Post-Resuscitation Care: Optimizing & Improving Outcomes after Cardiac Arrest

Nicole L. Kupchik RN, MN, CCNS
CCRN-CMC
Clinical Nurse Specialist
Harborview Medical Center
Seattle, WA

Objectives:
At the end of the learning activity the attendee will be able to:
• Discuss evidence-based care of the resuscitated patient.
• Discuss hemodynamic optimization after cardiac arrest.
• Discuss the benefits of implementing therapeutic hypothermia after cardiac arrest.

U.S. stats
• About 164,600 out-of-hospital cardiac arrests occur annually in the US

• The rate of survival to discharge after in-hospital cardiac arrest is 18% among adults
  However, adults with an initial rhythm of ventricular fibrillation or ventricular tachycardia have a similar good prognosis (42% survival to discharge) (Nadkarni V, et al, for the National Registry of Cardiopulmonary Resuscitation Investigators. First documented rhythm and clinical outcomes from in-hospital cardiac arrest among children and adults: the National Registry of Cardiopulmonary Resuscitation Investigators. JAMA. 2006;295:50-57).
• U.S. survival to discharge is 6.4%
  (estimated as many, especially those ≥65 yrs old
• Seattle survival to discharge is ~20%

(References: aha.org, Cobb et al. JAMA. 2002;288:3008-13.)
Location, Location, Location!!!
Regional Differences: 10 cities

<table>
<thead>
<tr>
<th>Region</th>
<th>Overall</th>
<th>Phoenix</th>
<th>Miami</th>
<th>Portland</th>
<th>Seattle</th>
<th>Toronto</th>
<th>Vancouver</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival (%)</td>
<td>79.6</td>
<td>79.6</td>
<td>79.6</td>
<td>79.6</td>
<td>79.6</td>
<td>79.6</td>
<td>79.6</td>
<td>79.6</td>
</tr>
<tr>
<td>Adjusted OR</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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</tbody>
</table>

Designated cardiac arrest centers

Arizona
- 24/7 Cardiac Catheterization
- Therapeutic Hypothermia
- Center are identified by the AZ DOHS

NYC
- January 2009
- Therapeutic Hypothermia

OPALS Study: Outcomes better at larger teaching hospitals vs. small & rural hospitals with higher volumes

Trends in Resuscitation

Pre-hospital phase
Early defibrillation
Quality CPR
Post arrest:
Supportive care

Adult Immediate Post-Cardiac Arrest Care

The New England Journal of Medicine
Therapeutic Hypothermia after Cardiac Arrest

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Randomization</th>
<th>Temp.</th>
<th>Rhythm</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Bernard et al.</td>
<td>77</td>
<td>43 Hypothermia</td>
<td>33° x 12 hrs</td>
<td>V-fib 21/43 (49%) w/ good neuro outcome (Hypothermia)</td>
</tr>
<tr>
<td></td>
<td>NEJM (2002); 346(8): 557-563</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HACA</td>
<td>275</td>
<td>137 Hypothermia</td>
<td>32/34° x 24 hrs</td>
<td>V-fib</td>
<td>75/138 (55%) w/ good neuro outcome (Hypothermia)</td>
</tr>
<tr>
<td></td>
<td>NEJM (2002); 346(8): 549-556</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V-tach</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>RR</th>
<th>(95% CI)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.4</td>
<td>1.08–1.81</td>
</tr>
</tbody>
</table>

21/43 (49%) w/ good neuro outcome (Hypothermia) 9/34 (26%) w/ good neuro outcome (Control) (p=0.045)

HACA trial

<table>
<thead>
<tr>
<th>Complication</th>
<th>Neurotherapy</th>
<th>Hypothermia</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (total n %)</td>
<td>N (total n %)</td>
<td></td>
</tr>
<tr>
<td>Bleeding of any severity</td>
<td>26/336 (7.7)</td>
<td>30/338 (9)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>5/336 (1.5)</td>
<td>6/338 (1.8)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>14/336 (4.2)</td>
<td>15/338 (4.5)</td>
</tr>
<tr>
<td>Hemolysis</td>
<td>6/336 (4)</td>
<td>6/338 (4)</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>5/336 (1.5)</td>
<td>6/338 (1.8)</td>
</tr>
<tr>
<td>Seizures</td>
<td>11/336 (3.3)</td>
<td>12/338 (3.6)</td>
</tr>
<tr>
<td>Lethal or long lasting arrhythmia</td>
<td>44/336 (13.1)</td>
<td>49/338 (14.6)</td>
</tr>
<tr>
<td>Pressor naïve</td>
<td>6/336 (1.8)</td>
<td>6/338 (1.8)</td>
</tr>
</tbody>
</table>

*p=0.009

Table 4. Complications during the First Seven Days after Cardiac Arrest

HACA trial

Median initiation of cooling = 105 min.
Median time to goal temp = 8 hours
ILCOR/ACLS Advisory Statement

October 2002, the Advanced Life Support (ALS) Task Force recommended:

Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32-34°C for 12 to 24 hours when the initial rhythm was ventricular fibrillation

Ia Recommendation

Such cooling may also be beneficial for other rhythms or in-hospital arrest

IIb Recommendation

Can we safely cool cardiogenic shock/PCI?

