Post Cardiac Arrest Syndrome, Care and Hypothermia

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The Pulse Returns…

Congratulations, You Made it!
Now what?
The post-arrest problem

- CPR
- ROSC
- arrest data
- in-hospital arrest data
- % Surviving
- Time

52%
18%
Persistent precipitating pathology
Anoxic brain injury
Post-cardiac arrest myocardial dysfunction
Systemic ischemia/reperfusion response
Post Cardiac Arrest Syndrome

No Flow
- Depletion in cellular $O_2$ stores
  - 4-6 minutes
- Interruption of cellular function
  - Membrane and pumps dysfunction:
    - influx of calcium
    - lactate acidosis
    - FFA occurrence
    - oxidative stress
  - Free radical triggered injury & excitotoxicity:
    - lipid peroxidation
    - primary necrosis
    - apoptosis
  - Splanchnic damages:
    - endotoxin release
    - inflammatory response

Low Flow
- Complete loss of energetic (ATP) stores
- Reoxygenation-induced reactions

ROSC

Mongardon et al. Annals of Intensive Care 2011 1:45
ischemia → reperfusion

- reactive oxygen species (ROS)
- mitochondrial dysfunction
- inflammatory cascades
- vascular dysfunction/hypotension
- apoptosis – organ dysfunction
- cerebral edema
Identification and treatment of the cause
  - PCI
Airway & ventilation management
Haemodynamic management
Targeted Temperature Management / Therapeutic Hypothermia
Glycaemic control
Seizure management and Neuroprognostication
Cerebral metabolism increases 8% per degree Celsius *increase*

- Decreases 7% per degree Celsius *reduction*

- Prevent fever

- Better still, induce hypothermia
Hypothermia mechanisms

1. Ischemia
   - Reactive oxygen species (ROS)
   - Inflammatory cascades
   - Mitochondrial dysfunction
   - Vascular dysfunction/hypotension
   - Apoptosis – organ dysfunction
   - Cerebral edema

2. Reperfusion

Hypothermia mechanisms
Historically...

Russian Method 1803

Baron Dominique Jean Larrey
Cooling methods

External Cooling

Internal Cooling
Cooling methods

Specialised cooling pads

Evaporative cooling
What cooling looks like

Cooling (8-12 hr)

Cold maintenance

Rewarming (24 hr)

HACA, 2002
Modern era of hypothermia use

The New England Journal of Medicine

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INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

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

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

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
Side effects of Hypothermia..

- Slowing of heart rate
- Shivering
- Increased bleeding
- Increased infections
- Fluid, Electrolyte and glucose changes
- Drug metabolism changes
- Procedural-specific risks

- Bottom line, TH is relatively safe!
Feb 2012 – 1st U Penn TH course in Sg!
Before and after TH protocol

% of patients

Overall  Before  After

TH rate Survival Rate
## Factors associated with survival

<table>
<thead>
<tr>
<th>Factors</th>
<th>Univariate Analysis</th>
<th>Multivariate Analysis</th>
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<tbody>
<tr>
<td></td>
<td>Odds Ratio of Survival</td>
<td>p value</td>
</tr>
<tr>
<td>Age</td>
<td>0.956</td>
<td>0.001</td>
</tr>
<tr>
<td>Male Gender</td>
<td>0.572</td>
<td>0.163</td>
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<tr>
<td>DM</td>
<td>0.692</td>
<td>0.358</td>
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<tr>
<td>CKD</td>
<td>0.803</td>
<td>0.642</td>
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<td>LVEF ≤ 40</td>
<td>0.636</td>
<td>0.437</td>
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<tr>
<td>VF</td>
<td>8.62</td>
<td>&lt;0.001</td>
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<tr>
<td>CCU</td>
<td>4.26</td>
<td>0.001</td>
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<tr>
<td><strong>TH</strong></td>
<td>1.11</td>
<td>0.805</td>
</tr>
<tr>
<td>Protocol</td>
<td>1.41</td>
<td>0.412</td>
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Factors associated with survival

<table>
<thead>
<tr>
<th>Factors</th>
<th>n (%)</th>
<th>Discharged Alive</th>
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<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Bystander CPR present</td>
<td>801 (20.3)</td>
<td>2.29</td>
</tr>
<tr>
<td>Public access defibrillation present</td>
<td>14 (0.36)</td>
<td>11.10</td>
</tr>
<tr>
<td>FRP dispatched</td>
<td>97 (2.46)</td>
<td>4.63</td>
</tr>
<tr>
<td>Ambulance defibrillation</td>
<td>853 (21.6)</td>
<td>6.04</td>
</tr>
<tr>
<td>EMS mechanical CPR</td>
<td>30 (0.76)</td>
<td>2.25</td>
</tr>
<tr>
<td>Hospital mechanical CPR</td>
<td>328 (8.32)</td>
<td>1.22</td>
</tr>
<tr>
<td>Hospital hypothermia therapy</td>
<td>10 (0.25)</td>
<td>28.9</td>
</tr>
</tbody>
</table>
More Reputable Publications!

Cooling the body can ‘cut risk of fatality’ after cardiac arrest

By POON CHIAN HUI

CARDIAC arrest sufferers can be kept alive using a new technique that cools their bodies to below the normal temperature and then slowly reheat them.

