Case Presentation

- 78 year old man collapses at the mall
- EMS activated
- No bystander CPR
- No AED
- EMS arrives 8 minutes after collapse
78 year-old man

- CPR initiated for 2 minutes
78 year-old man

- Intubated
- More CPR
- Epinephrine
- Atropine
- Rhythm check
78 year-old man

- ROSC after 20 minutes from collapse
- Transported to local ED
Emergency Department

- **Past Medical History**
  - Hypertension
  - Diabetes
  - Coronary Artery Disease
    - 2 stents 6 years ago

- **Medications**
  - Atenolol
  - ASA
  - Lipitor
  - Lisinopril
  - MVI
Emergency Department

- BP 108/54
- HR 92
- RR 12(vent)
- SpO2 100% on 100% FiO2

- GCS 7
  - E 2 – opens eyes to pain
  - V 1 – intubated
  - M 4 – withdraws from pain
Head CT
Because you don’t want to miss…
Now what?

- What if he was on coumadin?
- What if he was down for 45 minutes?
I’m not dead yet!
The Problem

- High field mortality rate
- High in-hospital mortality rate
- Survivors have high neurologic morbidity
Objectives

- History
- Pathophysiology
- Practical application
- Initial Management
- Complications
- Case presentations
Epidemiology

- **Incidence of sudden cardiac arrest**
  - 62 per 100,000 people (industrial countries)
  - 350,000 cases per year (US and Europe)

- **Despite nearly 40 years of ALS – survival rates are still very poor**
  - < ½ of those with ROSC survive to hospital discharge

- **Physician surveys show disappointing rates of hypothermia use**
  - 91% from US
  - 74% had never used hypothermia for cardiac arrest
    - Insufficient data available
    - Technically difficult
    - Not included in ACLS guidelines
To treat cardiac arrest, doctors cool the body

By Robert Davis
USA TODAY

When his heart stopped in the middle of his workday, Dean Cowles fell clinically dead in one of the best places in the world to suffer sudden cardiac arrest.
Doctors are reinventing how they treat sudden cardiac arrest, which is fatal 95 percent of the time. A report from the border between life and death.

BACK FROM THE DEAD

BY JERRY ADAMSON

BONVAR KNOWS EXACTLY WHERE HE DIED: ON THE SIDWALK OUTSIDE HIS HOME IN A RETIREMENT COMMUNITY IN SOUTHERN NEW JERSEY. IT WAS 10:30 ON THE NIGHT OF MAY 23, A WEDNESDAY, AND BONVAR WAS

APOTOMIS: CELLULAR SUICIDE

Nature's natural means of eliminating damaged or abnormal cells, resulting in more cell death and endangering the patient.

UC Neuroscience Institute
Hypothermia therapy saves Loveland man

BY BRIAN O’DONNELL • LOVELAND@COMMUNITYPRESS.COM • NOVEMBER 16, 2009

When Thomas Hufford was diagnosed with prostate cancer last year, he had three treatment options, all of which would give him 10 to 15 years to live.

• More Loveland news

Hufford, a 76-year-old Loveland resident, chose to have radioactive seeds surgically implanted into his prostate to kill the cancer.

Immediately after the surgery, his life expectancy changed drastically when he suffered a massive heart attack.

Dr. Andrew Burger, a University Hospital physician, and his team expected a grim outcome.
Focus on Technology

Controlled hypothermia is helping restore life. Details during Focus on Technology with Ann Thompson.

By Ann Thompson

Listen to the MP3 (4:36)

Focus on Technology Podcasts

Debra Siegel, the patient, in her Hyde Park home
History of Hypothermia

- First clinical reports on use of hypothermia published in the 1940s and 1950s

- Many studies on physiologic effects in humans performed in the 1950s

- Case series and experimental studies published in the 1950s and 1960s
  - No randomized controlled trials
  - Moderate or deep hypothermia
History of Hypothermia

- Described by ancient Egyptians, Greeks and Romans

Hippocrates

Celcus en Galaenus
History of Hypothermia

- **1814 - Napoleonic Wars**
  - Baron Larrey - Napoleon’s surgeon-general
  - Wounded soldiers put close to a campfire died earlier than those who were not re-warmed
History of Hypothermia

- First clinical reports published in the 1940s and 1950s


EARLY EXPERIENCES WITH LOCAL AND GENERALIZED REFRIGERATION OF THE HUMAN BRAIN

TEMPLE FAY, M.D.

