Post-Cardiac Arrest Syndrome

MICU Lecture Series
58 y/o female collapses at home, family attempts CPR, EMS arrives and notes VF, defibrillation x 3 with return of spontaneous circulation, brought to ED. Patient has no response to painful stimuli.
Determine cause of arrest

- Acute coronary syndrome
- Cardiomyopathy
- Arrhythmia
- Tamponade
- Airway obstruction
- Asthma/COPD
- Pulmonary embolism
- Pneumothorax
- Trauma
- GI Bleed
- AAA rupture
- Intracranial Hemorrhage
- Electrolyte Disturbances
- Medications/Drugs
Determine cause of arrest

- History and Physical Exam
- Neurologic Exam
- ABG
- Electrolytes/LFTs
- CBC
- Lactate
- INR/PT/PTT
- Tox Screen

- EKG +/- Echocardiogram
- CXR +/- Chest CT
- Bedside Ultrasound
- Head CT
- Abdomen/Pelvis CT
- Cardiac revascularization
Therapeutic Hypothermia

Indications

• Not following commands
• No purposeful movements

Contraindications

• Active, non-compressible bleeding
• DNR order

Goal is to reduce risk of neurologic injury following cardiac arrest with ROSC
Cooling Protocol

* Cool to core temp of 32 – 34 – 36 degrees
* Cool within 6 hours of ROSC
* Cool for 12 – 24 hours
* Intravascular: Cold saline
* Surface: Cooling blankets/Ice packs
* Temperature: Central venous, esophagus, rectal
* Rewarm 0.2 – 0.25 degrees per hour

Central Line, Arterial Line
Four Key Components

1. Post-cardiac arrest brain injury
2. Post-cardiac arrest myocardial dysfunction
3. Systemic ischemia/reperfusion response
4. Persistent precipitating pathology
Monitoring with labs

- ABG Q6
  - pO2 and pCO2 will be overestimated
  - pH and HCO3 will be underestimated
- Electrolytes Q6
- Lactate Q6
- CBC, LFTs
Hemodynamics

* MAP 80 – 100 to maintain cerebral perfusion
* CVP 8 – 12
* UOP > 0.5 mL/kg/hour
* Vasopressors (norepi, dopamine)
* Inotropes (milrinone, dobutamine)

Cooling slows cardiac conduction, resulting in ↓HR (35 – 40) and ↓CO
↑CVP, ↑SVR, ↑BP
Respiratory

* Goal PaO2 100 – 300
  * avoid hypoxia, hyperoxia
* Goal PaCO2 > 40 – 45 mmHg
  * avoid vasodilation, cerebral edema

Cooling will decrease minute ventilation requirements
Neurologic

* Seizure activity is common
* Continuous EEG monitoring
* Phenytoin, valproic acid, etc.
* Suppression of shivering with sedation
  * Propofol, fentanyl, versed, paralytics
Physiologic Response to Cooling

- Shivering
- Coagulopathy
- Infection
- Slows cardiac conduction
- Hyperglycemia (goal 140 – 180)
- Electrolyte disturbances (↓Mg, ↓K, ↓Ca)
- Pharmacodynamics will be altered
MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

THE HYPOTHERMIA AFTER CARDIAC ARREST STUDY GROUP*

- 273 patients with shockable rhythms at 9 European center
- Cooleed to 32 – 34 degrees
Improved survival at 6 months (59% vs 45% with usual care)
Favorable neurologic outcome defined as CPC 1 - 2

- better neurologic outcome at 6 months (55% vs 39%)

** Favorable neurologic outcome defined as CPC 1 - 2
Cerebral Performance Category

* CPC 1
  * **Good cerebral performance (normal life).** Details: Conscious, alert, able to work and lead a normal life. May have minor psychological or neurologic deficits (mild dysphasia, nonincapacitating hemiparesis, or minor cranial nerve abnormalities).

* CPC 2
  * **Moderate cerebral disability (disabled but independent).** Details: Conscious. Sufficient cerebral function for part-time work in sheltered environment or independent activities of daily life (dress, travel by public transportation, food preparation). May have hemiplegia, seizures, ataxia, dysarthria, dysphasia, or permanent memory or mental changes.

* CPC 3
  * **Severe cerebral disability (conscious but disabled and dependent).** Details: Conscious; dependent on others for daily support (in an institution or at home with exceptional family effort). Has at least limited cognition. This category includes a wide range of cerebral abnormalities, from patients who are ambulatory but have severe memory disturbances or dementia precluding independent existence to those who are paralyzed and can communicate only with their eyes, as in the locked-in syndrome.

