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HIGH-RISK EMERGENCY MEDICINE

Cardiogenic Shock

ED Diagnosis & Management

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University of Virginia

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Two Cases

- 58 male – dyspnea
- Chest pain -- now

- Doorway impression - SICK

- 58 male - dyspnea
- Chest pain – 3 days ago, now with Dyspnea

- Doorway impression - SICK

Cardiogenic Shock

Summary

Compromised cardiac output plus shock +/- pulmonary edema

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Little improvement in high mortality rate has occurred over past 2 decades

Minimal research exists on most appropriate treatment options

It's a bad thing ...try to avoid it

Cardiogenic Shock

Definition

Primary Cardiac Disorder

with

Circulatory Failure due to Low Cardiac Output

&

Related End-organ Hypoperfusion & Tissue Hypoxia

+/-

Pulmonary Edema

Cardiogenic Shock

Definition - Hemodynamic Criteria

Perfusion

SBP ≤ 90 mmHg sustained for ≥ 30 min

or

SBP ≤ 90 mmHg despite vasopressor Rx

&

Evidence of hypoperfusion

Cardiac output

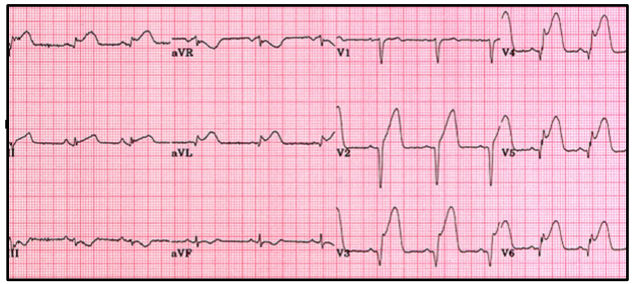
Cardiac index ≤ 2.2 L/min/m^2 BSA
(normal: 2.5 – 4.2)

&

Pulmonary-capillary wedge pressure >15 mmHg
(normal: 6 - 12)

A Typical ED Example…

Primary Cardiac Disorder…



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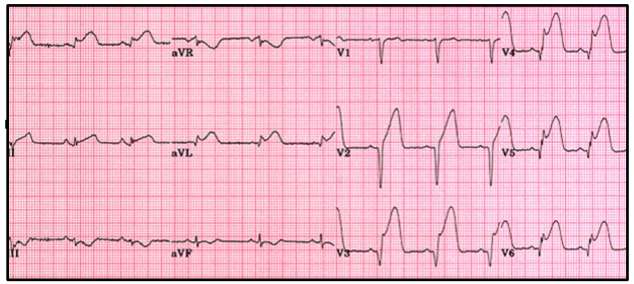

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Circulatory Failure due to Low Cardiac Output…

BP 75/45 - MAP 55

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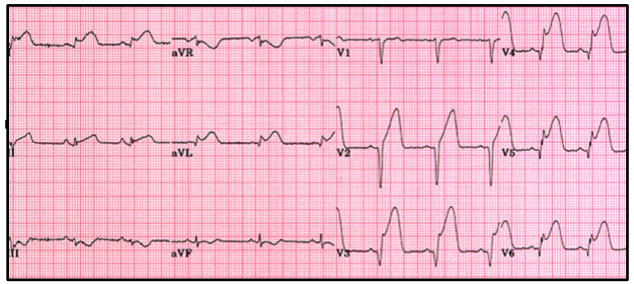

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Related End-organ Hypoperfusion & Tissue Hypoxia… **Lactate 6.5**

A Typical ED Example…

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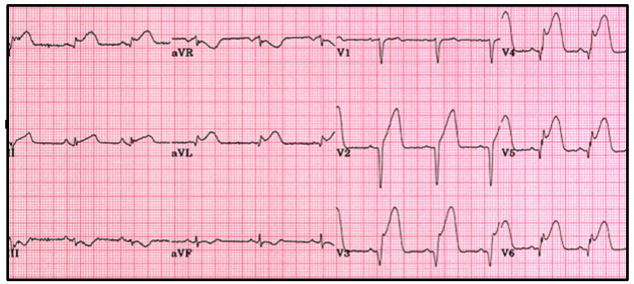

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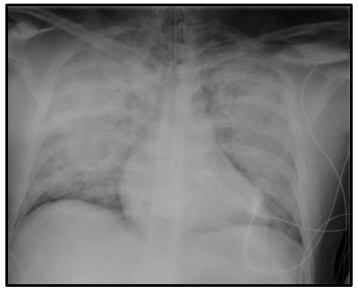
+/-

Pulmonary Edema…



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Royal Infirmary of Edinburgh

“New Hospital”

Scottish Ambulance Service

epidemiology & etiology

Cardiogenic Shock
Epidemiology

- **Cause is most often ACS, usually STEMI**

Cardiogenic Shock
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- **Complicates 8-10% STEMI & 3% NSTEMI**

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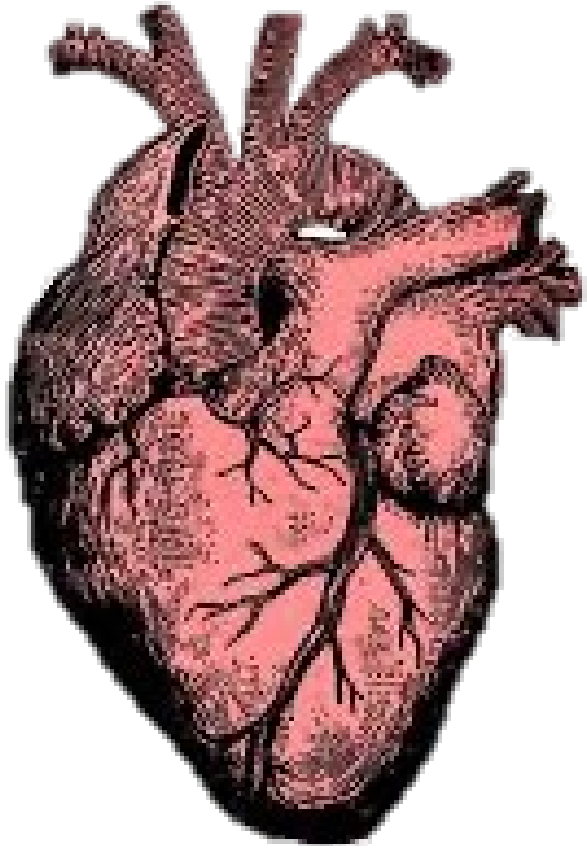
Cardiogenic Shock
Epidemiology

