Role of Therapeutic Hypothermia After Cardiac Arrest: Why? When? How?

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Objectives

- Discuss current problem after cardiac arrest.
- Review destructive processes in the brain following ischemia/reperfusion.
- Summarize results of literature describing evidence of benefits of therapeutic hypothermia.
- Describe physiology of therapeutic hypothermia and list its clinical benefits.
- Identify possible complications during therapeutic hypothermia implementation and potential management.
- Compare and contrast various cooling and rewarming methods.
- Summarize pharmacotherapy used during cooling and rewarming.

Scope of Problem

- Cardiac arrest – cessation of cardiac mechanical activity
- Confirmed by the absence of signs of circulation
- Survivors suffer from mild memory impairment to permanent brain damage

Statistics

- In the US out-of-hospital cardiac arrest: 250,000-300,000/year
- Cardiac arrest due to V.fib or V.tach in 20-38% of patients
- Rate of survival from cardiac arrest: 6-12%
- The rate of survival of in-hospital cardiac arrest: ~18%

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The Clinical Use of Hypothermia Following Cardiac Arrest.  
From The Department of Surgery, The Johns Hopkins University School of Medicine and Hospital, Baltimore, Maryland

<table>
<thead>
<tr>
<th>Case number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Jan 1957</td>
<td>Aug 1957</td>
<td>Sep 1957</td>
<td>Nov 1957</td>
</tr>
<tr>
<td>Age</td>
<td>5 yr.</td>
<td>9 yr.</td>
<td>38 yr.</td>
<td>39 yr.</td>
</tr>
<tr>
<td>Cause of arrest</td>
<td>Bronchogram</td>
<td>Asthma</td>
<td>Stab wound</td>
<td>Stab wound</td>
</tr>
<tr>
<td>Duration of arrest</td>
<td>5 minutes</td>
<td>5 minutes</td>
<td>5 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Neurological damage</td>
<td>Severe</td>
<td>Severe</td>
<td>Severe</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Hypothermia:  
Range: 32-34°C  
Duration: 72 hours  
Residual neurological defect: None  

What is Therapeutic/Induced Hypothermia (TH/ITH) & Why is it Used?  
- Controlled lowering of core temperature for therapeutic reasons  
- Used for improving neurologic outcomes after cardiac arrest

Historic Background on TH  
- Ancient times: Hippocrates advocated the packing of wounded soldiers in snow & ice  
- 1812: TH used during Napoleon’s Russian campaign to preserve injured limbs & to numb areas during amputation  
- 1945: First clinical study of TH was published  
- 1950: Positive effect of mild hypothermia after brain ischemia & traumatic brain injury were demonstrated in dogs  
- 1990: More studies in lab animals  
- 1991: Sterz & colleagues have demonstrated in a dog model that TH after cardiac arrest was associated with improvements in neurologic outcomes  
- 2002: Two landmark human studies have demonstrated effectiveness of TH in patients who suffered out-of-hospital cardiac arrest

Success or Failure of Cooling Treatment Depends on:  
- Speed of induction of hypothermia  
- Duration of cooling  
- Speed of rewarming  
- Proper management & prevention of side effects

Insight Why Early Experiences With Hypothermia Led to Problems  
- Deep hypothermia to <=30°C  
- Overshoot  
- Not reliable cooling & rewarming methods  
- Applied to heterogeneous patient population
European Study

- Multi-center, randomized controlled study
- Duration: March 1996 – January 2001
- 275 patients in nine European hospitals
  - N=137 mild hypothermia group (32-34°C x24hrs)
  - N=138 standard normothermia group


European Study (Cont.)

