Management of Ventricular Tachycardia or Fibrillation:

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<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Incidence Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland (Helsinki)</td>
<td>1999</td>
<td>48.2%</td>
</tr>
<tr>
<td>USA (Seattle)</td>
<td>2000</td>
<td>41%</td>
</tr>
<tr>
<td>USA (Miami)</td>
<td>2001</td>
<td>38.6%</td>
</tr>
<tr>
<td>Sweden (Goteborg)</td>
<td>1997</td>
<td>32%</td>
</tr>
<tr>
<td>Sweden</td>
<td>2001</td>
<td>28% (at home)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41% (outside home)</td>
</tr>
<tr>
<td>Japan (Osaka)</td>
<td>1999</td>
<td>16.8%</td>
</tr>
<tr>
<td>Taiwan (Taipei)</td>
<td>2001</td>
<td>12.6%</td>
</tr>
</tbody>
</table>

* Witnessed OHCA

References:

- Eur Heart J 2000; 21: 1251
- Lancet 2001; 358: 473
- JAMA 2002; 288: 3008
- Circulation 2002; 106:1058
- Resuscitation 2003; 59: 329
- 2004; 60: 283
- 2004 63: 137
Chain of Survival

Early EMS  Early CPR  Early Defibrillation  Early ACLS
Resuscitation After Cardiac Arrest

- Time-sensitive progression of resuscitation physiology which in turn requires time-critical intervention!
- VF $\rightarrow$ early defibrillation (Class I)
- “Compression first vs. Shock first for VF” !?

Electrical phase

- VF → early defibrillation (Class I)
- Each passing minute decreased survival by 8-10%

Circulation 1997; 96: 3308

NEJM 2004; 351:632-4
PULSELESS ARREST
- BLS Algorithm: Call for help, give CPR
- Give oxygen when available
- Attach monitor/defibrillator when available

1. Shockable
   - Check rhythm
     - Shockable rhythm?

2. Check rhythm
   - Not Shockable
     - Asystole/PEA
       - Resume CPR immediately for 5 cycles
         - When IV/IO available, give vasopressor
           - Epinephrine 1 mg IV/IO
           - Repeat every 3 to 5 min
           - May give 1 dose of vasopressin 40 U IV/IO to replace first or second dose of epinephrine
           - Consider atropine 1 mg IV/IO for asystole or slow PEA rate
             - Repeat every 3 to 5 min (up to 3 doses)

3. Give 1 shock
   - Manual biphasic: device specific
     - (typically 120 to 200 J)
     - Note: if unknown, use 200 J
   - AED: device specific
   - Monophasic: 360 J
   - Resume CPR immediately

4. Check 5 cycles of CPR*
   - Continue CPR while defibrillator is charging
     - Give 1 shock
       - Manual biphasic: device specific
         - (same as first shock or higher dose)
         - Note: if unknown, use 200 J
       - AED: device specific
       - Monophasic: 360 J
     - Resume CPR immediately after the shock
       - When IV/IO available, give vasopressor during CPR
         - (before or after the shock)
       - Epinephrine 1 mg IV/IO
         - Repeat every 3 to 5 min
         - May give 1 dose of vasopressin 40 U IV/IO to replace first or second dose of epinephrine

5. Check rhythm
   - Shockable
     - Continue CPR while defibrillator is charging
       - Give 1 shock
         - Manual biphasic: device specific
           - (same as first shock or higher dose)
           - Note: if unknown, use 200 J
         - AED: device specific
         - Monophasic: 360 J
       - Resume CPR immediately after the shock
         - Consider antarrhythmic; give during CPR
           - (before or after the shock)
           - amiodarone 300 mg IV/IO once, then consider additional 150 mg IV/IO once or
           - lidocaine (1 to 1.5 mg/kg first dose, then 0.5 to 0.75 mg/kg IV/IO, maximum 3 doses or 3 mg/kg)
         - Consider magnesium, loading dose 1 to 2 g IV/IO for torsades des points
       - After 5 cycles of CPR*, go to Box 5 above

6. Check 5 cycles of CPR*
   - If asystole, go to Box 10
   - If electrical activity, check pulse. If no pulse, go to Box 10
   - If pulse present, begin postresuscitation care

