Time to Defibrillation...
What Can We Do to Improve Shock Success?

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Objectives

• Review the 2010 American Heart Association Guidelines
• Describe physiologic changes associated with ventricular fibrillation
• Discuss the benefit of biphasic shocks for successful conversion of ventricular fibrillation
Chances of surviving an In-Hospital Cardiac Arrest?

<table>
<thead>
<tr>
<th></th>
<th>Estimate by Admissions</th>
<th>Estimate by Population/Year</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Adult</td>
<td>6.65/1000</td>
<td>200,000</td>
<td>Chan et al&lt;sup&gt;a&lt;/sup&gt; Nadkami et al&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Pediatric</td>
<td>3.26/1000</td>
<td>6000</td>
<td>Chan et al&lt;sup&gt;a&lt;/sup&gt; Nadkami et al&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Outcomes</td>
<td></td>
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<tr>
<td>Adult</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Survival to discharge</td>
<td>...</td>
<td>18%</td>
<td>Nadkami et al&lt;sup&gt;b&lt;/sup&gt; Nadkami et al&lt;sup&gt;b&lt;/sup&gt; and Fiser&lt;sup&gt;c&lt;/sup&gt; Booth et al&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>CPC good</td>
<td>...</td>
<td>73%</td>
<td>Nadkami et al&lt;sup&gt;b&lt;/sup&gt; Nadkami et al&lt;sup&gt;b&lt;/sup&gt; and Fiser&lt;sup&gt;c&lt;/sup&gt; Booth et al&lt;sup&gt;d&lt;/sup&gt;</td>
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<tr>
<td>Survival at 1 year</td>
<td>...</td>
<td>6.60%</td>
<td>Booth et al&lt;sup&gt;d&lt;/sup&gt; Booth et al&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Survival at 3 years</td>
<td>...</td>
<td>5.20%</td>
<td>Booth et al&lt;sup&gt;d&lt;/sup&gt; Booth et al&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>27%</td>
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CPC indicates cerebral performance categories; and IHCA, in-hospital cardiac arrest.

Circulation (2013); Morrison, et al.
Most common In-Hospital Arrest?

- Asystole
- PEA
- Vfib/Pulseless VT
Asystole & PEA make up 67% of all adult In-Hospital cardiac arrests

Circulation (2013); Morrison, et al.
Strategies for Improving Survival After In-Hospital Cardiac Arrest in the United States: 2013 Consensus Recommendations: A Consensus Statement From the American Heart Association

Laurie J. Morrison, Robert W. Neumar, Janice L. Zimmerman, Mark S. Link, L. Kristin Newby, Paul W. McMullan, Jr, Terry Vanden Hoek, Colleen C. Halverson, Lynn Doering, Mary Ann Peberdy and Dana P. Edelson

on behalf of the American Heart Association Emergency Cardiovascular Care Committee, Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Peripheral Vascular Disease
2010 AHA Guidelines for V-fib Arrest
The purpose of defibrillation...

- To briefly terminate all electrical activity
- It does not restart the heart!!!
- Pacemakers of the heart will resume electrical activity

- Why continue chest compressions after shock?
  - Initial post-shock rhythm is often slow
  - Inadequate cardiac output & perfusion
Monophasic vs. Biphasic
Biphasic Waveform?

- Biphasic is the standard of care
Fibrillating Heart

Fibrillating heart with ECG.mpg

copyright 2002 Medtronic, Inc.
Comparing Mono & Biphasic

- Electrophysiology Lab
- Induced VF 115 patients prior to ICD placement

**Table 3. First-shock Efficacy for First Episode of Ventricular Fibrillation in Each Patient**

<table>
<thead>
<tr>
<th>Group</th>
<th>Sample Size</th>
<th>First-shock Success, n (%)</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-J monophasic</td>
<td>68</td>
<td>61 (89.7%)</td>
<td>79.9–95.8%</td>
</tr>
<tr>
<td>200-J biphasic</td>
<td>39</td>
<td>39 (100.0%)</td>
<td>91.0–100%</td>
</tr>
<tr>
<td>130-J biphasic</td>
<td>47</td>
<td>39 (83.0%)</td>
<td>69.2–92.4%</td>
</tr>
</tbody>
</table>