- Inclusion Criteria
  - Witnessed cardiac arrest
  - V.fib or V.tach as the initial cardiac rhythm
  - Presumed cardiac origin of the arrest
  - Age of 18 to 75 years
  - Estimated interval of 5-15 min from the pt’s collapse to the first attempt at resuscitation
  - Interval of no more than 60 min from collapse to restoration of spontaneous circulation (ROSC)

- Exclusion Criteria
  - Tympanic T <30°C on admission
  - Comatose state before the cardiac arrest due to administration of drugs that depress CNS
  - Pregnancy
  - Response to verbal command after the ROSC and before randomization
  - Pregnancy
  - Enrolment in another study
  - Occurrence of cardiac arrest after the arrival of emergency medical personnel
  - Known preexisting coagulopathy

European Study Results: Neurological Outcome & Mortality at Six Months

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Normothermia Group</th>
<th>Hypothermia Group</th>
<th>Risk Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<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>


European Study Results (Cont.): Cumulative Survival

- Total number of complications didn’t significantly differ between groups P=0.09.
Australian Study

- Prospective randomized study
- Duration: September 1996 – June 1999
- 77 comatose pts
  - N=43 hypothermia group (33°C x 12hrs)
  - N=34 normothermia group


Australian Study (Cont.)

- Inclusion Criteria
  - Initial cardiac rhythm of V.fib at the time of arrival of the ambulance
  - Successful ROSC
  - Persistent coma after the ROSC
  - Transfer to one of four participating emergency departments

- Exclusion Criteria
  - Age of less than 18 years for men, an age of less than 50 years for women
  - Cardiogenic shock (SBP <90 mmHg despite NE infusion)
  - Possible causes of coma other than cardiac arrest (drug OD, head trauma, CVA)
  - Intensive care bed was not available at a participating institution

American Heart Association & International Liaison Committee on Resuscitation Recommendations

- Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32-34°C for 12-24 hrs when the initial rhythm was V.fib.
  - Grade IIa

- Similar therapy may be beneficial for other rhythms (pulseless electrical activity, asystole) or in-hospital cardiac arrest.
  - Grade IIb

TABLE 5. OUTCOME OF PATIENTS AT DISCHARGE FROM THE HOSPITAL.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Hypothermia Group (N=43)</th>
<th>Normothermia Group (N=34)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable outcome</td>
<td>49%</td>
<td>26%</td>
<td>0.046</td>
</tr>
<tr>
<td>Mortality</td>
<td>51%</td>
<td>68%</td>
<td>0.145</td>
</tr>
</tbody>
</table>


Meta-Analysis Results

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Risk Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neurological outcome cooling vs. no cooling</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Survival cooling vs. no cooling</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Adverse events</td>
<td></td>
</tr>
</tbody>
</table>

### Adverse Events

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Risk Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>1.38 (0.88, 2.16)</td>
</tr>
<tr>
<td>Need for platelets</td>
<td>5.11 (2.05, 10.57)</td>
</tr>
<tr>
<td>PNA</td>
<td>1.27 (0.90, 1.78)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>1.93 (0.89, 1.78)</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>0.51 (0.05, 5.57)</td>
</tr>
<tr>
<td>Renal failure or oliguria</td>
<td>0.88 (0.48, 1.61)</td>
</tr>
<tr>
<td>HD</td>
<td>1.11 (0.43, 3.01)</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>1.76 (0.81, 5.12)</td>
</tr>
<tr>
<td>Seizures</td>
<td>0.85 (0.39, 2.02)</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>1.21 (0.88, 1.67)</td>
</tr>
<tr>
<td>Cardiac complications</td>
<td>0.16 (0.01, 3.21)</td>
</tr>
<tr>
<td>Hypokalemia</td>
<td>0.91 (0.31, 2.68)</td>
</tr>
<tr>
<td>Hypophosphatemia</td>
<td>1.12 (0.65, 2.25)</td>
</tr>
</tbody>
</table>
**TH Proposed Mechanism of Action: Blunt, Reverse, or Prevent Destructive Processes**

- **Slowing of cellular metabolism**
  - For every 1°C drop in T, cellular metabolism slows by 6-8%.