7. Check rhythm
   - Not Shockable
   - Shockable
     - Go to Box 4

8. During CPR
   - Push hard and fast (100/min)
   - Ensure full chest recoil
   - Minimize interruptions in chest compressions
     - One cycle of CPR: 30 compressions
       - Then 2 breaths; 5 cycles =2 min
   - Avoid hyperventilation
   - Secure airway and confirm placement
     - After an advanced airway is placed, reassess no longer deliver "cycles" of CPR
     - Give continuous chest compressions without pauses for breaths.
     - Give 8 to 10 breaths/minute. Check rhythm every 2 minutes
   - Rotate compressors every 2 minutes with rhythm checks
   - Search for and treat possible contributing factors:
     - Hypovolemia
     - Hypoxia
     - Hypo/glycemia
     - Hypothermia
     - Toxins
     - Tension pneumothorax
     - Thrombosis (coronary or pulmonary)
     - Trauma
3

VF/VT

4

Give 1 shock
- Manual biphasic: device specific (typically 120 to 200 J)
  Note: If unknown, use 200 J
- AED: device specific
- Monophasic: 360 J
Resume CPR immediately

5

Give 5 cycles of CPR

6

Check rhythm
Shockable rhythm?

Shockable

Continue CPR while defibrillator is charging

Give 1 shock
- Manual biphasic: device specific (same as first shock or higher dose)
  Note: If unknown, use 200 J
- AED: device specific
- Monophasic: 360 J
Resume CPR immediately after the shock
When IV/IO available, give vasopressor during CPR (before or after the shock)
- Epinephrine 1 mg IV/IO
  Repeat every 3 to 5 min
  or
- May give 1 dose of vasopressin 40 U IV/IO to replace first or second dose of epinephrine
During CPR

- Push hard and fast (100/min)
- Ensure full chest recoil
- Minimize interruptions in chest compressions
- One cycle of CPR: 30 compressions then 2 breaths; 5 cycles ≈2 min
- Avoid hyperventilation
- Secure airway and confirm placement

* After an advanced airway is placed, rescuers no longer deliver “cycles” of CPR. Give continuous chest compressions without pauses for breaths. Give 8 to 10 breaths/minute. Check rhythm every 2 minutes

- Rotate compressors every 2 minutes with rhythm checks
- Search for and treat possible contributing factors:
  - Hypovolemia
  - Hypoxia
  - Hydrogen ion (acidosis)
  - Hypo-/hyperkalemia
  - Hypoglycemia
  - Hypothermia
  - Toxins
  - Tamponade, cardiac
  - Tension pneumothorax
  - Thrombosis (coronary or pulmonary)
  - Trauma
Clinical and hemodynamic comparison of 15:2 and 30:2 compression-to-ventilation ratios for CPR

- Design: prospective randomized study

![Graphs showing cardiac output, common carotid blood flow, end tidal CO2, and PaCO2-ETCO2 comparisons between 15:2 and 30:2 ratios with and without ITD.]

Crit Care Med 2006(e-pub)
Electrode-Patient Interface

- Treatment Recommendation
  - Paddles and electrode pads should be placed on the exposed chest in an anterolateral position.
  - Acceptable alternative positions are anteroposterior and apex-posterior.
  - In large-breasted patients it is reasonable to place the left electrode pad lateral to or underneath the left breast.
  - Defibrillation success may be higher with 12-cm electrodes than with 8-cm electrodes. Small electrodes (4.3 cm) may be harmful; myocardial injury can occur.

