Multidisciplinary Approach to Cardiogenic Shock
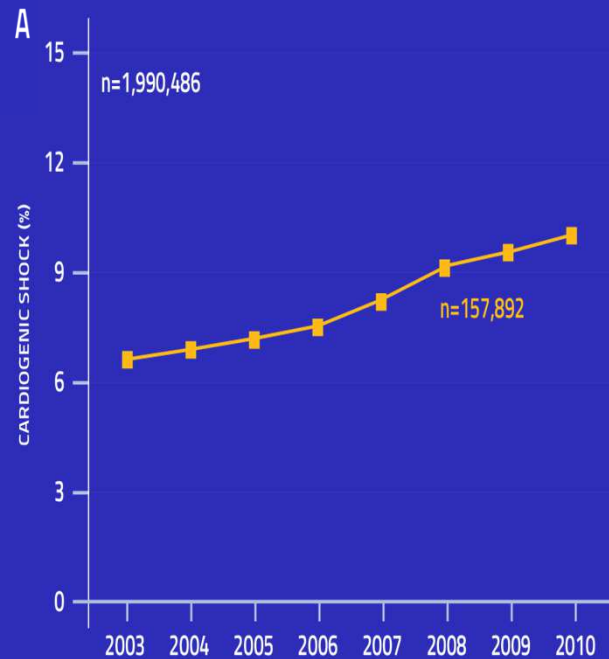
Azam Hadi M.D.

Incidence of Cardiogenic Shock Growing

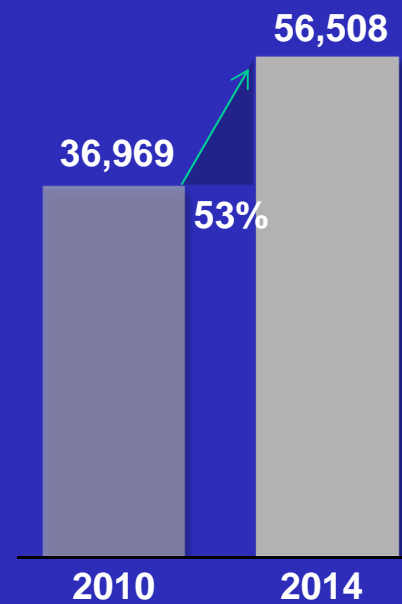## Cardiogenic Shock in STEMI Increasing [1]

STEMI Cardiogenic Shock in Medicare Age Increasing [2]

1. Dhaval Kolte et al. J Am Heart Assoc 2014 NATIONWIDE INPATIENT SAMPLE
2. Centers for Medicare and Medicaid database, MEDPAR FY14

Age $\geq$65 only, excludes non-Medicare population

History: Who gets Cardiogenic Shock?

LV failure 78.5%

Rupture/tamponade 1.4%

Acute MR 6.9%

VSD 3.9%

RV shock 2.8%
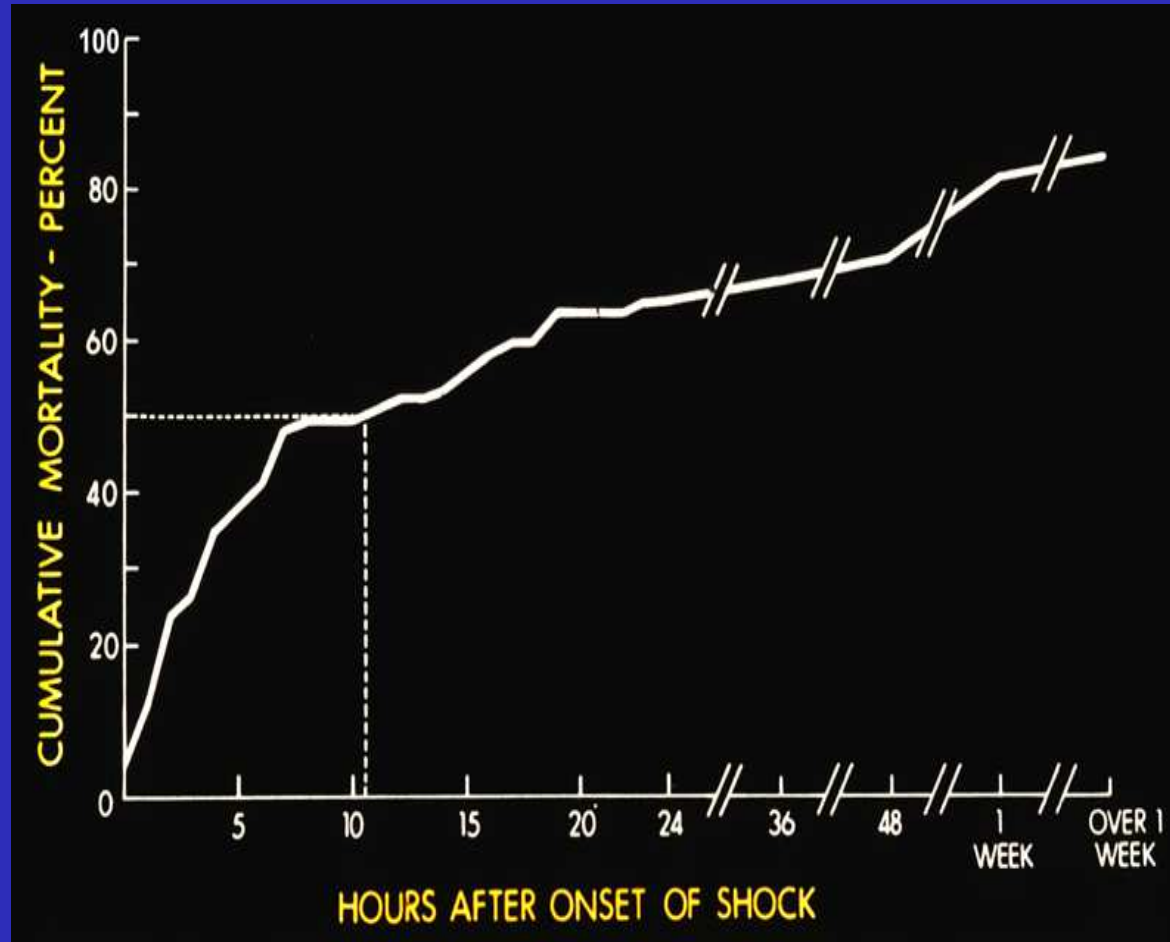
Other 6.5%

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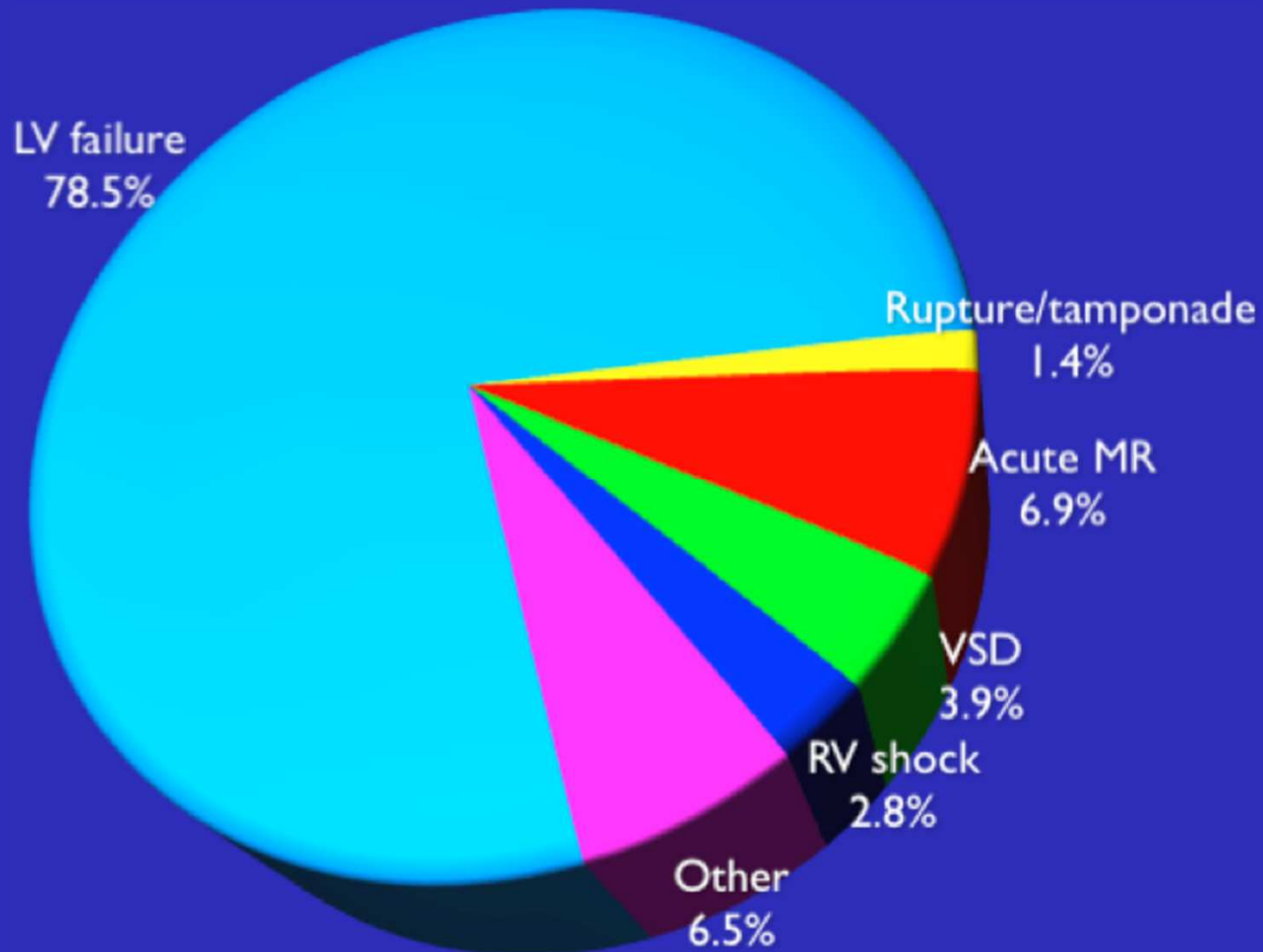
TIMEFRAME FOR DEVELOPMENT OF CARDIOGENIC SHOCK

