MODULE 8

North Carolina College Of Resuscitation

Cardiac Arrest Resuscitation System
Hypothermia Therapy

Brent Myers MD, MPH
Director
Wake County Department of EMS
Raleigh, NC
Bring Out Your Dead
The Plan:

• Why cool?
• When to cool?
• Who to cool?
• How to cool?
Why Hypothermia?

- Of those who survive to hospital admission but do not survive to discharge:
  - 10% die due to recurrent dysrhythmias
  - 30% die due to cardiovascular collapse
  - 40% die due to neurologic impairment
  - 20% die due to other causes (sepsis, etc.)
Figure 2. Cumulative Survival in the Normothermia and Hypothermia Groups.
Censored data are indicated by tick marks.
<table>
<thead>
<tr>
<th>Author, date and country</th>
<th>Patient group</th>
<th>Study type (level of evidence)</th>
<th>Outcomes</th>
<th>Key results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernard SA et al, 1997, Australia</td>
<td>22 adults who remained unconscious after return of spontaneous circulation after out of hospital cardiac arrest Hypothermia group cooled to 33°C for 12 h and rewarmed over 6 h to 36°C</td>
<td>Prospective study with historical control group. (Glasgow outcome scale 1 or 2)</td>
<td>Neurologic recovery</td>
<td>Hypothermia gp 11/22 versus Normothermia gp 3/22, p&lt;0.05</td>
</tr>
<tr>
<td>Yanagawa Y et al, 1998, Japan</td>
<td>13 adults with out of hospital cardiac arrest and return of spontaneous circulation Core temperature 33–34°C for 48 h. Rewarmed to 37°C at 1 °C/day. Control group 15 patients treated before the hypothermia protocol was started</td>
<td>Prospective study (GOS 1)</td>
<td>Neurologic recovery</td>
<td>Hypothermia gp 7/13 versus Normothermia gp 1/15, p=0.27</td>
</tr>
<tr>
<td>Bernard SA et al, 2002, Australia</td>
<td>77 adults who remained unconscious after resuscitation from out of hospital cardiac arrest Hypothermia to 33°C for 12 h versus normothermia</td>
<td>Randomised control trial (GOS 1–2)</td>
<td>Neurologic recovery</td>
<td>Hypothermia gp 21/43 versus normothermia gp 9/34, p=0.046</td>
</tr>
<tr>
<td>The Hypothermia after Cardiac Arrest Study Group, 2002, Europe</td>
<td>275 adults with out of hospital cardiac arrest and return of spontaneous circulation Hypothermia to 32–34°C for 24 h then passive rewarming over 8 h versus normothermia</td>
<td>Randomised controlled trial with blinded assessment of outcome (GOS 1 or 2)</td>
<td>Neurologic recovery</td>
<td>Hypothermia gp 75/136 versus normothermia gp 54/137, p=0.009</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Survival at 6 months</td>
<td>80/136 versus normothermia gp 61/137, p=0.02</td>
</tr>
</tbody>
</table>

**Table 5**

<table>
<thead>
<tr>
<th>Neurologic</th>
<th>50% vs 14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td>50% vs 23%</td>
</tr>
<tr>
<td>Neurologic</td>
<td>49% vs 26%</td>
</tr>
<tr>
<td>Survival</td>
<td>48% vs 32%</td>
</tr>
<tr>
<td>Neurologic</td>
<td>55% vs 39%</td>
</tr>
<tr>
<td>Survival</td>
<td>59% vs 45%</td>
</tr>
</tbody>
</table>
Meta-analysis:

- Short term benefit ratio
  - 1.68; 95% CI 1.29-2.07
- 6 mos benefit ratio
  - 1.44 95% CI 1.11-1.76
- NNT 6 CI (4-13)
- Other NNT
  - ASA (MI) 25
  - Beta blocker 42
  - Cath facility 15
Side Effects of IH:

