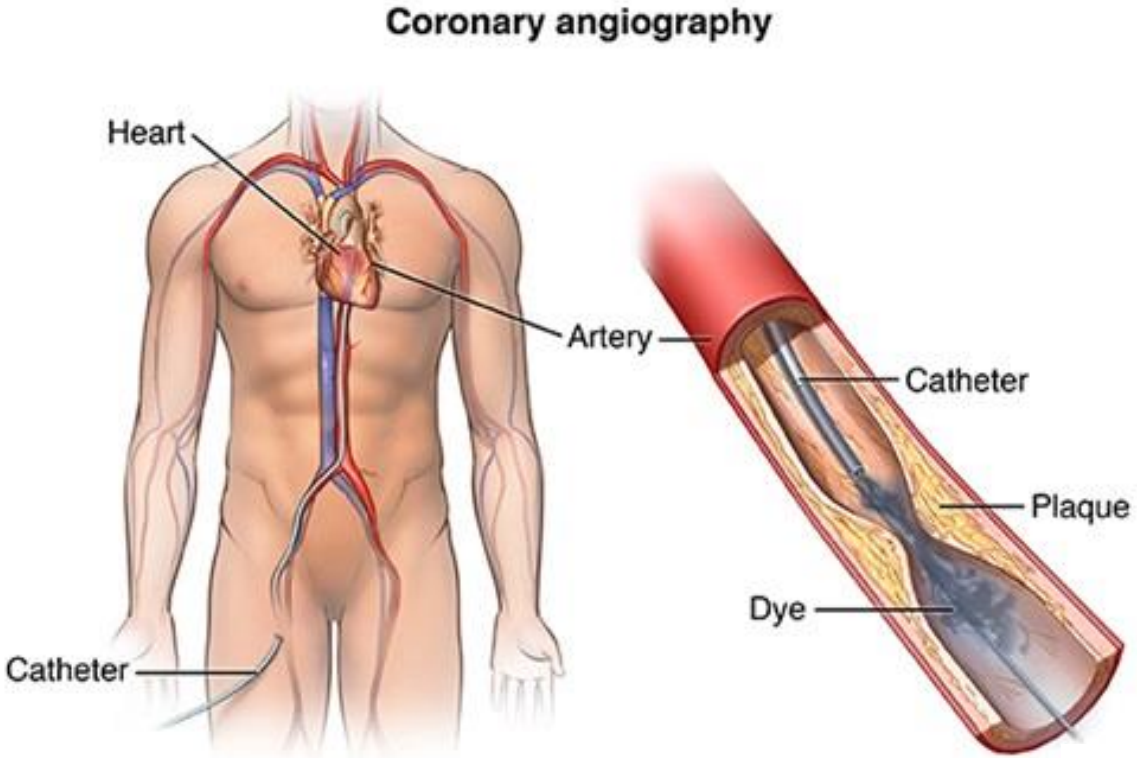
Rate	77	Sinus rhythm	Req Provider: ED PER STANDINC
PR	171	Consider left ventricular hypertrophy	
QRSd	83	No previous ECG available for comparison	
QT	373	Electronically Signed On 10-28-2024 11:37:14 CDT by Matt Kapalis DO	
QTc	423		
--Axis--			
P	29		
QRS	68		
T	76		

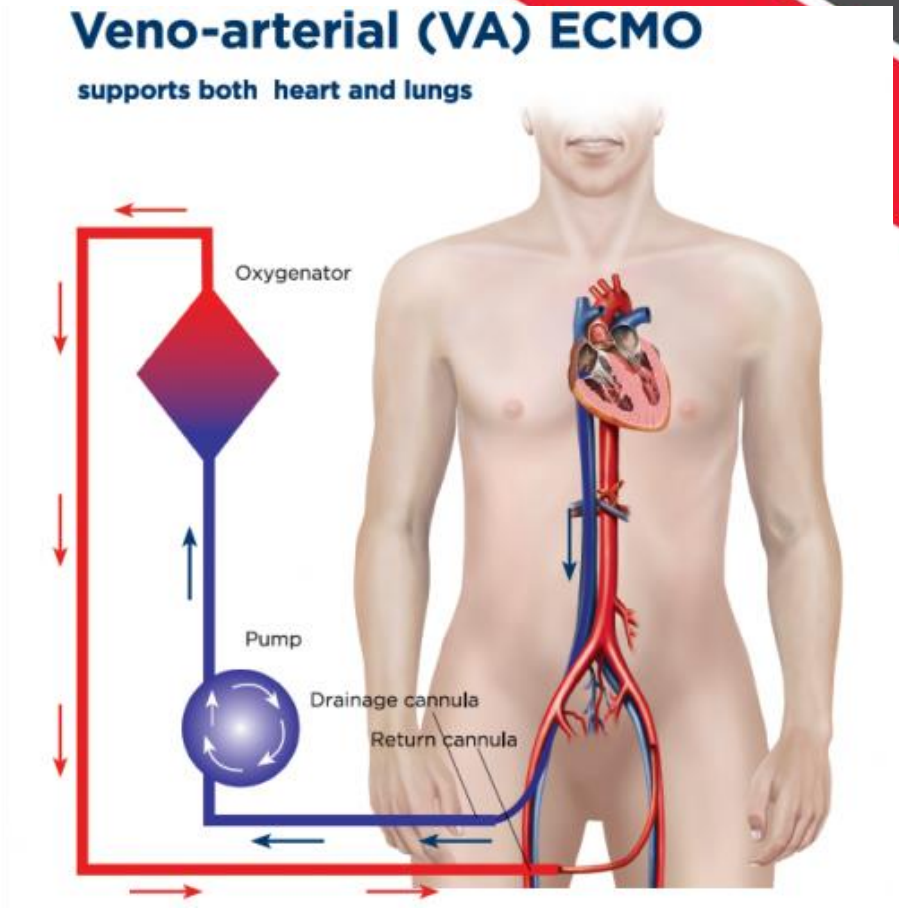


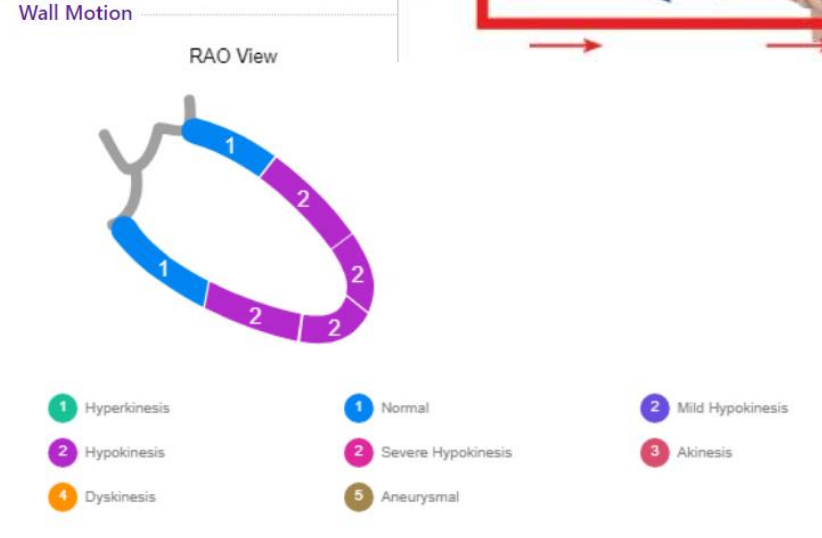
- Sinus Bradycardia
- First AV Block
- Left Ventricular Hypertrophy
- Concave ST segments Leads V5-V6 “scooping”
- T-Wave inversion V1-V3 normal until 16; > 16 needs eval in Caucasians
- Axis deviation (Left: I up/II down; Right: I down/II up)

