Presenter Disclosure Information

• Colby Rowe

• FINANCIAL DISCLOSURE:
  • No relevant financial relationship exists
  • No Unlabeled/Unapproved Uses in Presentation
Prehospital Resuscitation for the 21st Century Program Emphasis
Two Inch Compression with Complete Release

“Hard and Fast”

At least 100 compressions per minute
Good Release = Good Venous Return to the Heart
Optimal Blood flow During CPR

“Optimal is marginal… so make the marginal optimal. Achieve your full 25%!"
Blood flow During CPR with Under-compression

- Normal Blood Flow
- Blood Flow During CPR

- 100%
- 75%
- 50%
- 25%
- 0%
Blood flow During CPR with Under-compression and Hyperventilation

Normal Blood Flow

Blood Flow During CPR

Normal Blood Flow

Ventilation, defibrillation, intubation, IV, drugs, etc.

Blood Flow During CPR
Chest Compressions and CPP

Coronary Perfusion pressure (Ao diastolic - RA diastolic)

Berg, Circ 2001
Shock Success by Compression Depth

Effect of Compression Depth on Survival

Sister Out-of Hospital data n= 284

% Admitted Alive

Compression depth quartile

- <1.2 inch
- 1.2 to 1.3 inch
- 1.3 to 1.6 inch
- >1.6 inch
Rate Matters!

Survival to Discharge (%) vs. Chest Compression Rate (CC/min)

- Sham ITD
- Active ITD

N = 6188

- <90
- 90-99
- 100-109
- 110-119
- 120-129
- >129
Diagram of preshock, postshock, and perishock pause.
Pre-Shock Pause Duration and Defibrillation Success

## Peri-Shock Pause and Survival

<table>
<thead>
<tr>
<th>Pre-shock pause, secs.</th>
<th>&lt;10 secs.</th>
<th>10–19 secs.</th>
<th>≥20 secs.</th>
<th>Survival, %</th>
<th>P=0.02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival, %</td>
<td>35.1</td>
<td>35.5</td>
<td>25.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-shock pause, secs.</th>
<th>&lt;10 secs.</th>
<th>10–19 secs.</th>
<th>≥20 secs.</th>
<th>Survival, %</th>
<th>P=0.06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival, %</td>
<td>31.8</td>
<td>30.8</td>
<td>22.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peri-shock pause, secs.</th>
<th>&lt;20 secs.</th>
<th>20–39 secs.</th>
<th>≥40 secs.</th>
<th>Survival, %</th>
<th>P=0.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival, %</td>
<td>32.6</td>
<td>31.9</td>
<td>20.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Hyperventilation Reduces Venous Return

<table>
<thead>
<tr>
<th>Consecutive Case</th>
<th>Ventilation Rate (breaths/min)</th>
<th>Ventilation Duration (secs./breath)</th>
<th>% Positive Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Mean ± SEM</td>
<td>37 ± 4*</td>
<td>0.85 ± .07*</td>
</tr>
<tr>
<td></td>
<td>Mean ± SEM</td>
<td>0.85 ± .07*</td>
<td>50 ± 4%</td>
</tr>
<tr>
<td>Group 2</td>
<td>Mean ± SEM</td>
<td>22 ± 3*</td>
<td>1.18 ± .06*</td>
</tr>
<tr>
<td></td>
<td>Mean ± SEM</td>
<td>44 ± 8.2%*</td>
<td>±</td>
</tr>
<tr>
<td>* p &lt; 0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Porcine Survival Study

<table>
<thead>
<tr>
<th>Breaths/Minute</th>
<th>O2/CO2</th>
<th>Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Pigs = 12 BPM</td>
<td>100% O2</td>
<td>6/7 (86%)</td>
</tr>
<tr>
<td>7 Pigs = 30 BPM</td>
<td>100% O2</td>
<td>1/7 (14%)*</td>
</tr>
<tr>
<td>7 Pigs = 30 BPM</td>
<td>95% O2/5% CO2</td>
<td>1/7 (14%)*</td>
</tr>
</tbody>
</table>

*P < 0.05

Illustration of the Impact of Manual & Automated Chest Compression on Cerebral Perfusion in Two Patients

- Automated CPR (patient 1)
- Manual CPR (patient 2)
Impact of automated CPR on rSO$_2$

* $p= <0.0001$ Mann-Whitney Test, (Manual CPR n=22, Automated CPR n=12)
Quality of Compressions
AHA Standards

Stapleton E. *Quality of CPR During Transport*. JEMS 1991Sep;16(9):63-4, 66, 68
Automatic CPR leads to higher Return Spontaneous Circulation Following Cardiac Arrest

ROSC = Return of Spontaneous Circulation lasting > 20 mins.