- Holzer & Bernard\textsuperscript{4,21}
  - No difference in complication rates in normothermic and hypothermic cohorts
- Potassium shifts
  - Intracellular shift with induction
  - Extracellular shift with warming
- Fluid status
  - Cooling causes diuresis
  - Warming causes hypovolemia
- Respiratory Alkalosis
  - Temperature corrected ABG allows changes in minute ventilation to support normal PaCO\textsubscript{2}
- Hyperglycemia
  - HACA grp and Bernard found that high blood glucose after cardiac arrest is associated with poor neurologic outcomes but did not find any improvement with tight glucose controls.\textsuperscript{4,5}
Complications of IH in Other Applications:

- **Neutropenia**
  - Neutropenia and increased incidence of pneumonia seen in patients exposed to prolonged hypothermia (>24hrs) in other applications

- **Coagulopathy**\(^{18,19,20}\)
  - May alter clotting cascade, platelet function

- **Cardiac dysrhythmias**
  - Little risk for clinically significant dysrhythmias if temperatures are maintained >30°C\(^{17}\)
Lack of Money
Is the Root
Of all Evil

-- George Bernard Shaw
Hypothermia is Free:

- Cost for our EMS System:
  - $5000 total start up cost
  - ~$4 per patient

- Cost in-hospital:
  - ~$100,000 start up costs
  - $1,000 per patient

- Institutional budget dust
Questions Now:

• When should we start?
  – During CPR
  – Immediately after ROSC
  – In the Emergency Department
  – In the ICU

• Who should receive the treatment?
  – PEA/Asystole
  – Trauma, stroke, head injury, MI
Hot Off the Press:

• Bernard et al compared outcomes for patients receiving pre-hospital versus rapid in-hospital cooling

• Community well-versed in hypothermia

• Raises the question about pre-hospital vs in-hospital cooling
Induction of Therapeutic Hypothermia by Paramedics After Resuscitation From Out-of-Hospital Ventricular Fibrillation Cardiac Arrest

A Randomized Controlled Trial

Stephen A. Bernard, MD; Karen Smith, BSc, PhD; Peter Cameron, MD; Kevin Masci; David M. Taylor, MD; D. James Cooper, MD; Anne-Maree Kelly, MD; William Silvester, MB, BS; for the Rapid Infusion of Cold Hartmanns (RICH) Investigators*

Circulation 2010:122;737-42
<table>
<thead>
<tr>
<th>Variable</th>
<th>Paramedic Cooling: Group 1 (n=118)</th>
<th>Hospital Cooling: Group 2 (n=116)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS temperature on scene, °C</td>
<td>35.9 (1.0)</td>
<td>35.8 (0.8)</td>
<td>0.63</td>
</tr>
<tr>
<td>EMS temperature on hospital arrival, °C</td>
<td>34.6 (1.3)</td>
<td>35.4 (1.0)</td>
<td>0.01</td>
</tr>
<tr>
<td>Temperature in emergency department on arrival, °C</td>
<td>34.4 (1.2)</td>
<td>35.2 (1.0)</td>
<td>0.001</td>
</tr>
<tr>
<td>Temperature in emergency department 30 min after arrival, °C</td>
<td>34.4 (1.2)</td>
<td>34.8 (1.0)</td>
<td>0.03</td>
</tr>
<tr>
<td>Temperature in emergency department 60 minutes after arrival, °C</td>
<td>34.7 (1.1)</td>
<td>34.7 (0.9)</td>
<td>0.70</td>
</tr>
<tr>
<td>Outcome</td>
<td>Paramedic Cooling (n=118)</td>
<td>Hospital Cooling (n=116)</td>
<td>P*</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>---------------------------</td>
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</tr>
<tr>
<td>Favorable outcome, n (%; 95% CI)</td>
<td>56 (47.5; 38.2–56.9)</td>
<td>61 (52.6; 43.1–61.9)</td>
<td>0.433</td>
</tr>
<tr>
<td>Discharge to home, n (%; 95% CI)</td>
<td>24 (20.3; 13.5–28.7)</td>
<td>34 (29.3; 21.2–38.5)</td>
<td>...</td>
</tr>
<tr>
<td>Discharge to rehabilitation, n (%; 95% CI)</td>
<td>32 (27.1; 19.3–36.1)</td>
<td>27 (23.3; 15.9–32.0)</td>
<td>...</td>
</tr>
<tr>
<td>Discharge to nursing home awake, n</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Discharge to nursing home comatose, n (%; 95% CI)</td>
<td>0</td>
<td>1 (0.9; 0.02–4.7)</td>
<td>...</td>
</tr>
<tr>
<td>Dead, n (%; 95% CI)</td>
<td>62 (52.5; 43.1–61.8)</td>
<td>54 (46.6; 27.2–56.0)</td>
<td>...</td>
</tr>
</tbody>
</table>
What About During CPR?