Skin, Bones, Hearts & Private Parts

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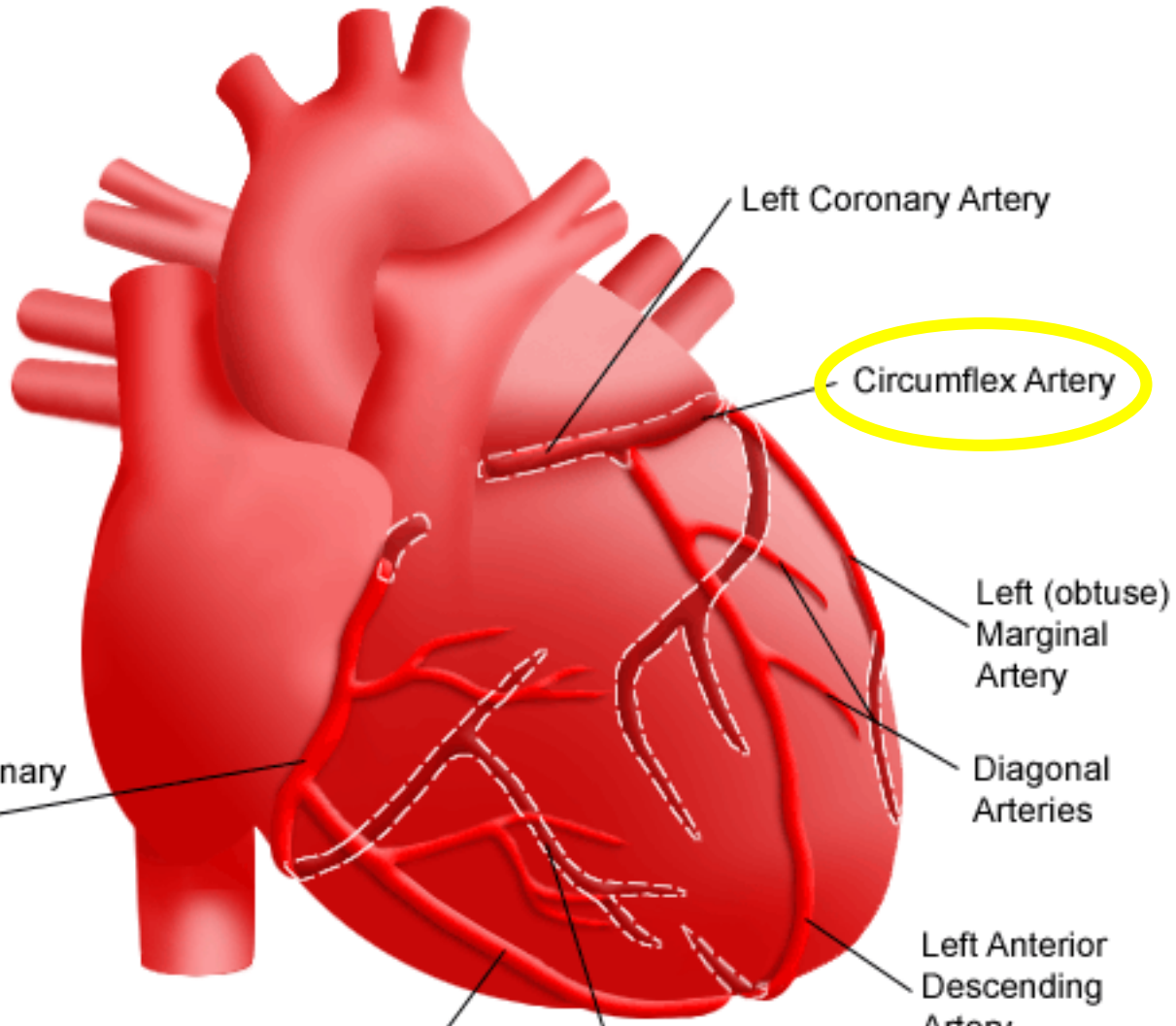


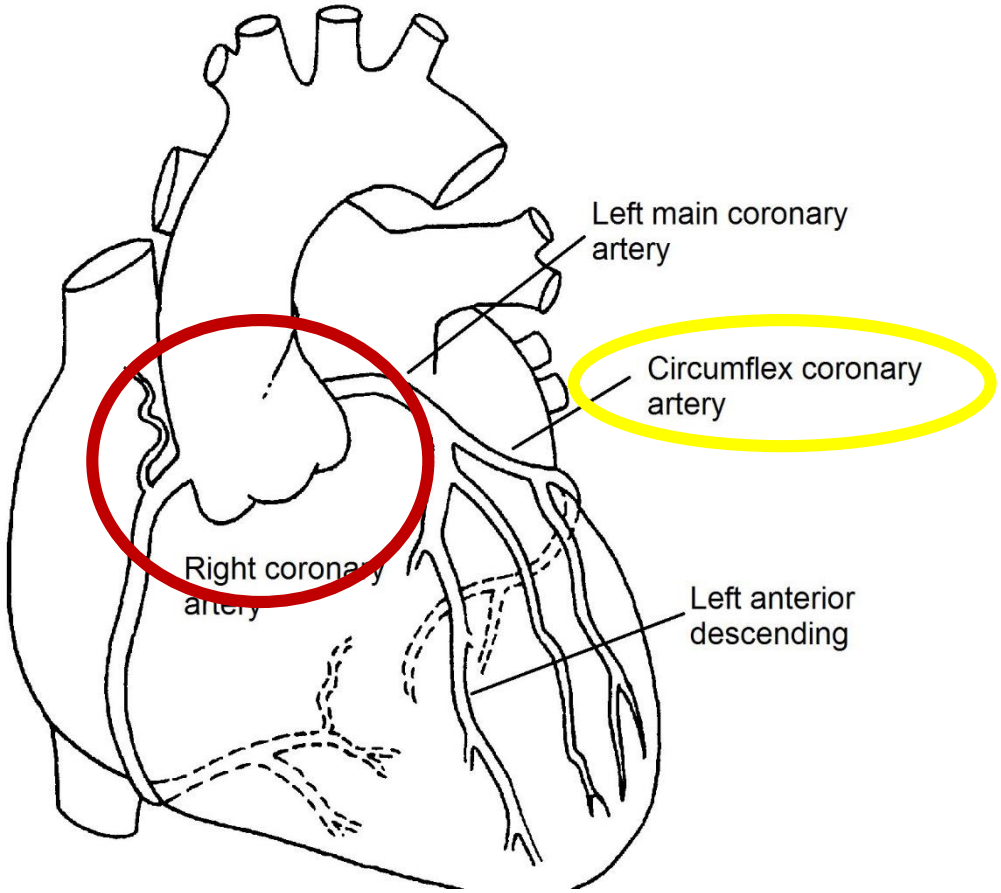
RCA is angiographically normal
Can't get in to the LAD
Circumflex looks to be anomolous

