Prehospital Treatment of Hypotension

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Disclosures

- No personal financial conflict
- DoD grant to study the effectiveness of the Impedance Threshold Device in hypotensive patients.

Hypotension

- Is it low blood pressure?
- Is it poor perfusion?
- Is it shock?
Causes of Shock

• **Three Causes**
  • Not enough fluid
  • Too much space
  • Not enough pump
Causes of Shock

• **Hypovolemic** – not enough Fluid
• **Sepsis** – not enough fluid, too much space
• **Anaphylaxis** – Too much space
• **Cardiogenic** – Not enough pump
• **Neurogenic** – Too much space

Treatment of Shock

• If the Tank is low
  • Fill the tank
• If the Tank is too big
  • Make the tank smaller
• Not enough pump
  • Make the pump work better
Anaphylaxis
**Therapy Goals**

- **Antihistamine**
  - Diphenhydramine
  - Famotidine

- **Epinephrine**
  - Vasoconstriction
  - Increased Heart rate and contractility
  - Bronchodilation
  - Reduced cytokine production

**Sepsis**

- **Fluids**
  - Lots
- **Antibiotics**
  - Early
- **Vasopressors**
  - Early
Cardiogenic Shock

• Multifactorial -
  
  Diastolic Heart Failure
  Systolic Heart Failure
  Structural
  Rate related

Trauma

Common Cause of Shock
Keys to Survival

- **Air** must go in and out.
- **Blood** must go round and round.
- For **Blood** to work it must be on the inside not the outside
Another Myth

• Large volume resuscitation with isotonic crystalloids (3:1)

• Extracellular fluid redistributes during shock into both intravascular and intracellular spaces

• Optimal resuscitation corrects the extracellular deficit

....dogma that has stood unchallenged for over 40 years...

Leaky Buckets
The Problem:

Salty water neither clots nor carries oxygen

Permissive Hypotensive Resuscitation

• How high must the systolic pressure be to perfuse adequately?

• Resuscitate to lower pressures slowing the rate of blood loss while still perfusing vital tissues.
Saline infusion to maintain MAP in pigs; MAP of 40, 80, & 0 with survival rate 87.5%, 37.5% & 12%; attempts to normalize BP increased mortality, and increased hemorrhage.

— J Trauma 1992
TREATMENT OF HYPOTENSION

Maintaining adequate blood flow to vital organs is the key to patient survival and quality of life!

• **Traditional Therapies:**
  – Positioning (e.g. Trendelenburg)
  – Vasopressors
  – Fluids
  – Anti-shock garments (e.g. MAST)

These therapies are NOT always practical, beneficial or even effective in treating hypotension.
Novel Therapies

TXA – CRASH 2 Study
Lancet Online Article 2010

Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial

- Prospective, randomized controlled trial
- Over 20,000 patients
- TXA significantly reduced all causes mortality from 16.0% to 14.5%
- TXA significantly reduced death from bleeding from 5.7% to 4.9%
Intrathoracic Pressure Regulation

Impedance threshold Device
ResQGARD™

- FDA Approved Impedance Threshold Device
- Research Protocol to analyze improvements on SAFD patient population
- Spontaneously breathing
  - Dehydration
  - Sepsis
  - Trauma (Military funding the project – specific interest in trauma)
  - Orthostatic intolerance
  - Severe allergic reaction
- See improvement quickly (3-4 breathes)

IPR for Hypotension: ResQGARD ITD

Patient / Inspiration Port
Connects to a mouthpiece or facemask.

Atmospheric Pressure Sensing Valve
Provides therapeutic inspiratory resistance until the patient creates at least -7 cmH₂O pressure with respiratory effort.

Exhalation Port

O₂ Port
Permits administration of up to 15 lpm supplemental oxygen.
ResQGARD on Facemask or Mouthpiece

Important: Maintain Tight Seal!

ResQGARD Impact

Normal Breathing

Exhalation

Inspiration

Inhalation with ResQGARD
Impact of IPR on Pressures

No IPR

- Intrathoracic Pressure
- Intracranial Pressure
- Aortic Pressure
- Cerebral Perfusion Pressure

With IPR

Animal Model with 40% bleed and no intervention

Impact of IPR on Pressures


Application: Spontaneously Breathing Hypotensive Patients

- Trauma
- Sepsis
- Dehydration
- Orthostasis
- Dialysis
- Heat exhaustion
When Not to Use

- If you would use CPAP, don’t use the ResQGARD as the effects are the opposite
  - Pulmonary edema/congestive heart failure
  - Bronchospasm

- Also:
  - Shortness of breath
  - Loss of intact chest wall (trauma)
  - Pneumothorax

