Hypothermia
— EMS Style —
from Science to Application

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Operational Medical Director
Chesterfield Fire and EMS
Epidemiology of OHCA

- Cardiac arrest is **common**
  - 295,000 OHCA per year in US
    - 23% VF
    - 31% Bystander CPR
  - Median survival all rhythms 7.9%, VF 21%
  - Prior to hypothermia
      - 17.5% survival to hospital discharge
      - 34% VT/VF subgroup
    - Since hypothermia (2006-2011 data)
      - 6 month survival with GNO
        - Overall 30.6% (includes 55% PEA & Asystole)
        - 58% VT/VF subgroup
      - IHCA adults: 19% (despite 95% witnessed or monitored)

Circulation 2010;Jan 26:e12-13
Current Statistics

• Majority of resuscitative efforts fail
  – Anoxia
  – Reperfusion injury
  – Neurologic injury
  – Airway/Breathing
  – Circulation
  – Other complications
How do we, as EMS systems, improve this?
We Buy Toys!!!!!!!!!
The Field

• **Changed CPR:**
  – Emphasis on effective uninterrupted compression
  – Decreased emphasis on importance of ventilation
  – Slower ventilatory rates
The Technology

- Fully capable monitors
- Use of ETCO$_2$:  
  - As confirmation of ETT placement  
  - Goal directed respiratory rate
The Technology

- Use of Mechanical CPR:
  - Consistant high quality chest compressions
The Technology

• EZ IO drill:
  – Possible primary route or at least a rapid IV access if initial IV attempt fails
Change in Philosophy

• Emphasis on compressions
• De-emphasize airway
Change in Philosophy

• Pit Crew model
Pit Crew Model

• Standardization of response
Pit Crew Model

• Standard Operations
Induced hypothermia is part of a multifaceted approach to optimizing neurologic resuscitation.
Data supports this. There are several landmark studies on the subject.
Therapeutic Hypothermia

- Hippocrates advocated packing bleeding patients in snow
- Profound hypothermia *Lancet* 1959
  - Ronald Belsey (Cardiac surgery) performed cardiac surgery in cooled patients with no perfusion > 60 minutes
  - Research was inconsistent
  - Predisposition to infection
  - Fell out of favor
- Safar et al *Crit Care Medicine* 1988
  - FV in dogs better outcome if hypothermic
THE USE OF HYPOTHERMIA AFTER CARDIAC ARREST

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FRANK C. SPENCER, M.D.
ADOLPH J. YATES, M.D.