- Median time frame for development of cardiogenic shock is 10 hours into AMI

- 39.6% develop cardiogenic shock within 6 hours

- 63.2% develop cardiogenic shock within 24 hours

- The majority of patients develop shock after arrival to the hospital

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Source: Hasdai D, et al. American Heart Journal. 1999;138 (1 Pt 1):21-31

Cardiogenic Shock is Bad

Definition

clinical criteria:

- hypotension (SBP of <90 mm Hg for at least 30 minutes or the need for supportive measures to maintain a sbp of ≥90 mm Hg) and
- end-organ hypo-perfusion (cool extremities or a urine output of <30 ml/hr, and a heart rate of ≥60 beats per minute).

hemodynamic criteria:

- cardiac index of no more than 2.2 liters/min/sq.m BSA
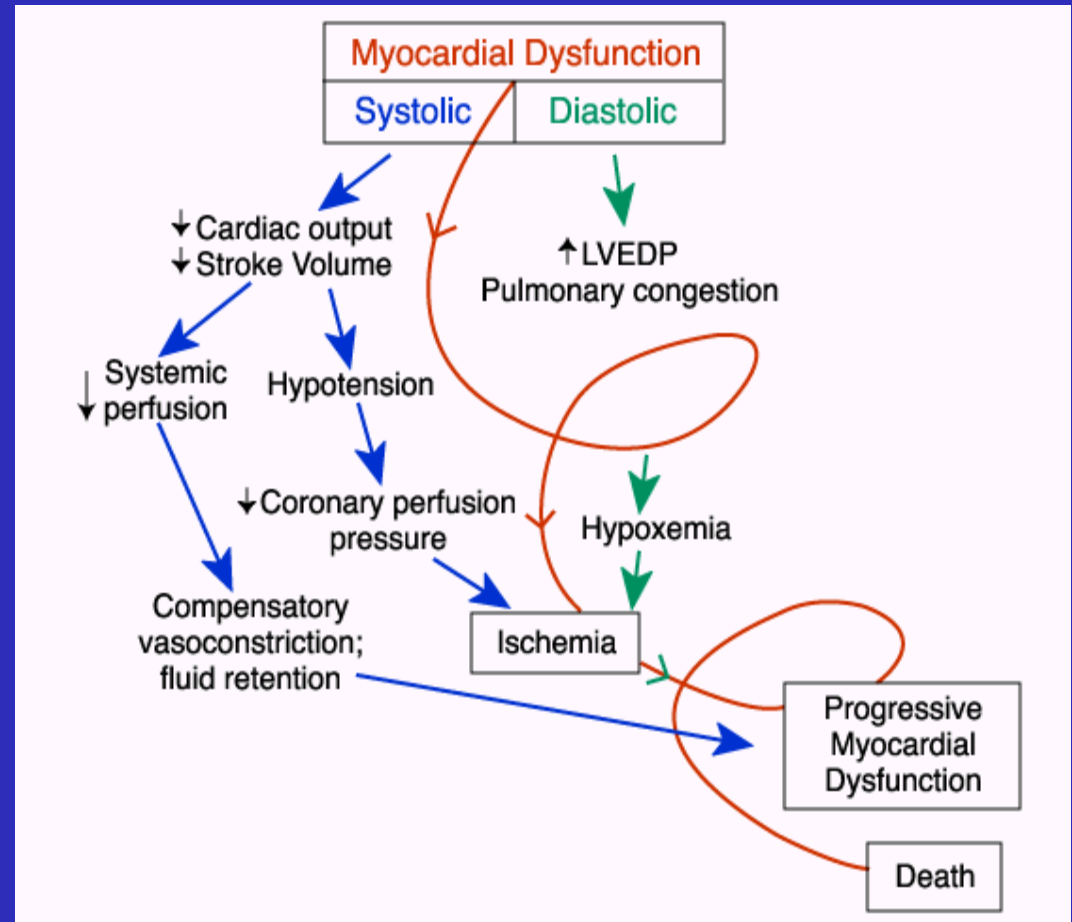- pulmonary-capillary wedge pressure of at least 15 mm Hg.

STEMI - CATH

- HR=105, B/P= 98/58 (69)
- Few crackles in lungs
- PA 45/25
- PCWP 24
- CVP 13
- CO 3.5
- SVR 1500
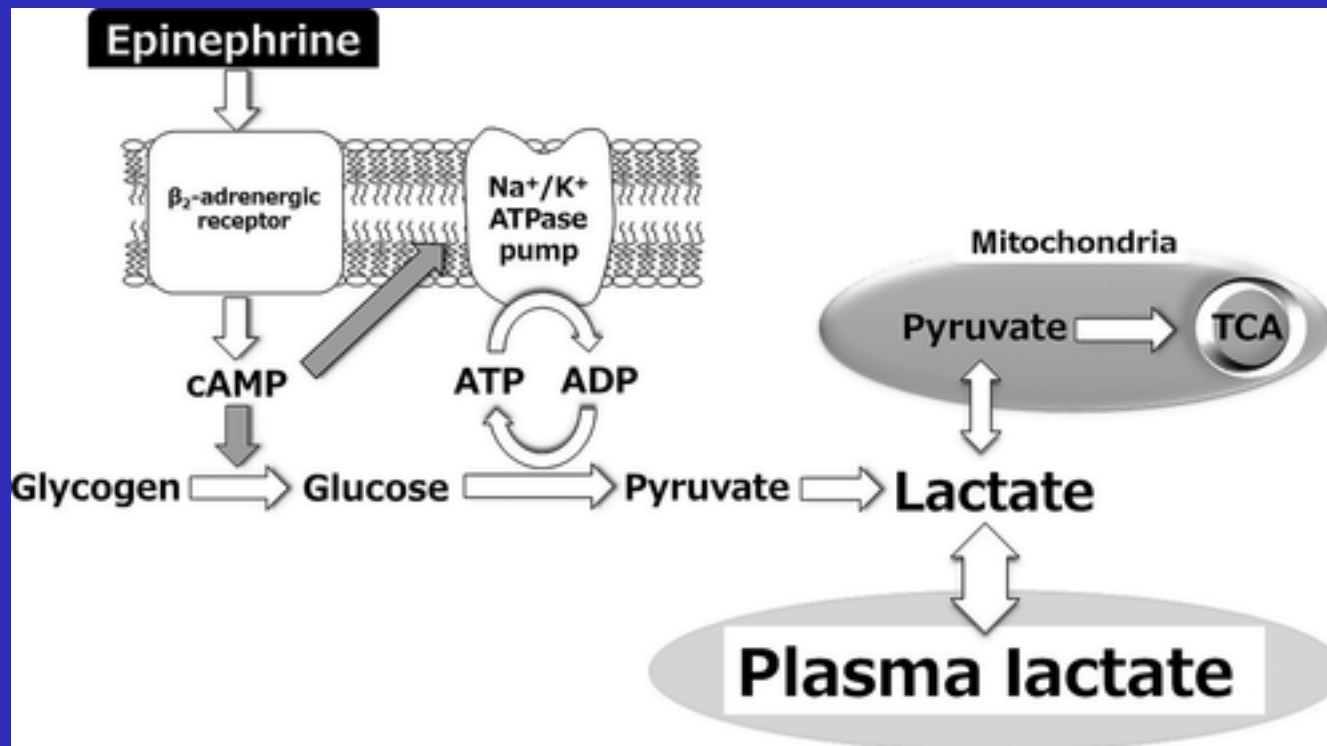

