IN HOSPITAL CARDIAC ARREST AND SEPSIS

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OVERVIEW

• Background
• Epidemiology of in hospital cardiac arrest (IHCA)
• Use a case scenario to introduce new guidelines
• Review surviving sepsis guidelines
• Focus on pre-, intra-, and post-arrest care
BACKGROUND

- Over 200,000 adult in-hospital cardiac arrests (IHCA) per year in US
- ~ 6,000 pediatric IHCAs per year
- Only about 25% of patients with IHCA survive to discharge

First Documented Rhythm and Clinical Outcome From In-Hospital Cardiac Arrest Among Children and Adults

<table>
<thead>
<tr>
<th>First Documented Rhythm</th>
<th>Pediatrics (n = 880)</th>
<th>Adults (n = 36,902)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asystole</td>
<td>350 (40)</td>
<td>13,024 (35)</td>
<td>0.006</td>
</tr>
<tr>
<td>PEA</td>
<td>213 (24)</td>
<td>11,963 (32)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>VF or pulseless VT</td>
<td>120 (14)</td>
<td>8361 (23)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Unknown by documentation</td>
<td>197 (22)</td>
<td>3554 (10)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

- PEA/Asystole most common initial rhythm in adults and children
Survival to hospital discharge depends on initial rhythm

- Survival after PEA/Asystole is higher in children that adults (24% vs 11%)
- Survival is higher after VF or Pulseless VT compared to PEA/Asystole in adults (36% vs 11%)

JAMA. 2006 Jan 4;295(1):50-7

| Table 4. Outcomes of In-Hospital Pulseless Cardiac Arrest by First Documented Pulseless Arrest Rhythm* |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|
|                                                 | VF or Pulseless VT | Asystole | PEA | Unknown Rhythm |
|                                                 | Pediatric (n=120) | Adult (n=3361) | Pediatric (n=310) | Adult (n=13024) | Pediatric (n=213) | Adult (n=11953) | Pediatric (n=197) | Adult (n=3304) |
| Any ROSC                                         | 86 (66.7)         | 5620 (67.3)     | 184 (52.6)     | 5658 (45.9)     | 125 (57.7)       | 6270 (52.4)     | 137 (69.5)       | 2062 (68.8)   |
| ROSC >20 min                                     | 74 (61.7)         | 5185 (62.8)     | 137 (44.9)     | 4997 (38.4)     | 108 (50.7)       | 5135 (42.0)     | 120 (60.9)       | 1966 (52.3)   |
| Survival to discharge                           | 35 (29.2)         | 3013 (36.6)     | 78 (22.3)      | 1379 (10.6)     | 57 (26.8)        | 1340 (11.2)     | 66 (33.5)        | 753 (21.7)    |
| Neurological outcome                            | Good              | 22 (62.9)       | 2268 (75.3)    | 43 (55.1)       | 841 (61.3)       | 36 (63.2)       | 634 (62.3)       | 447 (59.4)    |
| Poor                                             | 1 (2.9)           | 264 (8.8)       | 16 (20.5)      | 243 (17.6)      | 13 (22.8)        | 222 (16.5)      | 11 (16.7)        | 111 (14.7)    |
| Unknown                                         | 12 (24.3)         | 481 (16.8)      | 19 (24.4)      | 295 (21.6)      | 8 (14.9)         | 284 (21.2)      | 20 (30.3)        | 195 (25.8)    |

- Survival of non-white patients is lower

NEJM. 2009; 361:22-31

Epidemiologic Study of In-Hospital Cardiopulmonary Resuscitation in the Elderly

William J. Ehlenbach, M.D., M.Sc, Amber E. Barnato, M.D., M.P.H.,
J. Randall Curtis, M.D., M.P.H., William Kreuter, M.P.A.,
Thomas D. Koepsell, M.D., M.P.H., Richard A. Deyo, M.D., M.P.H.,
and Renee D. Stapleton, M.D., M.Sc.

