Biphasic Waveform Energy Levels for Defibrillation and Cardioversion and the 2010 Guidelines—What’s New?

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Class Code: 674

Learning Objectives

- List the recommended energy dosing sequence for pediatric patients as stated in the 2010 AHA Guidelines
- Name one reason shock success improves CPR quality.
- Name the recommended shock dosing protocol for adult ventricular fibrillation.

AHA Guidelines 2010

Released October, 2010

- Some new energy level recommendations
  - Biggest change in pediatric energy level recommendations
- Escalating energy recommended for most rhythms
- No known harm to humans with energy levels up to 360J
Facts about Biphasic Waveforms

- Current flows in two directions
- More efficient and more effective at removing VF
- Biphasic waveforms are much “gentler” than monophasic waveforms
  - less peak current
  - 100J biphasic waveform has about the same peak current as a 360J monophasic waveform
- Biphasic waveforms have not yet been shown to improve survival
  - This study has not been done

2010 AHA Guidelines & Energy Dosing—Pediatric
Energy Levels for Defibrillation and Cardioversion

Tachycardias
2010: Initial biphasic energy dose for cardioversion is 0.5-1J/kg. If the initial shock fails, increase the dose in a stepwise fashion to 2J/kg.
2005: Same as 2010

Defibrillation for VF and pulseless VT
2010: First shock 2J/kg, second shock at least 4J/kg, subsequent shocks 4-10J/kg.
  • “Even with higher energies up to 50J/kg, defibrillation has been successful with no clear adverse effects.”

Defibrillation with an AED
2010: OK to use for children less than 8 years of age
2005: OK to use for children ≥ 1 year of age
  • Use AED that has a high specificity to recognize pediatric shockable rhythms
  • Use attenuated energy levels
  • Editorial Comment: Using AED on pediatric patients requires “trade offs”

2010 AHA Guidelines & Defibrillation Dosing—Adult Cardioversion

Atrial Fibrillation
2010: Initial biphasic energy dose for cardioversion of atrial fibrillation is 120 to 200J. If the initial shock fails, increase the dose in a stepwise fashion
2005: Start at 100J, increase in a stepwise fashion up to 360J monophasic or clinically equivalent biphasic dose

SVT and atrial flutter
2010: Initial energy of 50-100J. If initial shock fails increase the dose in a stepwise fashion
2005: Start with 50J monophasic, increase in stepwise fashion with monophasic or clinically equivalent biphasic

Monomorphic VT with a pulse
2010: Initial energy of 50J. If initial shock fails it’s reasonable to increase the dose in a stepwise fashion
2005: Start at 100J, increase in a stepwise fashion up to 360J monophasic or clinically equivalent biphasic dose

Polymorphic VT or VT without a pulse
Treat as VF

1AHA Guidelines 2010 for CPR and ECC. Circulation 2010; 122[suppl 3]: S752
Defibrillation Dosing—VF and Pulseless VT

- First, some background information
- AHA: Stacked shocks eliminated in 2005
  - Goal was to maximize CPR time and limit interruptions
  - Monophasic shocks should be given at 360J

Conventional Wisdom...
(AHA Guidelines 2005 and 2010)

- “Biphasic shocks (even low energy biphasic shocks) succeed >90% of the time.”

Published Clinical Experience:
Cardiac Arrest Patients Treated w/ Biphasic Shocks
**Published Clinical Experience:**
Cardiac Arrest Patients Treated w/ Biphasic Shocks

**First shock VF termination rate**

70% - 150 J (White J Interv Card Electrophysiol 1997)
89% - 150 J (Gliner Biomed Instrum Technol 1998)
90% - 150 J (Gliner Resuscitation 1999)
90% - 150 J (Kramer-Johansen Resuscitation 2007)
91% - 100/150 J (Walsh Am J Cardiol 2004)
94% - 180/200 J (Whitfield Resuscitation 2005)
90% - 150 J (White Resuscitation 2002)
86% - 150 J (Koster Resuscitation 2008)
88% - 200 J (Van Alem Resuscitation 2003)
84% - 150 J (Gliner Biomed Instrum Technol 1998)
89% - 150 J (Stiell Circulation 2007)
79% - 150 J (Stothert Prehosp Emerg Care 2004)
67% - 120 J (Stiell Prehosp Emerg Care 2004)

* Paper only reported on first shock of each VF episode

**Papers reporting VF termination rate for all shocks**

<table>
<thead>
<tr>
<th>Papers reporting VF termination rate for all shocks</th>
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<tr>
<td># patients</td>
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<tr>
<td>White Resuscitation 2002 (150 J)</td>
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<tr>
<td>Stiell Prehosp Emerg Care 2004 (120 – 360 J)</td>
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<tr>
<td>Weishe J Cardiol 2004 (180 – 200 J)</td>
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<tr>
<td>Kramer-Johansen Resuscitation 2007 (150 J)</td>
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<tr>
<td>Steil Circulation 2007 (150 J – 360 J)</td>
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<tr>
<td>Koster Resuscitation 2009 (200 – 360 J)</td>
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<tr>
<td>Walker Resuscitation 2000 (200 – 360 J)</td>
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<td>Jones Circulation 2010 (100 – 200 J)</td>
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66% biphasic shocks
18% monophasic shocks