- Cause is most often ACS, usually STEMI
- Complicates 8-10% STEMI & 3% NSTEMI
- ~10% CCU admissions, increased over past decade
- **Mortality ~50% with little-to-no reduction in past decade**

Cardiogenic Shock

Etiology

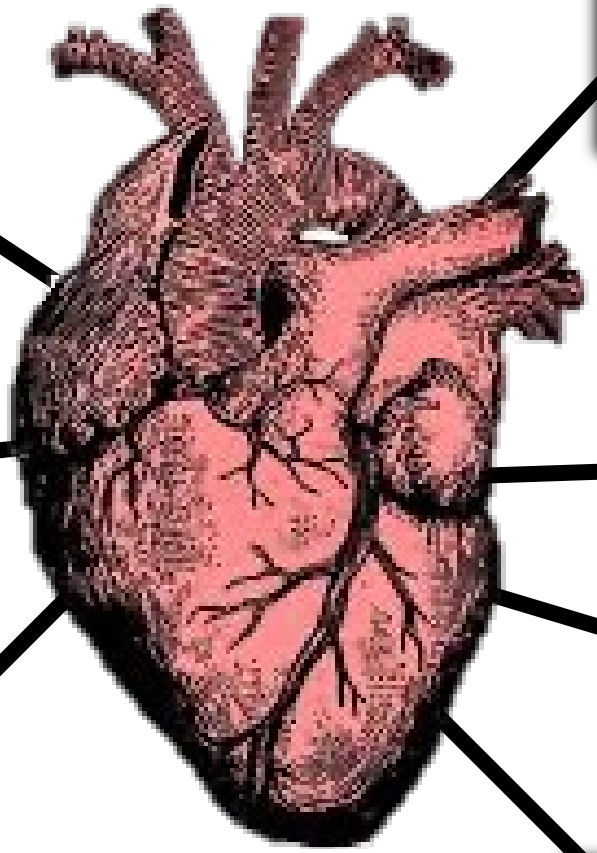
Ischemic
80%



Non-Ischemic
20%

Cardiogenic Shock

Etiology



STEMI

Mechanical Dysfunction

Contractility Dysfunction

Right Ventricular Failure
(with & without PE)