- Any indication this provides benefit?
- Will defibrillator be efficacious?
- Will drugs be efficacious?
What About During CPR?

Delay in cooling negates the beneficial effect of mild resuscitative cerebral hypothermia after cardiac arrest in dogs: a prospective randomized study.


<table>
<thead>
<tr>
<th>Group</th>
<th>Deficit Score</th>
<th>Histologic Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normo</td>
<td>44</td>
<td>150</td>
</tr>
<tr>
<td>Immed</td>
<td>19</td>
<td>81</td>
</tr>
<tr>
<td>Delay</td>
<td>38</td>
<td>107</td>
</tr>
</tbody>
</table>
During CPR – Does It Matter?
### During CPR – Does It Matter?

<table>
<thead>
<tr>
<th></th>
<th>Delayed hypothermia</th>
<th>Early hypothermia</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPC 5 or death</td>
<td>00000000</td>
<td>0</td>
</tr>
<tr>
<td>OPC 4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>OPC 3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>OPC 2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>OPC 1</td>
<td>0</td>
<td>0000</td>
</tr>
</tbody>
</table>
## During CPR – Does It Matter?

<table>
<thead>
<tr>
<th>Resuscitation Variables</th>
<th>DH</th>
<th>EH</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countershocks, total</td>
<td>13 (1–58)</td>
<td>1 (1–8)</td>
<td>0.125</td>
</tr>
<tr>
<td>Countershocks, total energy, J</td>
<td>2755 (150–14 770)</td>
<td>185 (150–1510)</td>
<td>0.125</td>
</tr>
<tr>
<td>ROSC, min of CPB</td>
<td>51 (15–235)</td>
<td>16.5 (15–80)</td>
<td>0.395</td>
</tr>
<tr>
<td>Total bicarbonate, mEq</td>
<td>107 (55–175)</td>
<td>95 (40–230)</td>
<td>0.908</td>
</tr>
<tr>
<td>Total epinephrine, mg</td>
<td>2.45 (1.3–4.3)</td>
<td>0.75 (0.2–3)</td>
<td>0.01</td>
</tr>
<tr>
<td>Total NE, mg</td>
<td>13.86 (5.22–26.64)</td>
<td>17.80 (2.47–112.94)</td>
<td>0.674</td>
</tr>
<tr>
<td>Duration of NE infusion, h</td>
<td>5.3 (3.8–35.6)</td>
<td>20.5 (0.9–85.4)</td>
<td>0.093</td>
</tr>
<tr>
<td>Survival, h</td>
<td>21 (4–96)</td>
<td>96 (48–96)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

NE indicates norepinephrine. Data are given as median (range).
During CPR – Will Defib Work?

• Animal model evaluating shock success at normothermia, moderate hypothermia (33 degrees), and severe hypothermia (30 degrees)

• Logistic regression demonstrated risk of post-defibrillation asystole to be 18% in the normothermic group vs. 1% in the hypothermic group

During CPR – Will Defib Work?

Normothermia First, then Moderate Hypothermia

- Hypothermia
- Normothermia

I SE
n = 10

Shock Success (%)

Selected Energy (Joules)
During CPR – Will Defib Work?