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Schematic

- LVEDP elevation
- Hypotension
- Decreased coronary perfusion
- Ischemia
- Further myocardial dysfunction
- Endorgan hypoperfusion

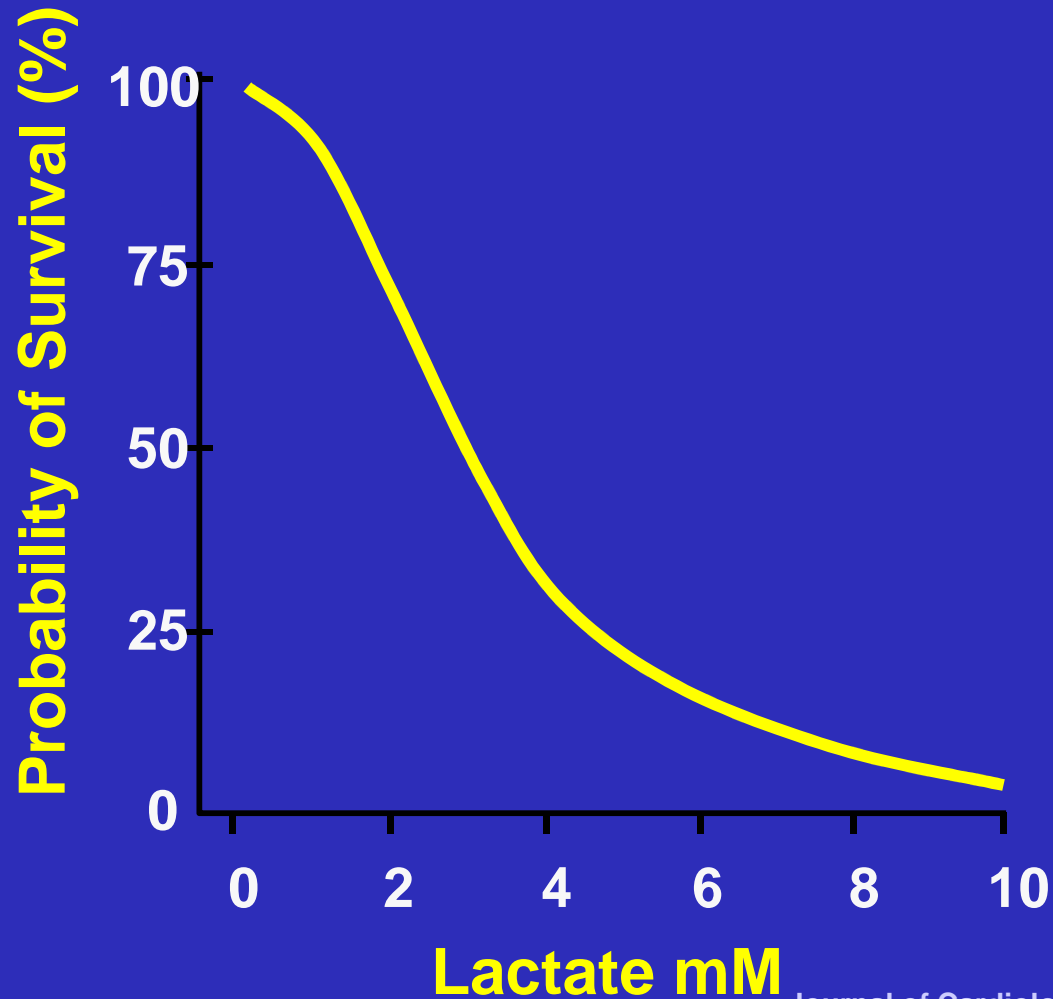# Lactate, a useful marker for disease mortality and severity

Pathophysiology of Shock

Hypotension + ↑ LVEDP → Myocardial Hypoperfusion →LV dysfunction → **Systemic lactic acidosis** → Impairment of non-ischemic myocardium → worsening hypotension.

Probability of Survival Based On Arterial Blood Lactate

BNP and prognosis

Table 4 **Patient Outcomes Stratified by BNP Levels**

Parameter	BNP Quartile				p Value
	Q1 <430 (n = 12,161)	Q2 430–839 (n = 12,146)	Q3 840–1,729 (n = 12,156)	Q4 ≥1,730 (n = 12,166)	
In-hospital mortality (%)	1.9	2.8	3.8	6.0	<0.0001
Mechanical ventilation (%)	3.1	3.7	3.9	4.1	.0002
Cardiopulmonary resuscitation (%)	0.6	0.9	1.2	1.7	<0.0001
ICU admission (%)	12.8	15.4	16.6	19.6	<0.0001
Length of stay, mean, median, 25th, 75th (days)	5.2 4.0, 2.7, 6.2	5.7 4.3, 2.9, 7.0	5.9 4.5, 3.0, 7.1	6.3 4.9, 3.0, 7.8	<0.0001*
Asymptomatic at hospital discharge (%)	48.8	49.6	48.0	43.6	<0.0001

Fonarow GC et al. *J Am Coll Cardiol* 2007; 49(19):1943-1950

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Cardiogenic Shock Admission Quality Metric

- **Shock order set**

- **Consult activated**

Cardiac power is the strongest hemodynamic correlate of mortality in cardiogenic shock
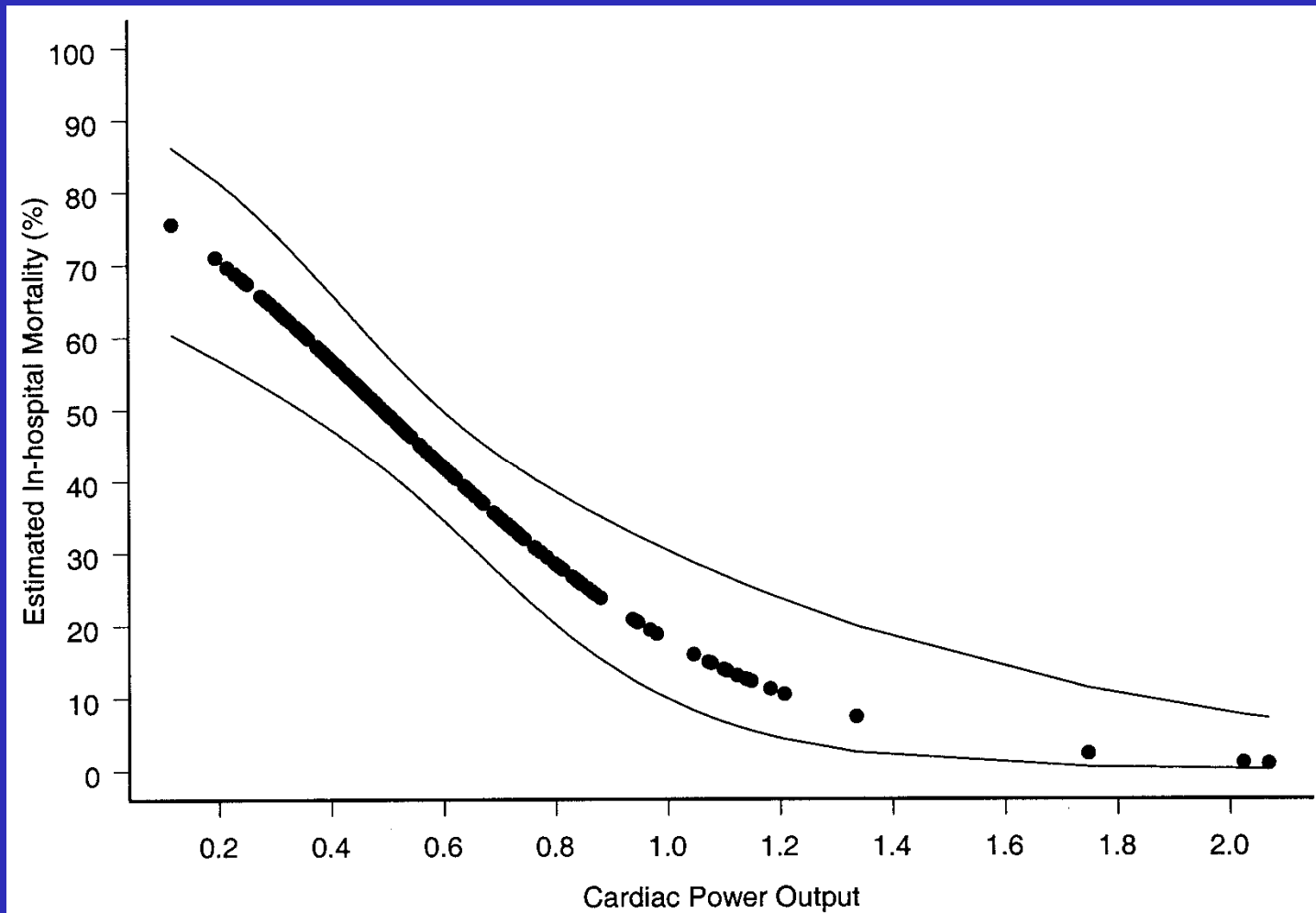
NOW LET'S TAKE A LOOK AT THIS PATIENT 4-6 HOURS LATER IN THE CCU