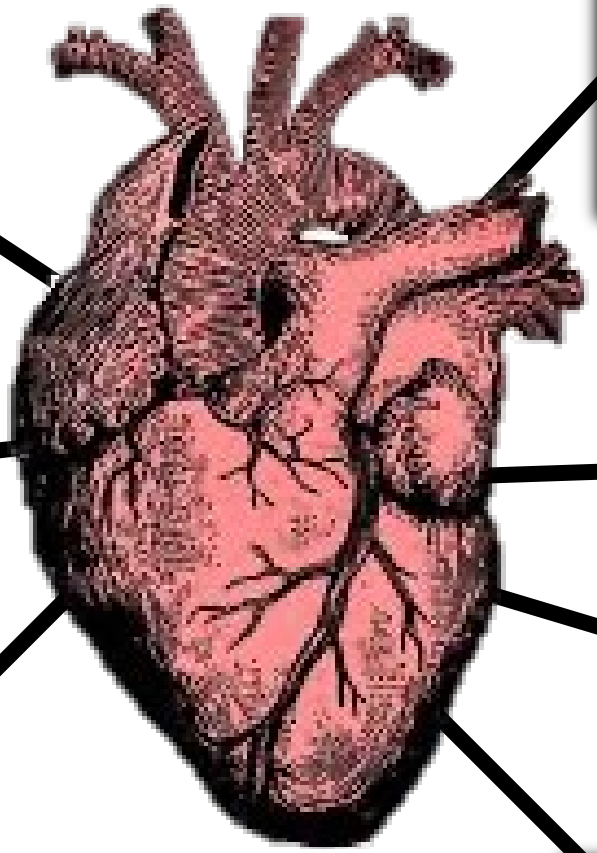
Medication Toxicity & Overdose

Metabolic Disorders

Other Disorders

Cardiogenic Shock

Etiology



STEMI
70%

Mechanical Dysfunction
10%

Contractility Dysfunction
8%

Right Ventricular Failure
(with & without PE)
5%

Medication Toxicity & Overdose
3%

Metabolic Disorders
2%

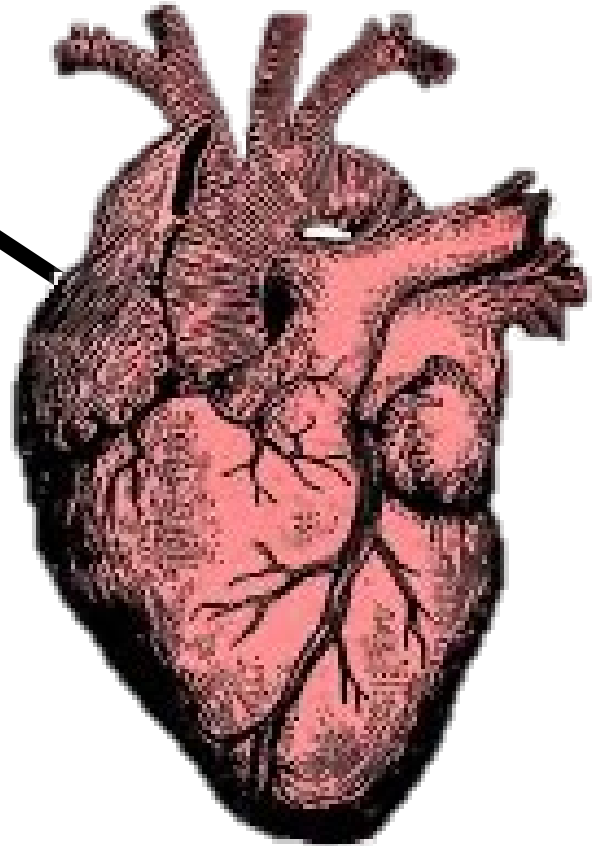
Other Disorders
2%

Cardiogenic Shock
Etiology

STEMI
70%

80%
If we include STEMI-related mechanical complications…

papillary muscle rupture with acute MR & ventricular free wall rupture

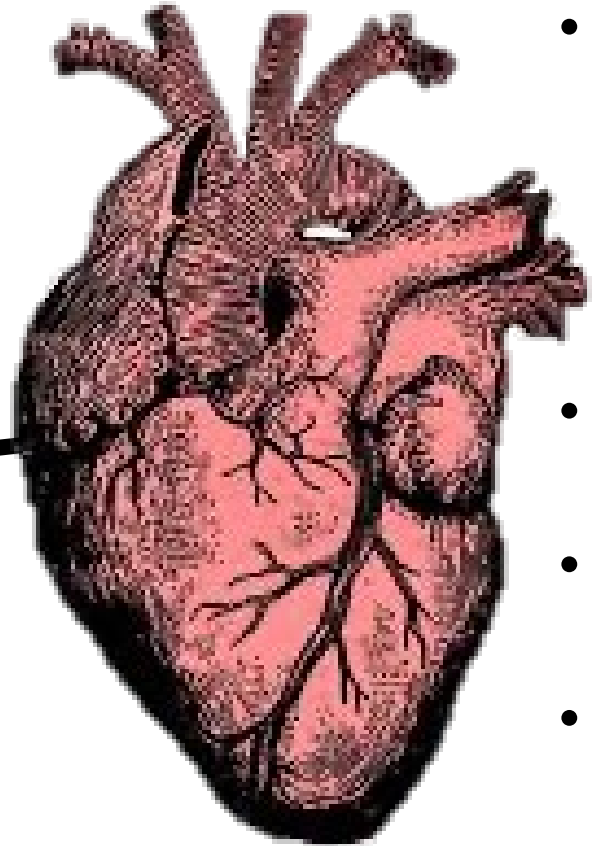


- Most common cause
- Frequently extensive anterior, anterolateral STEMI, or BBB with AMI
- Risk issues in STEMI
  - Age > 70 years
  - SBP < 120 mmHg
  - Anterior or anterolaeral
  - Persistent sinus tachycardia or sinus bradycardia
  - Prolonged chest pain prior to therapy

Cardiogenic Shock

Etiology

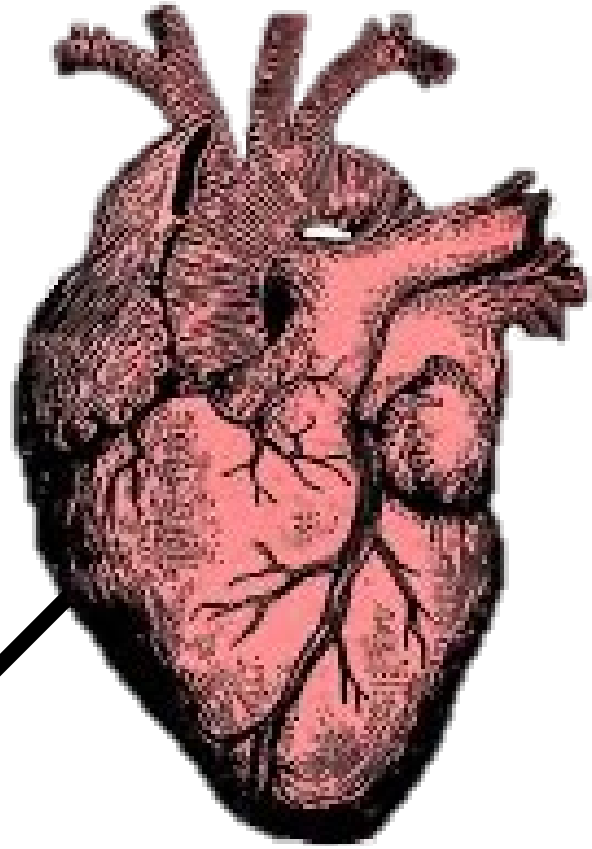
Mechanical Dysfunction 10%



- AMI-related
  - Acute mitral insufficiency (papillary muscle rupture)
  - Ventricular free wall rupture
- Endocarditis - valve destruction
- Cardiac tamponade
- Severe mitral stenosis
- Severe aortic outflow obstruction