![Graph showing the success of defibrillation with normothermia and hypothermia at different energy levels.](image)

- **Hypothermia**
- **Normothermia**

I SE
n = 10
* p < 0.001

**Shock Success (%)**

**Selected Energy (Joules)**

- 20J
- 30J
- 50J
- 100J
Hypothermia Improves Defibrillation Success and Resuscitation Outcomes From Ventricular Fibrillation

Kimberly A. Boddicker, MD; Yi Zhang, MD, PhD; M. Bridget Zimmerman, PhD; Loyd R. Davies, BS; Richard E. Kerber, MD

Circulation 2005;111:3195=3201
Percent First Shock Success:

- Normothermia
- Mild Hypothermia
- Moderate Hypothermia
- Severe Hypothermia

*p ≤ 0.05 vs. Normothermia*
Proportion with ROSC:

![Graph showing the proportion of Swine Achieving ROSC under different animal conditions: Normothermia, Mild Hypothermia, Moderate Hypothermia, Severe Hypothermia. The graph indicates a significant difference (*) in the proportion of Swine Achieving ROSC between the conditions.](image-url)
During CPR – Will Drugs Work?

- Animal study for severe hypothermia
  - Purpose was to study treatment for accidental, severe hypothermia with ventricular fibrillation arrest
  - Bottom line: The drugs worked
    - Wira C et al. Resuscitation 2006;69:509-16
During CPR – Will Drugs Work?

**CYCLE I**

- Sedation and Instrumentation
  - *Goal Temp 22 °C*
  - Induction of VF, Start CPR EPI or Saline
  - Defibrillation (50J, 100J, 200J)
  - Perfusing Rhythm

  - **YES**
    - Perfusing Rhythm for 15 min
    - **YES**
      - Euthanize
    - **NO**

  - **NO**

**CYCLE II**

- CPR, Administer EPI/AMIO
  - Defibrillation (200J x 3)
  - Perfusing Rhythm for 15 min
    - **YES**
      - Euthanize
    - **NO**
During CPR – Will Drugs Work?

Coronary Perfusion Pressure (mmHg)

- Pre-Rx
- Post-EPI*
- Post-EPI/AMIO**
During CPR – Will Drugs Work?

% ROSC

- Control: 30%
- Epi: 64%
- Epi/Amio: 91%

*Statistically significant difference.
Summary of “When”:

• Most evidence suggests earlier is better
• Preliminary animal data suggests we should consider induction during the resuscitation
• Certainly, induction immediately after ROSC appears indicated:
  – Absolutely for VF/VT
  – Probably for other rhythms as well

Jose G. Cabanas, Valerie J. De Maio, J. Brent Myers, Ryan Lewis, Robert Lee, Paul R. Hinchevy, Daniel Licatese, Wake County EMS, WakeMed Health & Hospitals Clinical Research Unit
Results:

- CCC + ITD is control
- CCC + ITD + IH is experimental
- ROSC for non VF/VT rose from 7.6% to 38.2%
- D/C from 1.5% to 5.0%
So Why Should EMS Cool?

• Earlier induction may be beneficial

• It is inexpensive

• It does not appear to cause harm

• May improve success of ventricular fibrillation treatment
But Now for the Real Reason:

- The hospitals cannot be trusted to institute the treatment in all eligible patients

- Unpublished data from Australia indicates up to 25% of eligible patients will not be treated
FDNY Experience:
FDNY Experience:

Arrest Etiology for TH Patients

- Cardiac: 70.9%
- Respiratory / Hypoxia: 21.8%
- Overdose: 3.6%
- Stroke: 1.8%
- Hemorrhage: 0.9%
- Suicide Attempt: 0.0%
- Unknown: 0.0%
- Drowning: 0.0%
FDNY Experience:

![Bar Chart: Presenting Rhythm]

- **Presenting Rhythm**
- **All**, **Transported**, **TH Patients**
- **VF** and **NonVF**

Bar chart showing the percentage distribution of presenting rhythms among different groups.
FDNY Experience:

Neurologic Status of Discharged Patients

- 60.9%
- 17.4%
- 21.7%
- 0.0%
FDNY Experience:

**Contraindications to Hypothermia**

- Brainstem Dysfunction: 53.3%
- None: 15.0%
- Not Comatose: 9.3%
- Prolonged CPR / DNR: 13.1%
- Acidosis: 6.5%
- Refractory Hypotension: 0.0%
- Refractory Hypoxia: 0.0%
- Poor baseline function: 2.8%
So What is Actually Happening With Hypothermia?
Metro EMS Survey:

- New Orleans
- Houston
- Denver
- Vancouver/BC
- Richmond
- Louisville
- Houston
- Honolulu
- Phoenix
- El Paso
- Oklahoma City/Tulsa
- Kansas City
- Miami
- London (England)
- Portland
- San Diego
- Orlando
- Dallas
- Cincinnati
- Boston
- Memphis
- Austin
- St Paul
- San Antonio
- Columbus
- North Memorial (Twin Cities)
EMS Cooling:

Cooling

- IS CPR
- IS ROSC
- ICE CPR
- ICE ROSC
- Plans
- No Plans

Cooling
Comatose OHCA Destination:

- PCI Only
- Cooling Only
- Both
- Neither
Induced Hypothermia and/or Rewarming Status Post Cardiac Arrest Orders

Inclusion Criteria
- Non Traumatic Cardiac Arrest with Return of Spontaneous Circulation (ROSC)
- Core Temperature greater than 93.2°F (34°C) at presentation
- Time to initiation of hypothermia is less than 6 hours
- Comatose after ROSC: GCS less than 8, and no purposeful movements to pain

Exclusion Criteria
- Uncontrolled GI bleeding
- Patient requiring Mannitol therapy
- Advanced Directives or DNR status
- Cardiovascular instability as evidenced by: Uncontrollable dysrhythmias
- Refractory hypotension (unable to achieve target MAP with pressors – at least 75mmHg)
- Sepsis as suspected cause of cardiac arrest
- Suspected intracranial hemorrhage
- Major intracranial, intrathoracic or intrabdominal surgery within 14 days
- Gravid pregnancy

| DATE / TIME | Weight _______ kg | Time of ROSC _______ |
1. ☑ STAT point of care HCG. Inform MD of the results
2. ☑ Place temperature-sensing foley to monitor temp.
3. ☑ Set up for icy catheter insertion
4. ☑ TIME COOLING STARTED: __________ (in ED)
   (GOAL is to get core temp to 32°-34°C within 6 hrs of onset of arrest)
   ☑ If core temperature is greater than 93.2°F (34°C) at initiation of protocol, bolus with
     refrigerated 0.9% NS until patient’s core temperature is 93.2 °F (34°C). Bolus at 100mL/min
     with a maximum of 2 liters total. This is to include EMS volume. (Omit if already given by
     EMS)

Initiate Cool Guard protocol (preferred method)
5. If unable to use intravascular catheter above, initiate surface cooling by placing two cooling
   blankets (one anterior, and one posterior). Observe boney skin areas q 2hrs for any signs of
   breakdown. Place ice packs around neck, in axillary areas, and in groin.

☐ IF patient has recurring arrhythmias, discontinue active cooling, and inform ED MD.
6. ☑ BP, MAP, HR, O2 saturation, and cardiac rhythm hourly.
7. ☑ Record core temperature q 15 minutes
8. ☑ Alternative methods for monitoring core temp may be rectal probe
9. ☐ 0.9% NS at __________ mL/hr. Once icy catheter is inserted discontinue cold saline and replace
   with room temperature 0.45% NS at 100mL/hr.
10. Record total amount of cold saline infused prior to transporting to ICU __________ mL
11. ☑ Record initial foley output __________ mL

12. Labs:
    ☐ UA ☐ Phos ☐ ABG (temp corrected) ☐ CK’s q 3 hrs x 3
    ☐ PT ☐ Magneuseium ☐ UCG
    ☐ PTT ☐ Lactate ☐ Cardiac Panel
    ☐ Other:

Patient Identification:
Origin: R10/06
13. ✔ Set up CVP monitor. When functional, attach to icy catheter triple lumen.
   **CVP goal of 6-10 mmHg**

14. ✔ Nitroglycerin IV start at 5 mcg/min, increase by 5 mcg/min increments q 3-5 min until a BP
    response is noted. Goal is to keep MAP* less than 120 or ☐

15. ✔ Norepinephrine (Levophed) IV start at 0.5 mcg/min and titrate as needed to keep MAP
    greater than 75.
    ☐ Other pressor agent:

16. ☐ Fentanyl _____ mcg/hr (2 mcg/kg/hr initially) continuous infusion
    *(Consider if patient is hemodynamically unstable or has renal insufficiency, or if Creatinine
    Clearance < 50 mL/min.)*
    OR:
    ☐ Morphine _____ mg/hr (0.1 mg/kg/hr) continuous infusion
    *(Consider if patient is hemodynamically stable.)*

17. ☐ Lorazepam (Ativan): _____ mg/hr (0.01 mg/kg/hr initially) continuous infusion to maintain
    sedation.
    OR:
    ☐ Propofol (Diprivan): _____ mcg/min (5 mcg/kg/min initially) continuous infusion, titrate Q 5
    minutes to maintain sedation.