- Survival of non-white patients is lower

NEJM. 2009; 361:22-31
Survival decreases if cardiac arrest occurs at night or on weekend.

Outcomes of Critically Ill Patients Who Received Cardiopulmonary Resuscitation

Jianmin Tian1, David A. Kaufman1, Stuart Zurich1, Paul S. Chan1,2, Philip Ong1, Yaw Amoateng-Adjepong1, and Constantine A. Manthous1, for the American Heart Association National Registry for Cardiopulmonary Resuscitation Investigators

1Bridgeport Hospital and Yale University School of Medicine, Bridgeport, Connecticut; and 2Saint Luke’s Mid-America Heart Institute, Kansas City, Missouri

- Retrospective study of over 49K adult ICU patients between 2000-2008
- Overall survival to discharge was ~15.9%
- Factors associated with decreased survival
  - Patients on vasopressors at time of arrest (9.3% vs 21.2%)
  - Age > 65
  - Non-white
  - Mechanical ventilation
  - Arrest at night or on weekends

Am J Respir Crit Care Med. 2010 Aug 15;182(4):501-6
• Retrospective study of ~ 273K Taiwanese patients
• Only 7% survive to discharge
• Of that 7%
  • 1, 2, and 5 – year post-discharge survival 28%, 23%, and 14%
  • Mortality risk diminished at 2 years


TO SUMMARIZE THUS FAR,

• In-hospital cardiac arrest is bad
• Survival varies
  • Initial rhythm
  • Circumstances surrounding arrest
  • Race
  • Time of day
HOW TO IMPROVE

• Focus on 3 areas
  • Pre-arrest
  • Intra-arrest
  • Post-arrest

CASE SCENARIO

• A 62 yo obese woman is brought into the ED by EMS hypotensive with altered mental status
• PMHx: ESRD, DM-II, HTN, CAD
• Family found patient non-responsive this morning and called EMS

• Vitals: RR: 25, BP: 65/40, HR: 45 SpO₂: 98% on NRB
• GCS: 3
CASE SCENARIO

- Step 1: IV, O₂, monitor
- Step 2: A, B, C, D, E, F
  - A: airway
  - B: breathing
  - C: circulation
  - D: disability (GCS – 3)
  - E: exposure
  - F: fingerstick - 30

CASE CONTINUED....

- Nurses obtain one 20 gauge IV and gives 2 amps D-50
- Repeat fingerstick – 120
- GCS remains 3
- Monitor demonstrates wide complex tachycardia
- EKG is ordered
- BP decreases to 55/30

- Next step?
  - Fluids
  - Calcium
  - Vasopressors
  - Intubation
CASE CONTINUED…

- Patient given 2 L IVFs and BP improves to MAP 55
- Patient intubated on first attempt
- End-tidal CO$_2$ initially 35 after intubation is now < 10
- No pulse detected
- Chest compressions are started
- Peripheral IV is lost

INTUBATION

- Intubation is a critical time during sepsis resuscitation
- Positive pressure ventilation can raise intra-thoracic pressure:
  - Reducing venous return
  - Decreasing filling pressures
  - Decreasing cardiac output leading to PEA arrest
- Medications and timing matter
INTUBATION

• Hemodynamic instability or pressor requirement prior to intubation is the biggest factor associated with death and complications\(^1\).

• Ensure patient is as intravascularly replete as possible prior to intubation.
• Keep fluids and vasopressors available.

\(^1\)Schwartz et al. Anesthesiology 1995;82:367

WHAT MEDS TO USE?

• There are lots of options for RSI:
  • Propofol
  • Benzodiazepines
  • Barbiturates
  • Etomidate
  • Ketamine

• Minimize potential for hypotension
WHAT MEDS TO USE?

