Acute Myocardial Infarction Complicated by Cardiogenic Shock

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Director, Acute Circulatory Support Program
Director, Interventional Research Laboratories
Investigator, Molecular Cardiology Research Institute
56 year old man with new onset stuttering chest pain 24 hours prior to ED presentation. Persistent 3/10 chest pain. Initial ECG shows inferior ST-segment elevation (1-2mm).

HR: 100  BP: 110/80  RR: 24  \( O_2 \) Sat:98% FM
JVP: N/A.
+ S1/S2, +S4.
No murmur. No rub.
Cool lower extremities. No edema.

Echocardiogram while prepping: 
LVEF 35%
Inferoposterior akinesis
No VSD. No MR.
RV normal.
No pericardial effusion.

Yes, No, Maybe, or it doesn’t matter?
Defining Cardiogenic Shock

SHOCK Trial (1993-1998): Early revascularization vs Medical Therapy

- **Clinical criteria**
  - SBP<90 mm Hg for >30 minutes or supportive measures to maintain SBP>90 and
  - Hypoperfusion (cool extremities, urine output of <30 ml per hour, and HR>60)

- **Hemodynamic criteria**
  - Cardiac index < 2.2 LPM/BSA
    - NB: Contemporary definition: CI <2.2 on pharmacologic support or <1.8 without therapy
  - PCWP >15 mm Hg.
  - Pulmonary artery catheterization was not required if anterior MI with CHF.

- **Early Shock:**
  - < 36 hours after myocardial infarction; randomization <12 hours after the diagnosis of shock

- **Exclusion Criteria:**
  - Severe systemic illness, mechanical or other cause of shock, severe valvular disease, dilated cardiomyopathy, the inability of care givers to gain access for catheterization, and unsuitability for revascularization.
LVEF Does Not Define Cardiogenic Shock

Broad Range of LVEF in the SHOCK Trial

Mean LVEF = 30%

This differential should be running through your mind…

Predominant LV Failure: 74.5%

Acute Severe MR: 8.3%

VSD: 4.6%

Isolated RV Shock: 3.4%

Tamponade/rupture: 1.7%

Other: 7.5%

Shock Registry
JACC 2000 35:1063
Despite increasing use of PCI and IABP, mortality remains high in cardiogenic shock.
Temporal Trends in Care and Outcomes of Patients with Cardiogenic Shock Undergoing Percutaneous Coronary Intervention: A Report from the NCDR®

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<tbody>
<tr>
<td>Peri-procedural MI</td>
<td>1.6%</td>
<td>1.4%</td>
<td>3.8%</td>
<td>4.0%</td>
<td>&lt;0.0001</td>
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<tr>
<td>Ischemic Stroke</td>
<td>1.4%</td>
<td>1.3%</td>
<td>1.4%</td>
<td>1.4%</td>
<td>0.80</td>
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<tr>
<td>Renal Failure</td>
<td>5.3%</td>
<td>6.4%</td>
<td>3.1%</td>
<td>3.1%</td>
<td>&lt;0.0001</td>
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<tr>
<td>Any vascular complication</td>
<td>1.6%</td>
<td>1.3%</td>
<td>1.4%</td>
<td>1.2%</td>
<td>0.02</td>
</tr>
<tr>
<td>RBC Transfusion</td>
<td>23.1%</td>
<td>23.1%</td>
<td>18.7%</td>
<td>15.2%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Bleeding &lt;72 hrs</td>
<td>11.5%</td>
<td>12.3%</td>
<td>10.0%</td>
<td>8.7%</td>
<td>&lt;0.0001</td>
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<tr>
<td>Mortality</td>
<td>27.6%</td>
<td>27.4%</td>
<td>28.2%</td>
<td>30.6%</td>
<td>&lt;0.0001</td>
</tr>
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Wayangankar SA et al. J Am Coll Cardiol. 2015;65(10_S);S0735-1097(15)
What would you do? STEMI and ‘Shock’

Next steps?
1. LCx PCI
2. RHC
3. IABP
4. Impella CP
5. TandemHeart
6. CABG
Rapid Reperfusion Limits Myocardial Damage (Door to Balloon)

Door to Balloon Angioplasty (DTB)

- Plaque
- Expanded stent
- Widened artery
- Compressed plaque
- Increased blood flow

Graph:

- Maximal Benefit
- Definite Benefit
- No Clear Benefit

Time to Reperfusion Agent (Hours)

- 100%
- 75%
- 50%
- 25%
- 0%
Long-term Benefits of Early Treatment

Log-Rank $P=.03$

Proportion Alive

Early Revascularization

Initial Medical Stabilization

No. at Risk

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<tr>
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<th>ERV</th>
<th>IMS</th>
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<tr>
<td>152</td>
<td>38</td>
<td>150</td>
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<tr>
<td>56</td>
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<td>18</td>
<td>9</td>
<td>3</td>
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<tr>
<td>18</td>
<td>2</td>
<td>3</td>
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Hochman JS et al. JAMA 2006;295:2511–2515
Revascularization strategy among cardiogenic shock patients after receipt of coronary angiography

Something to keep in mind:

No incremental impact of DTB << 90 min on mortality in Anterior MI or Cardiogenic Shock.
What would you do? STEMI and ‘Shock’