Cardiogenic Shock

Etiology

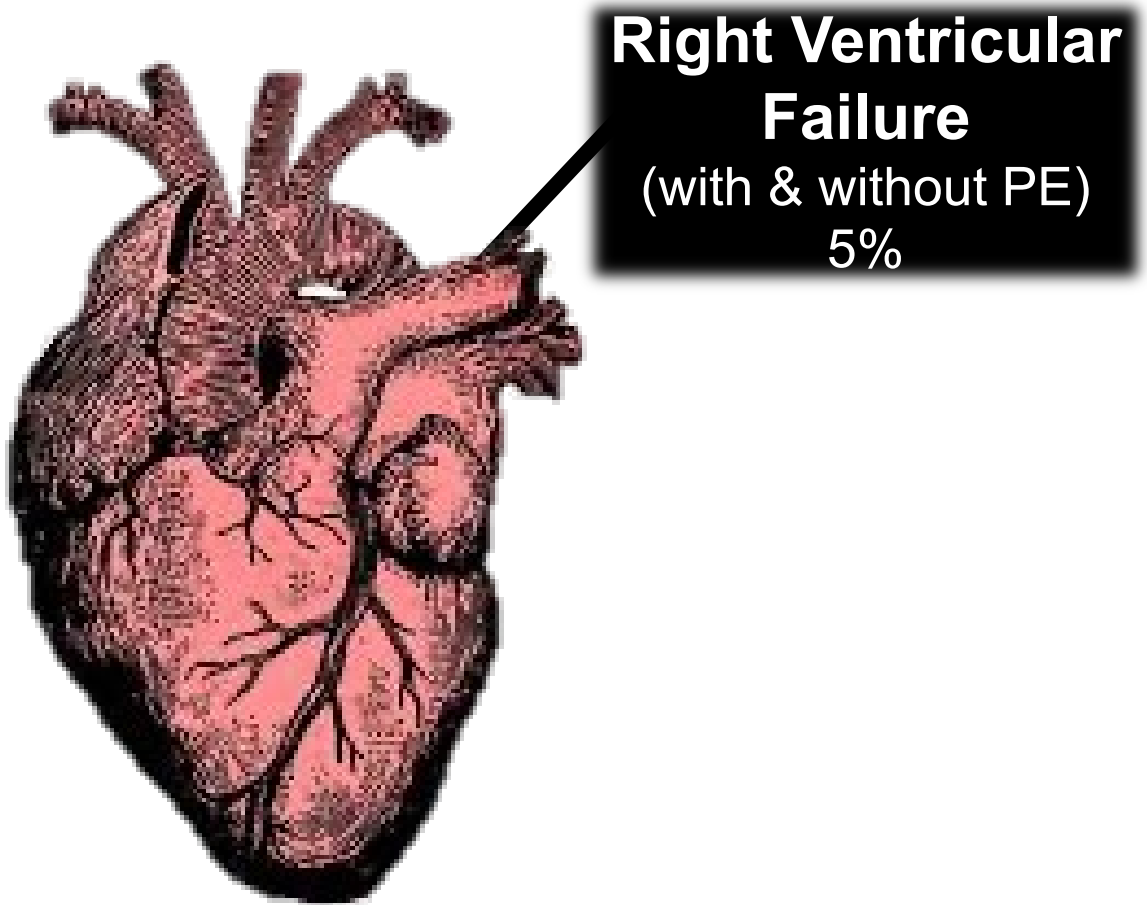


Contractility Dysfunction 8%

- Cardiomyopathy
- Takatsubo cardiomyopathy
- Sustained dysrhythmia
- Myocarditis
- Sepsis-related myocardial dysfunction

Cardiogenic Shock
Etiology

- RV failure +/- PE
- RV AMI with LV failure



EMS
Hong Kong

diagnosis

Cardiogenic Shock

ED Diagnosis

Awareness is key – Syndrome Recognition

Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

Cardiogenic Shock

ED Diagnosis

Awareness is key – Syndrome Recognition

Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

<u>Diagnostic Tools</u>

Examination

ECG, Labs, & CXR

Cardiac POCUS

Cardiogenic Shock
ED Diagnosis

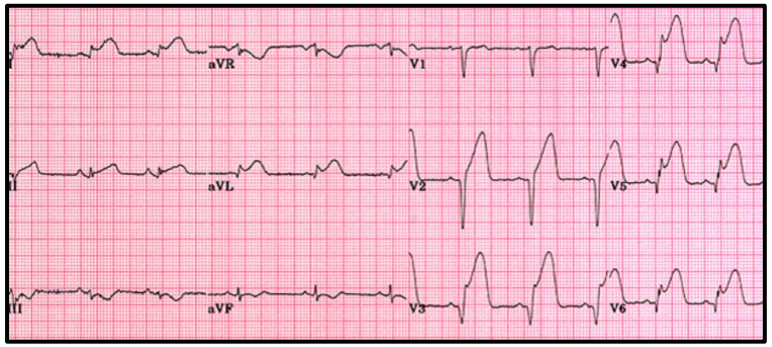
Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

- **Examination** – acute heart failure & hypoperfusion
  - Hypotension
  - Altered mentation
  - JVD
  - S3 gallop
  - Murmurs of valve dysfunction & VSD
  - Extremities: edema +/- cool & clammy
  - Rales
  - etc