BP 80/40 (55), HR – 135

becoming agitated, crackles more prominent

PA 45/25

PCWP 24

CVP 15

CO 3

SVR 900

Has not urinated since admission

12 Lead EKG shows no changes

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OUR PATIENT 4-6 HRS LATER

- 100% non-rebreather oxygen mask , BP 80/45 (55)

- Fluid bolus 250cc NS

- Dopamine 10 mcg/kg/min

- Dobutrex 5 mcg/kg/min

- Lasix 40 mg IV

Hemodynamics

PA 45/25 (32)

PCWP 26

CVP 25

CO 3

SVR 600

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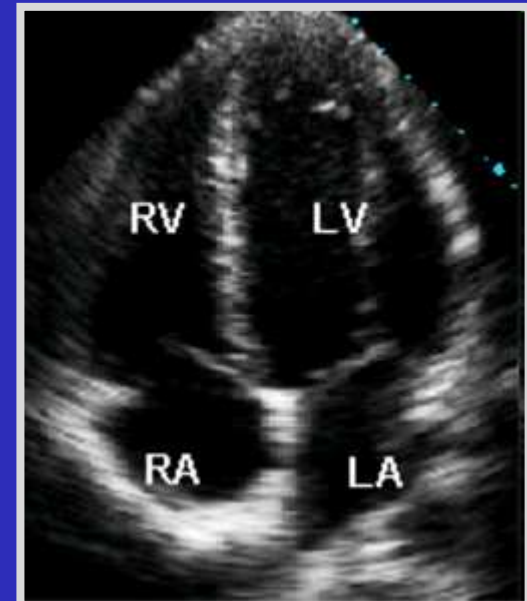
Pathophysiology: Downward Spiral
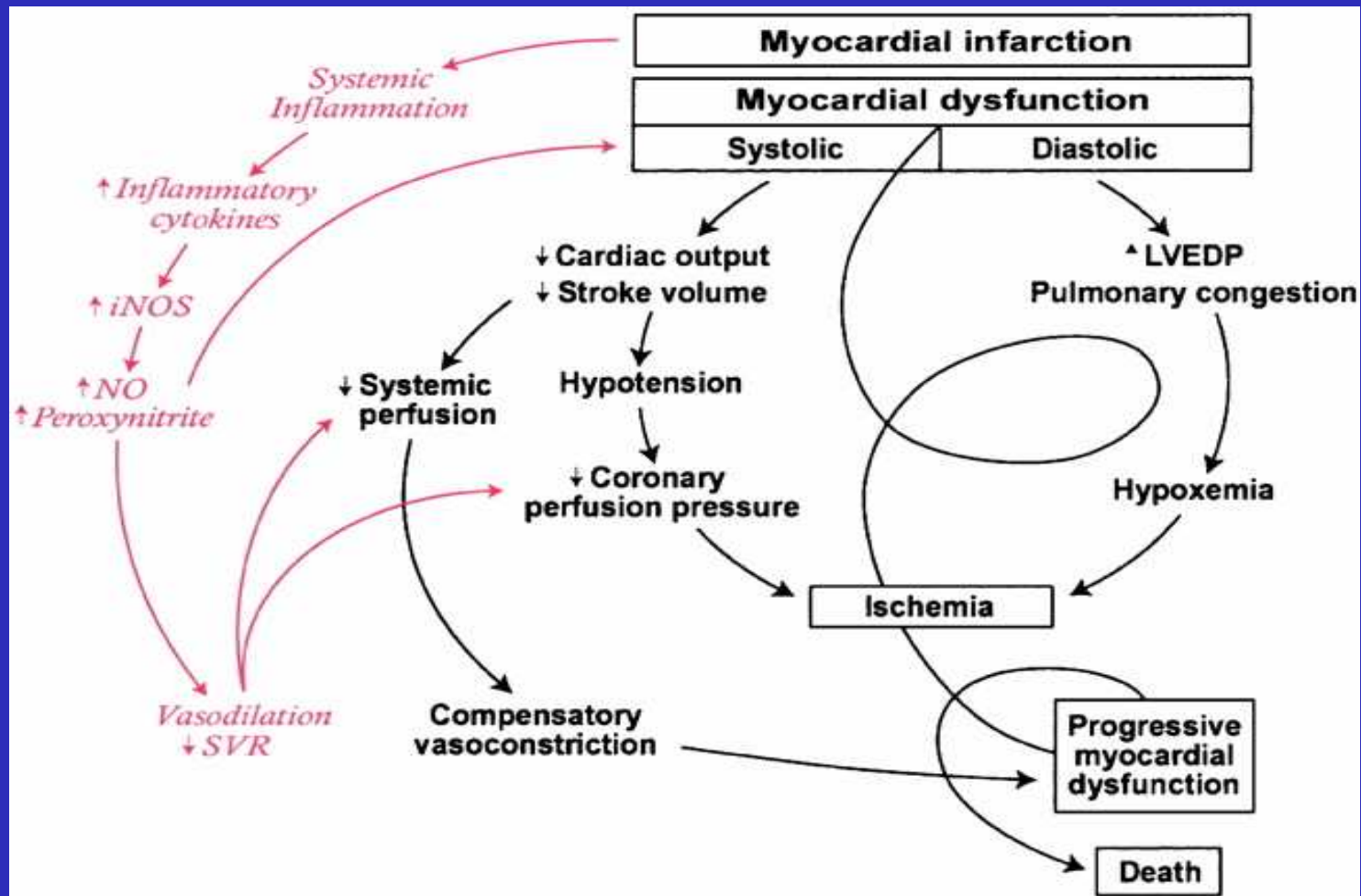
Limitations of Conventional Therapy

Mortality Risk with Inotropes/Vasopressors[1]
N = 40
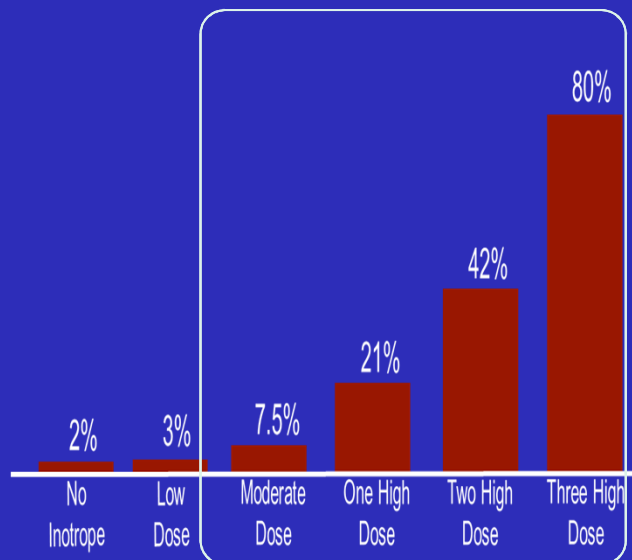
IABP-SHOCK II Randomized Controlled Trial[2]
N = 600