**Guidelines 2005**

- **Patients treated with Physio-Control biphasic shocks**
- **Patients treated with all other biphasic shocks**
Difficult to Defibrillate Patients

- Some patients are more difficult to defibrillate
  - And we can’t predict who they are ahead of time
  - Impedance not a factor

Higher Energy Levels are Associated with Higher Shock-Success Rates

2010 AHA Guidelines & Defibrillation Dosing—Adult VF

- Biphasic
  - "Manufacturer recommendation (120 – 200J); if unknown, use maximum available. Second and subsequent doses should be at least equivalent, and higher doses may be considered, if available."
  - "Evidence from 1 well-conducted randomized trial (LOE 1) and 1 other human study (LOE 2) employing BTE waveforms suggested that higher energy levels are associated with higher shock-success rates."

- Monophasic
  - 360J for all shocks

The Benefit of Higher Energy Regimens

- Among patients requiring more than 1 shock, the escalating higher energy regimen provided a significantly higher rate of VF termination

1 Stiell et al, Circulation 2007;115:1511-1517
Higher Conversion from VF to Organized Rhythms with Escalating, Higher Energy

- The first randomized, controlled clinical trial$^1$ to compare fixed lower with escalating higher-energy regimens for biphasic defibrillation showed:
  - Patients in VF benefit from higher biphasic energy levels if multiple defibrillation shocks are required

$^1$Stiell et al., Circulation 2007;115:1511-1517

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FDA is Investigating Biphasic Energy Levels \(\leq 200\) J November 5, 2009

- FDA Statement November 5, 2009:
  - Audience:
    - "Clinical community & specific healthcare professionals including Electrophysiology Labs, Code Teams, Cardiac Cath Labs, Operating Rooms, Intensive Care Units, Emergency Rooms, Risk Managers, Quality Managers, Patient Safety Coordinators, Directors of Nursing, Medical Directors, Biomedical/Clinical engineers, Emergency Medical Services"
  - Summary of Problem and Scope:
    - "We have received reports of 14 events since 2006 in which a 200J biphasic defibrillator was ineffective in providing defibrillation/cardioversion therapy to a patient, whereas a subsequent shock from a different 360J biphasic defibrillator resulted in immediate defibrillation/cardioversion."
  - FDA Recommendation:
    - "If you experience an event similar to those reported above, we encourage you to report to the FDA...

http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm189259.htm

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FDA Maude Database Entries:

- 200J failed, then 360J succeeded
  - Zoll 06/17/2009
  - Zoll 08/01/2008
  - Zoll 08/01/2008
  - Zoll 07/07/2008
  - Zoll 06/25/2008
  - Zoll 06/17/2009
  - Zoll 06/16/2008
  - Zoll 06/09/2008
  - Zoll 05/02/2009
  - Zoll 04/11/2008; Zoll 04/17/2008
  - Philips 05/07/2007
  - Philips 05/16/2006

- Did not specifically say second device was 360J:
  - (Zoll 06/02/2009)
  - (Zoll 07/16/2008)
  - (Zoll 07/07/2008)
  - (Zoll 06/16/2008)

- Multiple 200J failures
  - (Zoll 04/28/2008)
Why Shock Success Matters

- Ineffective shocks decrease CPR time
  - CPR time is interrupted.
  - "Wasted" interruption in CPR, necessitating at least one additional CPR interruption to re-attempt defibrillation
  - One study found median pre-shock and post shock pauses totaled 24 seconds for manual shocks and 42 seconds for AED shocks (Kramer-Johansen)
  - % of time doing CPR is related to survival (Christenson)
- Rhythm stays in VF during prolonged post-shock CPR interval ("VF burden")


Interruptions in Chest Compression Cause Drop in CPP

CPP decreases during each set of 2 breaths, and it takes several compressions of the next cycle before it is restored


CPR Case Report

Adapted from an unknown source.
Example of CPR Data from Defibrillator

Why Shock Success Matters

- Pre-shock and post shock pauses lead to CPR interruptions
- 24 second pre and post shock pause

Consequences of Failed Shocks

- 23 second pre and post shock pause
- Successful shock at 360J
**Minimal Interruption**

- 9 second pre and post shock pause

**No Interruption**

- No pre and post shock pause
- LUCAS mechanical chest compressions

**CPR Report: Pre-and Post-shock Pauses**
Summary

- Escalating Energy is recommended for almost all rhythms for cardioversion and VF
- Escalating energy improves shock success
- Some patients are more difficult to defibrillate than others
- Failed shocks are costly because they
  - Leave patients in VF longer
  - Increase interruptions in CPR
- CPR and code data can be obtained from defibrillator downloads
- A greater % of time doing CPR is related to survival