Philadelphia, Pennsylvania

Fig. 5. Early method of total refrigeration with recording thermocouple (89.5°F. rectal). Patient was under Amytal Sodium, chloral hydrate and paraldehyde anesthesia. This patient (a physician) insisted upon keeping socks on.
Fig. 8. With this mobile refrigeration apparatus, G.M. (April 9, 1940) was able to enjoy a fair degree of activity in the ward during the weeks of local refrigeration of the brain through an implanted capsule (Fig. 5) in the cavity of an evacuated glioma.
History of Hypothermia

- Nazi experiments simulated conditions soldiers (especially downed pilots) suffered during war

- **Purpose:**
  - To determine the cause of death from hypothermia: Cardiac or metabolic
  - To ascertain at what temperature death occurs
  - To determine the best resuscitation methods
  - To determine what type of protective clothing was most effective

> “SS [Schutzstaffel (protection echelon)] Sturmbannfuehrer Dr. Sigmund Rascher (right) and Dr. Ernst Holzlohner (left) observe the reactions of a Dachau prisoner who has been immersed in a tank of ice water in an attempt to simulate the extreme hypothermia suffered by pilots downed over frigid seas. The freezing experiments were designed to establish methods of treatment for persons in a state of shock as a result of prolonged exposure to the cold. The medical experiments performed on Dachau prisoners involved the placing of the victim in a tank of ice water until he lost consciousness (70-90 minutes), followed by abrupt attempts to restore his normal body temperature by various means.... This photo is taken from a film found in the Munich home of Dr. Sigmund Rascher.”
World War II

- **Methods:**
  - Immersion in ice-cold water
  - Exposure to outside environment
  - No interest in therapeutic hypothermia
  - Research purely aimed at accidental hypothermia
    - Recovery from hypothermia
THE USE OF HYPOTHERMIA AFTER CARDIAC ARREST

DONALD W. BENSON, M.D.
G. RAINEY WILLIAMS, JR., M.D.
FRANK C. SPENCER, M.D.
ADOLPH J. YATES, M.D.

Baltimore, Maryland*
MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

The Hypothermia after Cardiac Arrest Study Group*
TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA


<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Hypothermia (N=43)</th>
<th>Normothermia (N=34)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td></td>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td>Median</td>
<td>66.8</td>
<td>65.0</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>49–89</td>
<td>41–85</td>
<td></td>
</tr>
<tr>
<td>Male sex (%):</td>
<td></td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>Arrest witnessed (%)</td>
<td>95</td>
<td>94</td>
<td>0.81</td>
</tr>
<tr>
<td>Bystander-performed cardiopulmonary resuscitation (%)</td>
<td>49</td>
<td>74</td>
<td>0.03</td>
</tr>
<tr>
<td>Time from collapse to emergency-medical-services call (min)</td>
<td>2.1±1.9</td>
<td>2.7±3.0</td>
<td>0.32</td>
</tr>
<tr>
<td>Time from call to emergency-medical-services arrival (min)</td>
<td>7.9±3.1</td>
<td>8.3±2.8</td>
<td>0.60</td>
</tr>
<tr>
<td>Time from arrival to first DC shock (min)</td>
<td>2.5±2.2</td>
<td>2.0±1.2</td>
<td>0.22</td>
</tr>
<tr>
<td>Time from first shock to return of spontaneous circulation (min)</td>
<td>13.6±11.2</td>
<td>12.1±7.9</td>
<td>0.48</td>
</tr>
<tr>
<td>Time from collapse to return of spontaneous circulation (min)</td>
<td>26.5±12.9</td>
<td>25.0±8.9</td>
<td>0.54</td>
</tr>
<tr>
<td>Number of DC shocks</td>
<td>4.2±3.0</td>
<td>4.1±3.2</td>
<td>0.87</td>
</tr>
<tr>
<td>Dose of epinephrine (mg)</td>
<td>2.2±2.1</td>
<td>2.2±1.9</td>
<td>0.97</td>
</tr>
</tbody>
</table>
TREATMENT OF COMA TOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA


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

<table>
<thead>
<tr>
<th>OUTCOME*</th>
<th>HYPO THERMIA (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>
Hypothermia for neuroprotection after cardiac arrest:
Systematic review and individual patient data meta-analysis

Michael Holzer, MD; Stephen A. Bernard, MD; Said Hachimi-Idrissi, MD; Risto O. Roine, MD, PhD;
Fritz Sterz, MD; Marcus Müllner, MD, MSc on behalf of the Collaborative Group on Induced Hypothermia
for Neuroprotection After Cardiac Arrest
How does it work?
3 phase model of resuscitation

Electrical and Circulatory → reduce the duration of global ischemia (primary brain injury)

Metabolic → attenuate post-resuscitation disease due to reperfusion injury (secondary brain injury)
Common denominator?