Skin, Bones, Hearts & Private Parts

Bryan HEART

Coronary Arteries of the Heart

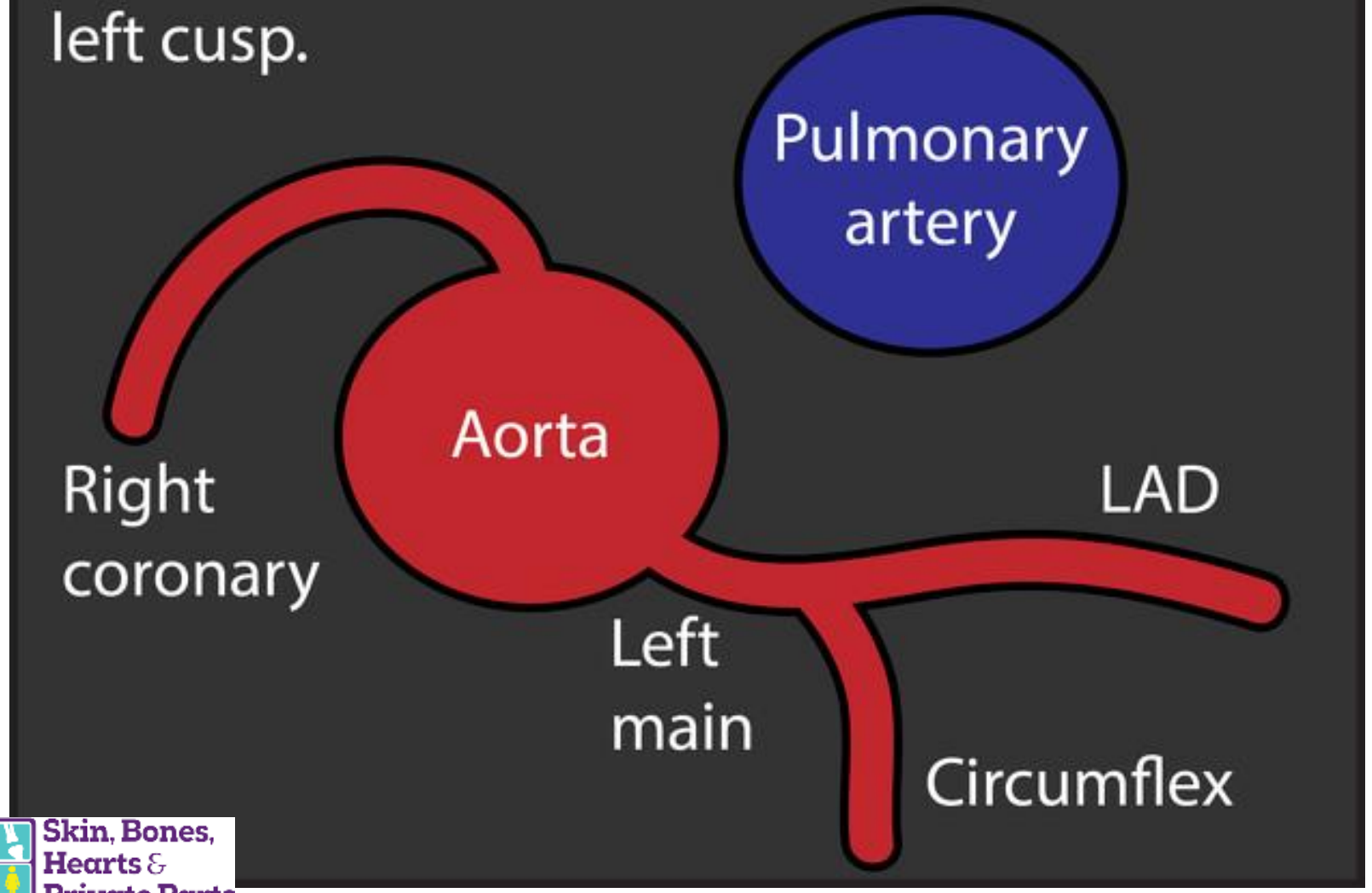




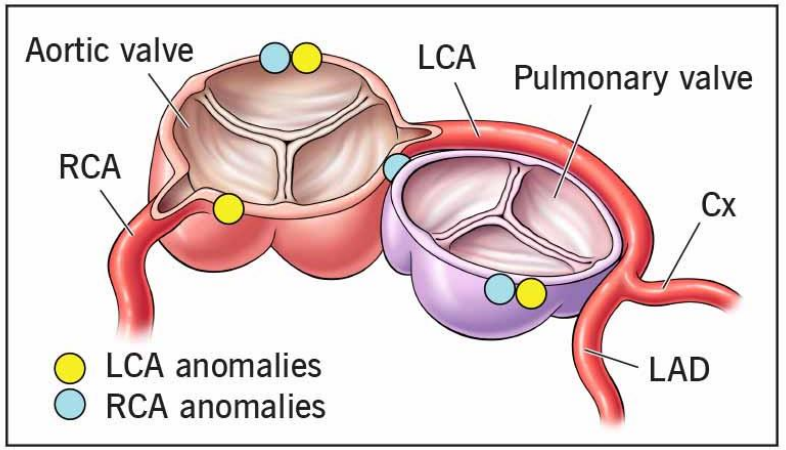
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The normal right coronary artery arises from the anteriorly located right cusp & the left coronary arises from the posteriorly located left cusp.