Circulation 2005; 112: III 17-24
Outcome of Rapid Defibrillation by Security Officer After Cardiac Arrest in Casinos

- Prospective study for sudden cardiac arrest in casinos  n=105
- Survival to discharge 53%
- 90 patients (86%) witnessed
  - Collapse to AED 3.5±2.9 min
  - Collapse to defibrillation 4.4±2.9 min
- Collapse to defibrillation ≤ 3 min
  - Survival to discharge 74%
- Collapse to defibrillation > 3 min
  - Survival to discharge 49%

NEJM 2000;343:1206
PAD – Chicago Airport

- AED within 1 minute anywhere in the airport
- Survival approaching 50% (10/18) for VF

NEJM 2002; 347: 1242
Public-Assess Defibrillation And Survival After OHCA

- Prospective, community-based, multicenter clinical trial, n=235

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CPR Only</th>
<th>CPR plus AED</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Definite cardiac arrests — no.</td>
<td>107</td>
<td>128</td>
<td>0.09*</td>
</tr>
<tr>
<td>Residential units</td>
<td>37</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Public units</td>
<td>70</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Survivors of definite arrest — no.</td>
<td>15</td>
<td>30</td>
<td>0.03†</td>
</tr>
<tr>
<td>Residential units</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Public units</td>
<td>14</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Survivors of definite or uncertain arrest — no.</td>
<td>16</td>
<td>31</td>
<td>0.03*‡</td>
</tr>
<tr>
<td>Cerebral performance category of survivors of definite arrest — no. (%)§</td>
<td></td>
<td></td>
<td>0.90¶</td>
</tr>
<tr>
<td>Normal</td>
<td>10 (71.4)</td>
<td>22 (73.3)</td>
<td></td>
</tr>
<tr>
<td>Mildly impaired</td>
<td>3 (21.4)</td>
<td>5 (16.7)</td>
<td></td>
</tr>
<tr>
<td>Moderately impaired</td>
<td>1 (7.1)</td>
<td>3 (10.0)</td>
<td></td>
</tr>
</tbody>
</table>

NEJM 2004; 351:637-646
AED Use in Hospital

- A Program Encouraging Early Defibrillation Results in Improved In-Hospital Resuscitation Efficacy

- Manual monophasic defibrillator vs. biphasic AED

<table>
<thead>
<tr>
<th>Table 2. Outcomes Before and After Program Initiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Period</td>
</tr>
<tr>
<td>2001-June</td>
</tr>
<tr>
<td>1995-2000</td>
</tr>
<tr>
<td>Outcome</td>
</tr>
<tr>
<td>Alive at discharge</td>
</tr>
<tr>
<td>Died in hospital</td>
</tr>
<tr>
<td>Neurological outcome</td>
</tr>
</tbody>
</table>

*The Glasgow-Pittsburgh Cerebral Performance Categories: 1) good cerebral performance, 2) moderate cerebral disability, 3) severe cerebral disability, 4) coma, vegetative state; 5) death. The score was determined for survivors only.

<table>
<thead>
<tr>
<th>Table 3. Multiple Logistic Model for Variables Associated With Failure to Survive to Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>Beta-blockers</td>
</tr>
<tr>
<td>Not prescribed vs. prescribed</td>
</tr>
<tr>
<td>Location of CPR event</td>
</tr>
<tr>
<td>Intensive care units vs. general ward</td>
</tr>
<tr>
<td>Intensive care units vs. emergency department</td>
</tr>
<tr>
<td>Intensive care units vs. other</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Every 10-yr increase</td>
</tr>
<tr>
<td>Initial rhythm</td>
</tr>
<tr>
<td>VT/VF*</td>
</tr>
<tr>
<td>Before vs. after program initiation</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Program initiation</td>
</tr>
<tr>
<td>Before program initiation</td>
</tr>
<tr>
<td>VT/VF vs. other</td>
</tr>
</tbody>
</table>

*VT/VF indicates pulseless VT or VF.
CPR = cardiopulmonary resuscitation; VF = ventricular fibrillation; VT = ventricular tachycardia.

JACC 2004; 44: 846-52
Use of AEDs

Recommendation

- Use of AEDs by trained lay and professional responders is recommended to increase survival rates in patients with cardiac arrest. Use of AEDs in public settings (airports, casinos, sports facilities, etc) where witnessed cardiac arrest is likely to occur can be useful if an effective response plan is in place.

- Use of AEDs is reasonable to facilitate early defibrillation in hospitals.