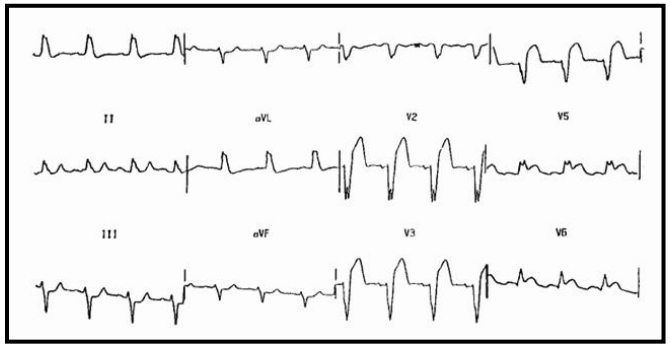
Cardiogenic Shock
ED Diagnosis

Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

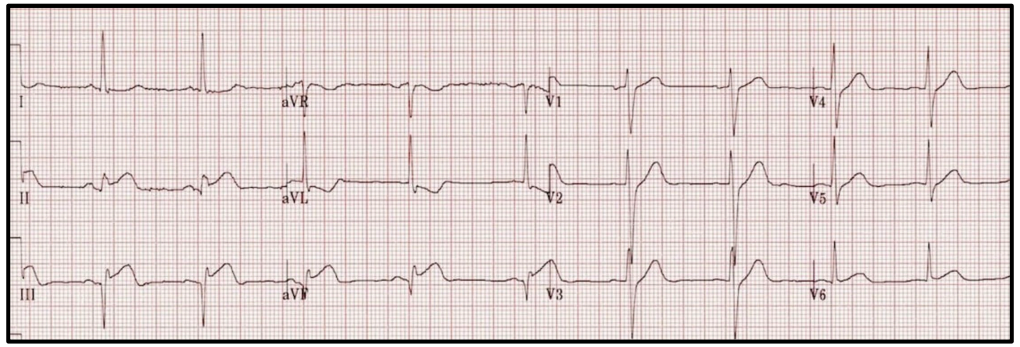
- **ECG** – AMI & other clues



Anterolateral STEMI



Left Bundle Branch Block AMI



Subacute Inferior AMI

Extensive Infarction with Significant Myocardial Injury

Subacute Inferior STEMI …Papillary Muscle Rupture with Acute MR

Cardiogenic Shock
ED Diagnosis

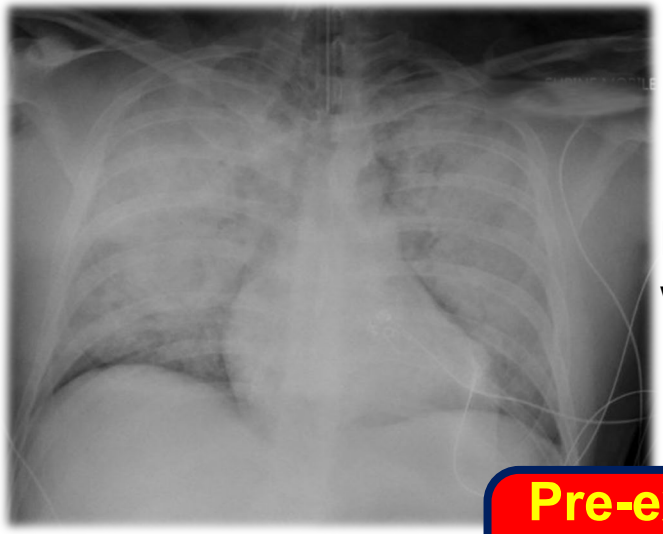
Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

- **Labs** – cardiac injury +/- hypoperfusion
  - Elevated hsTrp
  - Elevated BNP
  - Decreased HCO3 (CO2) & pH
  - Increased lactate
  - Abnormal LFTs
  - Increased Cr & K

Cardiogenic Shock
ED Diagnosis

Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

- **CXR** – pulmonary edema



Pulmonary Edema with Cardiomegaly

Pre-existing Heart Failure with New LV Dysfunction

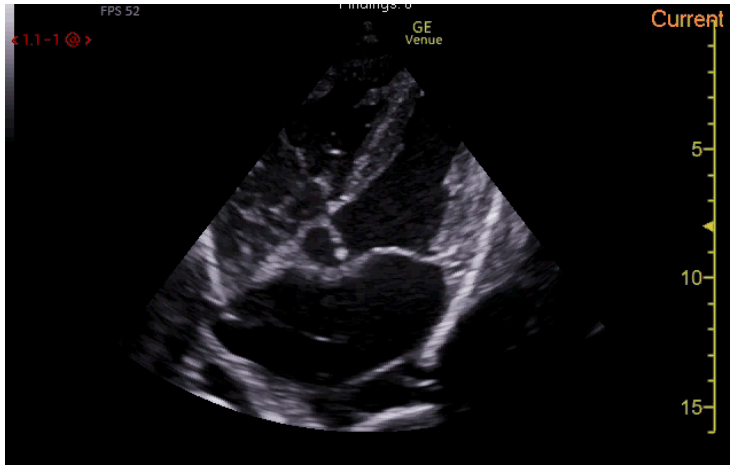
Pulmonary Edema with Normal Heart Size

New-onset Heart Failure

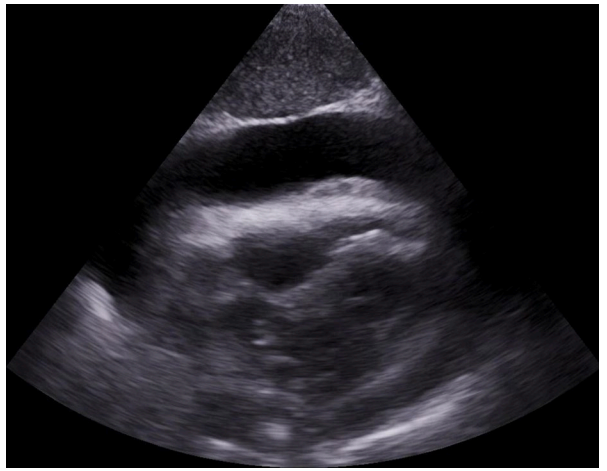
Cardiogenic Shock
ED Diagnosis

Primary Cardiac Event + **Acute Heart Failure** + **Circulatory Shock**

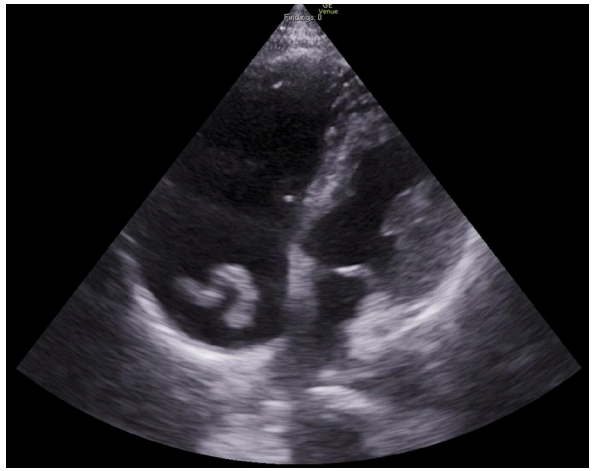
- **Cardiac POCUS** -- LVEF, contractility, mechanical issues, IVC