• Etomidate
  • Sedative-hypnotic
  • No analgesia so often paired with opioid analgesic
  • Has favorable hemodynamic profile\textsuperscript{1,2}
  • Etomidate and adrenocortical suppression\textsuperscript{3}
    • Single dose etomidate causes decreased serum cortisol\textsuperscript{3} and a higher rate of adrenal insuff compared to ketamine\textsuperscript{4}.
    • Etomidate use does not increase mortality\textsuperscript{5,6}

\textsuperscript{1} Acad Emerg Med. 2003;10(2):134; \textsuperscript{2} Emerg Med J. 2004;21(6):655; \textsuperscript{3} Acad Emerg Med. 2001;8(1):1;

WHAT MEDS TO USE?

• Ketamine
  • Dissociative anesthetic agent similar to PCP
  • Has analgesic and amnestic/sedative effects
  • Preserves respiratory drive
  • Also stimulates catecholamine receptors causing sympathetic stimulation
WHAT MEDS TO USE?

- Ketamine
  - Good for hypotensive patient
  - Sympathetic stimulation can be problematic in patients with active cardiac ischemia
  - Despite a recent meta-analysis demonstrating no adverse effects\(^1\), there remains theoretical concern that ketamine can raise ICP. This effect is mitigated by use of fentanyl\(^2\).

\(^1\) Ann Emerg Med. 2015;65(1):43
\(^2\) Crit Care Med. 2005;33(8):1109

PARALYTICS

- Depolarizing agent (Succinylcholine)
  - Rapid onset med
  - Contraindications:
    - malignant hyperthermia, rhabdomyolysis, hyperkalemia with EKG changes, or ACh receptor upregulation (denervation injury/disease, crush, burn)

- Non-depolarizing agents
  - Rocuronium or vecuronium (requires priming dose)
  - Longer duration of action
SLOW DOWN

- Assuming you have the opportunity:
  - Obtain reliable access
  - Ensure adequate volume resuscitation
  - Early, empiric antimicrobials
  - Tailor anesthetics
  - Initiate pressors prior to intubation and target a slightly higher MAP

PRE-ARREST

- Location of defibrillators and code-carts
- Establish emergency or rapid response teams
- Training of emergency response teams
- Appropriate cardiac monitoring
- DNR documentation

Circulation. 2013 Apr 9;127(14):1538-63
TO BE COMPLETED WITHIN 3 HOURS OF TIME OF PRESENTATION*:

1. Measure lactate level
2. Obtain blood cultures prior to administration of antibiotics
3. Administer broad spectrum antibiotics
4. Administer 30ml/kg crystalloid for hypotension or lactate ≥4mmol/L

* "Time of presentation" is defined as the time of triage in the emergency department or, if presenting from another care venue, from the earliest chart annotation consistent with all elements of severe sepsis or septic shock ascertained through chart review.

TO BE COMPLETED WITHIN 6 HOURS OF TIME OF PRESENTATION:

5. Apply vasopressors (for hypotension that does not respond to initial fluid resuscitation) to maintain a mean arterial pressure (MAP) ≥65mmHg
6. In the event of persistent hypotension after initial fluid administration (MAP < 65 mmHg) or if initial lactate was ≥4 mmol/L, re-assess volume status and tissue perfusion and document findings according to Table 1.
7. Re-measure lactate if initial lactate elevated.

Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock.

Critical Care Med 2006; 34:1589–1596
MORTALITY AND TIME TO ANTIBIOTIC

Mortality
Wards
ED
ICU

Time to first antibiotic, hours

BACK TO OUR PATIENT

- Ongoing CPR
- EKG
- Point of care labs: K – 8.5
- Patient given calcium, bicarbonate, insulin/D50
INTRA-ARREST

- Focus on high-quality CPR
- Appropriate chest compressions (100/min and ≥ 5 cm deep)
  - Rate < 90/min 28% of time, too shallow 37% of time, ventilation too high (> 20, 61% of time). JAMA. 2005 Jan 19;293(3):305-10.
- Minimize disruptions in chest compressions
- Optimize ventilation (30:2); avoid hyperventilation
- Early defibrillation
- Identify and treat underlying cause