- Previous trials excluded patients with shock symptoms, few with PCI
- Outcomes of 50 patients
  - 23/50 received IABP, 36/50 PCI
  - 41 (82%) survived until 6 mos.
  - 34 (68%) CPC 1 or 2
  - 7 (14%) CPC 3


To treat cardiac arrest, doctors cool the body
Active surface cooling protocol to induce mild therapeutic hypothermia after out-of-hospital cardiac arrest: A retrospective before-and-after comparison in a single hospital

491 patients from January 1, 2001 – December 31, 2004

Reperfusion Injury

- Depleted stores of O\textsubscript{2} & glucose
- Intracellular calcium influx
- Formation of O\textsubscript{2} free radicals
- Release of glutamate
- Intracellular acidosis
- Disruption in blood brain barrier
- Mitochondrial injury
- Apoptosis

Neuro-Protective Qualities:

- Cerebral Metabolic Rate
- Intracranial pressure
- Inflammation & cytokine release
- Cerebral edema
Physiologic Effects of Hypothermia

**Systemic effects of hypothermia:**

- ↓ Heart rate
- ↓ Cardiac output (by up to 25%)
- ↑ BP & SVR (d/t vasoconstriction)
- ↑ Urine output
- ↑ Lactate
- Prolonged clotting times
- ↓ Intestinal motility

**Arrhythmias/ECG changes**

- Negative chronotropic effects of pacemaker cells
- Prolonged PR, QT intervals
- J wave
- More susceptible to atrial fibrillation (<32°C)
- Ventricular arrhythmias at lower temps (Below 28-30°C)
Electrolyte Imbalance

- Decreased: Due to intracellular shifts
  - Potassium
  - Magnesium (has neuro-protective qualities)
  - Phosphate
  - Calcium
- Assess electrolytes upon initiation, goal, then at regular intervals (q 4-6 hrs)

Hyperglycemia: ↓ insulin secretion

Glucose Control

- 234 subjects post cardiac arrest
- Assessed glucose levels 12 hours after ROSC with 6 month survival
- Conclusion: Tight control may not be needed
  - Losert et. al. (2007); Resuscitation
- 90 subjects post vfh arrest/therapeutic hypothermia
- Strict glycemic control group, moderate group
- Conclusion: No survival benefit from strict glycemic control
  - Okanen et. al. (2007); Intensive Care Medicine

ABGs

- Shift to the left
- Decreased O$_2$ consumption
- CO$_2$ production slows
Oxygen Saturation Monitoring

- Digit sensor often unreliable d/t peripheral vasoconstriction
- Study compared forehead sensors with digit sensors

Shivering:

- Increases O₂ consumption by 40-100%
- Neuromuscular blockade
- Ensure adequate sedation
- TOF monitoring- unreliable <35º C (slowing of neuromuscular junction)

Other strategies:
- Propofol/Sedatives
- Opiates
- Meperidine

Columbia Shiver Scale

<table>
<thead>
<tr>
<th>Score</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NO</td>
<td>Absence of shivering on palpation of neck or pectoralis muscles</td>
</tr>
<tr>
<td>1</td>
<td>MILD</td>
<td>Localized to the neck and/or thorax. May be present only on palpation</td>
</tr>
<tr>
<td>2</td>
<td>MODERATE</td>
<td>Involvement of the upper extremities +/- neck or pectoralis muscles</td>
</tr>
<tr>
<td>3</td>
<td>SEVERE</td>
<td>Generalized, whole body involvement</td>
</tr>
</tbody>
</table>
Monitoring Temperature

- Pulmonary Artery (PA) catheter
- Bladder
- Esophageal
- Rectal

Methods of Cooling

**Surface**
- Ice packs
- External water blankets
- Forced cool air blankets
- Hydrogel

**Endovascular Catheters**

Challenges with cooling:

- **Obese patients**
  (Adipose insulates 3x's as well as muscle)
- **Young patients**
  (react to changes in body temperature)

**Easy cooling:**
Older patients
- Lower BMI
- Lower rate of metabolism
- Less effective vascular response
Re-warming

- Important to re-warm slowly (8-24 hours)
- If re-warm too quickly, can possibly negate benefits of hypothermia
- Rebound hyperthermia