ROSC!!!!

Now What Do I Do?

Cynthia Shen, DO, FACEP, FACOEP
Fellow Emergency Critical Care Medicine
Georgetown Medstar Washington Hospital Center
EMS Radio Consult

- 65 y.o male
- From Church
- Witnessed collapse
- CPR in progress, started by bystanders
- Epi x 2
- Defibrillation x 1
Team Focused CPR

• Rehearsed and pre-assigned roles/responsibilities
• De-emphasis on endotracheal intubation, intravenous drug administration
• 200 compression cycles
• Ventilated breath at 20th compression
• Defibrillator charged at 180th compression
• Pulse check at 200th compression

From Carolinas Medical Center (Charlotte, NC)
Mr. Jones
Your work has just begun!

• Mechanical Ventilation
• Circulatory Support
• Therapeutic Hypothermia
• Reperfusion Therapy
• Supportive care
• Prognostication
Increasing Critical Care Admissions from U.S. Emergency Departments, 2001-2009

• Analysis of National Hospital Ambulatory Medical Care Survey
  ✓ Annual critical care unit admissions increased by 79%
  ✓ Total annual hours of critical care increased by 217%
  ✓ Average daily amount of critical care provided tripled to 5.6 hours

Herring, AA et al. Crit Care Med 2013
Post-Cardiac Arrest Syndrome

- Post-cardiac arrest brain injury
  - Coma, seizures, myoclonus, neurocognitive dysfunction, brain death
- Post-cardiac arrest myocardial dysfunction
  - LV dysfunction, myocardial stunning, cardiogenic shock
- Systemic ischemia/reperfusion injury
  - Inflammatory response, impaired regulation, oxygen delivery and utilization, resulting in hypotension/MSOF
- Persistent precipitating pathology
  - STEMI, PE, toxic ingestion, hypoxia, hemorrhage, sepsis

To Do List:

• Mechanical Ventilation
  • Intubation
  • Initial Ventilator Settings
  • Ventilator associated lung injury
  • Goals of ventilation
  • Goals of oxygenation
• Survey academic EM attendings
• 7 teaching hospitals with EM residencies
• Most receive $\leq 3$ hours of mechanical ventilation training a year
Ventilator Associated Lung Injury

- **Oxygen toxicity**
  - ✓ Reduce FIO<sub>2</sub> to &lt;60%

- **Macrobarotrauma**
  - ✓ Overdistension that can result in pneumothorax, pneumomediastinum or subcutaneous emphysema

- **Microbarotrauma/Volutrauma**
  - ✓ Overdistension that results in inflammatory injury

Slutsky AS and VM Ranieri, Crit Care Med 2013
Mechanical Ventilation

• Mode
• Respiratory rate
• Tidal volume
• PEEP
 ✓ Academic, tertiary care hospital
 ✓ ARDS diagnosed within 48 hours
 ✓ Only 5 of 34 (15%) patients received the recommended tidal volume
 ✓ Initial tidal volumes that exceeded recommendations by an average of 1.5 ml/kg
Lung Protective Ventilation

• Tidal volume: 6-8 ml/kg IBW
• Permissive hypercapnia
• PEEP/F\textsubscript{i}O\textsubscript{2}: maintain adequate oxygenation
• Reduce F\textsubscript{i}O\textsubscript{2} as soon as possible
Goals of Ventilation

• Acceptable PCO2 (40) and pH (7.4)
  ✓ Increase tidal volume or respiratory rate
    ➢ Increases minute ventilation
    ➢ Decreases PCO₂

• Plateau pressure less than 30 cm H₂O
  ✓ Varies positively with the set PEEP and Tidal volume
  ✓ Varies negatively with the compliance of the respiratory system

• Avoid Autopeep
  ✓ The buildup of additional positive pressure due to breath stacking
  ✓ Persistent end expiratory flow
Goals of Oxygenation

• Oxygen saturation $\geq 90$
  • Oxygen-ICU trial

✓ Higher $O_2$ Sat target of 97-100% was associated with a higher rate of ICU mortality compared to lower $O_2$ Sat target of 94-98%

• $F_1O_2 < 60$

Girardis M et al. *Jama* 2016
Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

• ED / ICU of academic, tertiary center
• Evaluate the effectiveness of an ED-based lung-protective mechanical ventilation protocol on pulmonary complications
Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

- **Intervention**
  - Tape measure for accurate height
  - Tidal volume: 6ml/kg PBW
  - Limit plateau pressure < 30 cm H$_2$O
  - Titrate F$_1$O$_2$ / SpO$_2$ 90–95%
  - Elevate HOB
Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

• Results – ED
  ✓ LPV increased by 48.4%
  ✓ Tidal volume decreased by 1.8 ml/kg PBW
Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

- Results – ICU
  - LPV increased by 30.7%
  - Tidal volume decreased by 1.1 ml/kg PBW
Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

• **Results**
  ✓ Decreased ICU and hospital LOS
  ✓ Mortality: **14.5%** absolute risk reduction

ED Ventilator Settings Matter!