Possible Anomaly Locations

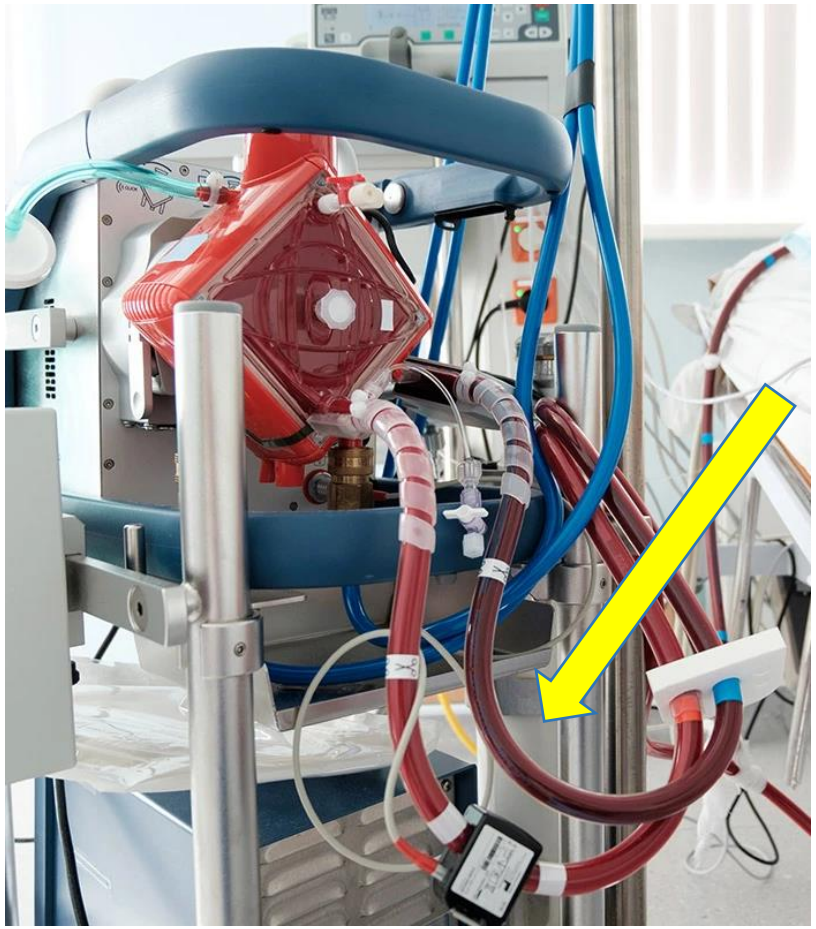


Skin, Bones, Hearts & Private Parts

Bryan HEART

Confirm pre-pump chugging → Fluid resuscitation only for severe hypovolemia or shock → Decrease pump speed → Confirm correct cannula position and check for thrombus → Add a second drainage cannula