18. ☐ Vecuronium (Norcuron): _____ mcg/min (0.8-1.2 mcg/kg/min) continuous infusion.
    Pharmacy to mix 1:1 in NS *(Avoid in significant renal or hepatic impairment.)*
    ✔ Insert NGT to low intermittent wall suction
    ✔ Intake and output hourly
    ✔ If femoral line, reverse Trendelenberg to raise HOB as much as possible without kinking line

19. Vent Settings
    ✔ No warm humidified air
    ✔ Continuous ETCO2 monitoring
    ✔ ABG
    *(Goal PaCO2 35-45)*

20. STAT Diagnostics:
    ☐ PCXR    ☐ 12 lead ECG    ☐ Other: __________________________

<table>
<thead>
<tr>
<th>Physician signature:</th>
<th>Transcribed by:</th>
<th>Checked by (Nurse):</th>
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</thead>
<tbody>
<tr>
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</table>

Beeper #: --- Date: Time: | Date: Time:
#1 Stakeholder buy-in:

- Identify all stakeholders
- Present rationale
- Identify key players
Stakeholders:

• ED
  – Nursing
  – Physicians

• Cardiology
  – Cath lab nursing
  – CCU nursing
  – Cardiologists

• ICUs
  – Nursing
  – Intensivists

• Neurology

• Pharmacy

• Hospital Admin
Old Habits:

• One facility wanted to use the HACA criteria strictly
  – Was resuscitation started between 5 and 15 minutes after collapse?
  – Did the entire code last > 60 minutes?

• Many hesitate to initiate therapy when:
  – Initial rhythm was not VF/VT
  – Patient is going to the cardiac cath lab
Problems – Old Habits

- Reluctance when not v-fib or when going to the cath lab.

- Disparate experience with IH.

- Induction decision based on down time, duration of CPR and neuro
Old Habits:

• The immediate post-resuscitation neurologic exam

• One of the reasons we use paralysis – to get people not to do this!

• The immediate post-resuscitation neurologic exam is useless as a prognostic tool
A more recent meta-analysis of predictive studies suggested only 4 variables had a high specificity: absent pupillary light reactions on day 3, absent motor response to pain on day 3, bilaterally absent median SSEPs within week 1, and burst suppression or isoelectric EEGs within week 1.
Data From the Neurological Literature:

- 2006 Evidence-Based Review of the literature
- A must-read for clinicians caring for victims of cardiac arrest
- None of us are proposing that we fill ICUs with hopeless cases
- It is imperative, however, that we define hopeless in an evidence-based way
  - Wijdicks EFM et al. Neurology 2006;67:203-10
Do Circumstances of Arrest Adequately Predict Outcome?

Conclusions. Anoxia time, duration of CPR, and cause of cardiac arrest are related to poor outcome after CPR, but none of these variables can discriminate accurately between patients with poor and those with favorable outcomes.

Recommendations. Prognosis cannot be based on the circumstances of CPR (recommendation level B).
Is Elevated Body Temperature Predictive of Poor Outcome?

Conclusions. Elevated body temperature (>37 °C) is associated with poor outcome. However, hyperthermia alone could not discriminate accurately between patients with poor and those with favorable outcomes.

Recommendations. Prognosis cannot be based on elevated body temperature alone (recommendation level C).
Conclusions. The following clinical findings accurately predict poor outcome (FPR of 0 with narrow CIs); myoclonus status epilepticus within the first 24 hours in patients with primary circulatory arrest, absence of pupillary responses within days 1 to 3 after CPR, absent corneal reflexes within days 1 to 3 after CPR, and absent or extensor motor responses after 3 days.
Are Physical Exam Findings Predictive of Outcome?