✓ Tape measure for accurate height
✓ Tidal volume: 6ml/kg PBW
✓ Limit plateau pressure < 30 cm H$_2$O
✓ Titrate $F_iO_2$ / $SpO_2$ 90–95%
✓ Elevate HOB

Radosevich MA¹, Wanta BT¹, Meyer TJ², Weber VW², Brown DR¹, Smischney NJ¹, Diedrich DA¹.

- Electronic order set that included specified oxygenation and ventilation goals
- Implemented by RTs
- Improved compliance to 88.2%
To Do List:

• Circulatory Support

✓ Central Venous Access
✓ Invasive Blood Pressure Monitoring
✓ Laboratory diagnostic testing
✓ Foley catheter
✓ Sedation
✓ Pain Control
Early Vasopressors

• Topijan, et al., *Crit Care Med* 2014
  ✓ 15 Childrens Hospitals
  ✓ Hypotension was associated with higher in-hospital mortality and worse neurologic outcome

• Kilgannon, et al., *Resuscitation* 2008
  ✓ Hypotension after ROSC is an independent predictor of death
  ✓ 83% higher mortality

• Trzeciak, et al., *Crit Care Med* 2009
  ✓ Odds ration for death 2.7
Early Vasopressors

Impact of Early Vasopressor Administration on Neurological Outcomes after Prolonged Out-of-Hospital Cardiac Arrest

✓ 2100 Patients
✓ 43.5% ROSC
✓ Cerebral performance decreased by 10% for every minute delay in vasopressor administration
• Loss of Cerebral autoregulation
  • Cerebral blood flow is highly pressure dependent
• Myocardial dysfunction and inability to maintain adequate cardiac output
• Need to maintain a high mean arterial blood pressure (MAP)
  • Goal between 65 - 100 mm of Hg
# Vasoactive Drugs

<table>
<thead>
<tr>
<th>Drug</th>
<th>Typical Starting Dose (Then Titrated to Effect)</th>
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<tr>
<td>Epinephrine</td>
<td>0.1–0.3 mg/kg/min in 70 kg adult, 7–25 mg/min</td>
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<tr>
<td></td>
<td>* Useful for symptomatic bradycardia. Felty's and sarcoidosis reactions preventing fatal or life-threatening hypotension.</td>
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<td></td>
<td>* Used to treat severe hypotension (e.g., systolic blood pressure &lt;70 mm Hg).</td>
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<td></td>
<td>* Useful for anaphylaxis associated with hemodynamic instability or respiratory depression.</td>
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<tr>
<td>Norepinephrine</td>
<td>0.1–0.35 mg/kg/min in 70 kg adult, 7–25 mg/min</td>
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<td>* Used to treat severe hypotension (e.g., systolic blood pressure &lt;70 mm Hg) and a low total peripheral resistance.</td>
</tr>
<tr>
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<td>* Relatively contraindicated in patients with hypovolemia. It may increase myocardial oxygen requirements, monitoring caution is advised in patients with ischemic heart disease.</td>
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<td>* Usually limited to endovascular vasopressors; in sepsis, however, norepinephrine improves renal blood flow and urine output.</td>
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<tr>
<td>Phenytoine</td>
<td>0.5–2.0 mg/kg/min in 70 kg adult, 30–140 mg/min</td>
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<td>* Used to treat severe hypotension (e.g., systolic blood pressure &lt;70 mm Hg) and a low total peripheral resistance.</td>
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<tr>
<td>Dobutamine</td>
<td>5–10 mcg/kg/min</td>
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<td></td>
<td>* Used to treat hypotension, especially if it is associated with symptomatic bradycardia.</td>
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<tr>
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<td>* Although low-dose dopamine infusion has frequently been recommended to maintain renal blood flow or improve renal function, more recent data have failed to show a beneficial effect from such therapy.</td>
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<td>* The (+) isomer is a potent beta-adrenergic agonist, whereas the (-) isomer is a potent alpha-1-agonist.</td>
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<td>* The vasodilating beta-2-adrenergic effects of the (+) isomer counterbalance the vasoconstricting alpha-1-adrenergic effects, often leading to little change or a reduction in systemic vascular resistance.</td>
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<tr>
<td>Milrinone</td>
<td>Load 0.5 mg/kg over 10 minutes then infusion of 0.375 mcg/kg/min</td>
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<tr>
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<td>* Used to treat low cardiac output.</td>
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<tr>
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<td>* May cause less tachycardia than dobutamine.</td>
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Early Vasopressors