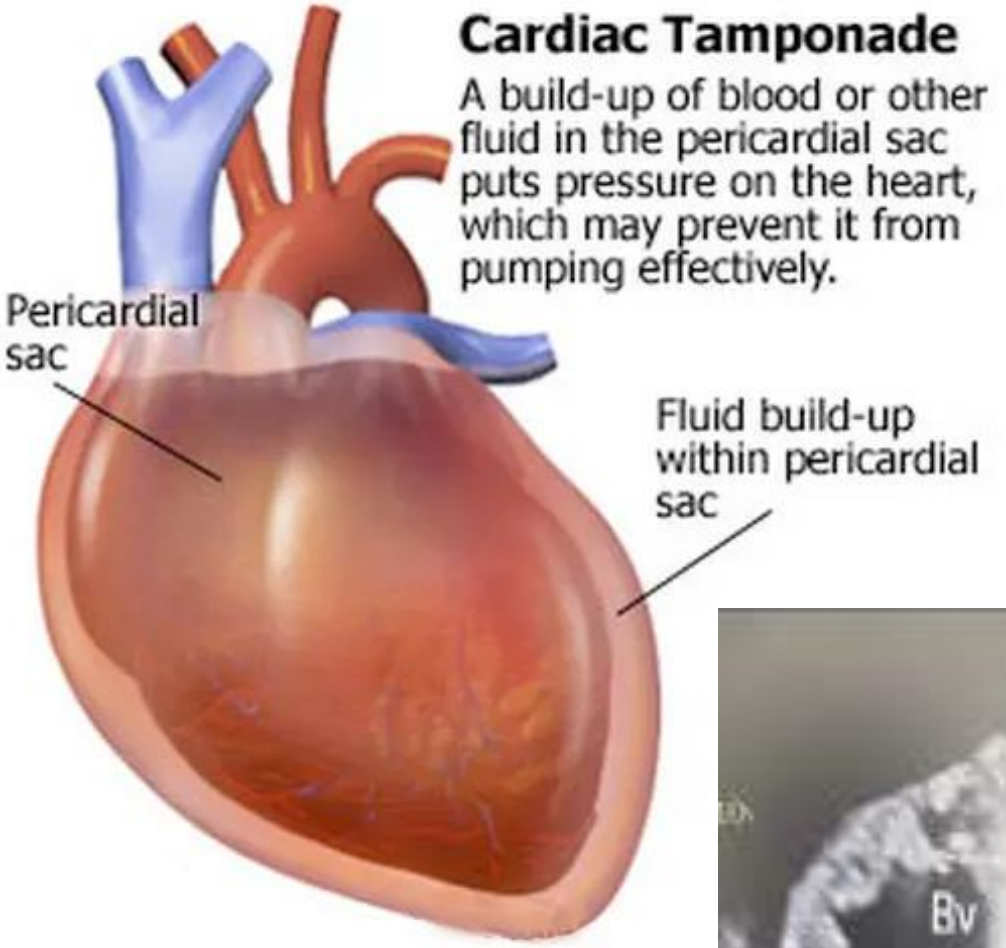


Skin, Bones, Hearts & Private Parts

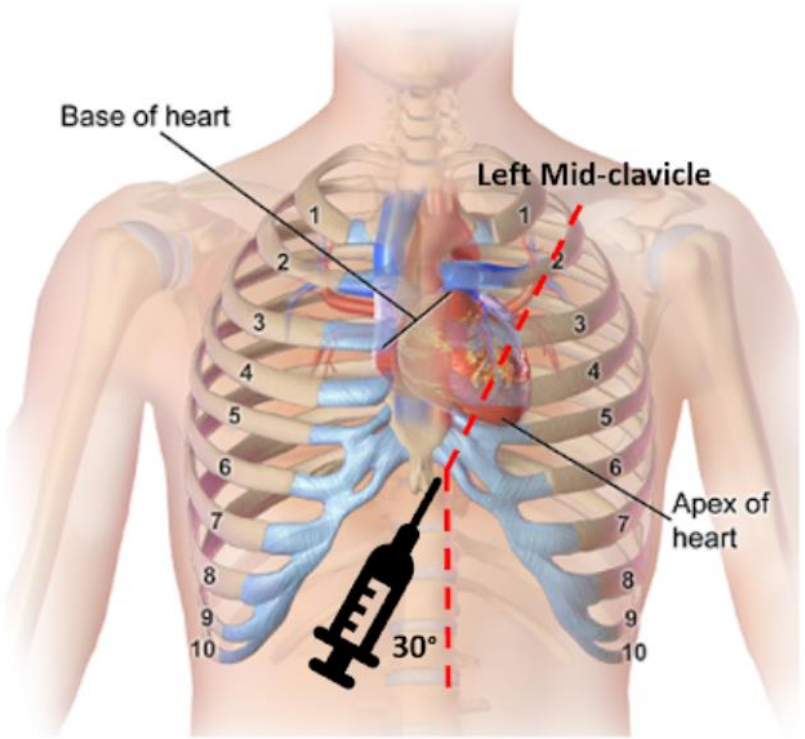
Bryan HEART

Cardiac Tamponade

A build-up of blood or other fluid in the pericardial sac puts pressure on the heart, which may prevent it from pumping effectively.