Higgins et al 2000 Pre-Hospital Emergency Care
# Post Shock Rhythm

**Table 4. Rhythms Present after Successful First Shocks, Expressed as Percentages of the Number of Successes for Each Shock Type**

<table>
<thead>
<tr>
<th>Rhythm</th>
<th>200-J Monophasic (n = 61)</th>
<th>200-J Biphasic (n = 39)</th>
<th>130-J Biphasic (n = 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal sinus rhythm</td>
<td>52.5</td>
<td>53.8</td>
<td>38.5</td>
</tr>
<tr>
<td>Sinus bradycardia</td>
<td>14.8</td>
<td>20.5</td>
<td>25.6</td>
</tr>
<tr>
<td>Sinus tachycardia</td>
<td>0.0</td>
<td>0.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Supraventricular tachycardia (not sinus)</td>
<td>11.5</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Idioventricular</td>
<td>4.9</td>
<td>2.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Paced</td>
<td>9.8</td>
<td>10.3</td>
<td>12.8</td>
</tr>
<tr>
<td>Junctional</td>
<td>1.6</td>
<td>5.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Other</td>
<td>4.9</td>
<td>2.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Higgins et al 2000 Pre-Hospital Emergency Care
Among patients requiring more than 1 shock, the escalating higher energy regimen provided a significantly higher rate of VF termination.

Escalating energy for Vfib!

- Energy varies by manufacturer recommendation
- Physio-Control Biphasic
  - 200 joules – 1\textsuperscript{st} shock
  - 300 joules – 2\textsuperscript{nd} shock
  - 360 joules – all following shocks
- Monophasic
  - 360 joules – all shocks
## AHA 2010 Energy Level Recommendations

<table>
<thead>
<tr>
<th>Rhythm</th>
<th>2010 Guideline</th>
<th>Escalate?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pediatric Tachycardias</strong></td>
<td>0.5-1J/kg. If initial shock fails increase the dose in a stepwise fashion to 2J/kg</td>
<td>YES</td>
</tr>
</tbody>
</table>
| **Pediatric VF and Pulseless VT** | 1<sup>st</sup> shock: 2J/kg  
2<sup>nd</sup> shock: at least 4J/kg  
Subsequent shocks: 4-10J/kg | YES        |
| **Adult AF**                  | 120J-200J. If initial shock fails increase in a stepwise fashion               | YES        |
| **Adult SVT/Atrial Flutter**  | 50-100J. If initial shock fails increase in a stepwise fashion                  | YES        |
| **Adult VT with a Pulse**     | 100J. If initial shock fails increase in a stepwise fashion                     | YES        |
| **Adult VF and Pulseless VT** | Manufacturer recommendation: 120 – 200J. Second and subsequent doses should be at least equivalent, and higher doses may be considered, if available | YES        |

Consider if available, but it’s OK to repeat the equivalent dose.
Transthoracic Impedance (TTI)

- What affects it?
  - Body mass
  - Temperature
  - COPD/Barrel chest

  Impedance Values
  - 70 – 90 ohms Normal
  - > 100 ohms Increased
  - > 150 ohms Very high

- Challenging
  - Metabolic abnormalities
  - Duration of arrhythmia prior to shock
  - Myocardial ischemia
When to shock?

- Earlier is better – UNDER 3 MINUTES!!!
- We know survival decreases over time
- For every minute that passes, survival drops from 7-10% if no compressions are provided
- With compressions, the decline is 3-4% per minute
  - Vfib often deteriorates to asystole

- Shock early, but when?
- Compressions to off-load the right ventricle & provide forward flow to the left ventricle?
- (Class IIb, LOE B)
Vfib

Steen et al. Resuscitation. 2003; 58: 249-258

5min in 10s
6½min VF + 3½min Compressions

Decreasing time to defibrillation?