Bar chart values: No Inotrope 2%, Low Dose 3%, Moderate Dose 7.5%, One High Dose 21%, Two High Dose 42%, Three High Dose 80%

IABP (n=301)
Medical Therapy (n=299)
41.3%
39.7%

MORTALITY (%)
TIME AFTER RANDOMIZATION (DAYS)
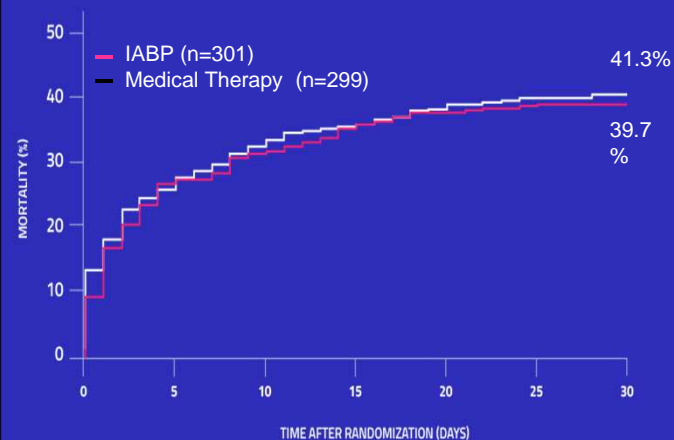
1- Samuels LE et al , J Card Surg. 1999
2- Thiele H et al. NEJM 2012 - Clinicaltrial.gov # NCT00491036

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CARDIOGENIC SHOCK
A CHANGE IN PARADIGM

DOOR TO BALLOON ➡ **DOOR TO SUPPORT**

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New Shock Paradigm
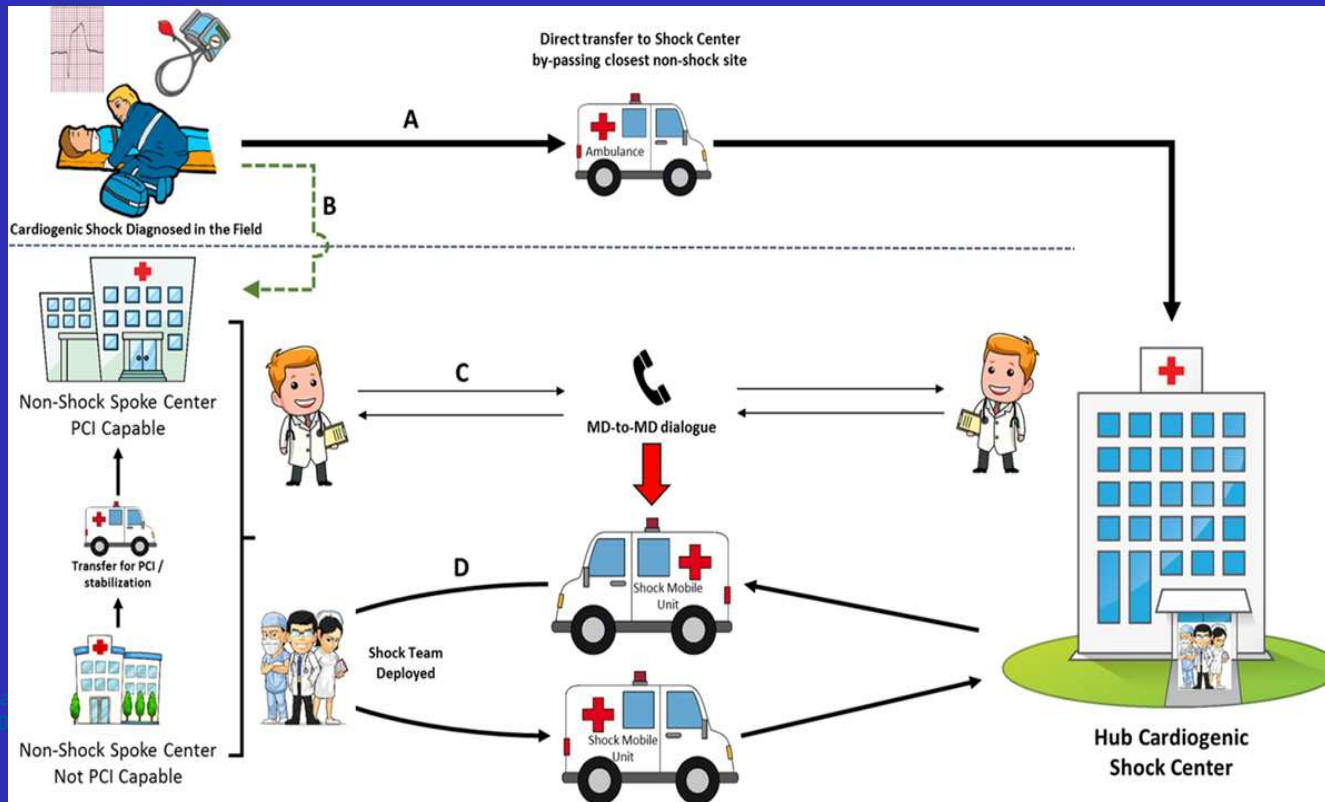
Cardiogenic Shock Program
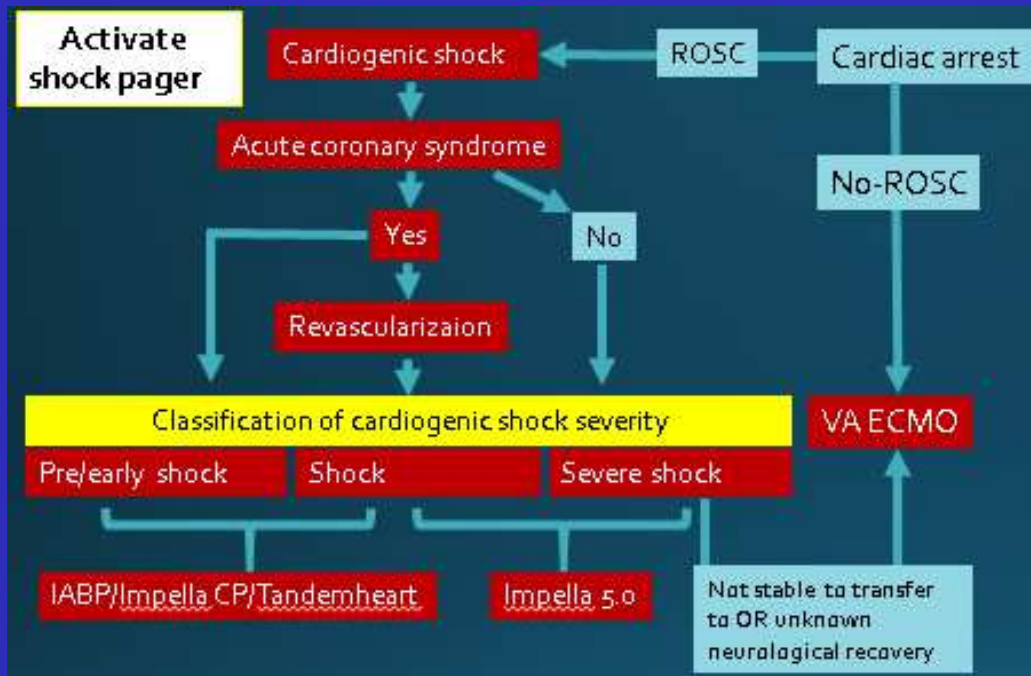
Paging 24/7

Goals of Shock Program:

✓ **Early recognition of Cardiogenic Shock**

✓ **Appropriate escalation of care**

✓ Optimal and timely utilization of resources e.g. Temporary MCS

✓ Improve patient outcomes

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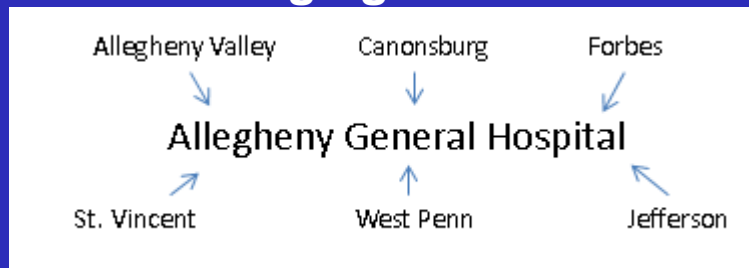
Detroit Shock Initiative