Diffuse Hypokinesis



Pericardial Tamponade



Acute RV Failure (PE)

Images courtesy of Matt Kongkatong MD - University of Virgina

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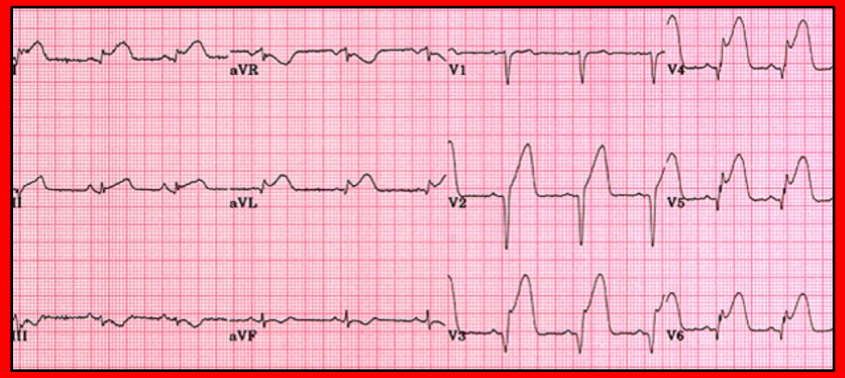

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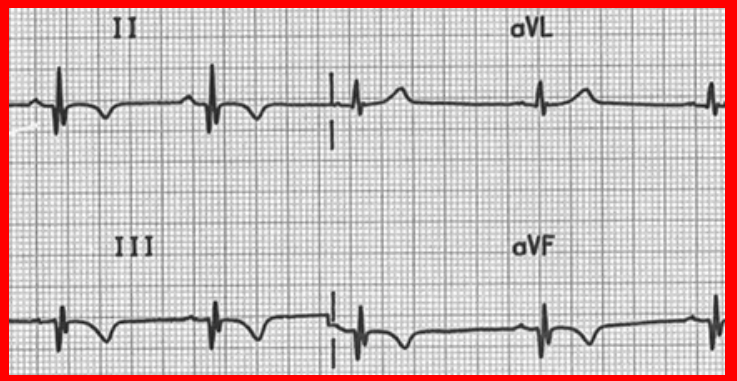
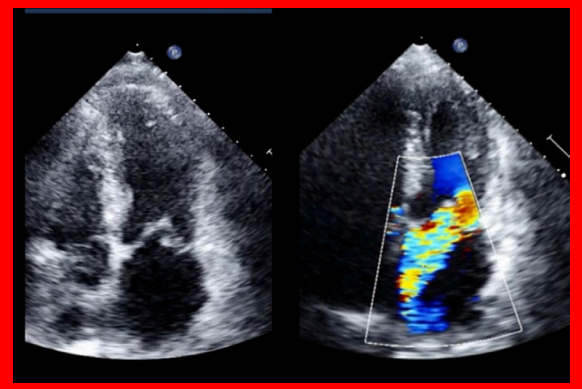
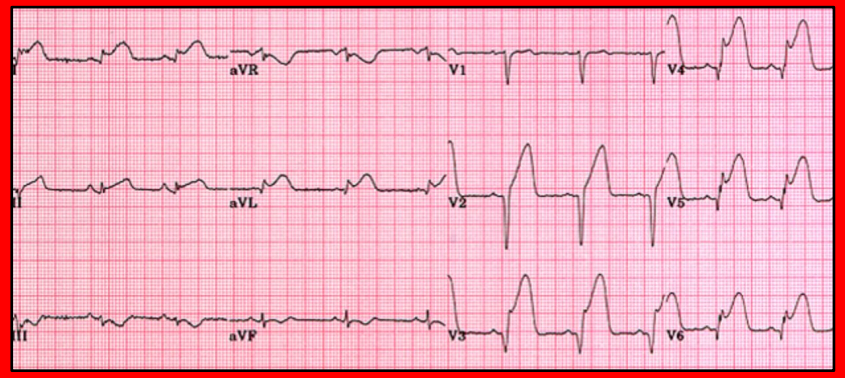