- Traumatic Brain Injury
- Cardiac Arrest
- Oxygen deprivation
- Stroke
- Cardiac Surgery
- Neonatal Encephalopathy
- Acute Myocardial Infarction

ISCHEMIA
Simplified scheme of the mechanisms of ischemia
Effects of Mild Hypothermia
Complications of Hypothermia

- Most significant complications are related to degree of hypothermia
  - Hypothermia abandoned for 40+ years!

- Strict adherence to MILD (32-34°C) hypothermia
  - Do not overcool

- Complications most prominent with deep hypothermia
  - (>30°C)
# 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 no. (%)</td>
<td>no./total 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>
# Hypothermia for Cardiac Arrest

## Timed Flowsheet

**Cause of arrest (if known)**

**Initial rhythm (if known)**

**Time to CPR (downtime - if known)**

---

**Time of arrest**

**Time of Return of Spontaneous Circulation**

**Time NSICU fellow called**

**Time Cooling Initiated**

**Time Target Temperature Obtained**

---

*Flow sheet starts at time target temperature is obtained*

<table>
<thead>
<tr>
<th>Time</th>
<th>Hours</th>
<th>Temperature</th>
<th>Action</th>
<th>Labs due</th>
<th>Sent by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling + 1</td>
<td></td>
<td></td>
<td></td>
<td>EP-1, Mg, Phos, ScvO2</td>
<td></td>
</tr>
<tr>
<td>Cooling + 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 6</td>
<td></td>
<td></td>
<td></td>
<td>ARB, ScvO2, EP-1, lactate</td>
<td></td>
</tr>
<tr>
<td>Cooling + 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 8</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 9</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cooling + 10</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 12</td>
<td></td>
<td></td>
<td></td>
<td>ARB, ScvO2, EP-1, lactate</td>
<td></td>
</tr>
<tr>
<td>Cooling + 13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 17</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 18</td>
<td></td>
<td></td>
<td></td>
<td>ARB, ScvO2, EP-1, lactate</td>
<td></td>
</tr>
<tr>
<td>Cooling + 19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cooling + 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling + 24</td>
<td></td>
<td></td>
<td></td>
<td>ARB, ScvO2, EP-1, lactate</td>
<td></td>
</tr>
<tr>
<td>Rewarm + 1</td>
<td></td>
<td></td>
<td></td>
<td>EP-1</td>
<td></td>
</tr>
<tr>
<td>Rewarm + 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewarm + 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewarm + 4</td>
<td></td>
<td></td>
<td></td>
<td>EP-1</td>
<td></td>
</tr>
<tr>
<td>Rewarm + 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewarm + 6</td>
<td></td>
<td></td>
<td></td>
<td>EP-1</td>
<td></td>
</tr>
<tr>
<td>Rewarm + 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rewarm + 8</td>
<td></td>
<td></td>
<td></td>
<td>EP-1</td>
<td></td>
</tr>
</tbody>
</table>
Institute concurrently with reperfusion

Do not delay one therapy for the other
Practical Applications
New Technology
Barriers

- Optimal cooling devices
- Institutional sandbox
- Busy ED
- Consultant buy-in
- Reimbursement - no specific billing code to justify cooling devices
**Prognostication after Cardiac Arrest and Hypothermia: A Prospective Study**

Andrea O. Rossetti, MD,¹ Mauro Oddo, MD,² Giancarlo Logroscino, MD, PhD,³ and Peter W. Kaplan, MBBS, FRCP¹,⁴