- **Decreasing body's demand for O₂ & glucose**
  - Harmful effects of O₂ deprivation (↓ ATP synthesis/free radical production/release of excitatory amino acids/Ca shifts)

- **Prevents injuries after circulation returns to the brain (reperfusion injury)**
  - ↓ Pro-inflammatory mediators & O₂ radicals production → prevents cell injury/cell death


**Clinical Benefits of Hypothermia**

- **Initial increase in HR**
- **As the body T drops <35°C → bradycardia**
  - At 32°C -> HR 40-45 beats/min
- **Decrease in CO & SV**
- **Increase in SVR & BP**
- **Reduction in ICP in patients with traumatic brain injury**
- **Reduction in infarct size after MI**

**Who is a Candidate For TH After Cardiac Arrest?**

- Comatose patients at the time of cooling
- Patients on mechanical ventilation for whom TH can be initiated within 6hrs of cardiac arrest
- Patients with cardiac arrest due to V.fib or V.tach
- Other criteria
  - Able to maintain SBP >/=90 mmHg after CPR with or without vasopressors

**Who SHOULD NOT Be Treated With TH After Cardiac Arrest**

- Major surgery within 14 days of cardiac arrest
- Risk of infection & bleeding
- Systemic infection or sepsis
- Comatose due to other causes
- Known bleeding risk or active ongoing bleeding
- Do not resuscitate status
- Body T<30°C after cardiac arrest
- Pregnant women

**Phases of Cooling Treatment**

- **Induction**
  - Getting to desired goal temperature

- **Maintenance**
  - Keeping the patient at the goal temperature for a period of time

- **Rewarming**
  - Slowly returning patient’s temperature to normal
Optimum Ranges of Hypothermia

- **Goal:** rapidly cool patient to 32-34°C (89.6-93.2°F) x24hrs to preserve brain function
- **Achieve:** optimum balance between clinical effect & complications
- **Below 32°C:** associated with increased risk of complications

### Cooling Methods: Factors to Consider

- Location of hypothermia induction
- Rapidity of induction
- Ability to control rewarming
- Portability of used device
- Encountered complications
- Cost

***Note:***
- Older patients: faster cooling rates
- Obese patients: takes longer to reach target hypothermic T

### Types of Cooling Methods

#### Surface Cooling

- **Two types:**
  - Generalized cooling
  - Selective brain cooling
- Noninvasive & easy to use
- More time required to reach target T
- Less efficient in reducing T of target organs: brain & heart
- Highly variable
- Unintentional overcooling is common
- Risk of skin sores/breakdown due to covering majority of pt’s body (generalized cooling)

#### Invasive Cooling

- **Two types:**
  - IV infusions of large volumes of ice-cold (4°C) fluids
  - Endovascular cooling
- More invasive
- Variable but rapid induction of hypothermia

### Surface Cooling

- Involves entire body.
- Involves brain ONLY.
- Can be used in combination with other methods.
- Balloon catheter is inserted into femoral vein & patient's blood cools as it circulates past the internal cooling unit.

#### Invasive Cooling

- Cooling rate: 0.03-0.18°C/hr.
- Can use: 0.9% NaCl, Lactated Ringer’s, albumin.
- Cooling rate: 4°C/hr.

#### Generalized cooling

- Use cooling blankets, ice packs, cooling pads.
- Use cooling helmet which contains aqueous glycerol solution.

#### Selective brain cooling

- Infuse 30-40 ml/kg or 2 L over 30-60 min.
- Cooling rate: 0.8-1.2°C/L of fluid.
- More reliable & very accurate: decrease T to within 0.1°C of target T.
- Requires monitoring MD and increased cost.

#### Endovascular Cooling

- CI: pulmonary edema, chronic renal failure on dial.

### Rewarming

- Initiated 24 hrs after the initiation of cooling, **NOT from the time target T was reached**
- Peripheral blood vessels begin to dilate
- ↑’s inflammatory cytokines
- Hypotension
- ↑’s ICP
- ↓’s cerebral perfusion pressure
Rewarming (Cont.)