Baltimore, Maryland
### DATA FROM TWENTY-SEVEN CASES OF CARDIAC ARREST

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age</th>
<th>Sex</th>
<th>Site of arrest and date</th>
<th>Operation or episode at arrest</th>
<th>Neurological status after arrest</th>
<th>Interval from arrest to hypothermia, hr.</th>
<th>Average temperature during hypothermia, °C</th>
<th>Duration of hypothermia, hr.</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>64</td>
<td>F</td>
<td>Recovery room 6/24/57</td>
<td>Postcholecystectomy; 4 hr.</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>15</td>
<td>84</td>
<td>F</td>
<td>Operating room 11/21/57</td>
<td>General anesthesia; incarcerated hernia</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>16</td>
<td>65</td>
<td>F</td>
<td>Bronchoscopy 11/28/57</td>
<td>Bronchoscopy; local anesthesia</td>
<td>Severe</td>
<td>1 hr.</td>
<td>30°C</td>
<td>3</td>
<td>Died 4 hr.</td>
</tr>
<tr>
<td>17</td>
<td>45</td>
<td>F</td>
<td>Operating room 6/19/58</td>
<td>General anesthesia; breast biopsy</td>
<td>Severe</td>
<td>1 hr.</td>
<td>32°C</td>
<td>24</td>
<td>Died 24 hr.</td>
</tr>
<tr>
<td>18</td>
<td>55</td>
<td>M</td>
<td>Operating room 2/7/58</td>
<td>General anesthesia; thoracotomy</td>
<td>Severe</td>
<td>1 hr.</td>
<td>31°C</td>
<td>48</td>
<td>Died 3 days; did not respond</td>
</tr>
<tr>
<td>19</td>
<td>55</td>
<td>M</td>
<td>Operating room 6/16/58</td>
<td>General anesthesia; hernia repair</td>
<td>Severe</td>
<td>3 hr.</td>
<td>30°C</td>
<td>5 days</td>
<td>Died 9 days; did not respond</td>
</tr>
<tr>
<td>20</td>
<td>57</td>
<td>M</td>
<td>Operating room 9/24/58</td>
<td>General anesthesia; suprapubic prostatectomy</td>
<td>Severe</td>
<td>1 hr.</td>
<td>30°C</td>
<td>77</td>
<td>Died 3 days</td>
</tr>
<tr>
<td>21</td>
<td>58</td>
<td>M</td>
<td>Operating room 8/18/58</td>
<td>General anesthesia; pneumonectomy</td>
<td>Severe</td>
<td>6 hr.</td>
<td>31°C</td>
<td>84</td>
<td>Died 5 days</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>M</td>
<td>X-ray department 1/22/57</td>
<td>General anesthesia; bronchogram</td>
<td>Severe</td>
<td>2 hr. 40 min.</td>
<td>31°C</td>
<td>36</td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>23</td>
<td>6</td>
<td>F</td>
<td>Bronchoscopy 8/12/58</td>
<td>General anesthesia; bronchoscopy</td>
<td>Severe</td>
<td>1 hr.</td>
<td>32°C</td>
<td>48</td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>24</td>
<td>9</td>
<td>F</td>
<td>Accident room 8/29/57</td>
<td>Asthmatic attack</td>
<td>Severe</td>
<td>1 hr. 30 min.</td>
<td>30°C</td>
<td>34</td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>M</td>
<td>Operating room 4/5/58</td>
<td>General anesthesia; rectal pull-through</td>
<td>Severe</td>
<td>1 hr. 30 min.</td>
<td>32°C</td>
<td>72</td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>26</td>
<td>38</td>
<td>M</td>
<td>Accident room 9/28/57</td>
<td>Pericardial tamponade</td>
<td>Severe</td>
<td>1 hr. 50 min.</td>
<td>32°C</td>
<td>36</td>
<td>Lived; no residual</td>
</tr>
<tr>
<td>27</td>
<td>39</td>
<td>F</td>
<td>Accident room 11/16/57</td>
<td>Stab wound of chest</td>
<td>Severe</td>
<td>3 hr.</td>
<td>31°C</td>
<td>48</td>
<td>Lived; no residual</td>
</tr>
</tbody>
</table>
Clinical evidence for TH after CA

• Largest RCT of TH in OHCA survivors
  – 275 patients randomized to TH or routine care
  – Europe 1996-2001
• Absolute 16% increase in chance of a good neurological outcome
• Absolute 14% decrease in 6 month mortality

Clinical evidence for TH after CA

### Table 2. Neurologic Outcome and Mortality at Six Months.

<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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Favorable neurologic outcome‡</td>
<td>54/131 (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.

†Two-sided P values are based on Pearson’s chi-square tests.

‡A favorable neurologic outcome was defined as a cerebral-performance category of 1 (good recovery) or 2 (moderate disability). One patient in the normothermia group and one in the hypothermia group were lost to neurologic follow-up.
Clinical evidence for TH after CA

- Australian Randomized clinical trial conducted 1996-1999
- Randomized on alternating days to TH or routine care
- TH: good outcome 49%, routine care good outcome: 26% (p=0.046)

**Table 5. Outcome of Patients at Discharge from the Hospital.**

<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>

*The difference between the rates of a good outcome (normal or with minimal or moderate disability) in the hypothermia and the normothermia groups (49 percent and 26 percent, respectively) was 23 percentage points (95 percent confidence interval, 13 to 43 percentage points; P=0.046). The unadjusted odds ratio for a good outcome in the hypothermia group as compared with the normothermia group was 2.65 (95 percent confidence interval, 1.02 to 6.88; P=0.046). The odds ratio for a good outcome in the hypothermia group as compared with the normothermia group, after adjustment by logistic regression for age and time from collapse to return of spontaneous circulation, was 5.25 (95 percent confidence interval, 1.47 to 18.76; P=0.011).
What are the risks?

