Prehospital Post Arrest Care
AHA Strive to Revive 2017
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University of Pittsburgh

Disclosures - Rittenberger

• Employers:
  – University of Pittsburgh
  – UPMC

• Grants:
  – Mallincrodt, LLC (inhaled NO study)
  – BrainCool, LLC (surface cooling device study)
  – Laerdal Foundation (early EEG study)
  – AHA Innovation Award (Rehabilitation after cardiac arrest)
  – AHA Grant in Aid (Neurostimulants after cardiac arrest)
  – NIH/NINDS (NETT and SIREN research consortia)
Outline

• Preventing the "Crump"

• Treating the etiology

• Resuscitate the Brain

• 64M arrests on treadmill at YMCA
• Bystander calls 911, applies AED with shock *1
• ALS arrives to find asystolic
• Receives 3mg IV epinephrine, shock *2 with ROSC
Why do patients die after CPR?

- Classify cause of death in 223 charts of non-survivors
  - Deaths < 72 hours were mostly (50%) “unstable”
  - Deaths > 72 hours were mostly (63%) “neurological”

*University of Pittsburgh 2011*
Goals?

- SBP > 100 mmHg
- MAP > 65 mmHg
- SPB > 90 mmHg
- SpO2 > 90%
- HR > 0
Blood Pressure and Ventilation

Auto-regulation
Impaired / right-shifted

CO2-reactivity
Preserved

CBF vs. MAP

CBF vs. pCO2

Auto-regulation
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CBF vs. MAP

CBF vs. pCO2

Emergency Medicine
Infused norepinephrine to increase CBF

Blood pressure goal?

- We aim for MAP >80 mmHg
  - Threshold: MAP >70

  Higher is better
  Regardless of pressor use
A bolt in the head...

Individual physiology varies

![Graphs showing brain tissue oxygenation under different conditions with mean arterial pressures (MAP) of 109 mmHg and 75 mmHg.]

- Intact autoregulation
- Tissue hypoxia
- Pressure passive
- Hypoxia corrected
- Autoregulation essentially intact throughout
  - No tissue hypoxia at any MAP
Hyperoxia

- Drives oxidative injury, ROS generation, etc
- Hyperoxia is common despite guideline recommendation SaO₂ 98-100%
- Some OBSERVATIONAL data associate hyperoxia with worse outcomes

![Graph showing PaO2 levels over time with different categories of oxygen levels and outcomes](image)


This effect varies across patients

![Graph illustrating brain tissue hypoxia frequency by SaO₂](image)
Oxygenation goals

- In absence of monitoring, we aim for normoxia to mild hyperoxia (PaO2 100-200)
- With monitoring, PbtO$_2$ >20 mmHg

Carbon dioxide goals

- We aim for PaCO$_2$ 40mmHg (temp corrected)
- Observational data mixed


Schneider, et al. Resus. 2013
Blood Pressure and Ventilation

This is scenario for first several hours after CPR

CBF

MAP

50 150

pCO2

25 35 45 55

WHY?
Emergency Medicine

Brain: Catastrophic CNS Event

Heart: ACS
- Primary Arrhythmia
- Congenital/Structural Heart Disease
- Secondary Arrhythmia (cardiomyopathy)
- Cardiogenic Shock
- Pulmonary Hypertension/RV Failure

Blood: Trauma
Non-traumatic exsanguination

Bugs: Distributive Shock (sepsis)

Minerals: Metabolic derangements (hypokalemia, DKA, etc)

Toxicological

Lung: Large airway obstruction
- Pulmonary failure (COPD, Asthma, etc)

Blockages: PE
- Obstructive shock

Environment: Electrocution
- Hypothermia

Emergency Medicine

Minerals: Metabolic derangements (DKA)

Heart: ACS

Blood: Trauma
Non-traumatic exsanguination

Environment: Electrocution
- Hypothermia
Catheterization Usually Followed by Intervention

- Stenting or coronary bypass surgery (CABG) followed CATH
  - 34/42 (81%) STEMI
  - 30/54 (55%) nonSTEMI cases.
- Intraaortic Balloon Pump (IABP) was used
  - 16/42 (38%) STEMI
  - 18/54 (33%) nonSTEMI cases.
- LV assist device (LVAD), or transplantation for
  - 4/42 (9.5%) STEMI
  - 10/54 (19%) nonSTEMI cases.
**Examination**

- AV fistula: Hyperkalemia
- Needle in arm: Overdose?
- Tracheostomy with mucous plug: Obstruction?
- Found in snowbank: Hypothermia?
- Blood on floor: Bleeding?
- Low glucose: Hypoglycemia?
“Primum Non Nocere”
TEMPERATURE?