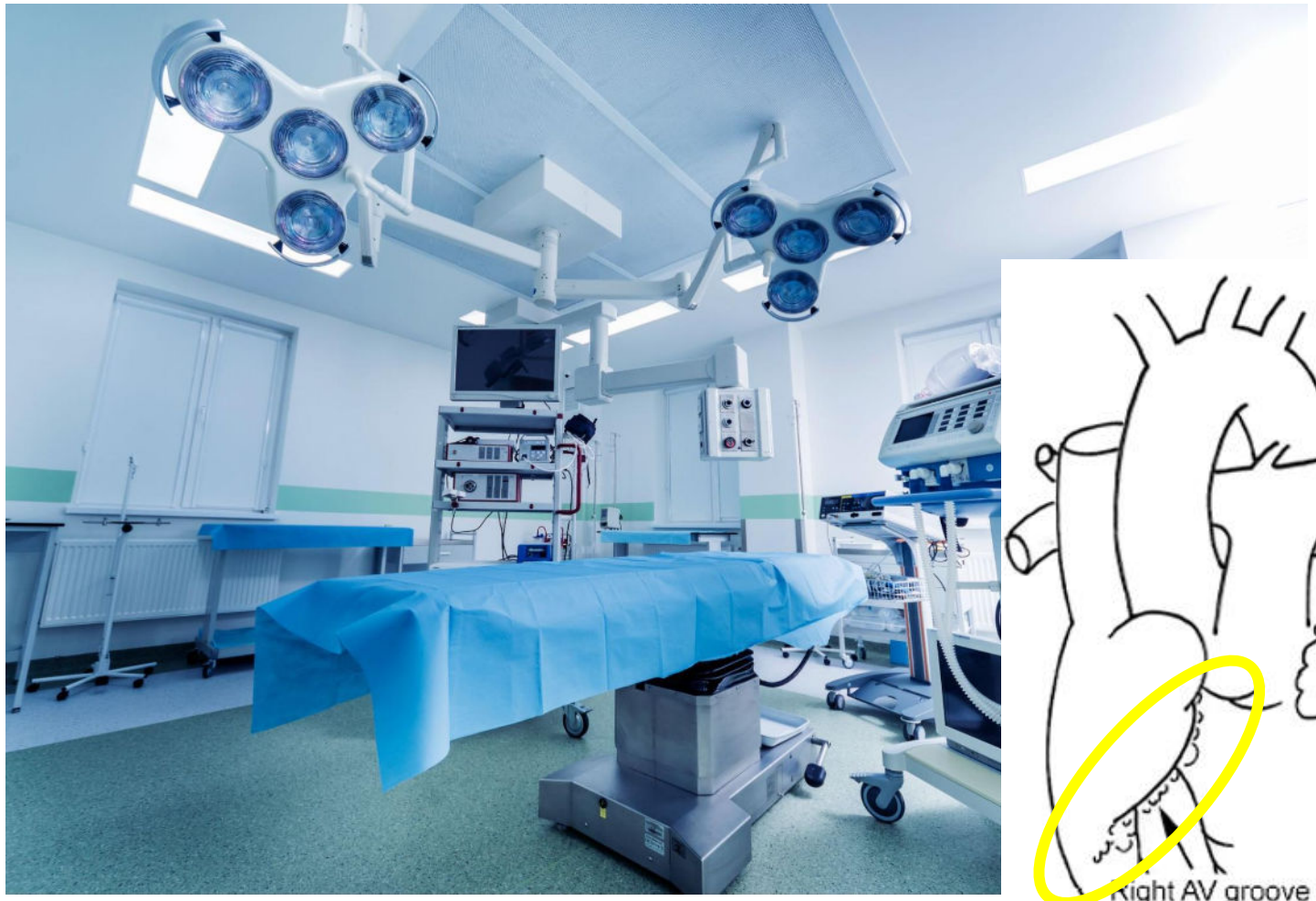


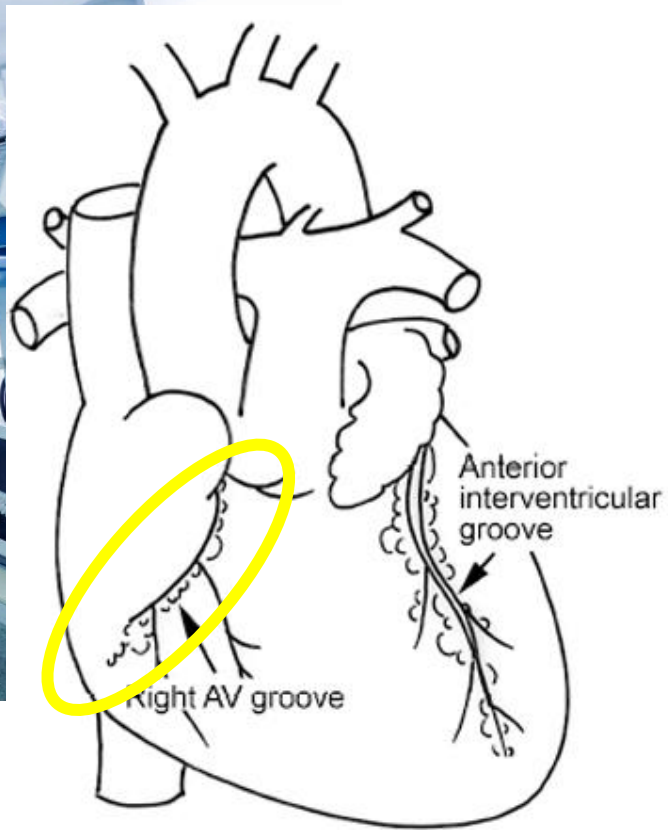
Subxiphoid



Skin, Bones, Hearts & Private Parts

Bryan HEART







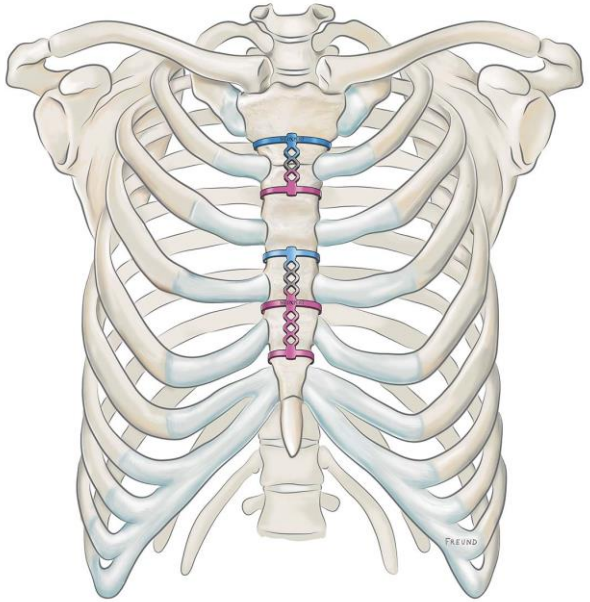
Found a laceration to the superior aspect of the Right Atrium at the Atrioventricular Groove