- More infections – Lung
- Trends toward more bleeding*
- Electrolyte shifts
- Clinically insignificant bradycardia
- Changes in drug metabolism

**TABLE 4. COMPLICATIONS DURING THE FIRST SEVEN DAYS AFTER CARDIAC ARREST.**

<table>
<thead>
<tr>
<th>COMPLICATION</th>
<th>NORMOTHERMIA</th>
<th>HYPOTHERMIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no./total</td>
<td>no. (%)</td>
</tr>
<tr>
<td>Bleeding of any severity†</td>
<td>26/138 (19)</td>
<td>35/135 (26)</td>
</tr>
<tr>
<td>Need for platelet transfusion</td>
<td>0/138</td>
<td>2/135 (1)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>40/137 (29)</td>
<td>50/135 (37)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>9/138 (7)</td>
<td>17/135 (13)</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>2/138 (1)</td>
<td>1/135 (1)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>14/138 (10)</td>
<td>13/135 (10)</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>6/138 (4)</td>
<td>6/135 (4)</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>5/133 (4)</td>
<td>9/136 (7)</td>
</tr>
<tr>
<td>Seizures</td>
<td>11/133 (8)</td>
<td>10/136 (7)</td>
</tr>
<tr>
<td>Lethal or long-lasting arrhythmia</td>
<td>44/138 (32)</td>
<td>49/135 (36)</td>
</tr>
<tr>
<td>Pressure sores</td>
<td>0/133</td>
<td>0/136</td>
</tr>
</tbody>
</table>

*None of the comparisons between the two groups, performed with the use of Pearson's chi-square test, indicated significant differences.

†The sites of bleeding were mucous membranes, the nose, the urinary tract, the gastrointestinal tract, subcutaneous tissue, and skin, as well as intracerebral and intraabdominal sites.

HCASG. NEJM 2002;346:549-56
Bottom Line:
It’s the right thing to do for patients
Next Question: When do we do it?
Starting cooling early is better

• Start cooling ASAP!

• For every hour delay to onset of cooling, mortality increased by 20%!!

**Therapeutic Hypothermia After Out-of-Hospital Cardiac Arrest**

**Evaluation of a Regional System to Increase Access to Cooling**

Michael R. Mooney, MD; Barbara T. Unger, RN; Lori L. Boland, MPH; M. Nicholas Burke, MD; Katie Y. Kebed, BS; Kevin J. Graham, MD; Timothy D. Henry, MD; William T. Katsiyannis, MD; Paul A. Satterlee, MD; Sue Sendelbach, PhD, RN, CCNS; James S. Hodges, PhD; William M. Parham, MD

**Background**—Therapeutic hypothermia (TH) improves survival and confers neuroprotection in out-of-hospital cardiac arrest (OHCA), but TH is underutilized, and regional systems of care for OHCA that include TH are needed.

**Methods and Results**—The Cool It protocol has established TH as the standard of care for OHCA across a regional network of hospitals transferring patients to a central TH-capable hospital. Between February 2006 and August 2009, 140 OHCA patients who remained unresponsive after return of spontaneous circulation were cooled and rewarmed with the use of an automated, noninvasive cooling device. Three quarters of the patients (n=107) were transferred to the TH-capable hospital from referring network hospitals. Positive neurological outcome was defined as Cerebral Performance Category 1 or 2 at discharge. Patients with non-ventricular fibrillation arrest or cardiogenic shock were included, and patients with concurrent ST-segment elevation myocardial infarction (n=68) received cardiac intervention and cooling simultaneously. Overall survival to hospital discharge was 56%, and 92% of survivors were discharged with a positive neurological outcome. Survival was similar in transferred and nontransferred patients. Non-ventricular fibrillation arrest and presence of cardiogenic shock were associated strongly with mortality, but patients with these event characteristics had high rates of positive neurological recovery (100% and 89%, respectively). A 20% increase in the risk of death (95% confidence interval, 4% to 39%) was observed for every hour of delay to initiation of cooling.