* CPC 4
  * **Coma or vegetative state (unconscious).** Details: Unconscious, unaware of surroundings, no cognition. No verbal or psychologic interaction with environment.

* CPC 5
  * **Brain death.** Details: Certified brain dead or dead by traditional criteria.
TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA


- 77 patients with V fib in Australia
- Cooled to 33 degrees
49% survived with hypothermia, vs. 32% with usual care

<table>
<thead>
<tr>
<th>Outcome*</th>
<th>Hypothermia (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>
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Clinical Investigations

Clinical application of mild therapeutic hypothermia after cardiac arrest*

Jasmin Arrich, MD; The European Resuscitation Council Hypothermia After Cardiac Arrest Registry Study Group
Table 5. Outcome and temperature profiles of patients with pulseless electrical activity/electromechanical dissociation or asystole as first rhythm (n = 197)

<table>
<thead>
<tr>
<th></th>
<th>Hypothermia (n = 124)</th>
<th>Normothermia (n = 73)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfavorable outcome, n (%)</td>
<td>89 (81)</td>
<td>59 (81)</td>
<td>.977</td>
</tr>
<tr>
<td>Died during hospital stay, n (%)</td>
<td>79 (65)</td>
<td>59 (81)</td>
<td>.023</td>
</tr>
</tbody>
</table>

**Temperature profiles of cooled patients**

<table>
<thead>
<tr>
<th></th>
<th>Median (IQR)</th>
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<tbody>
<tr>
<td>Time from collapse to initiation of cooling, mins</td>
<td>141 (78–210)</td>
</tr>
<tr>
<td>Time from ROSC to initiation of cooling, mins</td>
<td>115 (95–194)</td>
</tr>
<tr>
<td>Cooling rate after 1 hr, °C</td>
<td>1.4 (0.6–2)</td>
</tr>
<tr>
<td>Duration of cooling, hrs</td>
<td>24.3 (23.8–25.5)</td>
</tr>
<tr>
<td>Coldest temperature reached, °C</td>
<td>32.7 (32.1–33)</td>
</tr>
<tr>
<td>Duration of rewarming, hrs</td>
<td>9 (7.4–13.9)</td>
</tr>
</tbody>
</table>
Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest

Niklas Nielsen, M.D., Ph.D., Jørn Wetterslev, M.D., Ph.D., Tobias Cronberg, M.D., Ph.D., David Erlinge, M.D., Ph.D., Yvan Gasche, M.D., Christian Hassager, M.D., D.M.Sc., Janneke Horn, M.D., Ph.D., Jan Hovdenes, M.D., Ph.D., Jesper Kjaergaard, M.D., D.M.Sc., Michael Kuiper, M.D., Ph.D., Tommaso Pellis, M.D., Pascal Stammet, M.D., Michael Wanscher, M.D., Ph.D., Matt P. Wise, M.D., D.Phil., Anders Åneman, M.D., Ph.D., Nawaf Al-Subaie, M.D., Søren Boesgaard, M.D., D.M.Sc., John Bro-Jeppesen, M.D., Iole Brunetti, M.D., Jan Frederik Bugge, M.D., Ph.D., Christopher D. Hingston, M.D., Nicole P. Juffermans, M.D., Ph.D., Matty Koopmans, R.N., M.Sc., Lars Køber, M.D., D.M.Sc., Jørund Langørgen, M.D., Gisela Lilja, O.T., Jacob Eifer Møller, M.D., D.M.Sc., Malin Rundgren, M.D., Ph.D., Christian Rylander, M.D., Ph.D., Ondrej Smid, M.D., Christophe Werer, M.D., Per Winkel, M.D., D.M.Sc., and Hans Friberg, M.D., Ph.D., for the TTM Trial Investigators*
Methods

* 950 consecutive victims of out-of-hospital cardiac arrest at 36 centers in Europe and Australia
* 80% had a shockable initial rhythm (usually ventricular fibrillation), 12% had asystole and 8% PEA
* randomized to receive targeted temperature management to either 33° or 36° C for 28 hours, rewarms, then fever-reduction methods for 72 hours post-arrest
Results

* Primary outcome was death within 6 months following arrest (all causes)
* Secondary outcomes included poor neurologic outcome (CPC > 2)
* Hypothermia to 33C did not improve outcomes compared to 36C
Prognosis

- Absent or extensor motor response on day three
- Absent pupillary or corneal reflexes on day three
- Myoclonus status epilepticus
- Head CT/Brain MRI
Specialized Centers

* UPMC post cardiac arrest service
* Cardiology, neurology, critical care, PM&R
* Ongoing research
Thanks

Questions?