Bolus dose of epinephrine for refractory post-arrest hypotension

Michael Gottlieb, MD, RDMS*

✓ Case report of 3 patients
✓ Bolus dose of epinephrine as a bridge to vasopressor therapy
Early Vasopressors

Bolus dose of epinephrine for refractory post-arrest hypotension

Michael Gottlieb, MD, RDMS*

1. Obtain a 10-mL syringe of 0.9% normal saline.
2. Remove 1 mL of 0.9% normal saline from the syringe.
3. Inject 1 mL of cardiac epinephrine (100 micrograms/mL) into the syringe.
4. Shake the syringe well. The new solution will contain 10 micrograms of epinephrine per mL.
5. Give 0.5 – 2.0 mL (5 – 20 micrograms) every minute, titrating to the desired blood pressure.
Pain & Anxiety

• Patients experience pain

✓ CPR
✓ Mechanical ventilation
✓ Invasive procedures
✓ Surgical procedures
✓ Nursing care (repositioning, suctioning)
Pain & Anxiety

• Critically ill patients are unable to report pain
  ✓ Mechanical ventilation
  ✓ Altered mental status
  ✓ Medications
Pain & Anxiety

• Short-term consequences

✓ Increase catecholamines
✓ Arteriolar vasoconstriction
✓ Impair tissue perfusion
✓ Increase myocardial oxygen consumption
Pain & Anxiety

• Long-term consequences
  ✓ PTSD
  ✓ Post-ICU Syndrome
  ✓ Depression
  ✓ Impact on family / caregivers
Pain Assessment

• Difficult to evaluate
  ✓ Decreased consciousness level
  ✓ Delirium
  ✓ Effect of medications
Pain & Anxiety


Patients' recollections of stressful experiences while receiving prolonged mechanical ventilation in an intensive care unit.

Rotondi AJ¹, Chelluri L, Sirio C, Mendelsohn A, Schulz R, Belle S, Im K, Donahoe M, Pinsky MR.

✓ 150 Patients
✓ 4 ICU within a tertiary care hospital
✓ 82% recalled pain with ETT
Pain Assessment

- Using specific guidelines for assessment and management
  - Decreased ventilator days
  - Shorter length of hospitalization
  - Reduced cost of care
✓ Behavioral Pain Scale (BPS)
✓ Critical-Care Pain Observation Tool (CPOT)
✓ Non-verbal Pain Scale (NVPS)
✓ Numerical Rating Scale (NRS)
✓ Visual Analog Scale (VAS)
✓ Defense and Veterans Pain Rating Scale (DVPRS)
Visual Analog Scale

PAIN ASSESSMENT TOOL

- 0: No Pain
- 1-3: Mild
- 4-6: Moderate
- 7-9: Severe
- 10: Very Severe
- 10: Worst Pain Possible
## Behavioral Pain Scale (BPS)

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<td>4</td>
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<td>Upper limb movements</td>
<td>No movement</td>
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**BPS score ranges from 3 (no pain) to 12 (maximum pain).**

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<td>Muscle tension</td>
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<td>Talking in normal tone or no sound; Sighing, moaning; Crying out, sobbing</td>
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**Total, range:** 0-8

*Source: Am J Crit Care © 2006 American Association of Critical-Care Nurses*
Agitation

• Associated with adverse outcomes

• Underlying causes

✓ Pain
✓ Delirium
✓ Hypoxemia
✓ Hypotension
✓ Hypoglycemia
✓ Withdrawal from alcohol or other drugs
Agitation Assessment

- Sedation scales
- Sedation protocols
- Improved ICU outcomes
- Shortened duration of mechanical ventilation
- Shortened ICU and hospital LOS
- Decreased delirium and long term cognitive dysfunction
Agitation Assessment

• Richmond Agitation-Sedation Scale
• Sedation-Agitation Scale
• Ramsay Sedation Scale
• Sedation Intensive Care Score
• New Sheffield Sedation Score
### Richmond Agitation and Sedation Scale

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<td>Very agitated</td>
<td>Pulls or removes tube(s) or catheter(s); aggressive</td>
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<td>+2</td>
<td>Agitated</td>
<td>Frequent nonpurposeful movement, fights ventilator</td>
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<td>+1</td>
<td>Restless</td>
<td>Anxious, apprehensive but movements not aggressive or vigorous</td>
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<tr>
<td>0</td>
<td>Alert and calm</td>
<td></td>
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<tr>
<td>-1</td>
<td>Drowsy</td>
<td>Not fully alert, but has sustained awakening to voice (eye opening and contact &gt;10 seconds)</td>
</tr>
<tr>
<td>-2</td>
<td>Light sedation</td>
<td>Briefly awakens to voice (eye opening and contact &lt;10 seconds)</td>
</tr>
<tr>
<td>-3</td>
<td>Moderate sedation</td>
<td></td>
</tr>
<tr>
<td>-4</td>
<td>Deep sedation</td>
<td>Movement or eye opening to voice (but no eye contact)</td>
</tr>
<tr>
<td>-5</td>
<td>Unarousable</td>
<td>No response to voice or physical stimulation</td>
</tr>
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Pain & Anxiety

 Estimates of sedation in patients undergoing endotracheal intubation in US EDs.