Circulation 2005; 112: III17-24
## Monophasic vs. Biphasic Defibrillator in Out-of-Hospital Cardiac Arrest

AHA 2003

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monophasic</th>
<th>Biphasic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>434</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMS Interval</td>
<td>7.7 min</td>
<td>7.7 min</td>
<td>0.02</td>
</tr>
<tr>
<td>1° shock success</td>
<td>30%</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>14%</td>
<td>15%</td>
<td>NS</td>
</tr>
</tbody>
</table>

AHA 2003
Triphasic Shocks are Superior to Biphasic Shocks for Transthoracic Defibrillation

- Biphasic (7.2/7.2 ms) vs. Triphasic (4.8/4.8/4.8 ms)
- Adult, Swine (18 ~ 28 kg), VF model
- Results

Shock-induced VT and asystole occurred less often after triphasic shocks.

JACC 2003; 42: 568
Quadriphasic waveforms are superior to triphasic waveforms for transthoracic defibrillation in a cardiac arrest swine model with high impedance.

Fig. 2 Shock success of triphasic (5/5/5 ms) and quadriphasic (5/5/5/5 ms) waveform shocks in high-impedance (50 Ω resistor) animals. Quadriphasic waveform shocks achieved higher success rates at delivered energies of >65 J.

Fig. 3 Shock success of triphasic (5/5/5 ms) and quadriphasic (5/5/5/5 ms) waveform shocks in low-impedance (25 Ω resistor) animals. There was no difference in shock success between quadriphasic and triphasic waveforms.
Adverse Outcomes of Interrupted Precordial Compression During Automated Defibrillation

- Animal study (swine)
- Defibrillation × 3, each proceeded 3, 10, 15, 20 seconds interruptions of chest compression

Circulation 2002; 106:368
Interruption of CPR with the Use of AED on Out-of-Hospital Cardiac Arrest

- OHCA patients, n=184
- ECG and voice recording from AED were analyzed
- In shockable rhythm (n=96)
  - CPR 36 ± 20%
  - Programmed interruption 40 ± 15%
  - No CPR perfusion 23 ± 15%
  - Palpable pulse never present immediately after DC shock

Limiting “Hands-Off” Periods During CPR

- CPR before or during attachment of electrodes
- Minimal delay between chest compression and subsequent defibrillation
- Minimal delay after interruptions due to procedures
- Manual vs. AED defibrillation
- Not to check for pulse immediately after a shock

Resuscitation 2003; 58: 275
2003; 58: 271
2003; 58: 273
Circulation Phase

Compression first vs. Shock first for VF

- A 1.5- to 3-minute period of CPR before attempting defibrillation may be considered in adults with out-of-hospital VF or pulseless VT and EMS response (call to arrival) intervals > 4 to 5 minutes.

*Circulation 2005; 112: III 17-24*
Table 1. Recent papers evaluating a ‘delayed defibrillation’ approach

<table>
<thead>
<tr>
<th>Study</th>
<th>Type, n</th>
<th>Level of evidence</th>
<th>Intervention</th>
<th>Outcome, control</th>
<th>Outcome, experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niemann, et al. [31], 2000</td>
<td>Swine, 31</td>
<td>6</td>
<td>5 min of VF-1 min of CPR prior to defibrillation</td>
<td>64% ROSC (immediate defibrillation)</td>
<td>95% ROSC</td>
</tr>
<tr>
<td>Niemann, et al. [30], 1992</td>
<td>Canine, 28</td>
<td>6</td>
<td>7.5 min of VF-epi + CPR</td>
<td>21% ROSC (immediate defibrillation)</td>
<td>65% ROSC</td>
</tr>
<tr>
<td>Cobb, et al. [6**], 1999</td>
<td>Human (observational, prospective, population based), 1117</td>
<td>3</td>
<td>90 s of CPR prior to defibrillation</td>
<td>7% survival to hospital d/c (immediate defibrillation)</td>
<td>17% survival to hospital d/c</td>
</tr>
<tr>
<td>Stotz, et al. [32], 2003</td>
<td>Retrospective chart review-before and after, 168</td>
<td>4</td>
<td>EMS defibrillation capable (emphasis shift from CPR to rapid defibrillation)</td>
<td>23.7% (average defibrillation at 15.6 min)</td>
<td>14.1% (average defibrillation at 5.7 min)</td>
</tr>
<tr>
<td>Wik, et al. [33**], 2003</td>
<td>Human (randomized controlled trial; subgroup analysis of response times &gt;5 mins), 200</td>
<td>2</td>
<td>3 min of CPR prior to defibrillation</td>
<td>2/41 (4%) survival to hospital d/c (immediate defibrillation)</td>
<td>14/41 (24%) survival to hospital d/c</td>
</tr>
</tbody>
</table>

