Utilizing the Cath Lab for Cardiac Arrest

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Presenter Disclosure Information

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FINANCIAL DISCLOSURE
No relevant financial relationships to disclose.
Cardiac Arrest - Definition

- Ineffective cardiac contractions resulting in hemodynamic collapse
- Essentially a catastrophic arrhythmic event
  - Pulseless ventricular tachycardia
  - Ventricular fibrillation
  - Pulseless electrical activity (PEA)
  - Asystole
Cardiac Arrest – Rhythm Sequence

Cardiac Arrest - Underlying Substrate

Deshpande S et al. SCD in Brown DL: Cardiac Intensive Care; 1998, p391
How Can the Cath Lab Help?

- CAD
  - Anomalies
  - NSTEMI & chronic CAD
  - Cardiogenic shock
  - Monitoring and Resuscitation

- STEMI

- Pulmonary Embolism
  - Referral to surgery
  - IVC filter

- Thrombolysis

- Therapeutic Hypothermia

Keywords:
- CAD
- STEMI
- Cardiogenic shock
- NSTEMI & chronic CAD
- Pulmonary Embolism
- Thrombolysis
- Therapeutic Hypothermia
Cardiac Arrest- Relationship to MI

- STEMI presenting with resuscitated arrest  4-5% ¹
- Resuscitated arrest showing new ST elevation  20% ²
- Resuscitated arrest with evidence of healed MI  40-75% ²

² Myerburg RJ et al. SCD. In Zipes D: Cardiac Electrophysiology 2004; p 720
Arrest and Shock in STEMI

Arrest, Shock and Mortality in STEMI

- 30-day mortality with cardiogenic shock 40-50%
- 30-day mortality with resuscitated arrest 40-50%
- 30 day mortality with arrest and shock 60-70%
Acute STEMI Care is A Team Sport
In STEMI Patients, Time is Muscle
Why FMC-to-Device ≤90 Minutes?

In-Hospital Mortality (%)

Door-to-Balloon Time (Minutes)

≤90  >90 - 120  >120 - 150  >150

McNamara, JACC 2006;47:2180-86
Improvement of Early Mortality in STEMI

- Pre-CCU Era: 30% mortality
- CCU Era: 15% mortality
- Lytic Era: 7-8% mortality
- Current Era: 3-4% mortality

Improvements include:
- Defibrillation Monitoring Beta-blockers
- Fibrinolytics Aspirin Heparin
- Primary PCI Stents Anti-platelet Rx

Defibrillation and reperfusion strategies have significantly reduced early mortality in STEMI.
Cardiac Arrest in Context of STEMI

Therapeutic hypothermia should be started as soon as possible in comatose patients with STEMI and out-of-hospital cardiac arrest caused by VF or pulseless VT, including patients who undergo primary PCI.

Immediate angiography and PCI when indicated should be performed in resuscitated out-of-hospital cardiac arrest patients whose initial ECG shows STEMI.

ACC/AHA STEMI Guidelines, 2013
Evidence for Early Transfer to Cath Lab

- Retrospective propensity matched analysis
- 240 patients with resuscitated out of hospital arrest in the Seattle area
- Prior to routine application of hypothermia
- Improved hospital survival, but no significant difference in neurologic status

<table>
<thead>
<tr>
<th>Variable</th>
<th>≤6-Hour Group (n = 61)</th>
<th>&gt;6-Hour or No Catheterization Group (n = 179)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharged alive</td>
<td>44 (72%)</td>
<td>87 (49%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Days hospitalized</td>
<td>9.1 ± 6.0</td>
<td>9.8 ± 21.7</td>
<td>0.81</td>
</tr>
<tr>
<td>Percutaneous coronary intervention</td>
<td>38 (62%)</td>
<td>13 (7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Awakened</td>
<td>40/60 (67%)</td>
<td>93/174 (53%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Best neurologic status</td>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>Full recovery</td>
<td>18/43 (42%)</td>
<td>47/86 (55%)</td>
<td></td>
</tr>
<tr>
<td>Mild impairment</td>
<td>16/43 (37%)</td>
<td>19/86 (22%)</td>
<td></td>
</tr>
<tr>
<td>Severe impairment</td>
<td>4/43 (9%)</td>
<td>11/86 (13%)</td>
<td></td>
</tr>
<tr>
<td>Comatose</td>
<td>5/43 (12%)</td>
<td>9/86 (10%)</td>
<td></td>
</tr>
</tbody>
</table>

1001 patients who were discharged from hospital with resuscitated out of hospital arrest
- 38% underwent PCI
- 25% underwent hypothermia
- Adjusted RRR of death was reduced with PCI (by 54%) and hypothermia (by 30%)

Dumas F et al. JACC 2012; 60:21-27.
Co-Existence of Arrest and Shock in STEMI

MV PCI for STEMI, Arrest and Shock

Six Months Survival

Single vs. Multi-vessel Disease

Culprit only vs. Multi-vessel PCI

Advanced Support for Cardiogenic Shock

Is There Evidence to Support Mechanical Support?
Intra-Aortic Balloon Counter-pulsation

- Mainstay of hemodynamic support for cardiogenic shock pts
- Main mechanisms of action:
  - Improve cardiac index
  - Reduce afterload
  - Reduce LVEDP & PCWP
  - Improve coronary perfusion
- Indicated for CS (class IB ACC/AHA and IC ESC guidelines)
- Most commonly used support system
### IABP – Cardiogenic Shock

