Therapeutic hypothermia and regionalization of post-arrest care

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Center for Resuscitation Science
Department of Emergency Medicine
University of Pennsylvania

Mission: Lifeline - webinar July 2011
Post-arrest care saves lives

After initial resuscitation, race against time to preserve the heart and brain from injury.

Post-arrest care (hypothermia) improves brain recovery and survival:

36% survival → 53% survival

HACA, 2002
Cardiac arrest epidemiology

300,000 arrests / year in U.S.A.

3 / 4 Out-of-hospital

1 / 4 In-hospital

1-5% survival to hospital discharge

10-20% discharge

Becker et al, 1993
Peberdy et al, 2003
The post-arrest problem

% Surviving

Time

arrest

CPR

ROSC

in-hospital arrest data

hospital discharge

52%

18%
Reperfusion injury

Damage observed after restoration of blood flow to ischemic tissues
Modern era of hypothermia use

The New England Journal of Medicine

VOLUME 346  FEBRUARY 21, 2002  NUMBER 8

INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

Resuscitation 51 (2001) 275–281

Mild hypothermia induced by a helmet device:  
a clinical feasibility study

Said Hachimi-Idrissi *, Luc Corne, Guy Ebinger, Yvette Michotte, Luc Huyghens

Department of Critical Care Medicine and Cerebral Resuscitation Research Group, AZ-VUB, Free University of Brussels, Laarbeeklaan, 101, B-1090, Brussels, Belgium

HACA, 2002
Bernard, 2002
Idrissi, 2001
Modern era of hypothermia use

- Cooling (8-12 hr)
- Cold (24 hr)
- Rewarming (24 hr)

HACA, 2002
### Hypothermia trials: outcomes

<table>
<thead>
<tr>
<th></th>
<th>Hypothermia (%)</th>
<th>Normothermia (%)</th>
<th>RR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alive at hospital discharge with favourable neurological recovery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HACA</td>
<td>72/136 (53%)</td>
<td>50/137 (36%)</td>
<td>1.51 (1.14-1.89)</td>
<td>0.006</td>
</tr>
<tr>
<td>Bernard</td>
<td>21/43 (49%)</td>
<td>9/34 (26%)</td>
<td>1.75 (0.99-2.43)</td>
<td>0.052</td>
</tr>
<tr>
<td>Idrissi</td>
<td>4/16 (25%)</td>
<td>1/17 (6%)</td>
<td>4.25 (0.70-53.83)</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Alive at 6 months with favourable neurological recovery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HACA</td>
<td>71/136 (52%)</td>
<td>50/137 (36%)</td>
<td>1.44 (1.11-1.76)</td>
<td>0.009</td>
</tr>
</tbody>
</table>
Hypothermia clinical benefit is robust (consistent across numerous studies)
Hypothermia in the guidelines 2010

Comatose out-of-hospital VF: 
**Class I recommendation**

In-hospital arrest, other rhythms: 
**Class IIb recommendation**

Big change from 2005: 
Hypothermia for out-of-hospital VF 
Changed from **Class IIa** to **Class I**
More than just hypothermia

Post-arrest care is a critical care “bundle”:

- **Therapeutic hypothermia**
- Careful hemodynamic management
- Coronary intervention if STEMI or high probability of coronary cause
- Neurology consultation and assessment
More data from bundled care

Early goal-directed hemodynamic optimization combined with therapeutic hypothermia in comatose survivors of out-of-hospital cardiac arrest

David F. Gaieski, Roger A. Band, Benjamin S. Abella, Robert W. Neumar, Barry D. Fuchs, Daniel M. Kolansky, Raina M. Merchant, Brendan G. Carr, Lance B. Becker, Cheryl Maguire, Amandeep Klair, Julie Hylton, Munish Goyal

Cooling intervention with historical controls
Cooled any rhythm, both in and out of hospital arrest
Target temperature 33°C, maintained for 24 hrs

CPC 1-2 survivors

Before protocol 22% 44% After protocol

Gaieski et al, 2009
Post-arrest care: problem #1

SOME HOSPITALS LACK EXPERIENCE

300,000 arrest patients each year in USA
50,000 arrests reach hospital with a pulse
5,000 hospitals in USA

→ 10 arrests per year per hospital
Post-arrest care: problem #2

SOME HOSPITALS ARE NOT CAPABLE

5,000 hospitals in USA
many have no catheterization lab
many cannot perform EEG/neurocritical care
many do not have 24/7 intensivist availability
Post-arrest care: problem #3

EMS BRINGS TO INCORRECT HOSPITALS

Emergency Medical Services (EMS) designed to bring to nearest hospital

Not designed like an ER
EMS: quick decisions, varied training
Possible solution: Regionalization?