*p < 0.05 using Fischer's Exact test. (Manual CPR n=44, Automated CPR n=20)
Saving the PEA’s and Asystole Patients!
by Fine Tuning Appreciation of H’s and T’s
Adult Cardiac Arrest

Shout for Help/Activate Emergency Response

1. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator

2. VF/VT
   - Shock

3. CPR 2 min
   - IV/O access

4. Rhythm shockable?
   - Yes
   - CPR 2 min
     - IV/O access
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography
   - No

5. Rhythm shockable?
   - Yes
   - Shock

6. CPR 2 min
   - Epinephrine every 3-5 min
   - Consider advanced airway, capnography

7. CPR 2 min
   - Amiodarone
   - Treat reversible causes

8. CPR 2 min
   - If no signs of return of spontaneous circulation (ROSC), go to 10 or 11
   - If ROSC, go to Post-Cardiac Arrest Care

9. Asystole/PEA

10. CPR 2 min
    - IV/O access
    - Epinephrine every 3-5 min
    - Consider advanced airway, capnography

11. CPR 2 min
    - Treat reversible causes

12. Rhythm shockable?
    - Yes
    - Go to 5 or 7
    - No

CPR Quality
- Push hard (≥2 inches (5 cm)) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  - If PetCO₂ <10 mm Hg, attempt to improve CPR quality
- Intracranial pressure
  - If relaxation phase (diastolic pressure <20 mm Hg), attempt to improve CPR quality

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in PetCO₂ (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Shock Energy
- Biphasic: Manufacturer recommendation (eg, initial dose of 120-200 J; if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- Monophasic: 360 J

Drug Therapy
- Epinephrine IV/O Dose: 1 mg every 3-5 minutes
- Vasopressin IV/O Dose: 40 units can replace first or second dose of epinephrine
- Amiodarone IV/O Dose: First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm placement
  - 10 breaths per minute with continuous chest compressions

Reversible Causes
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

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<table>
<thead>
<tr>
<th>H's</th>
<th>T's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxia</td>
<td>Toxins</td>
</tr>
<tr>
<td>Hypovolemia</td>
<td>Tamponade (cardiac)</td>
</tr>
<tr>
<td>Hydrogen ion \textit{(acidosis)}</td>
<td>Tension pneumothorax</td>
</tr>
<tr>
<td>Hypo-/hyperkalemia</td>
<td>Thrombosis, pulmonary</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Thrombosis, coronary</td>
</tr>
</tbody>
</table>
What can Prehospital Providers do for H’s and T’s anyway?

- Decompress Tension Pneumothorax
- Pericardiocentesis
- Volume
- Toxicology Antidotes
- Treatment of Hyper/Hypokalemia

- Early notification
  - “Trauma system strategy”
  - “12 Lead ECG strategy”
H’s and T’s Process

1. Systematically consider - based on the presenting problem
   - Trauma = hypovolemia, tension pneumothorax, tamponade
   - History is a good first step!

2. How to recognize?
   - Tamponade = Ultrasound identification

3. How to treat?
   - Tamponade = Pericardiocentesis
Potential Usefulness of Ultrasound

- Pneumothorax,
- Tension Pneumothorax
- Pericardial Tamponade
- Hypovolemic
- Cardiogenic Shock
- Pulmonary Embolus
- ... and more
# The H’s and T’s

<table>
<thead>
<tr>
<th>Hypovolemia</th>
<th>History of Bleeding Ultrasound Collapsed IVC</th>
<th>Fluid, blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothermia</td>
<td>History of Submersion Core Body Temperature</td>
<td>Internal cooling</td>
</tr>
<tr>
<td>Hydrogen Ion (Acidosis)</td>
<td>Prolonged Arrest, ABG Salicylate OD</td>
<td>Bicarbonate</td>
</tr>
<tr>
<td>Hyper/Hypokalemia</td>
<td>Renal History, Dialysis Blood Test, ECG Changes</td>
<td>Pharmacology Treatment</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>Cyanosis, ABG Check Oxygen/Ventilation</td>
<td>Assure adequate Ventilation/Oxygen</td>
</tr>
<tr>
<td>Tablet’s or Toxins</td>
<td>History, Smells, Physical Findings, Smoke Inhalation</td>
<td>Supportive care Antidote if</td>
</tr>
<tr>
<td>Tamponade</td>
<td>Trauma, Recent Cardiac Surgery, Ultrasound</td>
<td>Pericardiocentesis</td>
</tr>
<tr>
<td>Tension pneumothorax</td>
<td>Breath Sounds, Neck Veins Ultrasound</td>
<td>Needle decompress. Chest tube</td>
</tr>
<tr>
<td>Thrombus – MI</td>
<td>History Chest Pain Prior to Collapse, 12 lead</td>
<td>Catherization Lab</td>
</tr>
<tr>
<td>Thrombus - PE</td>
<td>History Chest Pain, Ultrasound Dilated R. Ventricle</td>
<td>Thrombolitics</td>
</tr>
</tbody>
</table>
Thank you!