Recommendations. The prognosis is invariably poor in comatose patients with absent pupillary or corneal reflexes, or absent or extensor motor responses 3 days after cardiac arrest (recommendation level A). Patients with myoclonus status epilepticus within the first day after a primary circulatory arrest have a poor prognosis (recommendation level B).
Coma

Exclude major confounders

No brain stem reflexes at any time (pupil, cornea, oculocephalic, cough)

Or

Day 1 Myoclonus Status Epilepticus

Or

Day 1-3 SSEP absent N20 responses*

Or

Day 1-3 Serum NSE >33 μg/L*

Or

Day 3 Absent pupil or corneal reflexes; extensor or absent motor response

Yes

Brain Death testing

FPR 0% (0-8.8)

FPR 0.7% (0-3.7)

FPR 0% (0-3)

FPR 0% (0-3)

Yes

Poor outcome

No

Indeterminate outcome
Summary of Predictors:

- Situation of CPR and circumstances of resuscitation are not sufficiently predictive of outcome.

- The initial post-resuscitation exam is not predictive of outcome.
1. Return of Pulse
2. Age > 16
3. Not obviously pregnant
4. Temperature > 34° C
5. No purposeful pain response
6. Intubated with ETCO₂ >20

Preparation for Induction
1. Conduct NEURO assessment:
   a. Pupils (size, reactivity, equality)
   b. Motor Response to Pain
2. Remove clothing, protect modesty
3. Apply cold packs- axilla and groin
4. Goal ETCO₂=40. No hyperventilation
5. Attempt second IV, if not in place
“If it is not simple, it simply won’t be done”

-- Israeli Defense Force
Pearls:

- **Criteria for Induced Hypothermia:**
  - ROSC after cardiac arrest not related to trauma or hemorrhage.
  - Age greater than 16
  - Female without obviously gravid uterus
  - Initial temperature > 34°C
  - Patient is intubated and remains comatose (no purposeful response to pain)
- If patient meets other criteria for induced hypothermia and is not intubated, then intubate according to protocol before inducing cooling. If unable to intubate **DO NOT** initiate induced hypothermia.
- When exposing patient for purpose of cooling undergarments may remain in place. Be mindful of your environment and take steps to preserve the patient's modesty.
- Do not delay transport for the purpose of cooling.
- Reassess airway frequently and with every patient move.
- Patients develop metabolic alkalosis with cooling. **Do not hyperventilate.**
- If there is loss of ROSC after cooling is initiated or any other complication as the result of this protocol please complete...
That Was Then . . .

- Criteria for Induced Hypothermia
  - ROSC not related to blunt/penetrating trauma or hemorrhage
  - Temperature after ROSC greater than 34 C degrees
  - Advanced airway in place with no purposeful response to pain
ROSC

Criteria for Induced Hypothermia and initial temp > 34°C

No

ET Tube Placed and ETCO₂ reading > 20 mmHg

Yes

Perform Neuro Exam and Record in ECR Induced Hypothermia Procedure

Expose patient
Apply Ice Packs to Axilla & Groin

P Versed 0.15 mg/kg to max 10 mg

P Vecuronium 0.1 mg/kg to max of 10 mg

P Cold Saline Bolus 30 mL/kg to max of 2 liters

P Dopamine 10-20 mcg/kg/min for MAP 90-100

Postresuscitation protocol

Unsuccessful

Intubation Protocol

Successful

Legend

EMT

I

EMT-I

I

EMT-P

P

MC Order

M

AT ANY TIME
Loss of Spontaneous Circulation:
Discontinue cooling and go to appropriate protocol

Monitor ETCO₂ Target
40 mmHg
DO NOT HYPERVENTILATE
Wake County Experience:

- Community-wide, natural experiment with prospective data collection and observation
- Phase One: Continuous compressions
- Phase Two: Controlled ventilations, working codes in the field to futility or ROSC
- Phase Three: Induction of hypothermia
Wake County Experience:

Wake County Experience:

- Baseline: 4.2% (18/425) of CPC 1&2, n=11 (78.6% of survivors)
- Full Implementation: 11.5% (47/410) of CPC 1&2, n=36 (76.6% of survivors)
Wake County Experience:

- The combination of compressions, controlled ventilations, working arrests in the field, and hypothermia increased survival by 7% actually and 200% relatively.
- This is an increase of 3 lives saved per 100,000 population per year, or 25 additional lives saved annually in Wake County.
Summary:

- With proper monitoring, there are very few complications associated with hypothermia
- There is substantial evidence of benefit
- The treatment is inexpensive
- What are we waiting for?
1 Wake County EMS System
Induced Hypothermia

Screening for Utilization
1. Return of Pulse
2. Age > 16
3. Not obviously pregnant
4. Temperature > 34°C
5. No purposeful pain response
6. Intubated with ETCO₂ >20

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A more recent meta-analysis of predictive studies suggested only 4 variables had a high specificity: absent pupillary light reactions on day 3, absent motor response to pain on day 3, bilaterally absent median SSEPs within week 1, and burst suppression or isoelectric EEGs within week 1.
Data From the Neurological Literature:

- 2006 Evidence-Based Review of the literature
- A must-read for clinicians caring for victims of cardiac arrest
- None of us are proposing that we fill ICUs with hopeless cases
- It is imperative, however, that we define hopeless in an evidence-based way
  - Wijdicks EFM et al. Neurology 2006;67:203-10
Do Circumstances of Arrest Adequately Predict Outcome?

Conclusions. Anoxia time, duration of CPR, and cause of cardiac arrest are related to poor outcome after CPR, but none of these variables can discriminate accurately between patients with poor and those with favorable outcomes.

Recommendations. Prognosis cannot be based on the circumstances of CPR (recommendation level B).
Conclusions. Elevated body temperature (>37 °C) is associated with poor outcome. However, hyperthermia alone could not discriminate accurately between patients with poor and those with favorable outcomes.

Recommendations. Prognosis cannot be based on elevated body temperature alone (recommendation level C).
Conclusions. The following clinical findings accurately predict poor outcome (FPR of 0 with narrow CIs); myoclonus status epilepticus within the first 24 hours in patients with primary circulatory arrest, absence of pupillary responses within days 1 to 3 after CPR, absent corneal reflexes within days 1 to 3 after CPR, and absent or extensor motor responses after 3 days.
Recommendations. The prognosis is invariably poor in comatose patients with absent pupillary or corneal reflexes, or absent or extensor motor responses 3 days after cardiac arrest (recommendation level A). Patients with myoclonus status epilepticus within the first day after a primary circulatory arrest have a poor prognosis (recommendation level B).
Coma

Exclude major confounders

No brain stem reflexes at any time (pupil, cornea, oculocephalic, cough)

Yes → Brain Death testing

Or

Day 1
Myoclonus
Status Epilepticus

Yes → Poor outcome

FPR 0% (0-8.8)

Or

Day 1-3
SSEP absent N20 responses*

Yes → Poor outcome

FPR 0.7% (0-3.7)

Or

Day 1-3
Serum NSE >33 μg/L*

Yes → Poor outcome

FPR 0% (0-3)

Or

Day 3
Absent pupil or corneal reflexes; extensor or absent motor response

Yes → Poor outcome

FPR 0% (0-3)

No → Indeterminate outcome
Summary of Predictors:

• Situation of CPR and circumstances of resuscitation are not sufficiently predictive of outcome

• The initial post-resuscitation exam is not predictive of outcome.
Where Does This Leave Us?

• Post-resuscitation patients should receive hypothermia if initial rhythm was VF/VT
• Strong consideration should be given to providing the therapy to other post-resus patients
• Coordination between EMS, EM, ICU, and Cardiology is essential
Where Does This Leave Us?

- Post-resuscitation/cardiac specialty hospitals with expertise in these therapies should receive patients directly from the field or in prompt transfer.

- We may be starting all codes cold in the near future.
What Have We Found?

- Since October 2006, we have induced over 100 patients.
- We have experienced no complications and 2 mild protocol violations.
- “Doc, resuscitation is hard – this is easy”
So where are the numbers?

- We have completed survival analysis
- Currently looking at neuro outcomes
- We have submitted abstracts for SAEM in May 2008