Concept is not new; specialization in:

- Stroke Centers
- Trauma Centers
- Burn Centers
Trauma Centers

Purple: less than 60 min from a Level I Trauma Center
Trauma Centers

State of Pennsylvania

University of Pennsylvania Medical Center
Trauma Centers: do they work?

Good evidence supports trauma centers:

A National Evaluation of the Effect of Trauma-Center Care on Mortality


They save lives

They use resources efficiently

MacKenzie et al, 2006
Model for cardiac arrest centers?

Suggestion first made in 2005 that cardiac arrest may require regionalization as well

Lurie et al, 2005

Level 1 Cardiac Arrest Centers: Learning from the Trauma Surgeons

ACAD EMERG MED • January 2005, Vol. 12, No. 1 • www.aemj.org
The feasibility of a regional cardiac arrest receiving system

Daniel P. Davis\textsuperscript{a,\#}, Roger Fisher\textsuperscript{b}, Steven Aguilar\textsuperscript{c}, Marcelyn Metz\textsuperscript{d}, Ginger Ochs\textsuperscript{b}, Lana McCallum-Brown\textsuperscript{a}, Prasanthi Ramanujam\textsuperscript{a}, Colleen Buono\textsuperscript{a}, Gary M. Vilke\textsuperscript{a,d}, Theodore C. Chan\textsuperscript{a}, James V. Dunford\textsuperscript{a,b}
More on transport safety

The impact of prehospital transport interval on survival in out-of-hospital cardiac arrest: Implications for regionalization of post-resuscitation care

Daniel W. Spaite\textsuperscript{a,*}, Ben J. Bobrow\textsuperscript{b,c}, Tyler F. Vadeboncoeur\textsuperscript{d}, Vatsal Chikani\textsuperscript{b}, Lani Clark\textsuperscript{b,e}, Terry Mullins\textsuperscript{b}, Arthur B. Sanders\textsuperscript{e}

Over 1100 arrests evaluated, no relationship between survival and transport time
Initial experiences in the US

Initial attempts at regionalization:

Arizona
Minneapolis
New York City
Philadelphia

Some also attempting cooling in the field
Arizona experience

- Arizona Bureau of EMS met 12/2007
- Established **Cardiac Arrest Center** criteria
- Voluntary hospital participation/no cost
- All acute care hospitals meeting criteria were invited to participate
- EMS bypass guideline (approved 5/2008)
Required Steps for Becoming an Arizona Cardiac Arrest Center (CAC)

In order to be designated a Cardiac Arrest Center, a hospital must have:

1) a Therapeutic Hypothermia (TH) method and associated protocol for out-of-hospital cardiac arrest (OHCA)

2) 24/7 cardiac intervention capability including protocol for OHCA

3) a system, included in the protocol, for timely completion and submission of the one-page data collection tool for EACH OHCA patient (NOT just cooled patients). CAC data form can be found on the SHARE website: [http://www.azshare.gov/Info4CAC.htm](http://www.azshare.gov/Info4CAC.htm)

4) an evidence-based termination of resuscitation protocol

--- Providing CPR training for the community is encouraged ---
# SHARE Cardiac Arrest Center Data Form

<table>
<thead>
<tr>
<th>Hospital:</th>
<th>Transporting Agency:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Name (Last):</th>
<th>(First):</th>
<th>DOB:</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M[ ] F[ ]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of Incident:</th>
<th>Time of Collapse:</th>
<th>Time Arrive ED:</th>
<th>Intubated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>00/00/0000</td>
<td>00:00</td>
<td>00:00</td>
<td>Yes[ ] No[ ]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On arrival ED:</th>
<th>Pulse:</th>
<th>BP:</th>
<th>Spont. RR:</th>
<th>Cardiac rhythm:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eligible for Therapeutic Hypothermia?</th>
<th>Yes[ ] No[ ]</th>
</tr>
</thead>
</table>

If No, why not? □ >60 minutes of CPR prior to ED arrival □ regained consciousness □ no return of spontaneous circulation/flost spontaneous circulation □ other

<table>
<thead>
<tr>
<th>Therapeutic Hypothermia was initiated in the:</th>
<th>Field[ ] ED[ ] ICU[ ]</th>
</tr>
</thead>
</table>

What method of Therapeutic Hypothermia was used? Where? (check all that apply)

