Multidisciplinary Approach to Cardiogenic Shock

Azam Hadi M.D.
Incidence of Cardiogenic Shock Growing

Cardiogenic Shock in STEMI Increasing

STEIM Cardiogenic Shock in Medicare Age Increasing

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

Age ≥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%
CARDIOGENIC SHOCK — BACKGROUND

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

Cardiogenic Shock is Bad

[Graph showing cumulative mortality percentage over hours after onset of shock, with a steep increase in mortality starting around 10 hours.]
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
- LVEDP elevation
- Hypotension
- Decreased coronary perfusion
- Ischemia
- Further myocardial dysfunction
- End-organ hypoperfusion
Lactate, a useful marker for disease mortality and severity
Pathophysiology of Shock

Hypotension $\rightarrow$ LVEDP $\rightarrow$ Myocardial Hypoperfusion $\rightarrow$ LV dysfunction $\rightarrow$ **Systemic lactic acidosis** $\rightarrow$ Impairment of non-ischemic myocardium $\rightarrow$ worsening hypotension.
Probability of Survival Based On Arterial Blood Lactate

Journal of Cardiology
Volume 65, Issue 2, February 2015, Pages 164-170
### Table 4: Patient Outcomes Stratified by BNP Levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BNP Quartile</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1 &lt;430 (n = 12,161)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q2 430-839 (n = 12,146)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q3 840-1,729 (n = 12,156)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q4 ≥1,730 (n = 12,166)</td>
<td></td>
</tr>
<tr>
<td>In-hospital mortality (%)</td>
<td>1.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mechanical ventilation (%)</td>
<td>3.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cardiopulmonary resuscitation (%)</td>
<td>0.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ICU admission (%)</td>
<td>12.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Length of stay, mean, median, 25th, 75th (days)</td>
<td>4.0, 27, 6.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Asymptomatic at hospital discharge (%)</td>
<td>48.8</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Cardiogenic Shock Admission Quality Metric

- Shock order set
- Consult activated

<table>
<thead>
<tr>
<th>Cardiology Cardiogenic Shock</th>
<th>Manage My Version</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Vital Signs</strong></td>
<td></td>
</tr>
<tr>
<td>✓ PA Pressure</td>
<td></td>
</tr>
<tr>
<td>Routine, Every 4 hours First occurrence Today at 1042 for 72 hours</td>
<td></td>
</tr>
<tr>
<td>Fick/Thermodilution hemodynamics every 4 hours X 72 Hours</td>
<td></td>
</tr>
<tr>
<td><strong>Nursing Assessments</strong></td>
<td></td>
</tr>
<tr>
<td>✓ Strict Intake And Output</td>
<td></td>
</tr>
<tr>
<td>Routine, Every hour First occurrence Today at 1042 for 72 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Physician Consults</strong></td>
<td></td>
</tr>
<tr>
<td>[ ] Inpatient Consult to Advanced CHF</td>
<td></td>
</tr>
<tr>
<td>[ ] Inpatient consult to Cardiogenic shock</td>
<td></td>
</tr>
<tr>
<td>[ ] Details</td>
<td></td>
</tr>
<tr>
<td><strong>Labs</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Chemistry Basic</strong></td>
<td></td>
</tr>
<tr>
<td>✓ Lactic acid, venous, whole blood</td>
<td></td>
</tr>
<tr>
<td>Routine, Every 6 hours First occurrence Today at 1042 Last occurrence on Thu 7/26 at 0000 for 72 hours</td>
<td></td>
</tr>
<tr>
<td>✓ Basic Metabolic Panel</td>
<td></td>
</tr>
<tr>
<td>Routine, Every 6 hours First occurrence Today at 1042 Last occurrence on Thu 7/26 at 0000 for 72 hours</td>
<td></td>
</tr>
<tr>
<td>✓ Blood Gas, Mixed Venous</td>
<td></td>
</tr>
<tr>
<td>Routine, Every 4 hours First occurrence Today at 1042 Last occurrence on Thu 7/26 at 0400 for 72 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Other Tests</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cardiac Studies</strong></td>
<td></td>
</tr>
<tr>
<td>✓ Echocardiogram Transthoracic TTE</td>
<td></td>
</tr>
</tbody>
</table>
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
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
Pathophysiology: Downward Spiral
Limitations of Conventional Therapy

Mortality Risk with Inotropes/Vasopressors¹

<table>
<thead>
<tr>
<th>Dose Level</th>
<th>Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Inotrope</td>
<td>2%</td>
</tr>
<tr>
<td>Low Dose</td>
<td>3%</td>
</tr>
<tr>
<td>Moderate Dose</td>
<td>7.5%</td>
</tr>
<tr>
<td>One High Dose</td>
<td>21%</td>
</tr>
<tr>
<td>Two High Dose</td>
<td>42%</td>
</tr>
<tr>
<td>Three High Dose</td>
<td>80%</td>
</tr>
</tbody>
</table>

N = 40

IABP-SHOCK II Randomized Controlled Trial²

N = 600

- IABP (n=301)
- Medical Therapy (n=299)

Mortality Risk:
- IABP: 41.3%
- Medical Therapy: 39.7%

References:
2. Thiele H et al. NEJM 2012 - Clinicaltrial.gov # NCT00491036
CARDIOGENIC SHOCK
A CHANGE IN PARADIGM

DOOR TO BALLOON  DOOR TO SUPPORT
New Shock Paradigm
Cardiogenic Shock Program

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
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)
Quality Metrics

✓ Establish GOC
✓ 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
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


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
Variety Of Devices

Continuous Flow Pumps

<table>
<thead>
<tr>
<th>Pulsatile</th>
<th>Axial-Flow</th>
<th>Centrifugal Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>IABP (Intracorporeal)</td>
<td>Impella CP</td>
<td>PHP * (Extra-corporeal)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TandemHeart</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VA-ECMO</td>
</tr>
</tbody>
</table>

Axial Flow

- Impella RP
- VA-ECMO
- Tandem pRVAD
- Protek Oxy-RVAD
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

<table>
<thead>
<tr>
<th>Patient Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRN:</td>
</tr>
</tbody>
</table>

## Mechanical Circulatory Support

- Position
- Site of insertion
- Anticoagulation
- Extremity
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
Improve Patient Outcomes

Behnam N. Tehrani et al. J Am Coll Cardiol 2019;73:1659-
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 ± SD, 13 ± 13 vs. 27 ± 59 days in control, p= 0.33 and 16 ± 15 vs. 31 ± 59 days in control, p= 0.30.

Utah Cardiac Recovery (UCAR) “Shock Team (\textquotedblleft Shock-team\textquotedblright cohort) and compared with the immediately preceding 40 patients (\textquotedblleft Control\textquotedblright 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±30 Vs 16±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).
• Cardiogenic Shock is Multi-
• Multidisciplinary approach
• Hub and Spoke
• Protocols and Algorithm
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**
• Cardiogenic Shock is Multi-………
• Multidisciplinary approach
• Hub and Spoke
• Protocols and Algorithm

“There’s no easy way I can tell you this, so I’m sending you to someone who can.”
CARDIOGENIC SHOCK — BACKGROUND

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
Conclusion

- Cardiogenic Shock is Multi-…………
- Multidisciplinary approach
- Hub and Spoke
- Protocols and Algorithm