**Conclusions**—A comprehensive TH protocol can be integrated into a regional ST-segment elevation myocardial infarction network and achieves broad dispersion of this essential therapy for OHCA. *(Circulation. 2011;124:206-214.)*
• **Background**— Therapeutic hypothermia is recommended for the treatment of neurological injury after resuscitation from out-of-hospital cardiac arrest. Laboratory studies have suggested that earlier cooling may be associated with improved neurological outcomes. We hypothesized that induction of therapeutic hypothermia by paramedics before hospital arrival would improve outcome.
• In adults who have been resuscitated from out-of-hospital cardiac arrest with an initial cardiac rhythm of ventricular fibrillation, paramedic cooling with a rapid infusion of large-volume, ice-cold intravenousous fluid decreased core temperature at hospital arrival but was not shown to improve outcome at hospital discharge compared with cooling commenced in the hospital.
A total of 234 patients were randomly assigned to either paramedic cooling (118 patients) or hospital cooling (116 patients). Patients allocated to paramedic cooling received a median of 1900 mL (first quartile 1000 mL, third quartile 2000 mL) of ice-cold fluid. This resulted in a mean decrease in core temperature of 0.8°C ($P=0.01$). In the paramedic-cooled group, 47.5% patients had a favorable outcome at hospital discharge compared with 52.6% in the hospital-cooled group (risk ratio 0.90, 95% confidence interval 0.70 to 1.17, $P=0.43$).
Next Question:
Who do we do it to?
Conclusions: Although recommended, post–cardiac arrest therapeutic hypothermia was not routinely used. Patients with VF/VT and treated with hypothermia had better outcomes than those with PEA or asystole.
Conclusions—In this large cohort of cardiac arrest patients, hypothermia was independently associated with an improved outcome at hospital discharge in patients presenting with VF/V. By contrast, TMH was not associated with good outcome in nonshockable patients. Further investigations are needed to clarify this lack of efficiency in PEA/asystole.
• Overall, VF/VT have better outcomes.
• No significant data to show large benefit is non-shockable rhythms
  – No significant data showing you cannot!
Do them all and let the hospital sort them out!
Ok, Prehospital cooling be of some benefit. Now, how do I do it if I choose to?
• 125 patients randomized to prehospital vs ED cooling
  – 20/29 vs 10/22 (P=0.15)
• No safety concerns
• Average temp at ED arrival differed by only 1ºC

Ok, ice saline sounds simple and cheap.

Now, how do I keep it?
Managing Cold Saline

Keeping it cold enough to be effective
Managing Cold Saline

36-39° F (2-4 °C) is the target temperature
Managing Cold Saline

Model 15 Freezer

- 14qt Capacity
- 27 pounds
- 0 – 40 Degrees Fahrenheit
- 3.9 Amp Draw on 12V System
- Fits neatly in floorboard of vehicle
- Approx $400 to $600 retail
Managing Cold Saline

- Maintaining stock in refrigerator in Station at 45 degrees
- 6 Liters in 12V freezer units on select response units
- Add 12V freezers to all system ambulances as budget permits
Coolers

- Bag and a few ice packs
- Change out ice packs daily
- $40
Other devices - Arctic Sun

May not be ideal for EMS use
Ok, I have ROSC. I started iced saline. What now?
Problems - Shivering

- Drives up systemic metabolic rate
  - Increased CO2 production
  - Increased O2 consumption
  - Major cardiac stressor
- Drives up cerebral oxygen consumption
  - Favors ischemia
- Uncomfortable

Management of shivering

• Neuromuscular blockade
  – Must give **sedation**, first!!
  – **Vecuronium** bolus 0.1mg/kg prn for shivering
• Fentanyl infusion
• Propofol
What else do I have to unlearn?
Hyperoxia after Cardiac Arrest

- Project Impact database 2001-2005
- 6326 patients with cardiac arrest
- Evaluated ABG within 24h of the arrest

**Association Between Arterial Hyperoxia Following Resuscitation From Cardiac Arrest and In-Hospital Mortality**

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Alan E. Jones, MD
Nathan L. Shapiro, MD, MPH
Mark G. Angelos, MD
Barry Milearek, PhD
Krystal Hunter, MBA
Joseph E. Parrillo, MD
Stephen Trzeciak, MD, MPH
for the Emergency Medicine Shock Research Network (EMSNet) Investigators

**Context** Laboratory investigations suggest that exposure to hyperoxia after resuscitation from cardiac arrest may worsen anoxic brain injury; however, clinical data are lacking.