Next steps?
1. LCx PCI
2. RHC
3. IABP
4. Impella CP
5. TandemHeart
6. CABG
What would you do? STEMI and Shock

1. Initiated bivalirudin
2. Administered Prasugrel
3. Prepared for PCI
4. Started with a RHC

Rationale:
1. Vessel is going to be opened
2. If he is in shock, we would like to know since reperfusion may worsen his already marginal hemodynamic status.
3. An RA sat of 30% vs 90% might alter our approach here (both being bad).
Pathophysiology of Acute MI / Cardiogenic Shock

SVR often normal
In contrast, to chronic HF
Initial RHC

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<tbody>
<tr>
<td>RA</td>
<td>12</td>
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<tr>
<td>PA</td>
<td>36/18</td>
</tr>
<tr>
<td>PCWP</td>
<td>24</td>
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<tr>
<td>Fick CI</td>
<td>1.5</td>
</tr>
<tr>
<td>PA Sat</td>
<td>43%</td>
</tr>
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<td>FA Sat</td>
<td>99%</td>
</tr>
<tr>
<td>MAP</td>
<td>70</td>
</tr>
<tr>
<td>SVR</td>
<td>2400</td>
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<tr>
<td>Na⁺ (mEq/L)</td>
<td>136</td>
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<tr>
<td>Creatinine</td>
<td>1.1</td>
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What would you do? STEMI and Shock

This RHC data alters my approach:
First stabilize his hemodynamics, then revascularize when safe to do so
Caveat: Many would recommend opening the culprit artery first.
Is there Support for IABP Support in AMI/Shock?
Is there Support for Mechanical Support in AMI/Shock?

IABP-SHOCK II
Randomized ACS patients with clinically defined shock to PCI with- versus without- IABP support

Interpretation: Uniform use of IABP in ACS and ‘Shock’ is unnecessary.

Questions:
1. Unloading stable patients with ACS?
2. Timing of IABP pre- vs post-PCI?
3. No assessment of IABP function?

Conclusion:
Hard to make statements about unloading without hemodynamic data.

Thiele H et al. NEJM 2012
Is there Support for Mechanical Support in AMI/Shock?

- Cardiogenic shock
- PCI, no AMI or cardiogenic shock
- AMI, no cardiogenic shock

O’Neill: PROTECT II (HR-PCI)
O’Neill: USPELLA AMI/Shock
Kar: TandemHeart in CGS

Seyfarth: ISAR-SHOCK (Impella 2.5 vs IABP)
Use of Mechanical Circulatory Support in Patients Undergoing Percutaneous Coronary Intervention
Insights From the National Cardiovascular Data Registry

Amneet Sandhu, MD; Lisa A. McCoy, MS; Smita I. Negi, MD; Irfan Hameed, MD; Frashant Atri, MD; Subhi J. Al’Aref, MD; Jeptha Curtis, MD; Ed McNulty, MD; H. Vernon Anderson, MD; Adhir Shroff, MD; Mark Menegus, MD; Rajesh V. Swaminathan, MD; Hitinder Gurm, MBBS; John Messenger, MD; Tracy Wang, MD; Steven M. Bradley, MD, MPH

Marked Regional Variation for MCS for Shock
## USPella: STEMI and Shock Subset Analysis

### Pre- vs Post-PCI Impella Activation

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<tr>
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<th>Impella Pre-PCI</th>
<th>Impella Post-PCI</th>
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<tbody>
<tr>
<td></td>
<td>N = 63</td>
<td>N = 91</td>
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<tr>
<td></td>
<td>Pre Support</td>
<td>On Support</td>
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<tr>
<td>MAP, mmHg</td>
<td>67.9±20.7 (59)</td>
<td>94.5±21.3 (59)</td>
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<tr>
<td>PCWP, mmHg</td>
<td>30.8±7.8 (11)</td>
<td>19.7±7.9 (11)</td>
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<tr>
<td>Cardiac Index, L/min/m²</td>
<td>1.9±0.9 (7)</td>
<td>2.3±0.8 (7)</td>
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<tr>
<td>Cardiac Power Output, Watt</td>
<td>0.54±0.2 (7)</td>
<td>0.83±0.4 (7)</td>
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O’Neill W. JIC 2013
USPella: STEMI and Shock Subset Analysis
Pre- vs Post-PCI Impella Activation

Log-Rank, p=0.004

Cumulative survival

Number of patients at risk

0 5 10 15 20 25 30

Days from initiation of Impella 2.5 support

Pre - PCI

Post-PCI

O’Neill W. JIC 2013
What would you do? STEMI and Shock

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First Unload...
Then Reperfuse

\[ \text{O}_2 \text{ Demand} \quad \text{First Unload} \ldots \quad \text{O}_2 \text{ Supply} \quad \ldots \text{then Reperfuse} \]

Myocardial Perfusion
Take Home Messages

- Cardiogenic shock can be defined clinically at the bedside or using specific hemodynamic criteria.

- Mentally run through the cardiogenic shock differential check list before you revascularize in STEMI + Shock

- Early reperfusion saves lives. Do NOT ignore the importance of the door to balloon time.

- More rapid reperfusion (< 90 mins DTB) may not benefit all patients with cardiogenic shock.

- Hemodynamic interrogation helps you stratify patients and define your therapeutic strategy.