Study Design

- All Patients Treated by SAFD EMS

- Hypotension from all causes (exclusions)
Setting

• Quick Facts about SAFD
• Population served:
  – Fire: 1,352,906
  – EMS: 1,367,521
• Square Miles:
  – Fire: 469
  – EMS: 483
• Response Volume:
  – Fire: 100,894
  – EMS: 141,427

SAFD Emergency Medical Services

• 387 Paramedic Personnel (4 Shifts)
  – 32 Fulltime “Medic Units”
    * Up to 7 Peak Period Units
    – Each Medic Unit is staffed with 2 Paramedics (Nationally Registered and/or State Certified)
• 22 Command/Supervisory Personnel:
  – Medic Chief
  – Medic Executive Officer
  – 4 Medic Shift Commanders
  – 16 Medic Officers
• Medical Special Operations Unit (MSOU)
• 2 Fulltime Medical Directors
  – 4 BCEM Associate Medical Directors
  – EMS Fellowship
  – EMS Research
Disclaimer: No EMS Fellow, Paramedic or Accountant were harmed during the production of this video – Physically harmed anyway.

Data Collection

• Closed call rule
  – Paramedics could not complete PCR of any hypotensive patient without addressing device intervention

• Benefits:
  – Two patient populations
    • Hypotensive with device
    • Hypotensive without device (quasi control group)
Use of an impedance threshold device in spontaneously breathing patients with hypotension secondary to trauma: An observational cohort feasibility study

David Wampler, PhD, L.P. Victor A. Convertino, PhD, Shannon Weeks, EMT-P, Michael Hernandez, EMT-P, Jacob Larrumbide, and Craig Manifold, DO, San Antonio, Texas

### TABLE 1. Primary Impressions of the Patients Who Were Treated With the ITD

<table>
<thead>
<tr>
<th>Primary Impression</th>
<th>All Patients (n = 20)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altered mental status</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Chest/abdominal complications (nontraumatic)</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Diabetic complications</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Dizziness</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Generalized weakness</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>Primary dehydration</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Seizure</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Syncopeal episode</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Toxic ingestion/death</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Blunt and penetrating trauma</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>Undifferentiated hypotension</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

### TABLE 2. Mechanism of Injury for Trauma Patients Treated With the ITD

<table>
<thead>
<tr>
<th>Primary Impression</th>
<th>Trauma Subgroup (n = 23)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicle collision</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>Fall</td>
<td>10</td>
<td>43</td>
</tr>
<tr>
<td>Shooting/stabbing</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>Laceration</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

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### TABLE 3. Vital Signs for All Patients

<table>
<thead>
<tr>
<th></th>
<th>Systolic, mm Hg</th>
<th>Diastolic, mm Hg</th>
<th>MAP, mm Hg</th>
<th>Pulse (per minute)</th>
<th>Respirations (per minute)</th>
<th>SaO₂, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before ITD Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>78</td>
<td>51</td>
<td>60</td>
<td>87</td>
<td>19</td>
<td>97</td>
</tr>
<tr>
<td>Median (Q1–Q3)</td>
<td>80 (71–86)</td>
<td>52 (45–59)</td>
<td>62 (52–67)</td>
<td>86 (80–101)</td>
<td>18 (16–20)</td>
<td>98 (96–100)</td>
</tr>
<tr>
<td>SD</td>
<td>13</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>After ITD Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>97</td>
<td>63</td>
<td>70</td>
<td>85</td>
<td>18</td>
<td>99</td>
</tr>
<tr>
<td>Median (Q1–Q3)</td>
<td>95 (84–107)</td>
<td>60 (55–70)</td>
<td>68 (63–81)</td>
<td>84 (69–99)</td>
<td>18 (16–20)</td>
<td>100 (98–100)</td>
</tr>
<tr>
<td>p</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.07</td>
<td>0.31</td>
<td>0.28</td>
</tr>
</tbody>
</table>

SaO₂, arterial oxygen saturation.
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**All Hypotensive Trauma patients treated with the ITD.**

**Intrathoracic Pressure**

**High**
- Continuous Positive Airway Pressure (CPAP)
- Lower Cardiac Output
- Risk of Hypotension
- + 5 – 25 cmH\textsubscript{2}O
- Therapy for Pulmonary Edema

**Low**
- Impedance Threshold Device
- Increased Cardiac Output
- Therapy for Hypotension
- - 7 – 10 cmH\textsubscript{2}O
- Risk of Pulmonary Edema
Acknowledgments

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• Dr. Brian Eastridge
• Dr. Keith Lurie

QUESTIONS?