**Objective** To test the hypothesis that postresuscitation hyperoxia is associated with increased mortality.

**Design, Setting, and Patients** Multicenter cohort study using the Project IMPACT critical care database of intensive care units (ICUs) at 120 US hospitals between 2001 and 2005. Patient inclusion criteria were age older than 17 years, nontraumatic cardiac arrest, cardiopulmonary resuscitation within 24 hours prior to ICU arrival, and arterial blood gas analysis performed within 24 hours following ICU arrival. Patients were divided into 3 groups defined a priori based on PaO₂ on the first arterial blood gas values obtained in the ICU. Hyperoxia was defined as PaO₂ of 300 mm Hg or greater; hypoxia, PaO₂ of less than 60 mm Hg (or ratio of PaO₂ to fraction of inspired oxygen <300); and normoxia, not classified as hyperoxia or hypoxia.

**Main Outcome Measure** In-hospital mortality.

**Results** Of 6326 patients, 1156 had hyperoxia (18%), 3999 had hypoxia (63%), and 1171 had normoxia (19%). The hyperoxia group had significantly higher in-hospital mortality (732/1156 [63%]; 95% confidence interval [CI], 60%-66%) compared with the normoxia group (532/1171 [45%; 95% CI, 43%-48%]; proportion difference, 18% [95% CI, 14%-22%]) and the hypoxia group (2297/3999 [57%; 95% CI, 56%-59%]; proportion difference, 6% [95% CI, 3%-9%]). In a model controlling for potential confounders (eg, age, predischARGE functional status, comorbid conditions, vital signs, and other physiological indices), hyperoxia exposure had an odds ratio for death of 1.8 (95% CI, 1.5-2.2).

**Conclusion** Among patients admitted to the ICU following resuscitation from cardiac arrest, arterial hyperoxia was independently associated with increased in-hospital mortality compared with either hypoxia or normoxia.

JAMA. 2010;303(21):2165-2171
3 groups...

- **First ABG**
- **Hypoxia:**
  - PaO₂ < 60 mmHg
- **Normoxia**
  - PaO₂ 60-299 mmHg
- **Hyperoxia**
  - PaO₂ ≥ 300 mmHg

JAMA 2010;303:2165
Hyperoxia in post-resuscitation CA care questioned!

- “Normoxic resuscitation”
- “Lowest FiO2 to generate an SpO2 of 95-99%”

- Received consideration in new AHA and ACLS guidelines

- Turn down the FiO2 if tolerated!
  (but be careful)
I have ROSC. I have cold saline started. I stopped shivering. Where do I take my patients?
CA volume vs outcomes

- 4674 patients from 39 hospitals
- Overall mortality was 56.8%
  - Not all patients comatose
- After adjusting for age and severity of illness, institutional mortality ranged from 46% to 68%
- Annual case volume strongly associated with outcome

Table 4
Results of the logistic regression model for in-hospital mortality for patients admitted to the ICU after cardiac arrest.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (per 10 units)</td>
<td>1.16</td>
<td>1.11–1.22</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Acute physiology score (per 10 units)</td>
<td>1.33</td>
<td>1.29–1.37</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GCS on ICU admission (per 1 point)</td>
<td>0.94</td>
<td>0.92–0.96</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mechanical ventilation on ICU admission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-ventilated</td>
<td>1.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Ventilated</td>
<td>1.85</td>
<td>1.34–2.54</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Admission source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-ED</td>
<td>1.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>ED</td>
<td>1.04</td>
<td>0.90–1.21</td>
<td>0.56</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>1.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Northeast</td>
<td>1.24</td>
<td>0.70–2.19</td>
<td>0.45</td>
</tr>
<tr>
<td>Midwest</td>
<td>0.76</td>
<td>0.57–1.02</td>
<td>0.07</td>
</tr>
<tr>
<td>West</td>
<td>0.81</td>
<td>0.56–1.18</td>
<td>0.27</td>
</tr>
<tr>
<td>Hospital teaching status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic</td>
<td>1.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Community/teaching</td>
<td>0.84</td>
<td>0.61–1.15</td>
<td>0.28</td>
</tr>
<tr>
<td>Community</td>
<td>0.92</td>
<td>0.64–1.31</td>
<td>0.63</td>
</tr>
<tr>
<td>Hospital volume (cases/year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>1.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>20–34</td>
<td>0.78</td>
<td>0.55–1.11</td>
<td>0.16</td>
</tr>
<tr>
<td>35–50</td>
<td>0.71</td>
<td>0.45–1.11</td>
<td>0.13</td>
</tr>
<tr>
<td>&gt;50</td>
<td>0.62</td>
<td>0.45–0.86</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Hospital size and CA outcome

Mortality was lower at urban, teaching, and large hospitals.