- **Most critical**
- Most deaths during this phase
- Rewarm slowly & steadily to avoid rise in ICP
- Recommended rewarming rate: \(\leq 0.5-1^\circ C/hr\)
- Takes ~8 hrs

Rewarming Methods

**Active mechanisms**
- Heated-air blankets

**Passive mechanisms**
- Removal of cooling methods
- Allows body T to increase over time

- Continue: paralysis & sedation until patient’s T=35°C.
- Discontinue: electrolyte infusions due to electrolyte shift from intracellular to extracellular space.

Rewarming Methods: Active mechanisms

### Monitoring Temperature:

- **Continuously**
  - T of the blood from pulmonary artery catheter
  - Tympanic T
  - Peripheral T

| True core T | Reflective of core T | Obtained from bladder, rectum, mouth, esophagus, axill.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Most accurate</td>
<td>Not always accurate: measurement error, difficult to measure if patient’s head surrounded by ice packs.</td>
<td>Bladder T correlates well with core T. ***Note: bladder probe is only accurate when UO is adequate.</td>
</tr>
</tbody>
</table>

### Possible Complications

- **Arrhythmias**
- Hyperglycemia & hypoglycemia
- Bleeding
- Infection
- Fluid & electrolyte disturbances
- Shivering & cutaneous vasoconstriction
- Decrease in drug clearance

**Possible Complications: Arrhythmias**

- T <35°C \(\rightarrow\) (-) chronotropic effect \(\rightarrow\) AV block
- T <30°C \(\rightarrow\) A.fib & V.fib
- EKG: prolonged PR & QT intervals, widening of QRS complex, altered T wave, appearance of J wave
- Difficult to treat
- Bretylium – recommended as the DOC
- Amiodarone, lidocaine, procainamide
  - Efficacy questionable-to-ineffective
- If prophylactic therapy initiated: lidocaine preferable to amiodarone
- If severe arrhythmias occur: discontinue hypothermia & initiate active rewarming + ACLS.
Possible Complications: Hyperglycemia & Hypoglycemia

During hypothermia
- Hyperglycemia
  - ↓ in insulin secretion & sensitivity
  - ↑ in gluconeogenesis & glycogenolysis
- Management with regular insulin

During rewarming
- Hypoglycemia
  - Insulin sensitivity may ↑ rapidly

Possible Complications: Bleeding

- Risk well documented in literature
- ↑ degree of hypothermia → ↑ risk of bleeding
- For every 1°C decrease in T, coagulation-factor function decreased by 10%
- T <3/4°C affects coagulation cascade
- Proposed hypothesis for coagulopathy
  - Enzyme inhibition
  - Platelet alteration & depletion
  - Change in fibrinolytic process
- Monitor: PT/INR, APTT
- Management: platelets and/or FFP

Possible Complications: Infection

- Hypothermia suppresses immune system
- T <35°C neutrophil & macrophage activities are inhibited
- T=33°C phagocytic activity & killing potential of leukocytes is reduced
- Reduced secretion of proinflammatory cytokines
- Hypothermia-induced hyperglycemia may also increase infection risk
- Most common infections
  - Pulmonary (potential aspiration) & wound
- Blood cultures to screen for bacteremia
- Prophylaxis: antibiotics at the onset of hypothermia

Possible Complications: Fluid & Electrolyte Disturbances

- Initiation of cooling
  - Mild diuresis → possible hypovolemia
  - Electrolyte intracellular shift
  - Renal tubular dysfunction
- Depletion of Mg, K, Ca, PO4
- Low K & Mg may contribute to arrhythmias
- Management: maintain electrolytes at the higher end of normal range during hypothermia
- Start K supplementation if K <4 meq/L
- STOP electrolytes during rewarming

Possible Complications: Shivering

- Shivering & vasoconstriction: body's thermoregulatory defense mechanism to maintain constant core T
- T~36°C: body begins to shiver → ↑ core T/metabolic rate/heat production/O2 consumption
- Signs of shivering: ↓ mixed venous O2 saturation, ↑ RR, & facial tension

Shivering Management

Non-pharmacologically
- Warming of the face, hands, feet
- Not very effective due to small portion of the body