Level of Evidence, selected: Level 2 Randomized clinical trials with smaller or less significant treatment effects Level 3 Prospective, controlled, nonrandomized, cohort studies Level 4 Historical, nonrandomized, cohort, or case-control studies Level 5 Case series: patients compiled in serial fashion, lacking a control group Level 6 Animal studies or mechanical model studies CPR, cardiopulmonary resuscitation; EMS, emergency medical system; ROSC, return of spontaneous circulation; VF, ventricular fibrillation.
Three Minutes of Basic CPR of Pre-Hospital VF Patients before Defibrillation Increases the Number of Patients who Survive to Hospital Discharge and 1 Year Survival

- Randomized trial, n=200
- Defibrillation at once (group A) vs. 3 minutes of CPR before defibrillation (group B)

<table>
<thead>
<tr>
<th></th>
<th>A (n=96)</th>
<th>B (n=104)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSC</td>
<td>46 %</td>
<td>56 %</td>
<td>0.1</td>
</tr>
</tbody>
</table>

- Response time < 5 min n=81
  - No difference between group A and B
- Response time > 5 min n=119

<table>
<thead>
<tr>
<th></th>
<th>A (n=64)</th>
<th>B (n=55)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSC</td>
<td>38 %</td>
<td>58 %</td>
<td>&lt; 0.03</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>4 %</td>
<td>22 %</td>
<td>&lt; 0.003</td>
</tr>
<tr>
<td>1-yr survival</td>
<td>4 %</td>
<td>20 %</td>
<td>&lt; 0.003</td>
</tr>
</tbody>
</table>

JAMA 2003; 289: 1389
ECG-derived Measure of Myocardial Susceptibility to Defibrillation

- **Amplitude spectral area (AMSA)**
  - The greater the AMSA, the greater probability of reversal of VF
  - AMA > 13.0 mV-Hz in human study
    Successful defibrillation sensitivity 0.91, specificity 0.94

  *Critical Care Med 2004;32:S356-8*

- **Scaling exponent (ScE)**
  - Prolonged VF, as indicated by ScE > 1.3, immediate shock was not effective

  *Circulation 2004;109:926-31*

- **Angular velocity (AV)**
  - VF: 1min AV = 58 rad/s
    4min AV = 79 rad/s
    12.5min AV = 32 rad/s

  *Resuscitation 2004;60:79-90*
ALIVE Trial

Amiodarone vs. Lidocaine for shock-resistant VF
- Randomized double blind clinical trial, n=347
- Time interval
  - dispatch to scene 7 ± 3 min
  - dispatch to drug 25 ± 8 min

<table>
<thead>
<tr>
<th></th>
<th>Amiodarone</th>
<th>Lidocaine</th>
<th>OR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival to hospital</td>
<td>22.8 %</td>
<td>11.8 %</td>
<td>2.17</td>
<td>0.009</td>
</tr>
<tr>
<td>admission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Dispatch to drug < 24 min
  - 27.7 % vs 15.3 %  p=0.05

NEJM 2002; 346: 884-90
Comparing intravenous amiodarone or lidocaine, or both, outcomes for inpatients with pulseless ventricular arrhythmias

**Design:** Multicenter retrospective medical record review.

<table>
<thead>
<tr>
<th>Table 5. Proportion of patients alive at 24-hrs post-cardiac arrest and at hospital discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lidocaine</strong></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Proportion alive at 24 hrs, n (%)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Proportion alive at hospital discharge, n (%)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Number of patients available: lidocaine, n = 68; amiodarone, n = 62; lidocaine plus amiodarone, n = 34; <sup>b</sup>number of patients available: lidocaine, n = 79; amiodarone, n = 74; lidocaine plus amiodarone, n = 41.
In Case of Multiple Recurrent VF