>109,000 patients in the NIS
Regional Systems of Care for Out-of-Hospital Cardiac Arrest. A Policy Statement From the American Heart Association

Circulation published online Jan 14, 2010:
DOI: 10.1161/CIR.0b013e3181cdb7db
<table>
<thead>
<tr>
<th>EMS</th>
<th>Level 2 CRC</th>
<th>Level 1 CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical direction works with hospital to develop plan</td>
<td>Works with EMS medical direction to develop plan</td>
<td>Works with EMS medical direction to develop plan</td>
</tr>
<tr>
<td>External certification not self-designation</td>
<td>External certification not self-designation</td>
<td>External certification not self-designation</td>
</tr>
<tr>
<td>Initiates hypothermia as soon as feasible when indicated</td>
<td>Not capable of PCI</td>
<td>Capable of PCI</td>
</tr>
<tr>
<td>Field triage of patients with spontaneous circulation after OOHCA to level 1 CRC when feasible (eg, to allow angiography of catheterization-eligible patients within 90 min)</td>
<td>Early transport of patients resuscitated from OOHCA and transported from level 2 CRC to level 1 CRC (eg, via ground or air to allow angiography of catheterization-eligible patients within 90 min)</td>
<td>Hospital or most responsible physician group treats at least 40 patients resuscitated from OOHCA annually; meets ACC/AHA STEMI guidelines for PCI; resuscitation-related services available 24 hours a day, 7 days a week</td>
</tr>
<tr>
<td>Plan for and treat rearrest, including mechanical device or pharmacological support if appropriate</td>
<td>Plan for and treat rearrest, including mechanical device or pharmacological support if appropriate</td>
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</tr>
<tr>
<td>Not capable of electrophysiology testing and ICD assessment and placement</td>
<td>Provides CPR training for lay public</td>
<td>Provides CPR training for lay public</td>
</tr>
<tr>
<td>Provides CPR and ACLS training for staff</td>
<td></td>
<td>Provides CPR, ACLS, and PALS training for staff</td>
</tr>
<tr>
<td>Monitors, reports, and improves outcomes</td>
<td>Monitors, reports, and improves outcomes</td>
<td>Establishes and maintains multidisciplinary team including EMS, emergency medicine, nursing, cardiology, neurology, and critical care personnel, to monitor and improve resuscitation process and outcome</td>
</tr>
<tr>
<td>Reimbursed for participation</td>
<td>Reimbursed for participation</td>
<td>Reimbursed for participation</td>
</tr>
</tbody>
</table>

CRC indicates cardiac resuscitation centers; ACC/AHA, American College of Cardiology/American Heart Association; CPR, cardiopulmonary resuscitation; ACLS, advanced cardiovascular life support; and PALS, pediatric advanced life support.
## Cardiac Arrest Regionalization of Care

<table>
<thead>
<tr>
<th><strong>Primary CA centers</strong></th>
<th><strong>Comprehensive CA centers</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initial cardiopulmonary stabilization</td>
<td>- Receive patients from primary centers</td>
</tr>
<tr>
<td>- STEMI and neurological evaluation</td>
<td>- Therapeutic hypothermia protocols, pathway, equipment, expertise</td>
</tr>
<tr>
<td>- Initiation of hypothermia</td>
<td>- Cardiac revascularization and advanced hemodynamic support</td>
</tr>
<tr>
<td>- Rapid transfer to comprehensive center if appropriate</td>
<td>- Neurology consultation and EEG capacity</td>
</tr>
<tr>
<td>- Function as a community resource to train EMS, lay public in bystander “hands only” CPR</td>
<td>- Organ donation interface and grief counseling</td>
</tr>
<tr>
<td></td>
<td>- Resource for primary centers</td>
</tr>
</tbody>
</table>
ODEMSA Experience

• ROSC centers/Post cardiac arrest centers have created controversy
  – 24 hour EEG
  – Different post event neurological testing
  – Sharing of data
  – “Perception” of losing volume
    • Health systems have large investments in emergency cardiac care
Questions?

I think they can stop CPR.