<table>
<thead>
<tr>
<th>Ice</th>
<th>Cold IV fluids</th>
<th>Cooling blanket</th>
<th>Intravenous Catheter</th>
<th>External cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prehospital</td>
<td>Prehospital</td>
<td>Prehospital</td>
<td>Prehospital</td>
</tr>
<tr>
<td>Prehospital</td>
<td>ED</td>
<td>ICU</td>
<td>ICU</td>
<td></td>
</tr>
<tr>
<td>ICU</td>
<td></td>
<td></td>
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</tbody>
</table>

Other method:

Did patient receive vasopressor agent? Yes[ ] No[ ]

If Yes, which agent(s)

### NEUROLOGICAL ASSESSMENT: GCS upon arrival in the Emergency Department

<table>
<thead>
<tr>
<th>TIME ELEMENTS:</th>
<th>Time of ROSC: 00:00</th>
<th>Time Arrive ED: 00:00</th>
<th>Date: 00/00/0000</th>
</tr>
</thead>
</table>

Time cooling started: 00:00  Date: 00/00/0000  Time warmed started: 00:00  Date: 00/00/0000

| IF CARE TERMINATED: | Date: 00/00/0000  Time: 00:00  Where: |
|---------------------|-------------------|-----------------------------|
|                     |                   |                              |

ADVERSE EVENTS AS INPATIENT:

<table>
<thead>
<tr>
<th>Non[ ] Infection[ ] Bleeding[ ] DVT[ ] Hypertension[ ] other[ ]</th>
</tr>
</thead>
</table>

OUTCOME: Discharged alive[ ] Death[ ] Date of DVC or death: 00/00/0000

Cerebral Performance Category (CPC) Score on discharge (1-5) 0 (click here for link to CPC scale)

Organ Donation? Yes[ ] No[ ] Did patient receive ICD on discharge? Yes[ ] No[ ]

Suspected CAUSE OF INITIAL CARDIAC ARREST: STEMI[ ] No[ ]

Complete arterial occlusion on cardiac cath? Yes[ ] No[ ]

Any additional notes/comments:

**Please mail to: brazlip@azdhs.gov**
Enrollment into CAC system

EMS Bypass Protocol Approved
Patient Enrollment

713 Cardiac Arrest Patients

550 Individuals with Cardiac Arrest Evaluated

163 Excluded:
- 123 - Trauma, drowning or other respiratory causes
- 38 - Perfusing rhythm on ED arrival
- 2 - Outcome unknown

321 Occurred before CAC designation
- 35 Survived
- 286 Died

229 Occurred after CAC designation
- 47 Survived
- 182 Died
Arizona CACs save lives

Survival to Discharge

Initial EMS Rhythm

All rhythms
- Pre: 10.9%
- Post: 20.5%
- OR: 2.110 [1.312-3.395]

--Non-shockable
- Pre: 3.9%
- Post: 6.0%
- OR: 1.569 [0.514-4.794]

--Witnessed VF
- Pre: 20.3%
- Post: 39.5%
- OR: 3.098 [1.259-7.624]
Helicopter Locations 2009
In Response to the STEMI Program at MHI

Red– Zone II (90-120 mins)
Blue– Zone I (< 90 mins)
Regional Systems of Care to Optimize Timeliness
and Precision in the Treatment of ST-Elevation
Myocardial Infarction

A Regional System to Provide Timely Access to Percutaneous Coronary Intervention for ST-Elevation Myocardial Infarction

Timothy D. Henry, MD; Scott W. Sharkey, MD; M. Nicholas Burke, MD; Ivan J. Chavez, MD; Kevin J. Graham, MD; Christopher R. Henry, BS; Daniel L. Lips, MD; James D. Madison, MD; Katie M. Menssen, BA; Michael R. Mooney, MD; Marc C. Newell, MD; Wes R. Pedersen, MD; Anil K. Poulouse, MD; Jay H. Traverse, MD; Barbara T. Unger, RN; Yale L. Wang, MD; David M. Larson, MD
Level 1 MI Program

- STEMI diagnosis by emergency MD
- Single phone call to activate system
- Currently 33 hospitals trained
- Currently 45+ patients/month
- > 2700 pts served since 2003

If Cardiac arrest with ST elevation = L1 Cool it

“Cool It” therapeutic hypothermia program added Dec 2005
MHI Level 1 MI Program 2003 2006 “Cool it” added

Minneapolis Heart Institute
Abbott Northwestern Hospital
Inhouse 24/7:
Intensivists
Cardiologist
Anesthesiologist