Pharmacologically
- Drugs that have affect centrally
  - Neuromuscular blockers (NMBs), opiates (meperidine most effective but fentanyl & morphine are preferred), sedatives, Mg, anesthetics, α2-adrenergic agents - clonidine
  - Cons of using NMBs: masking of seizures
  - Combination of antishivering agents are most commonly used
Possible Complications: Drug Clearance

- Decreased rate of drug metabolism by liver
- Outcome
  - Increased drug level → enhance drug potency & effect duration
- Management
  - Use lower doses, use bolus doses rather than to increase maintenance dose

\[10/2/2012\]

Brief Summary of Pharmacotherapy During Cooling & Rewarming

<table>
<thead>
<tr>
<th>Sedation (during cooling)</th>
<th>Propofol or midazolam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analgesia (during cooling)</td>
<td>Fentanyl or morphine</td>
</tr>
<tr>
<td>NMB (during cooling)</td>
<td>Vecuronium or pancuronium or cisatracurium</td>
</tr>
<tr>
<td>Ophthalmic Lubricant Ointment</td>
<td></td>
</tr>
<tr>
<td>Vasoactive agents (if hemodynamically unstable)</td>
<td>Hypotension or low EF, dopamine, NE, dobutamine HTN, NTG</td>
</tr>
<tr>
<td>Electrolytes (during cooling)</td>
<td>KCl, MgSO₄, CaCl, NaPO₄</td>
</tr>
<tr>
<td>Insulin therapy (during cooling)</td>
<td></td>
</tr>
<tr>
<td>DVT prophylaxis</td>
<td>UFH or LMWH or Intermittent Compression Stockings</td>
</tr>
<tr>
<td>GI prophylaxis</td>
<td>H₂ blockers or PPI</td>
</tr>
</tbody>
</table>


Patient Case:

HPI

- 46 yo male, 5’8”, 90.5 kg
- Admitted to the ED on 5/31/12 with respiratory distress
- Pulse ox 74% -> intubated
- EKG: STEMI
- Went into full cardiac arrest due to V.fib
- Successfully resuscitated while in the ED

Patient Case (Cont.):

PMH

- Allergies: PCN, sulfonamides
- CAD (2000), HTN, hyperlipidemia, T2DM, CHF, stent placement after acute MI (5/2/12)
- SH
- Quit smoking after 1st MI on 5/2/12

Patient Case (Cont.):

Labs on Admission

<table>
<thead>
<tr>
<th>BMP</th>
<th>CBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Test</td>
<td>Lab Value</td>
</tr>
<tr>
<td>Na</td>
<td>138</td>
</tr>
<tr>
<td>K</td>
<td>4.0</td>
</tr>
<tr>
<td>Cl</td>
<td>102</td>
</tr>
<tr>
<td>Glucose</td>
<td>459</td>
</tr>
<tr>
<td>BUN</td>
<td>15</td>
</tr>
<tr>
<td>SCr</td>
<td>1.2</td>
</tr>
<tr>
<td>Ca</td>
<td>9.2</td>
</tr>
<tr>
<td>CPK</td>
<td>43</td>
</tr>
<tr>
<td>Troponin I</td>
<td>0.13</td>
</tr>
<tr>
<td>BNP</td>
<td>1209</td>
</tr>
</tbody>
</table>

Patient Case (Cont.):

5/31-Went to cath lab
- Left anterior descending artery re-opened

5/31-Transferred to CCU

5/31-Therapeutic hypothermia protocol initiated at 0800
**Patient Case (Cont.):**