Consider interventional therapy

- PCI
- IABP
- ECMO
- Thrombolytic therapy?
Prolonged CPR in Cardiac Arrest Patients Rescued by Extracorporeal Membrane Oxygenation

- **Candidates** (n=57)
  - Cardiac arrest receiving CPR > 10 min without ROSC
  - ECMO set up during CPR
- **Results**
  - Mean duration of CPR $47.6 \pm 13.4$ min
  - Mean duration of ECMO $96.1 \pm 87.9$ hr
  - Rate of weaning ECMO = 66.7%
  - Survival rate = 31.6%
  - Among survivors
    - 88.9% long-term survival
    - 5.6% severe neurological deficit

*JACC 2003; 41:197*
Strategies of Advanced Cellular Life Support in Metabolic Phase

- Hypothermia
- Hibernation
- Free radical scavenger
- Anti-apoptotic agent
- Modulation of inflammatory cascade
- Resuscitation proteomics
  - Vasopressin
  - Protein kinase C (epsilon)
Mild Therapeutic Hypothermia to Improve Neurological Outcome After Cardiac Arrest

- Patients resuscitated after cardiac arrest due to VF
- Hypothermia
  - 32° ~ 34°C, 24hrs
- Favorable neurological outcome
  - Hypothermia (n=136) 55% OR=1.40, 95% CI 1.48-1.81
  - Normothermia (n=137) 39%
- Mortality at 6 months
  - Hypothermia 41% OR=0.74, 95% CI 0.58-0.95
  - Normothermia 55%

NEJM 2002;346:549-56
Therapeutic Hypothermia After Cardiac Arrest

ILCOR Recommendation

- Unconscious adult patients with ROSC after OHCA should be cooled to 32 to 34 °C for 12 to 24 hours when the initial rhythm was VF
- Such cooling may also be beneficial for other rhythm or in-hospital cardiac arrest

Circulation 2003; 108:118
**Vasopressin vs. Epinephrine for Out-of Hospital CPR**

- Randomized, controlled study n=1186
- Vasopressin 40IU or Epinephrine 1mg (max×2), follow by epinephrine if needed

<table>
<thead>
<tr>
<th>Variable</th>
<th>Vasopressin Group (N=589)</th>
<th>Epinephrine Group (N=597)</th>
<th>P Value</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>n/o, total n/o (%)</td>
<td>n/o, total n/o (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous circulation restored with study drugs</td>
<td>145/519 (24.4)</td>
<td>167/507 (28.0)</td>
<td>0.19</td>
<td>1.2 (0.9–1.5)</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>234/519 (45.3)</td>
<td>268/507 (53.2)</td>
<td>0.06</td>
<td>0.8 (0.6–1.0)</td>
</tr>
<tr>
<td>Hospital discharge</td>
<td>57/519 (9.9)</td>
<td>10/507 (2.0)</td>
<td>0.09</td>
<td>1.0 (0.7–1.5)</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>82/223 (36.8)</td>
<td>106/249 (42.6)</td>
<td>0.20</td>
<td>1.3 (0.9–1.8)</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>101/223 (45.6)</td>
<td>107/249 (43.0)</td>
<td>0.48</td>
<td>0.9 (0.6–1.3)</td>
</tr>
<tr>
<td>Hospital discharge</td>
<td>39/219 (17.8)</td>
<td>47/245 (19.2)</td>
<td>0.70</td>
<td>1.1 (0.7–1.8)</td>
</tr>
<tr>
<td>Pulseless electrical activity</td>
<td>22/104 (21.2)</td>
<td>17/82 (20.7)</td>
<td>0.93</td>
<td>1.0 (0.5–2.1)</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>35/104 (33.7)</td>
<td>23/82 (28.0)</td>
<td>0.65</td>
<td>0.8 (0.5–1.6)</td>
</tr>
<tr>
<td>Hospital discharge</td>
<td>6/102 (5.9)</td>
<td>7/81 (8.6)</td>
<td>0.47</td>
<td>1.4 (0.5–4.7)</td>
</tr>
<tr>
<td>Asystole</td>
<td>42/262 (16.0)</td>
<td>44/266 (16.5)</td>
<td>0.87</td>
<td>1.0 (0.7–1.5)</td>
</tr>
<tr>
<td>Hospital admission</td>
<td>76/262 (29.0)</td>
<td>54/266 (20.3)</td>
<td>0.02</td>
<td>0.6 (0.4–0.9)</td>
</tr>
<tr>
<td>Hospital discharge</td>
<td>12/257 (4.7)</td>
<td>4/262 (1.5)</td>
<td>0.04</td>
<td>0.3 (0.1–1.0)</td>
</tr>
</tbody>
</table>