High Volume Cardiac Center
600 STEMI-PCI/yr
3 Critical Care Units, Rapid Response, HH nurses
3 Cooling devices

Referral Relationship with 35 Community
11 Helicopters Bases
> 40 EMS units
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; Kalie 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

2011
The U Penn experience

6 helicopters
100 mile flight radius

Most hospitals have helipads
The U Penn experience

**Multistep process:**

1. Support from hospital administration
2. Support from staff
3. Development of protocol and team
4. Development of communication system
5. Advertising to local hospitals
Saving Lives

Post-cardiac arrest therapeutic hypothermia (TH) saves lives. It not only increases survival from cardiac arrest, but also improves neurological outcomes. The Hospital of the University of Pennsylvania (HUP) is one of the country’s leading providers of this revolutionary treatment. In addition, the University of Pennsylvania’s Center for Resuscitation Science (CRS) is one of the world’s leaders in research about TH and other post-arrest therapies.

Contacts

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  Clinical Research Director, CRS
  Benjamin.Abbella@uphs.upenn.edu

- David F. Gaieski, MD
  Assistant Professor of Emergency Medicine
  Director, Clinical Center for Resuscitation
  David.Gaieski@uphs.upenn.edu

- Marion Leary, BSN, RN
  Nurse Research Coordinator, CRS
  Marion.Leary@uphs.upenn.edu

- Thomas T. Levins, BSN, RN, CCRN, CFRN
  Clinical Coordinator/Flight Nurse, PennSTAR
  Tom.Levins@uphs.upenn.edu

To call for post-cardiac arrest patient transfer:

1-877-777-7366 (PENN)

PennSTAR Flight
1499 Narcissa Road
Blue Bell, PA 19422

Hospital of the University of Pennsylvania
Emergency Department
3400 Spruce Street
Philadelphia, PA 19104

http://pennhealth.com
Emergency Transport

Since its formation in 1988, the PennSTAR flight program has provided emergency, air medical transport to the Southeast Pennsylvania region. Today they operate within a 100 mile radius of the University of Pennsylvania Health System, 24 hours a day, every day of the year, weather depending. PennSTAR now offers transportation of post-cardiac arrest patients from surrounding facilities to the Hospital of the University of Pennsylvania (HUP) for post-cardiac arrest therapeutic hypothermia (TH) treatment. HUP’s experience with TH and other aspects of post-arrest care ensures that all transported patients receive the best possible medical care.

Q: Why is post cardiac arrest care important?
A: Without modern post-arrest care, a depressingly low percent of cardiac arrest patients survive to discharge after resuscitation and even fewer survive neurologically intact.

Q: What can be done to improve those rates?
A: Therapeutic hypothermia is the most efficacious treatment modality to increase survival and improve neurologic outcomes in comatose, post-cardiac arrest patients.

Q: How soon should hypothermia treatment begin?
A: As soon as possible!

Q: How can we gain access to this treatment?
A: PennSTAR transports patients from outside hospitals to HUP for TH and integrated post-arrest care.

Q: What number do I need to call?
A: 1-877-777-7366 (PENN)

Q: How does the program work?
A: Dialing 1-877-777-7366 connects the caller with the PennSTAR Command Center. Communications specialists will connect you with the on-call Cardiac Arrest Attending Physician who will briefly review the patient’s history and clinical condition with you to determine eligibility for TH and post-arrest care. After this call, PennSTAR will dispatch a helicopter to transport the patient to HUP. In most cases the helicopter should arrive within 1 hour of the initial call. In the event of dangerous weather, we will arrange ground transportation to HUP.

Q: How will I find out the status of a transferred patient?
A: We send prompt patient updates to the referring physician, continuing these throughout their entire stay at HUP. Additionally, we will facilitate transfer of all patients back to their referring physician upon discharge from HUP.

Research

The University of Pennsylvania’s Center for Resuscitation Science, under the leadership of its director, Lance Becker, MD, strives to promote and improve TH and other aspects of post-arrest care.
Two-day CME course
For potential providers

Program on hypothermia implementation

Next course:
October, 2011

For more information, visit the course website at:
http://www.med.upenn.edu/resuscitation/hypothermia/HypothermiaTraining.shtml
Hypothermia in the news

Popular Science

January, 2009

“Freezing the Heart to Save the Life”

Good graphics showing effects of cooling
Hypothermia in the news

CNN television documentary and book
Features a number of arrest survivors

2009 - 2010

Cheating Death
Sanjay Gupta, MD
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Anne Grossestreuer
Sarah Perman

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