**Vitals & Labs During Cooling Phase**

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>T (°F)</th>
<th>BP</th>
<th>Na</th>
<th>K</th>
<th>Glucose</th>
<th>BUN</th>
<th>SCr</th>
<th>SGOT/AST</th>
<th>SGOT/ALT</th>
<th>CPK</th>
<th>Troponin I</th>
<th>Lactic Acid</th>
<th>WBC</th>
<th>PLT</th>
<th>INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/31 0000</td>
<td>94.8</td>
<td>87/41</td>
<td>125</td>
<td>6.5</td>
<td>794</td>
<td>23</td>
<td>1.6</td>
<td>558</td>
<td>749</td>
<td>246</td>
<td>2.99</td>
<td>605</td>
<td>27.1</td>
<td>151</td>
<td>2.3</td>
</tr>
<tr>
<td>5/31 1300</td>
<td>92.3</td>
<td>117/70</td>
<td>130</td>
<td>3.6</td>
<td>656</td>
<td>24</td>
<td>1.4</td>
<td>1382</td>
<td>2279</td>
<td>326</td>
<td>3.98</td>
<td>13</td>
<td>27.6</td>
<td>180</td>
<td>2.5</td>
</tr>
<tr>
<td>5/31 2118</td>
<td>89.7</td>
<td>118/73</td>
<td>136</td>
<td>4.6</td>
<td>326</td>
<td>26</td>
<td>5.1</td>
<td>3013</td>
<td>4319</td>
<td>419</td>
<td>4.6</td>
<td>24</td>
<td>23.9</td>
<td>153</td>
<td>2.8</td>
</tr>
<tr>
<td>6/1 0100</td>
<td>91.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

**Patient Case (Cont.):**

**Vitals & Labs During Rewarming Phase**

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>T (°F)</th>
<th>BP</th>
<th>Na</th>
<th>K</th>
<th>Glucose</th>
<th>BUN</th>
<th>SCr</th>
<th>SGOT/AST</th>
<th>SGOT/ALT</th>
<th>CPK</th>
<th>Troponin I</th>
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<th>WBC</th>
<th>PLT</th>
<th>INR</th>
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<tbody>
<tr>
<td>6/1 0925</td>
<td>96.9</td>
<td>117/70</td>
<td>139</td>
<td>4.6</td>
<td>794</td>
<td>29</td>
<td>0.8</td>
<td>2222</td>
<td>3973</td>
<td>342</td>
<td>2.47</td>
<td>18</td>
<td>16.1</td>
<td>144</td>
<td>3.7</td>
</tr>
<tr>
<td>6/1 1400</td>
<td>99.3</td>
<td>110/73</td>
<td>137</td>
<td>3.6</td>
<td>656</td>
<td>31</td>
<td>1.0</td>
<td>1556</td>
<td>4152</td>
<td>333</td>
<td>2.67</td>
<td>19</td>
<td>17.1</td>
<td>153</td>
<td>3.9</td>
</tr>
<tr>
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**Patient Case (Cont.):**

**Radiological and Culture Results**

- 5/31 MRSA screening (-)
- 6/1 CXR-Infiltrate and pleural effusion on right worse than previous exam, infiltrate on left slightly improved
- 6/3 CXR-Improvement in left basilar densities
- 6/3 Head CT-Sinus disease
- 6/4 CXR-No change
- 6/4 Blood cx-Negative

**Current Use of Postarrest Hypothermia**

- Not widely accepted
- Survey results: 74% US & 64% non-US physicians never used TH
- Most common reason for non-use:
  - "Not enough data"
  - "Not part of ACLS guidelines"
  - "Too technically difficult to use"

**Possible Ways to Increase Use of TH**

- Need for education & training
- Need for practical guidelines for implementation of TH
- Possible inclusion of hypothermia protocol as part of ACLS algorithm

**Hypothermia Resource Website**

- [http://www.med.upenn.edu/resuscitation/hypothermia/](http://www.med.upenn.edu/resuscitation/hypothermia/)
Conclusion

- TH has shown to be effective in improving neurologic outcomes in patients status post cardiac arrest
- Key factors for effective clinical usage of TH
  - Understanding underlying mechanisms
  - Awareness of physiological changes associated with cooling/rewarming
  - Prevention of potential side effects
- More studies are needed to confirm optimal time & methods for cooling to increase chance of neurologic recovery after cardiac arrest

References


References (Cont.)


References (Cont.)