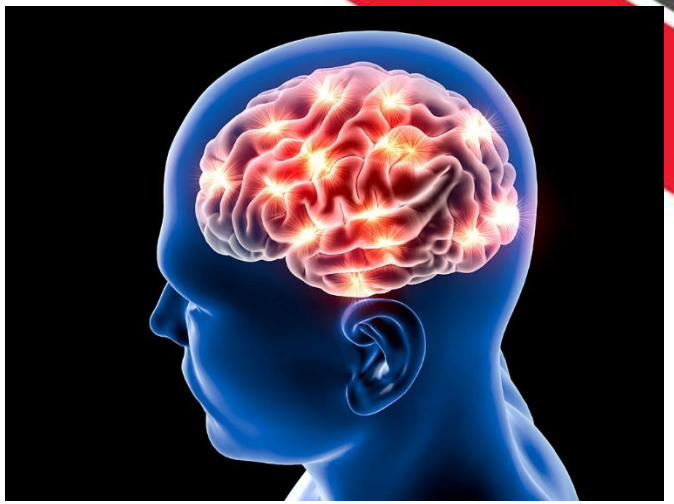
Skin, Bones, Hearts & Private Parts

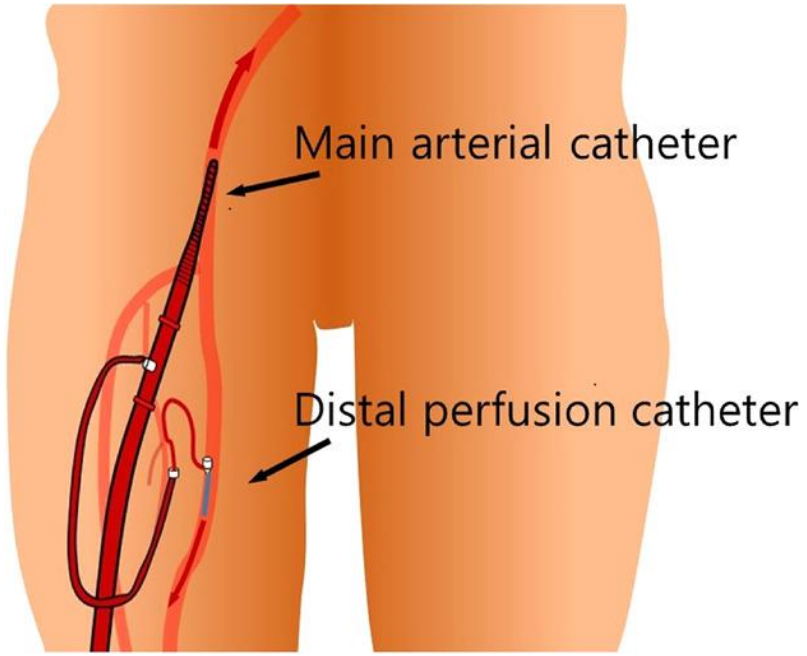
Bryan HEART

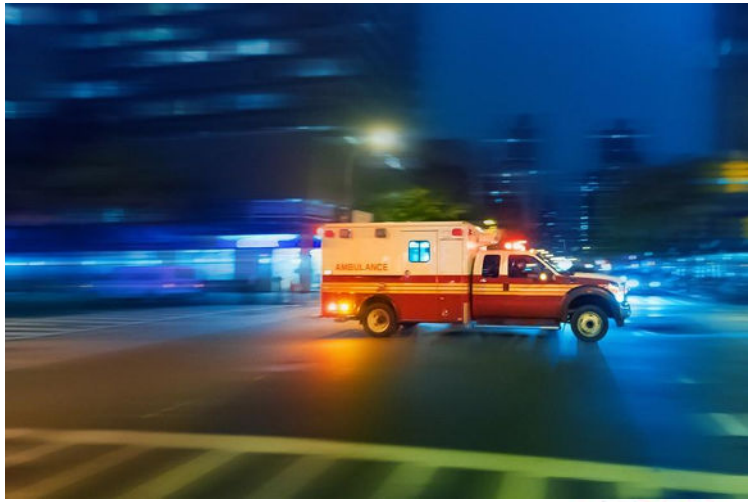












Skin, Bones, Hearts & Private Parts

Bryan HEART

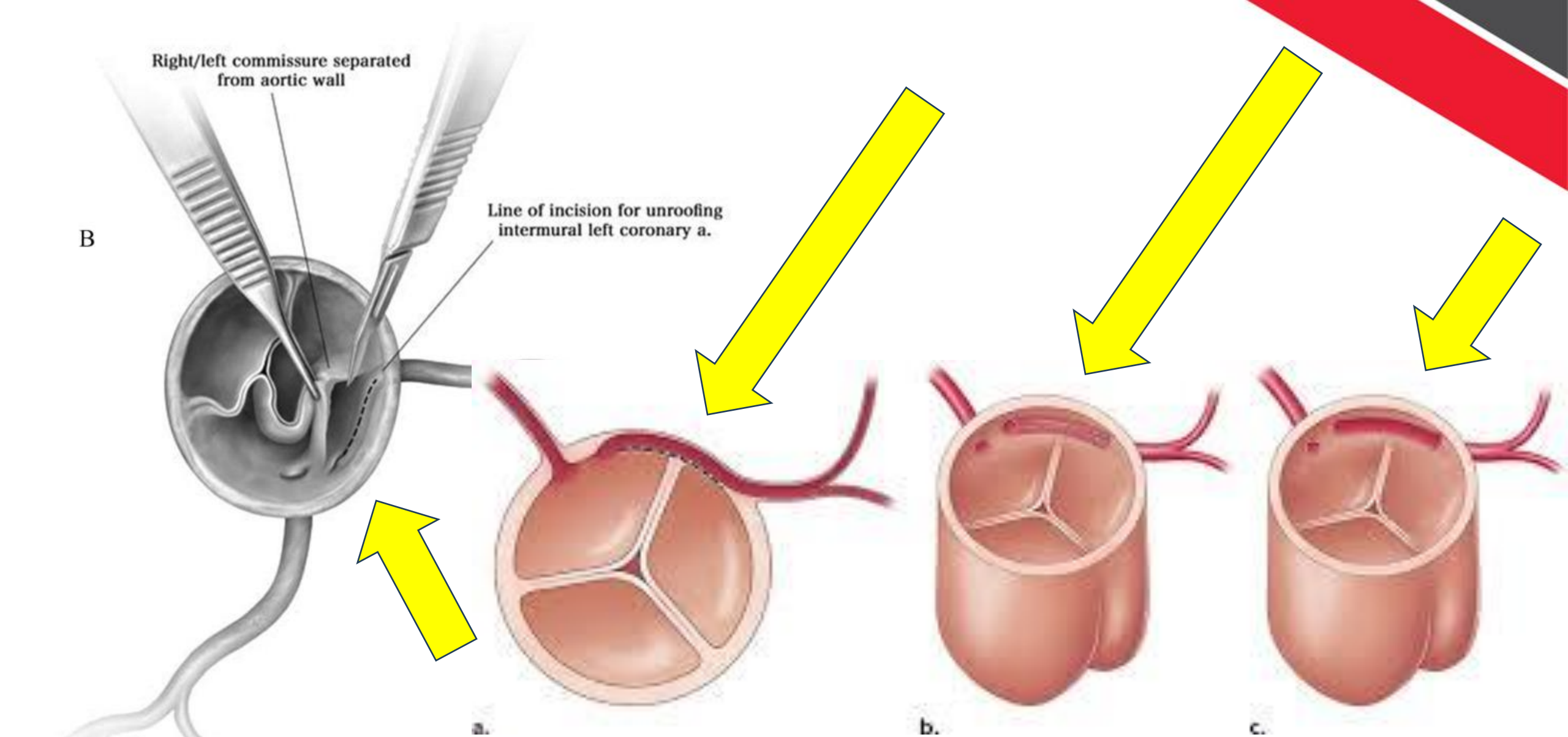
UNMC

UNMC Transfer 10/30/2024 → VA ECMO Decannulation → Extubation Confusion → Foot Drop

cMRI: EF 65%, Normal RV, Bicuspid AoV → CTA: Acute PE, anomalous LAD Rt Coronary Cusp → Acute Rehab, LifeVest → 