- July 2016 and February 2017, 4 metro Detroit sites

- 41 patients, avg age 65 ± 14 years, Prior to MCS,

  93% vasopressors/inotropes,

  >40% cardiac arrest

  17% were under active ACLS while MCS

- Door to support times avg 83 ± 58 minutes

- 71% of patients reduced levels of inotropes and vasopressors <24-hrs of index procedure

- Survival to explant 85% vs 51% ($p < 0.001$)

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Quality Metrics

- ✓ **Establish GOC**
- ✓ **Time to Optimal Support**
  - Utilization of resources e.g. Temporary MCS
  - <u>Multidisciplinary Team</u>
- ✓ **Prevent Iatrogenic Harm**
- ✓ **Improve patient outcomes**
  - 30 day mortality
  - ICU length of stay

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Cardiogenic Shock Algorithm

Patient with suspected cardiogenic shock (CS)

Clinical criteria to rapidly identify shock state:

Systolic blood pressure (SBP) <90 mm Hg for >30 minutes
(or use of inotropes/vasopressors to maintain SBP)

Evidence of end-organ hypoperfusion

Lactate level >2 mmol/l

Activate Shock Team through a one-call line for multidisciplinary discussion:
Interventional Cardiology; Cardiac Surgery; Advanced Heart Failure; Critical Care

Transfer patient to cardiac catheterization lab or cardiac intensive care unit (CICU) for evaluation
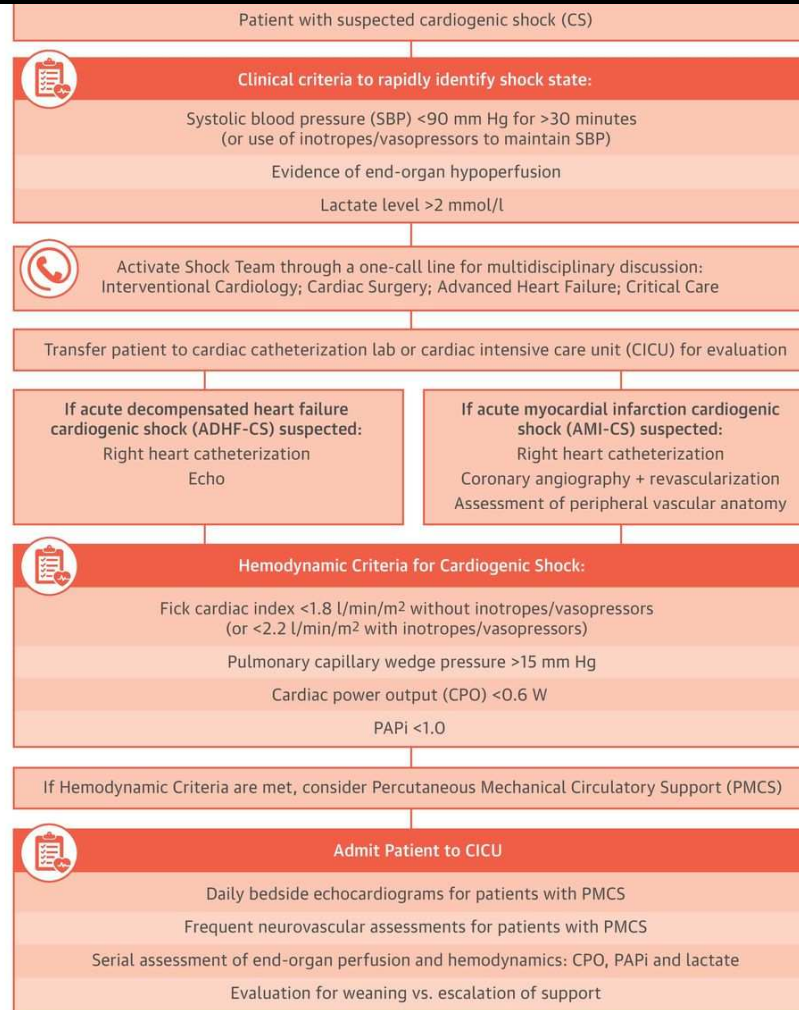
If acute decompensated heart failure cardiogenic shock (ADHF-CS) suspected:
Right heart catheterization
Echo

If acute myocardial infarction cardiogenic shock (AMI-CS) suspected:
Right heart catheterization
Coronary angiography + revascularization
Assessment of peripheral vascular anatomy

Hemodynamic Criteria for Cardiogenic Shock:

Fick cardiac index <1.8 l/min/m² without inotropes/vasopressors
(or <2.2 l/min/m² with inotropes/vasopressors)

Pulmonary capillary wedge pressure >15 mm Hg

Cardiac power output (CPO) <0.6 W

PAPi <1.0

If Hemodynamic Criteria are met, consider Percutaneous Mechanical Circulatory Support (PMCS)

Admit Patient to CICU

Daily bedside echocardiograms for patients with PMCS

Frequent neurovascular assessments for patients with PMCS

Serial assessment of end-organ perfusion and hemodynamics: CPO, PAPi and lactate

Evaluation for weaning vs. escalation of support

Tehrani, B.N. et al. J Am Coll Cardiol. 2019;73(13):1659–69.

Behnam N. Tehrani et al. J Am Coll Cardiol 2019;73:1659-1669

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Who do you want on *your* Shock Team?

1. Advanced HF Specialist
2. Interventional Cardiologist
3. Cardiac Surgeon
4. Critical Care / Intensivist (MD)
5. Critical Care Nursing Team
6. Palliative Care
7. CCU Pharmacist
8. Physical and Occupational Therapy
9. Nutritionist
10. Chaplain
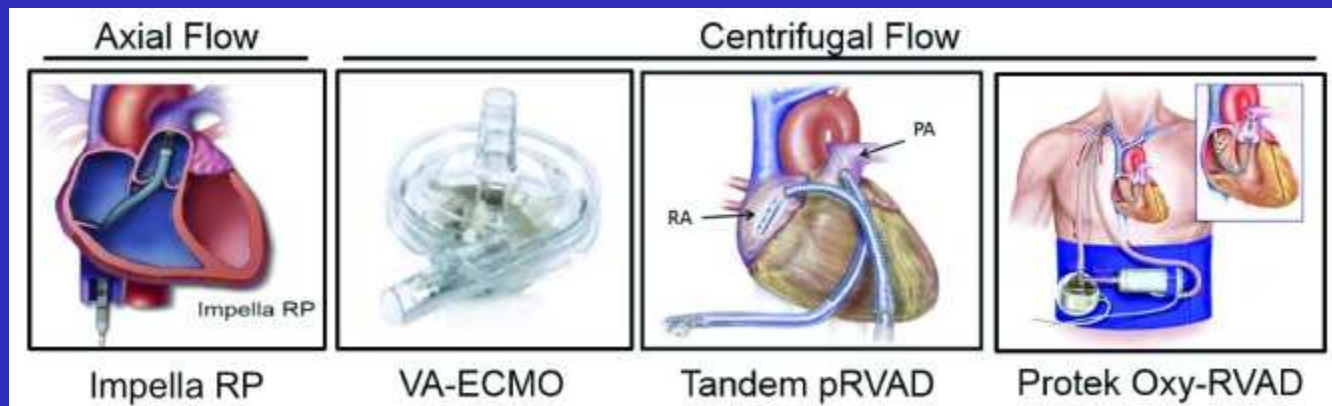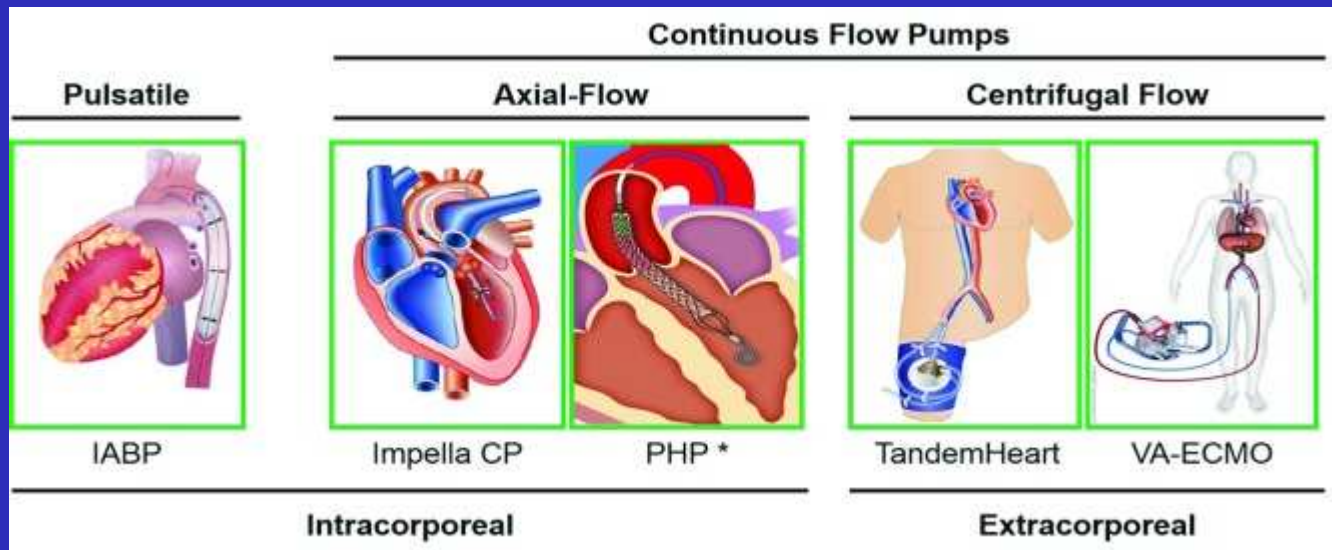
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Variety Of Devices