#### The SHOCK Trial

*Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock?*


<table>
<thead>
<tr>
<th>Outcome and Subgroup</th>
<th>Revascularization</th>
<th>Medical Therapy</th>
<th>Relative Risk (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-day mortality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>46.7 (152)</td>
<td>56.0 (150)</td>
<td>0.83 (0.67 to 1.04)</td>
<td>0.11</td>
</tr>
<tr>
<td>Age &lt;75 yr</td>
<td>41.4 (128)</td>
<td>56.8 (118)</td>
<td>0.73 (0.56 to 0.95)</td>
<td>0.01†</td>
</tr>
<tr>
<td>Age ≥75 yr</td>
<td>75.0 (24)</td>
<td>53.1 (32)</td>
<td>1.41 (0.95 to 2.11)</td>
<td></td>
</tr>
<tr>
<td>6-mo mortality‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50.3 (151)</td>
<td>63.1 (149)</td>
<td>0.80 (0.65 to 0.98)</td>
<td>0.027</td>
</tr>
<tr>
<td>Age &lt;75 yr</td>
<td>44.9 (127)</td>
<td>65.0 (117)</td>
<td>0.70 (0.56 to 0.89)</td>
<td></td>
</tr>
<tr>
<td>Age ≥75 yr</td>
<td>79.2 (24)</td>
<td>56.3 (32)</td>
<td>1.41 (0.97 to 2.03)</td>
<td>0.003†</td>
</tr>
</tbody>
</table>

* IABP was used in 86% of patients in each group

IABP – Acute MI without Shock

Shock II Trial

Randomized Comparison of IABP vs. OMT in Addition to Revascularization in Patients with Acute Myocardial Infarction Complicated by Cardiogenic Shock

- 600 pts with AMI + CS
- >95% revascularization
- 1:1 randomization to IABP+OMT vs. OMT alone
- Primary Endpoint: All-cause mortality at 30 days

A miniaturized pump motor that is delivered to the LV, with inlet and outlet holes straddling the aortic valve
- Femoral access (13F)
- Arterial access only — faster and easier to deliver
- Axial flow of 2.5L/min, Impella CP can provide 4.0L/min
- Impella 5.0 usually requires an arterial cut-down
Percutaneous LVADs – Impella®

The PROTECT II Trial: Post-hoc Analysis 1

All Patients, Counting Only Large MIs (N=426)

Log rank test, p=0.04

Death, Stroke, large MI, TVR

MACCE (%)
Percutaneous LVADs – Impella®

Baseline Angiograms

Caudal – High OM

Cranial - Mid LAD
Percutaneous LVADs – Impella®

Final Angiograms

Caudal – High OM

Cranial – Mid LAD
Percutaneous LVADs – Tandem Heart ®

- A miniaturized percutaneous centrifugal pump
- Femoral access
- Requires arterial and venous access
- Requires trans-septal puncture, venous catheter placed in LA
- More technically challenging
Percutaneous LVADs – ECMO

- A percutaneous cardiopulmonary bypass system
- Complete support of cardiac output and respiratory function
- Femoral and/or neck access
- Requires arterial and venous access
- Not time consuming to insert, but requires a perfusionist
Non-Coronary Arrest in the Cath Lab

- Massive and submassive PE
- Hypertrophic cardiomyopathy
- Anomalous coronary arteries
  - anomalous LM arising from R cusp
- Functional conditions
  - Long QT syndromes
  - Electrolyte disturbances
Pulmonary Embolism
Pulmonary Thrombolysis
Cardiac Arrest in the Young
Cardiac Arrest in the Young

Impact of Therapeutic Hypothermia

77 VT-VF patients, with No Cardiogenic Shock

The New England Journal of Medicine

INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST
TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>HYPOTHERMIA (N=43)</th>
<th>NORMOTHERMIA (N=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal or minimal disability (able to care for self, discharged directly to home)</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Moderate disability (discharged to a rehabilitation facility)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Severe disability, awake but completely dependent (discharged to a long-term nursing facility)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Severe disability, unconscious (discharged to a long-term nursing facility)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Death</td>
<td>22</td>
<td>23</td>
</tr>
</tbody>
</table>
## Impact of Therapeutic Hypothermia

The New England Journal of Medicine

VOLUME 346  FEBRUARY 21, 2002  NUMBER 8

MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

The Hypothermia after Cardiac Arrest Study Group*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Normothermia</th>
<th>Hypothermia</th>
<th>Risk Ratio (95% CI)*</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no./total no. (%)</td>
<td>no./total no. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Favorable neurologic outcome‡</td>
<td>54/137 (39)</td>
<td>75/136 (55)</td>
<td>1.40 (1.08–1.81)</td>
<td>0.009</td>
</tr>
<tr>
<td>Death</td>
<td>76/138 (55)</td>
<td>56/137 (41)</td>
<td>0.74 (0.58–0.95)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*The risk ratio was calculated as the rate of a favorable neurologic outcome or the rate of death in the hypothermia group divided by the rate in the normothermia group. CI denotes confidence interval.
Thus, unconscious adult patients with ROSC after out-of-hospital cardiac arrest should be cooled to 32°C to 34°C (89.6°F to 93.2°F) for 12 to 24 hours when the initial rhythm was VF (Class IIa). Similar therapy may be beneficial for patients with non-VF arrest out of hospital or for in-hospital arrest (Class IIb).
Cardiac Arrest in Context of STEMI

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Immediate angiography and PCI when indicated should be performed in resuscitated out-of-hospital cardiac arrest patients whose initial ECG shows STEMI.

ACC/AHA STEMI Guidelines, 2013
Endovascular Induction of Hypothermia
Endovascular Induction of Hypothermia
Induction of Hypothermia with ECMO