- Code team assignment
- Analyze the rhythm quickly, do not waste time!
- Have the defibrillator charged and ready to go before the end of the 2 minute compression cycle OR,
- Performing CPR while a defibrillator is readied for use is strongly recommended for all patients in cardiac arrest (AHA - Class I, LOE B)
- Compressions will deliver oxygen to the heart likely increasing the likelihood of shock success
Consequences of Failed Shocks

- Pre-shock and post shock pauses lead to CPR interruptions
- 24 second pre and post shock pause
- “Wasted” interruption—patient remained in VF

black = ECG
green = impedance
No Interruption

- No pre and post shock pause
- LUCAS mechanical chest compressions
Simulation - Critical Care Medicine 2005

• More likely to receive defibrillation when the physician team arrived
• Median arrival of 50 seconds
• Median delay of 85 seconds until chest compressions started
• Median delay of 100 seconds before the first defib
Minimize Pre and Post Shock Pauses

- Review system data and adjust energy levels
- Post event review with feedback and training to the team
- Use mechanical CPR to minimize pauses
- Charge the defibrillator while doing CPR
  - Briefly check rhythm, stand clear and shock
  - **Immediately** resume CPR

Immediately resume CPR
Minimize Pre & Post Shock pauses

Fig. 3. Receiver-operator curve for pre-shock interval using return of spontaneous circulation (ROSC) as the outcome variable (area under the curve 0.72). The optimal pre-shock interval was defined as <3 s.

Pre-Shock pause < 3 seconds

Sell et al 2010 Resuscitation

Fig. 4. Receiver-operator curve for post-shock interval using return of spontaneous circulation (ROSC) as the outcome variable (area under the curve 0.77). The optimal post-shock interval was defined as <6 s.

Post-Shock pause < 6 seconds
Defibrillation in non-tele areas?

- Consider AEDs
- Manual defibrillators in AED mode

- Focus training on BLS:
  - Compressions
  - Defibrillation
  - Airway/ventilation

- In areas where staff are trained in rhythm interpretation, use manual mode
Paddles vs. Pads

• Self-adhesive pads recommended by AHA
• Conduction medium is essential!
• Pads reduce risk & allow for monitoring
• Rapid delivery of shock
Pad Placement

Anterior/Lateral

Anterior/Posterior
Anterior/Left Infrascapular
Anterior/Right Infrascapular
Special Circumstances

- Hairy chest
- Chest wetness
  - Wipe off chest
- Transdermal Medication patches
  - Do not place on top of patches
  - May block energy
  - Skin burn
- Implantable Pacemaker/defibrillator
  - Not a contraindication!
  - Do not place pad on top of internal PM/ICD
  - Allow 30-60 seconds for the ICD to complete treatment cycle before shocking with an external device
Do drugs help?

• Epinephrine 1 mg IV/IO every 3-5 min
  • α-adrenergic effects
  • Escalating and high dose did not improve survival

• Vasopressin 40 units IV/IO x 1
  • Non-adrenergic peripheral vasoconstrictor
  • Use in place of 1st or 2nd Epi
  • No survival difference vs. Epi
Anti-arrhythmics

- Amiodorone
  - 300 mg IV/IO; repeat with 150 mg

- Lidocaine
  - 1 – 1.5 mg/kg IV/IO, then 0.5 – 0.75 mg/kg IV to a max of 3 mg/kg

- Magnesium Sulfate
  - Only for Torsades de Pointes
  - 1 – 2 Grams IV/IO

- ALP Study – King County
  - Amio vs. Lido vs. Placebo
What’s the cause?

5 H’s
- H+ (Acidosis)
- Hyper/Hypokalemia
- Hypovolemia
- Severe hypothermia
- Hypoxia

5 T’s
- Toxins
- Tension pneumothorax
- Tamponade
- Thrombus – PE
- Thrombus – MI
Post-Arrest Care

- Treat causes
  - STEMI/AMI
  - PCI
- Hemodynamics
  - Treat hypotension
- Monitor for re-arrest
- EtCO$_2$/waveform capnography
- Therapeutic Hypothermia
Training

- Know how to use your equipment!
- Training
- Designate a team member
- Mock codes
- Simulation
- Skills day training
- Crash cart checks to increase familiarity
- Designated person to deliver shocks?
In conclusion:

• Do not delay compressions!
• Minimize interruptions in compressions & shock pauses
• Defibrillate as quickly as possible (< 3 min)
• Escalate energy to improve shock success
• Provide post-arrest care
• Training is essential
• Know your stats!