Quality Metrics

- ✓ **Time to Optimal Support**
  - Utilization of resources e.g. Temporary MCS
  - Multidisciplinary Team
- ✓ **Prevent Iatrogenic Harm**
- ✓ **Improve patient outcomes**
  - 30 day mortality
  - ICU length of stay
  - ✓ **Establish GOC**

Check list for Devices

| CICU DAILY ROUNDING CHECKLIST	Patient Name: MRN:
Mechanical Circulatory Support	• Position • Site of insertion • Anticoagulation • Extremity

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Quality Metrics

✓ **Time to Optimal Support**

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- Multidisciplinary Team

✓ **Prevent Iatrogenic Harm**

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Improve Patient Outcomes

Behnam N. Tehrani et al. J Am Coll Cardiol 2019;73:1659-

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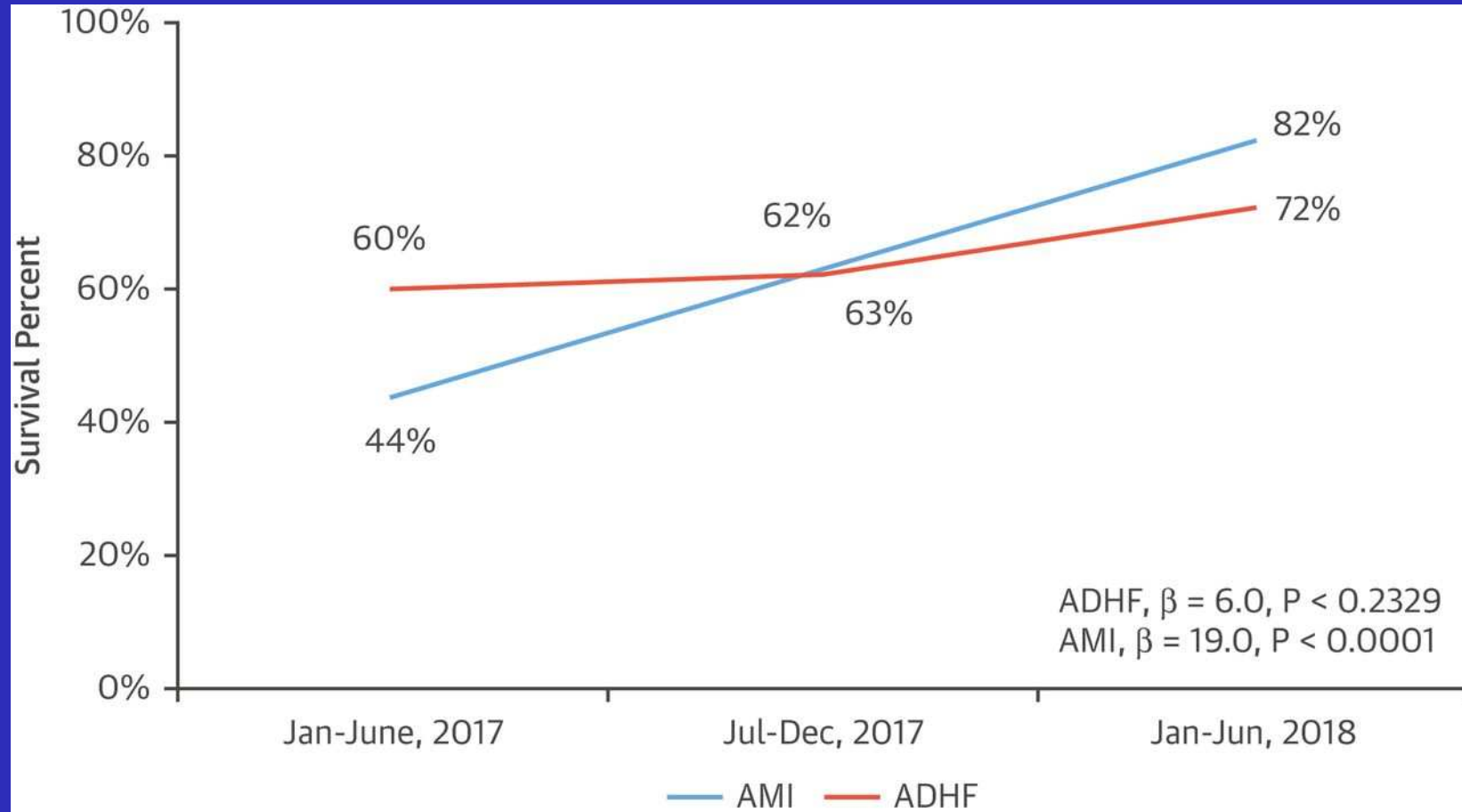
Study of Outcomes- Paucity of Data

56 vs. 55 in control comparable between the two groups.
Marginally significant lower 30-day mortality in the SHOCK TEAM group in a Cox regression model (38.9% vs. 60% in control group; hazard ratio, 0.65; confidence interval [CI], 0.41 to 1.04 in the intervention group; p= 0.07).
ICU stay and hospital stay also tended to be shorter in the SHOCK TEAM group (mean $\pm$ SD, 13 $\pm$ 13 vs. 27 $\pm$ 59 days in control, p= 0.33 and 16 $\pm$ 15 vs. 31 $\pm$ 59 days in control, p= 0.30

Utah Cardiac Recovery (UCAR) "Shock Team ("Shock-team" cohort) and compared with the immediately preceding 40 patients ("Control" cohort
Shock Team" cohort had at presentation shock liver (p=0.01), acute renal failure (p=0.04), lower ejection fraction (p=0.05), higher right atrial pressure (p=0.04) and underwent cardiopulmonary resuscitation (p=0.05). Despite a sicker population comprising the "Shock Team", the primary outcome of 30-day mortality did not show statistical significant difference in a Cox regression model. Correspondingly, "Shock to Support" time revealed faster MCS utilization on "Shock Team" (9$\pm$30 Vs 16$\pm$28 hrs., p=0.21).