Prehospital Cooling

Induction of Therapeutic Hypothermia by Paramedics After Resuscitation From Out-of-Hospital Ventricular Fibrillation Cardiac Arrest
A Randomized Controlled Trial

Stephen A. Bernard, MD; Karen Smith, BSc, PhD; Peter Cameron, MD; Kevin Masci;
David M. Taylor, MD; D. James Cooper, MD; Anne-Maree Kelly, MD; William Silvester, MB, BS;
for the Rapid Infusion of Cold Hartmanns (RICH) Investigators*

• Circulation 2010
Bernard 2010- Circulation

- Randomized 234 subjects to prehospital cooling or not
- Median fluid administration: 1900mL

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Table 2. Vital Signs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Paramedic Cooling: Group 1 (n=118)</th>
<th>Hospital Cooling: Group 2 (n=116)</th>
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<tbody>
<tr>
<td>EMS temperature on scene, °C</td>
<td>35.9 (1.0)</td>
<td>35.8 (0.8)</td>
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<td>EMS temperature on hospital arrival, °C</td>
<td>34.6 (1.3)</td>
<td>35.4 (1.0)</td>
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<td>Temperature in emergency department 60 minutes after arrival, °C</td>
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### Table 3. Outcomes at Hospital Discharge

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<td>Favorable outcome, n (%; 95% CI)</td>
<td>56 (47.5; 38.2–56.9)</td>
<td>61 (52.6; 43.1–61.9)</td>
<td>0.433</td>
</tr>
<tr>
<td>Discharge to home, n (%; 95% CI)</td>
<td>24 (20.3; 13.5–33.7)</td>
<td>34 (29.3; 21.2–38.5)</td>
<td>…</td>
</tr>
<tr>
<td>Discharge to rehabilitation, n (%; 95% CI)</td>
<td>32 (27.1; 19.3–36.1)</td>
<td>27 (23.3; 15.9–32.0)</td>
<td>…</td>
</tr>
<tr>
<td>Discharge to nursing home awake, n</td>
<td>0</td>
<td>0</td>
<td>…</td>
</tr>
<tr>
<td>Discharge to nursing home comatose, n (%; 95% CI)</td>
<td>0</td>
<td>1 (0.9; 0.02–4.7)</td>
<td>…</td>
</tr>
<tr>
<td>Dead, n (%; 95% CI)</td>
<td>62 (52.5; 43.1–61.8)</td>
<td>54 (46.6; 27.2–56.6)</td>
<td>…</td>
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Bernard 2010- Circulation

RCT of 1364 patients to prehospital TH or not
VF survival 43% in TH and 50% in not
Non VF survival 9% in TH and 9% in not
More diuretics and CHF in TH group
More re-arrest in TH group (early death not different)
Fig. 2. Kaplan–Meier survival estimates for sudden cardiac arrest victims surviving to hospital discharge, stratified according to treating center.
What is our Cardiac Arrest Center?

- Comprehensive post arrest care
  - Early aggressive resuscitation
  - Temperature management
  - Coronary revascularization
  - Prognostication
  - Secondary prevention
  - Rehabilitation
  - Teach CPR to survivors and their families

- Feedback to providers and referring physicians
- Referral to survivor support groups
- Research infrastructure to generate new knowledge
- System-wide quality control and improvement
- Survivor celebrations

Take Home

- First, prevent the re-arrest
  - Optimize organ oxygenation/perfusion

- Start working on the etiology
  - Fix what you can (i.e. bleeding, hypoglycemia, popsicles)

- Make sure they go to the right place
Thanks for your time!