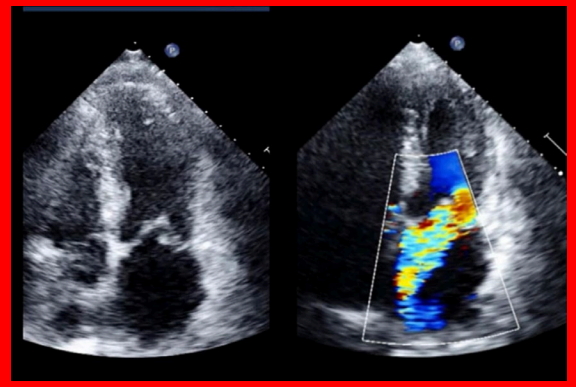


Two Cases

Anterolateral STEMI with Pulmonary Edema & Shock



Inferior MI 3 days ago with Papillary Muscle Rupture & Acute MR



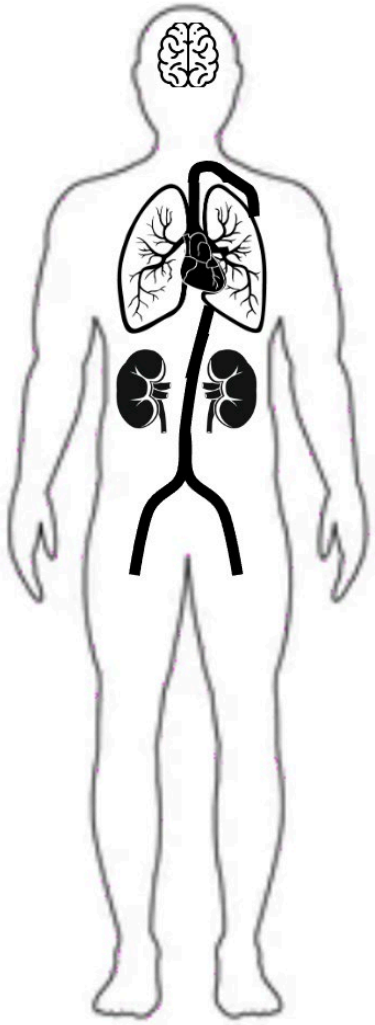
EMS
Venice

management

Cardiogenic Shock

Management

Resuscitation……



……Attention to the ABCs

Cardiogenic Shock

Management - Goals & Interventions

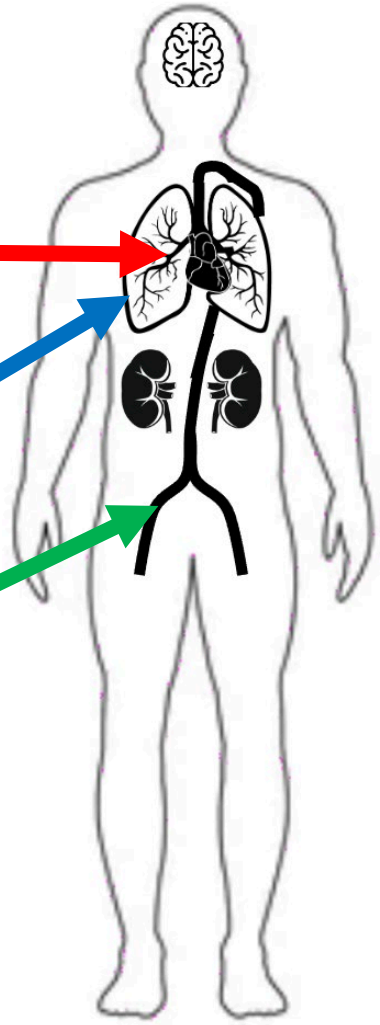
3 Goals

Restore cardiac output

Support respiratory function

Improve tissue perfusion

target MAP 65-70 mmHg



Interventions

Medical

IVF, vasopressors, & inotropes

Reperfusion therapy*

PCI > CABG >> Fibrinolysis

Mechanical support

IABP, pVAD, +/- ECMO

* **STEMI & Other Significant ACS**

Cardiogenic Shock
Medical Management

- **Primarily supportive** …no data suggests improved outcome

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  - norepinephrine - preferred agent
  - dopamine - second line agent
  - epinephrine - not the best choice
  - vasopressin - ? preferrable with RV failure

} **Caution with increased myocardial oxygen demand**

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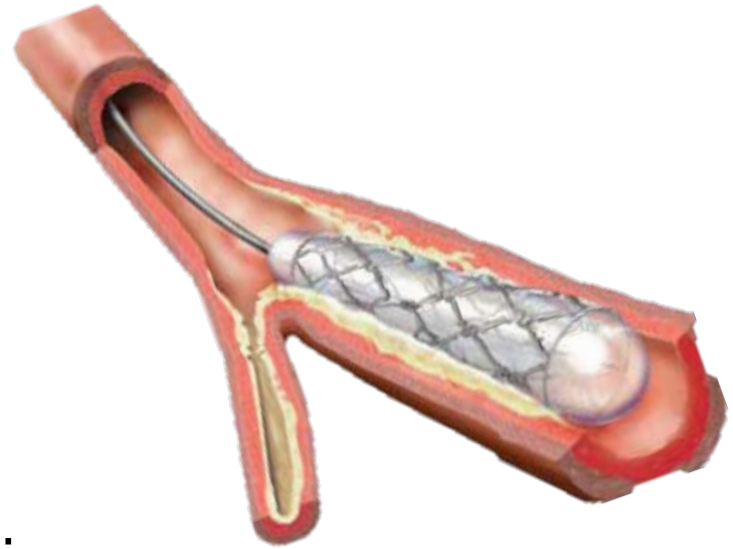
Caution with increased myocardial oxygen demand

- **Inotropes -** important intervention, frequently forgotten
  - dobutamine
  - milrinone