Circulation. 2015; 132[suppl 2]:S315-S367

H’S AND T’S FOR PEA/ASYSTOLE

- Hypoxia
- Hypovolemia
- Hydrogen ions (acidosis)
- Hypo/Hyper-kalemia
- Hypothermia
- Hypoglycemia
- Toxins
- Tamponade
- Tension pneumothorax
- Thrombosis (PE or coronary)
Epinephrine + Vasopressin + Steroids
- Randomized, double-blind, placebo-controlled, parallel group trial
- 268 patients with IHCA received either Vasopressin + Epi + methylprednisone or Placebo + Epi
- VSE group had higher survival to hospital discharge (13.9% vs 5.1%, P = 0.02)

AHA: Combination may be considered, but further studies are needed (Class IIb) *Circulation.* 2015;132:S315-S367

CASE CONTINUED
- ROSC obtained after 22 min of CPR
- Transcutaneously paced for bradycardia
- On epinephrine drip and moved to ICU to prepare for dialysis and possible transvenous pacer
- Broad spectrum antibiotics administered
- Family has arrived and is asking for an update
POST-ARREST

- Identify and treat underlying etiology
- Mitigate ischemia-reperfusion injury and prevent secondary organ injury
- Make accurate prognosis

Circulation. 2015; 132[suppl 2]:S315-S367

THERAPEUTIC HYPOTHERMIA

- Mild hypothermia improves outcome of comatose survivors of witnessed OHCA when initial rhythm is VF. N Engl J Med. 2002;346:557–563
- What about IHCA?
- What about non-shockable rhythms?
Hypothermia for neuroprotection in adults after cardiopulmonary resuscitation.
Arntz J, Holzer M, Havel C, Mütter M, Hörner H.

- Meta-analysis of 6 trials & 1412 patients using hypothermia after IHCA or OHCA.
- Mild hypothermia compared to no cooling led to improved neurological outcomes.
- Insufficient evidence for IHCA, asystole, or non-cardiac cause of arrest. Cochrane Database Syst Rev. 2016 Feb 15;2:CD004128

The Role of Targeted Temperature Management in Adult Patients Resuscitated from Nonshockable Cardiac Arrests: An Updated Systematic Review and Meta-Analysis
Lijuan Song, Liang Wei, Lei Zhang, Yubao Lu, Keifa Wang, and Yonqing Li.


POST-ARREST

- Targeted temperature management (32-36°C) for at least 24 hrs post-arrest
- Early coronary angio for patient with ST elevation as well as those without ST elevation if cardiac cause is suspected

Circulation. 2015; 132(suppl 2):S315-S367
CASE CONTINUED…

- 2 days after cardiac arrest, the patient remains unresponsive
- Time to withdraw care?

PROGNOSTICATION

- Delay until 72 hrs if not treated with targeted temp management
- Delay until 72 hrs after normothermia if treated with targeted temp management

Circulation. 2015; 132(suppl 2):S315-S367
POOR NEURO OUTCOMES

- Absence of pupillary light reflex ≥ 72 hrs post arrest
- Status myoclonus during first 72 hrs
- Absence of N20 somatosensory evoked potential cortical wave 24-72 hrs after arrest or rewarming
- Presence of marked reduction in gray-white ratio on CT obtained within 2 hrs of arrest
- Extensive restriction of diffusion on MRI 2-6 days after
- Persistent absence of EEG reactivity to stimuli at 72 hrs
- Persistent burst suppression or intractable status epilepticus

SUMMARY

- Poor outcomes for PEA and sepsis related cardiac arrests
- Slow down and stabilize before intubation if possible
- Prompt treatment of sepsis with fluids, antibiotics, and pressors
- Tailor anesthetic and paralytic to the situation
- Treat underlying cause of arrest
- Target pre-, intra-, and post-arrest care
- Prevention may be the best medicine