**NEJM 2004; 350:105**
High-Volume Hemofiltration After Out-of-Hospital Cardiac Arrest

- Randomized trial (n=61)
  - Control
  - High-volume filtration (200 ml/kg/h × 8 hr)
  - High-volume filtration + hypothermia (32°C for 24 hr)

- Conclusion:
  - High-volume filtration may improve overall prognosis after suscitation from OHCA

JACC 2005; 46: 432-37
VT/VF With High Recurrent Risk

- Therapeutic strategies to prevent sudden cardiac arrest is mandatory
Anti-arrhythmic Therapy for VT/VF

- Antiarrhythmic drugs
- ICD
- Catheter ablation
- Surgery
The Role of Antiarrhythmic Drugs in Management of VT / VF

- disfavor of class I drugs
- in favor of amiodarone, sotalol, azimilide
- β-blocker as first line treatment for patients with prior MI or CHF
- ↓ role of EP-guided antiarrhythmic drug treatment
Table 2. Selected Randomized, Clinical Trials of Implantable Cardioverter–Defibrillator (ICD) Therapy.*

<table>
<thead>
<tr>
<th>Trial</th>
<th>No. of Patients</th>
<th>Mean LVEF</th>
<th>Follow-up</th>
<th>Control Therapy</th>
<th>Mortality</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>yr</td>
<td>%</td>
<td>mo</td>
<td>Control</td>
<td>ICD</td>
</tr>
<tr>
<td>Secondary-prevention trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVID$^{19}$</td>
<td>1016</td>
<td>65±10</td>
<td>35</td>
<td>18±12</td>
<td>24.0</td>
<td>13.8</td>
</tr>
<tr>
<td>CIDS$^{20}$</td>
<td>659</td>
<td>64±9</td>
<td>34</td>
<td>36</td>
<td>29.6</td>
<td>25.3</td>
</tr>
<tr>
<td>CASH$^{21}$</td>
<td>288</td>
<td>58±11</td>
<td>45</td>
<td>57±34</td>
<td>44.4</td>
<td>36.4</td>
</tr>
<tr>
<td>Primary-prevention trials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MADIT$^{22}$</td>
<td>196</td>
<td>63±9</td>
<td>26</td>
<td>27</td>
<td>38.6</td>
<td>13.7</td>
</tr>
<tr>
<td>MADIT II$^{23}$</td>
<td>1232</td>
<td>64±10</td>
<td>23</td>
<td>20</td>
<td>19.8</td>
<td>14.2</td>
</tr>
<tr>
<td>CABG Patch$^{24}$</td>
<td>900</td>
<td>64±9</td>
<td>27</td>
<td>32±16</td>
<td>21.3</td>
<td>22.2</td>
</tr>
<tr>
<td>CAT$^{25}$</td>
<td>104</td>
<td>52±11</td>
<td>24</td>
<td>66±26</td>
<td>31.4</td>
<td>26.0</td>
</tr>
</tbody>
</table>

* Plus–minus values are means ±SD. LVEF denotes left ventricular ejection fraction. AVID Antiarrhythmics versus Implantable Defibrillators, CIDS Canadian Implantable Defibrillator Study, CASH Cardiac Arrest Study Hamburg, MADIT Multicenter Automatic Defibrillator Implantation Trial (first and second), CABG Patch Coronary Artery Bypass Graft Patch, and CAT Cardiomyopathy Trial.
MADIT-II Survival Results

Probability of Survival

No. At Risk

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Defibrillator</strong></td>
<td>2002</td>
<td>742</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>502 (0.91)</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>274 (0.94)</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>110 (0.78)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td><strong>Conventional</strong></td>
<td>2002</td>
<td>490</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>329 (0.90)</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>170 (0.78)</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>65 (0.69)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