437 patients were in the control and 110 in the protocol group. Baseline characteristics were similar and etiology of cardiogenic shock (i.e., post MI, acute myocarditis, acute systolic heart failure, etc) were similar in both groups. The protocol group had significant reduction in-hospital mortality i.e., 35% (38/110) vs. 45% (197/437) (*P* value < .05). The utilization of advanced mechanical support was significantly higher in the protocol group i.e., 30/110 vs. 55/437 in the control group (*P* value < .0003).
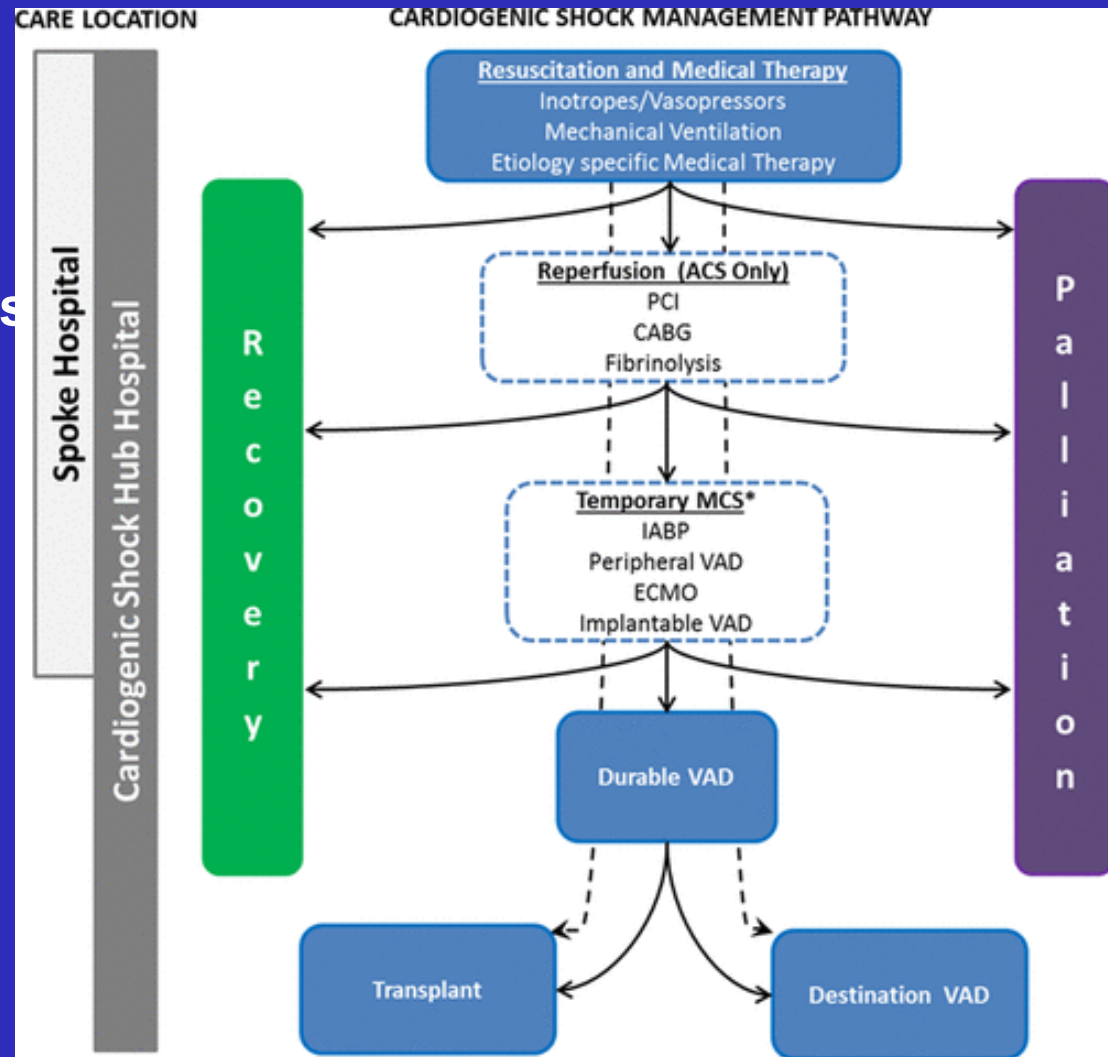
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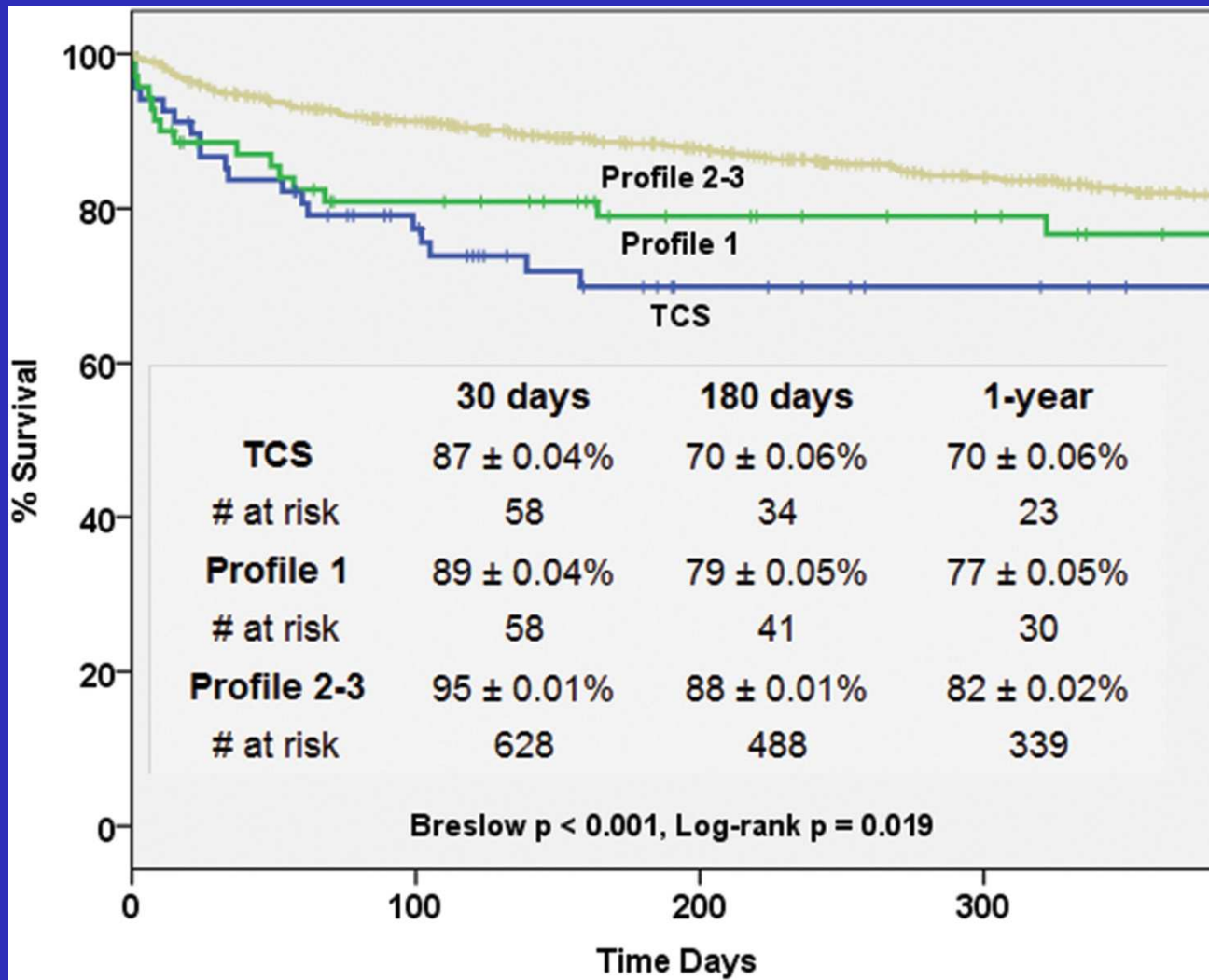
Quality Metrics

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- **Cardiogenic Shock is Multi-………**

- **Multidisciplinary approach**

- **Hub and Spoke**

- **Protocols and Algorithm**

CARE LOCATION — CARDIOGENIC SHOCK MANAGEMENT PATHWAY

Spoke Hospital

Cardiogenic Shock Hub Hospital

Recovery

Palliation

Resuscitation and Medical Therapy
Inotropes/Vasopressors
Mechanical Ventilation
Etiology specific Medical Therapy

Reperfusion (ACS Only)
PCI
CABG
Fibrinolysis

Temporary MCS*
IABP
Peripheral VAD
ECMO
Implantable VAD

Durable VAD

Transplant

Destination VAD

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"There's no easy way I can tell you this, so I'm sending you to someone who can."

CARDIOGENIC SHOCK RISK FACTORS

Four risk factors account for >85% of the

predictive information needed to determine if
a patient is at high risk to develop CS:

- Age

    - Single greatest risk factor

    - For every ten year increase in age, the risk of developing shock increases by 47%

- Systolic Blood Pressure

- HR

- Killip Class

CS patients were more likely to have a history of hypertension, dyslipidemia, and prior coronary angioplasty, non inferior MI

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Conclusion

- Cardiogenic Shock is Multi-………

- Multidisciplinary approach

- Hub and Spoke

- Protocols and Algorithm

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