Weingart GS¹, Carlson JN, Callaway CW, Frank R, Wang HE.

✓ Retrospective review
✓ National Hospital Ambulatory Medical Care Survey
✓ Only 46.4% received sedation
Pain & Anxiety

- 117 Patients
  - 33% received no anxiolytic
  - 53% received no analgesic
  - 20% received neither anxiolytic nor analgesic
Pain & Anxiety

✓ Retrospective review
✓ Single, urban academic center
✓ 292 pts paralyzed
✓ 18% did not receive concurrent sedation
• Target lighter levels of sedation
  ✓ RASS 0 to -2
• Use non-benzodiazepine sedatives
  ✓ Propofol
  ✓ dexmedetomidine
Pain Treatment

• Tylenol
• NSAIDS
• Opioids
  • Fentanyl
  • Morphine
  • Hydromorphone
Propofol

- Sedative
- Hypnotic
- Anxiolytic
- Amnestic
- Antiemetic
- Anticonvulsant
- NO analgesic effect
Propofol

• Side-effects

✓ Respiratory depression
✓ Hypotension
✓ Hypertriglyceridemia
✓ Acute pancreatitis
✓ Myoclonus
✓ Propofol infusion syndrome (PRIS)
Dexmedetomidine

- Selective $\alpha_2$-receptor agonist
- Sedative
- Analgesic / opioid sparing
- Sympatholytic
- Minimal respiratory depression
Dexmedetomidine

• Side-effects
  ✓ Hypotension
  ✓ Bradycardia

• Advantages
  ✓ Use in non-intubated patients
  ✓ Reduces opioid requirement
• Single, tertiary, academic center
• Assess relationship between ED sedation depth and outcome
• Measured sedation depth by **RASS -3 to -5**
Analgosedation

1,074 Mechanically ventilated patients assessed for eligibility

660 Excluded from analysis:
- 240 Extubated <24 hours
- 142 Died in ED
- 76 Neurological Injury
- 74 Died within 24 hours
- 59 Tracheostomy/chronic ventilation
- 40 Present in cardiac arrest
- 29 Transfer to another hospital

414 Patients included in final analysis

Died in Hospital
n = 60

Survived Hospitalization
n = 354
Primary outcome
✓ Hospital mortality

414 patients
✓ 85.5% Fentanyl
✓ 61.3% Midalzolam
✓ 46.9% Propofol
Analgosedation
Analgesia & Sedation

• Consequence of untreated pain / agitation
• Vital signs alone are not adequate predictors
• Implement protocols
• Start with analgesics
• Target RASS 0 to -2
• Avoid benzodiazepines
To Do List:

• Critical Care Ultrasonography (CCUS)

✓ Cardiac
✓ Thoracic
✓ Abdominal
✓ Vascular
To Do List:

• Targeted Temperature Management
• Prevent Ventilator-associated Pneumonia
• Prevent Stress-related Mucosal Injury
• Prevent Deep Venous Thrombosis
• Monitor Glucose
ROSC! Now What Do I Do?

- Mechanical Ventilation
- Circulatory Support
- Pain & Anxiety
- Agitation
- Critical Care Ultrasonography
- Therapeutic Hypothermia
- Supportive care
ED Ventilator Settings Matter!

• Tape measure for accurate height
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### Medscape® [www.medscape.com](http://www.medscape.com)

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</tr>
<tr>
<td>-1</td>
<td>Drowsy</td>
<td>Not fully alert, but has sustained awakening to voice (eye opening and contact &gt;10 seconds)</td>
</tr>
<tr>
<td>-2</td>
<td>Light sedation</td>
<td>Briefly awakens to voice (eye opening and contact &lt;10 seconds)</td>
</tr>
<tr>
<td>-3</td>
<td>Moderate sedation</td>
<td></td>
</tr>
<tr>
<td>-4</td>
<td>Deep sedation</td>
<td>Movement or eye opening to voice (but no eye contact)</td>
</tr>
<tr>
<td>-5</td>
<td>Unarousable</td>
<td>No response to voice, but movement or eye opening to physical stimulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No response to voice or physical stimulation</td>
</tr>
</tbody>
</table>
Analgesia & Sedation

• Consequence of untreated pain / agitation
• Vital signs alone are not adequate predictors
• Implement protocols
• Start with analgesics
• Target RASS 0 to -2
• Avoid benzodiazepines
Questions