**TABLE 1: Frequency of Occurrence of Clinical and Electrophysiological Characteristics of Survivors and Nonsurvivors of CA at Hospital Discharge**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Survivors</th>
<th>Nonsurvivors</th>
<th>p</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, No. (%)</td>
<td>45 (41)</td>
<td>66 (59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean yr ± SD (range)</td>
<td>60.2 ± 14.9 (17–85)</td>
<td>58.8 ± 14.7 (22–84)</td>
<td>0.630</td>
<td>t</td>
</tr>
<tr>
<td>Female gender, No. (%)</td>
<td>7/45 (16)</td>
<td>15/66 (22)</td>
<td>0.468</td>
<td>Fisher</td>
</tr>
<tr>
<td>Noncardiac etiology, No. (%)</td>
<td>3/45 (7)</td>
<td>13/66 (20)</td>
<td>0.166</td>
<td>Fisher</td>
</tr>
<tr>
<td>Non-VF CA (asystole or PEA), No. (%)</td>
<td>7/45 (16)</td>
<td>38/66 (58)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>ROSC &gt;25 minutes, No. (%)</td>
<td>11/45 (24)</td>
<td>43/66 (65)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>≥1 brainstem reflexes absent, No. (%)</td>
<td>2/45 (4)</td>
<td>45/66 (68)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>Motor response worse than flexion, No. (%)</td>
<td>11/45 (24)</td>
<td>58/66 (88)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>Early myoclonus, No. (%)</td>
<td>2/45 (4)</td>
<td>35/66 (53)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>Epileptiform activity on the first EEG, No. (%)</td>
<td>4/45 (9)</td>
<td>35/65 (54)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>Unreactive EEG background, No. (%)</td>
<td>3/45 (8)</td>
<td>53/65 (81)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>Bilaterally absent N20 on the SSEP, No. (%)</td>
<td>0/44 (0)</td>
<td>33/56 (59)</td>
<td>&lt;0.001</td>
<td>Fisher</td>
</tr>
<tr>
<td>Time to first EEG, median days, range (No. of subjects)</td>
<td>2, 1–4 (45)</td>
<td>2, 1–5 (65)</td>
<td>0.319</td>
<td>U</td>
</tr>
<tr>
<td>Time to SSEP, median days, range (No. of subjects)</td>
<td>2.5, 1–6 (44)</td>
<td>2, 1–8 (56)</td>
<td>0.341</td>
<td>U</td>
</tr>
</tbody>
</table>

*Papillary, ocu萝 cephalic, corneal.
CA = cardiac arrest; SD = standard deviation; VF = ventricular fibrillation; PEA = pulseless electrical activity; ROSC = return of spontaneous circulation; EEG = electroencephalography; SSEP = somatosensory evoked potentials.
Focus on Technology

Controlled hypothermia is helping restore life. Details during Focus on Technology with Ann Thompson.

By Ann Thompson

Listen to the MP3 (4:36)

Focus on Technology Podcasts

Debra Siegel, the patient, in her Hyde Park home
Prognosis

- No reliable markers of prognosis available

- Certainly not in the first 24 hours!
Return to the case...

- Cath lab activated...
- 2 liters normal saline IV (4°C) infused
- Icepacks to neck, axillae, trunk, and groin
- BP drops to 80/40
- HR 90s
- Levophed gtt initiated 5µg/min
- Transported to Cath Lab
100% RCA occlusion
- Successfully stented
- TIMI 3 flow
Cardiovascular ICU

- Zoll Alsies Thermoguard Catheter placed
  - Neurocritical Care consult
Vital signs recorded every hour
IV sedation throughout
IV paralytics until temperature $\geq 36 \, ^\circ C$
Labs drawn at asterisks
ICU Course

- Maintained intubated, sedated and paralyzed for 24 hours
- Required levophed for 30 hours
- No seizures were noted
- Rewarmed at 0.3°C/hr
ICU Course

- Followed commands on HD 2
- Extubated on HD 3
- Discharged to home on HD 6
Future Directions

- State of the art equipment

- Hypothermia Resuscitation becomes primary focus
  - Application to other disease processes?
    - TBI
    - Stroke
    - SAH

- Hypothermia Resuscitation Teams
  - Early Goal Directed Therapy?
  - EMS bypass non-cooling centers?
Questions?
References

- Jones, AE. Hypothermia after Cardiac Arrest: We Can Do This. Acad Emer Med. 2008; 15(6): 558-559
References

- Kilgannon JH. Et al. Use of a Standardized Order Set for Achieving Target Temperature in the Implementation of Therapeutic Hypothermia after Cardiac Arrest: A Feasibility Study. *Acad...
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  - www.massgeneral.org/stopstroke/clinServ.aspx
  - Kees Polderman, MD
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  - Mauro Oddo, MD