Skin, Bones, Hearts & Private Parts

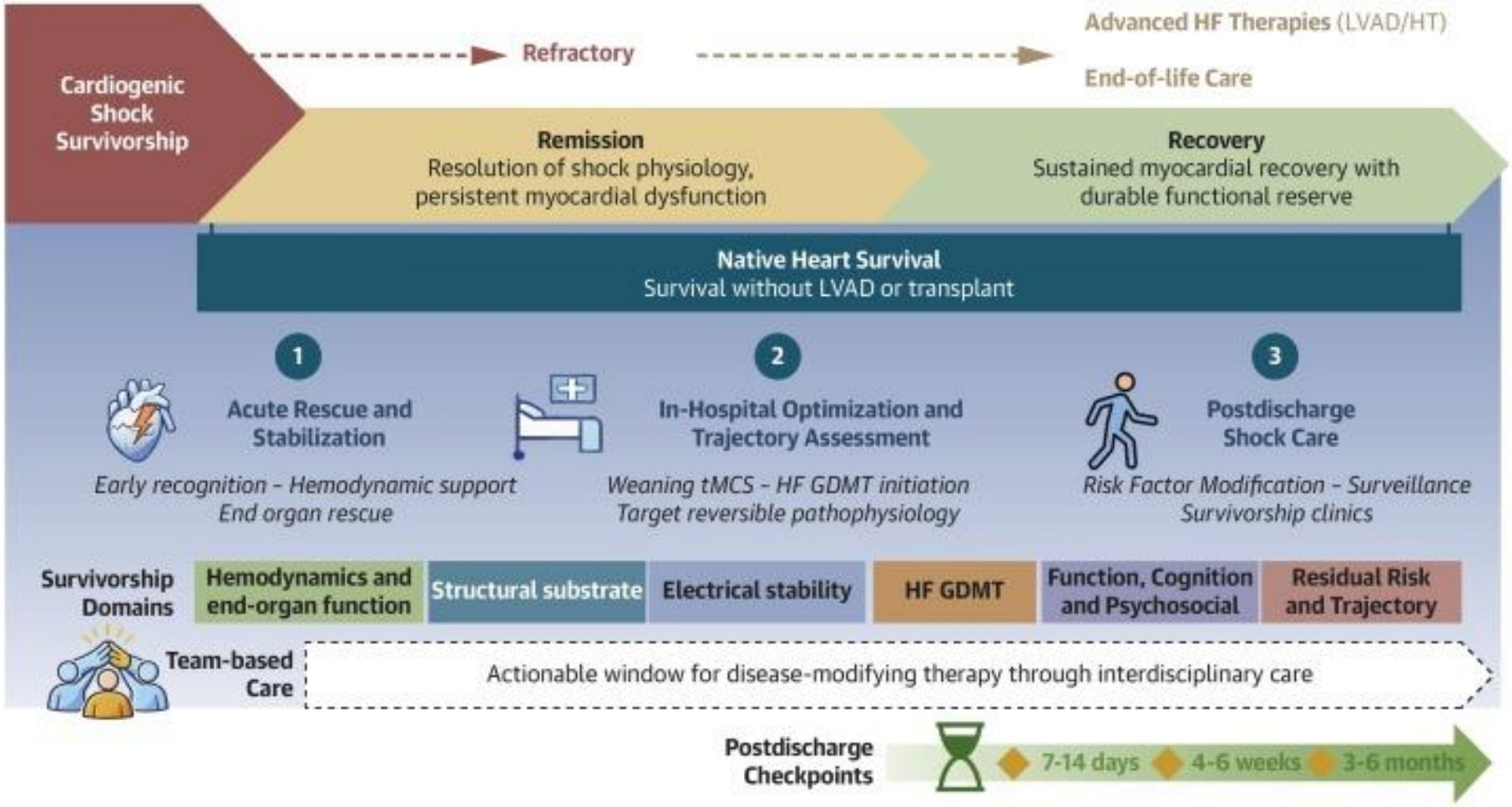
Bryan HEART



Skin, Bones, Hearts & Private Parts

Bryan HEART

CENTRAL ILLUSTRATION: Cardiogenic Shock Survivorship Continuum



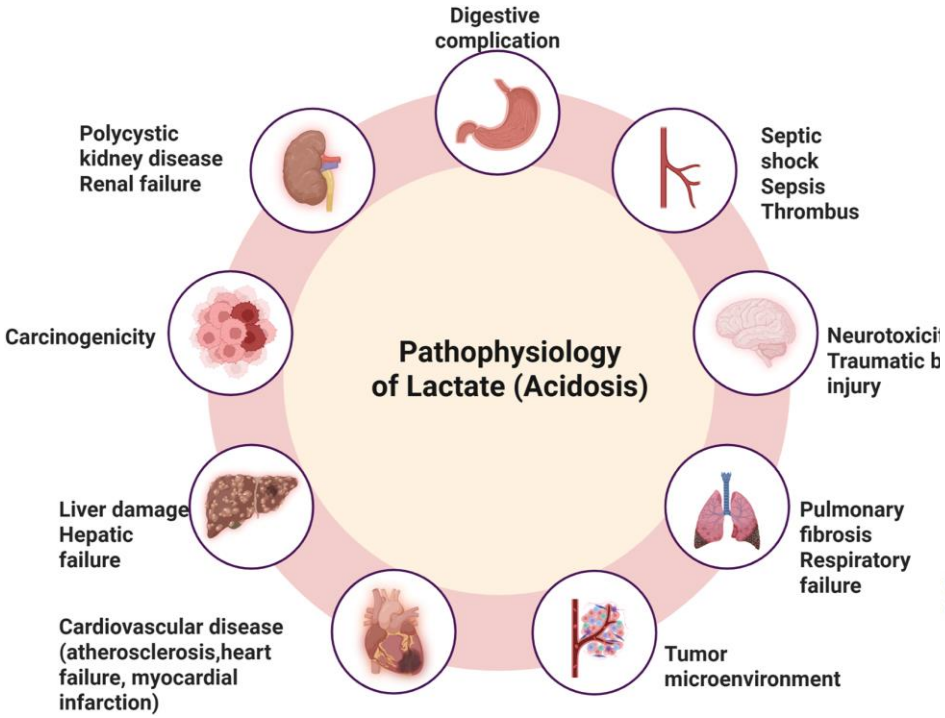
Blumer V, et al. JACC. 2026;10.1016/j.jacc.2026.02.5080

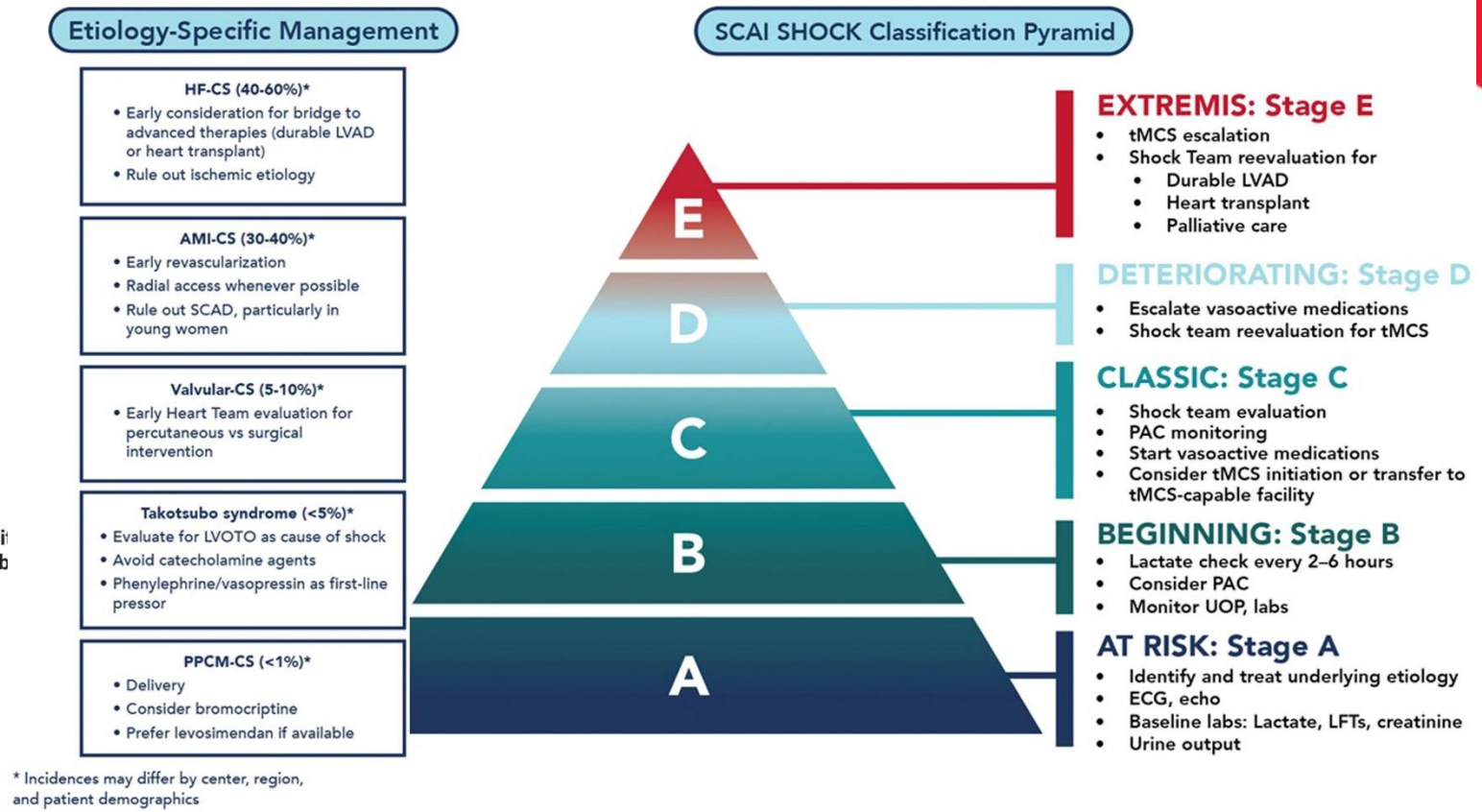
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[Cardiogenic Shock Survivorship: A Multidisciplinary Approach Across the Continuum of Care - ScienceDirect]

Final PEARLS…





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Frontiers | Dual role of lactate in human health and disease

2025 SCAI/EAPCI/ACVS Guidelines for Cardiogenic Shock in Women - Guideline Summary - Guideline Central

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Questions?



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