The “therapeutic hypothermia” treatment more than triples their chances of surviving, according to preliminary results of a clinical trial in Singapore.

It also reduces the risk of brain damage – a common problem among those who live.

The technique – which is already used in countries such as Australia – spells new hope for the 1,500 people in Singapore who suffer a cardiac arrest outside hospital every year.

At the moment, their survival rate is a dismal 2.7 per cent.

First, the patient’s body is rapidly cooled to between 32 deg C and 34 deg C. This is done either by wrapping large cooling-gel pads around the torso and legs or by pumping cool saline into a catheter that is inserted into the body.

The temperature is then maintained for 24 hours while the patient is put into a medically induced coma.

After that, the body is gradually warmed to the normal 36.5 deg C.

Bringing the temperature down helps to save barely alive cells, said Associate Professor Marcus Ong, who is the lead researcher in the trial at Singapore General Hospital (SGH).

This is because when oxygen is cut off during a cardiac arrest, “it starts a chain reaction that ultimately leads to cell death.”

But when the cells are cooled, they do not need as much oxygen, which reduces the damage.

“If left alone, the area of damage would increase and becomes permanent,” added Prof Ong, a senior consultant in emergency medicine at the hospital.

Forty cardiac arrest patients aged 18 to 80 were involved in the clinical trial between 2008 and last year.

Most of the survivors given conventional intensive care ended up in a coma or vegetative state.

By contrast, more than half of the patients who received the hypothermia treatment woke up with minimal brain damage.

They include information technician peng Hua, who collapsed suddenly at work last September.

Colleagues and paramedics managed to resuscitate him. And by the time the 30-year-old arrived at hospital, his heart had started beating again.

He was then cooled and slowly warmed again, using the catheter system.

The first few days after waking up were hazy, but he later found he could “remember all that I was supposed to remember”.

“I can recognise people, I can do everything just as before,” said Mr Peng, who is married with one daughter.

“My memory came back to me all in one piece.”

The cooling treatment is currently offered for free at SGH as part of the clinical trial, which is set to run for another year and involve a total of about 50 patients.

Not everyone is suitable, however. Patients need to have a stable pulse and blood pressure.

They also have to be unresponsive after being revived. The cause of the cardiac arrest should not be a traumatic event, such as a car crash, as the person may have other injuries.

National University Hospital has also started applying the technique to selected patients.

Dr Benjamin Leong, a consultant in its emergency medicine department, said the results had been encouraging – with a roughly 30 per cent survival rate for those treated this way.

The hospital uses temperature-control mattresses which circulate cold or warm water to regulate body temperature.

But therapeutic hypothermia “will not resuscitate what is already dead”, said Prof Ong.

“It preserves what is still alive. It will not bring the dead back to life.”

4/4/2013
TTM Recommendations

• OHCA with shockable rhythms
  • Strong recommendation

• OHCA with nonshockable rhythms
  • Weak recommendation

• IHCA (all rhythms)
  • Weak recommendation

• Prevention of fever
  • Strong recommendation
TTM targets

- 33-36 degrees
  - Minimise temperature variations to within 1 degree
- OHCA with shockable rhythms
  - 33 degrees recommended
- All other rhythms or contraindications to lower temperature
  - 36 degrees
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
Long-term prognosis following resuscitation from out of hospital cardiac arrest

- Improved 5 yr survival for those who received PCI
  - 78% vs 54%

- Improved 5 yr survival for those who received TH:
  - 77.5% vs 60%

Dumas et al: J Am Coll Cardiol 2012; 60:21-27
Survival curve according to PCI after OHCA

Dumas et al: J Am Coll Cardiol 2012; 60:21-27
59/Ch/Male

- C/O Chest pain
- Drives to GP Clinic
- GP dials 995

The paramedics arrive...
1034hrs: Initial rhythm
1037hrs: Prehosp 12-lead ECG
1043hrs: Whilst loading onto ambulance
Manual CPR + 4 shocks

10:53:44 Analysis 4
10:53:50 Shock Advised
10:54:01 Shock 4 360J

CODE SUMMARY™
critical event record
Power On: 26 Mar 13 10:32:20
Device: LP154184
Site: 888
Total Shocks: 4
Total Time Paced: 00:00:00
Total 12-leads: 2
Elapsed Time: 00:22:29
Comments: 

MEDTRONIC PHYSIO-CODE FLX
1056hrs: Arrives at ED...

- Mechanical CPR
- ETT
- 7 Shocks
- IV adrenaline
- IV amiodarone
- Intermittent ROSC (last 1120hrs)
- IV Dopamine
- GCS 3
- Occ breaths

- And he is not stable...
Hello...?

- I’ve got a pt with ROSC from OHCA due to STEMI....

- I know he’s not really stable but....
“OK”
1st ever in NUH!

Transported with mech CPR en route to Cath Lab

1140hrs ROSC again

1155hrs balloon...
Over to CCU

- TH protocol started
Temperature
ECG
Day 3

- Extubated
- Talking
- C/O soreness on chest (CPR)
- Knows his name and address
- Knows his wife!
- Discharged Day 7
You miss one hundred percent of the shots you don't take.
Wayne Gretzky
16/1/1983