reasonable combination
norepinephrine & dobutamine

Cardiogenic Shock
Reperfusion Therapies

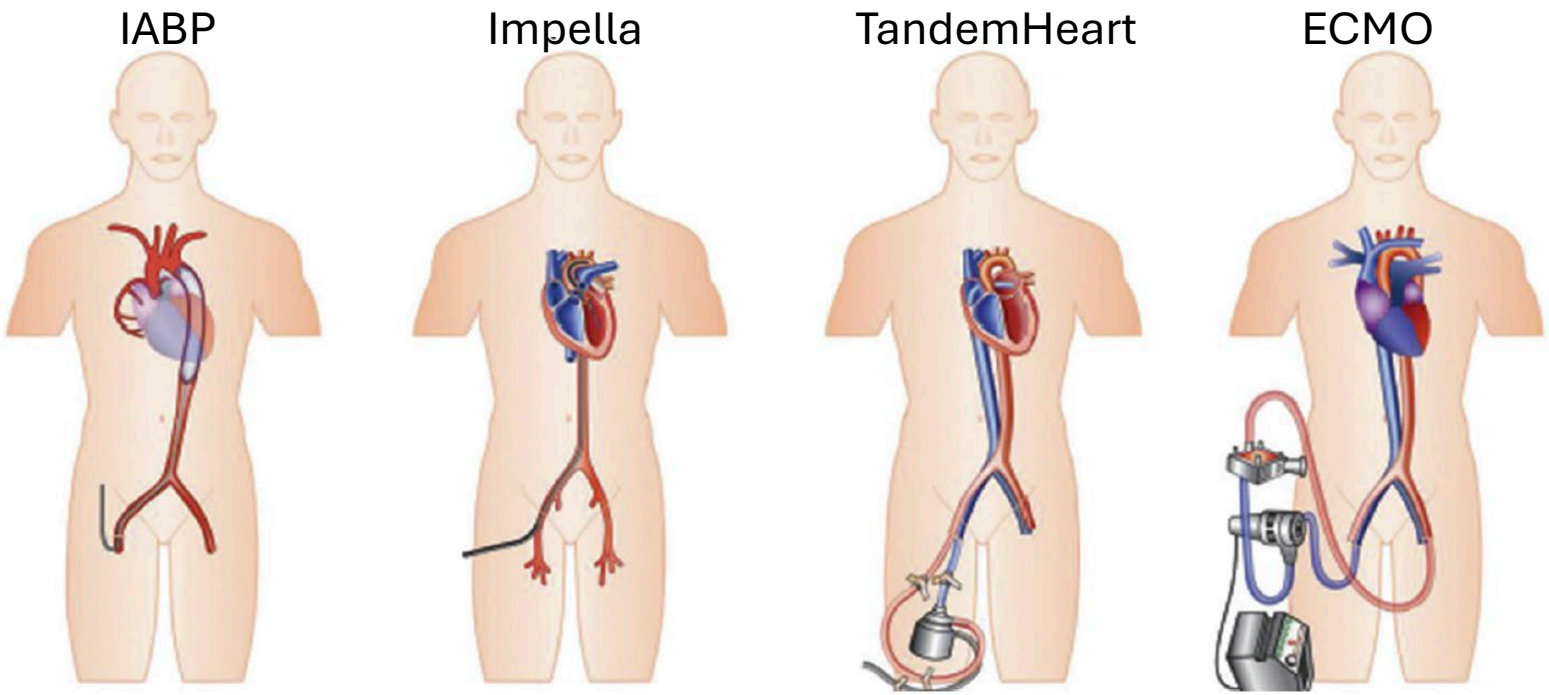
- **Patient selection**
  - STEMI > NSTEMI
  - LV vs LV & RV



- **Reperfusion therapies**
  - **PCI** – preferred reperfusion intervention
  - **CABG** - patients with “failed” PCI or other mechanical ischemic complications
  - **Fibrinolysis** – less effective & only recommended with STEMI & delay to PCI transfer

Cardiogenic Shock
Mechanical Circulatory Support

- **Require expert consultation & application**
- **Not available at all hospitals**



percutaneous ventricular assist devices

Werdan et al, Eur Heart J, 2013

University of Virginia Emergency Department &
Charlottesville Albemarle Rescue Squad

1963

Two Cases

Anterolateral STEMI with Pulmonary Edema & Shock

IVF bolus
Later norepinephrine
Cards recommendation - dobutamine

Helicopter transfer to PCI Center

PCI with IABP

Inferior MI 3 days ago with Papillary Muscle Rupture & Acute MR

IVF bolus & CT-PA: negative for PE

Addition of norepinephrine

Admission with Echo: acute MR

Cardiac surgery: stabilize then surgery

outcome, disposition, & pitfalls

Cardiogenic Shock
Outcome

- **Mortality ~50%** …varies related to underlying cardiac issue

Cardiogenic Shock
Outcome

- **Mortality ~50%** …varies related to underlying cardiac issue
- **Factors associated with increased mortality**
  - age ≥ 75 years & female gender
  - non-AMI cause of shock
  - peripheral arterial disease & chronic kidney disease
  - out-of-hospital cardiac arrest
  - left main culprit artery & LVEF ≤ 30%
  - need for dialysis +/- mechanical circulatory support

CABG or PCI associated with reduced hospital mortality

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CABG or PCI associated with reduced hospital mortality

- **Patients with cardiogenic shock frequently experience…**
  - Malignant dysrhythmias & cardiac arrest – Afib with RVR, VT, & CHB
  - Multi-organ failure – respiratory failure & AKI
  - Thromboembolism & stroke

Jung et al, *NEJM Evid,* 2024

Two Cases

Anterolateral STEMI with Pulmonary Edema & Shock

D/C 10 days later with moderate LV dysfunction

Inferior MI 3 days ago with Papillary Muscle Rupture & Acute MR

Patient arrested & expires

Cardiogenic Shock
Disposition

- **ICU admission**
- **Involvement of cardiology +/- cardiac surgery**
- **Transfer to “cardiac center,” if appropriate & possible**

Cardiogenic Shock
Pitfalls

- ✓ Failure to recognize syndrome
- ✓ In non-ischemic cases, failure to consider diagnosis
- ✓ Slow application of vasopressor
- ✓ Lack of inotrope use
- ✓ Slow escalation of care in non-ischemic cases

Two Cases

Anterolateral STEMI with Pulmonary Edema & Shock

Rapid diagnosis yet somewhat slower application of supportive care

Need for transfer to cardiac center for PCI & multidisciplinary supportive care

Very ill patient with somewhat straightforward diagnosis

Inferior MI 3 days ago with Papillary Muscle Rupture & Acute MR

Slower everything

…diagnosis
…application of supportive therapy
…definitive care

Very ill patient with very challenging diagnosis & high mortality rate

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That’s it …thanks!

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