P = 0.007

NEJM. 2002;346:877-83.
SCD-HeFT

Study Design

DCM
Ischemic or Non-ischemic

Class II or III

ACE I + BB

EF \leq 35 \%

N = 2500

Placebo

Amiodarone

ICD

NEJM 2005;352:225-37
Mortality by Intention-to-Treat

Amiodarone vs. Placebo 1.06 0.86, 1.30 0.529
ICD Therapy vs. Placebo 0.77 0.62, 0.96 0.007

NEJM 2005;352:225-37
ICD Indications

- Class I
  - ICD is recommended as 2nd prevention to prolong survival in pts who have a history of cardiac arrest, VF, or hemodynamically destabilizing VT not due to a transient or reversible cause.
  - ICD therapy is recommended for primary prevention to reduce total mortality in pts with ischemic heart disease (at least 40 days post-MI), or non-ischemic cardiomyopathy who have an LVEF ≤ 30%, with NYHA functional class II or III while undergoing chronic optimal medical therapy, and have reasonable expectation of survival with a good functional status for ≥ 1 year.
ICD Indications (II)

- Class IIa
  - Placement of an ICD is reasonable in pts with LVEF of 30% to 35% of any origin with NYHA functional class II or III who are taking chronic optimal medical therapy and who have reasonable expectation of survival with good functional status of $\geq 1$ year.
Catheter Ablation for VT/VF

- Limited success
  - multiple reentrant pathway
  - substrate emerge over time
  - hemodynamic status during VT/VF
- Adjunctive therapy
Ablation of Ventricular Fibrillation

- Purkinje system and PVCs have been shown to be responsible for initiation of VF
- Ablation of there triggers may prevent recurrence of future VF
- A therapy best reserved to small proportion of patients who fail medical managenent
- Limited experience and lack of long-term follow-up

Circulation 2002;106:962-7
Circulation 2003; 108: 925-8
Circulation 2003; 108: 3011-6
JACC 2004; 43: 1715-20
Surgery

- **Direct antiarrhythmic surgical technique**
  - map-guided endocardial resection
  - encircling endocardial ventriculotomy
  - intra-operative map-guided cryoablation
  - Little applicability
    - type of arrhythmia favoring surgical approach is infrequently observed

- **Coronary revascularization**
  - definite role if ischemic myocardium was responsible for the event and suitable surgical anatomy is present
Summary (I)

- For patient with life-threatening VT/VF
  - Strengthen “chain of survival”
  - Optimize hospital care
  - Well-defined therapeutic strategies
  - Judicious use of
    - Antiarrhythmic drugs, ICD, surgery, catheter ablation
Summary (II)

- Resuscitated VF, unrelated to AMI or reversible factors
  - ICD is superior to antiarrhythmic drugs
- Sustained VT, hemodynamically compromising
  - LVEF ≤ 0.4
    - (1) ICD  (2) Amiodarone and/or β-blocker
  - LVEF > 0.4
    - ICD or Amiodarone and/or β-blocker
- Sustained VT, hemodynamically stable
  - catheter ablation or antiarrhythmic drugs
Summary (III)

Primary prevention of VF induced sudden cardiac death

- **Class I**
  - ICD therapy is recommended for primary prevention to reduce total mortality in pts with ischemic heart disease (at least 40 days post-MI), or non-ischemic cardiomyopathy who have an LVEF ≤ 30%, with NYHA functional class II or III while undergoing optimal medical therapy, and have reasonable expectation of survival with a good functional status for ≥ 1 year.

- **Class IIa**
  - Placement of an ICD is reasonable in pts with LVEF of 30% to 35% with NYHA functional class II or III who are taking optimal medical therapy and who have reasonable expectation of survival with good functional status of ≥ 1 year.
Summary (IV)

- Other evidence-based management
  - Aspirin for CAD pts
  - Statins for CAD with hypercholesterolemia
  - ACEI or ARB for LV dysfunction pts
  - β-blocker for prior MI or CHF pts
  - CABGS or PTCA for CAD pts