Multnomah County EMS Survival in Out of Hospital Cardiac Arrest whose Initial Rhythm was Pulseless Electrical Activity

Jon Jui MD, MPH
PEA Confusing terminology
Potential Misclassification

PEA BRADYCARDIA

PEA AGONAL
## Potential Misclassification

<table>
<thead>
<tr>
<th>Terminology</th>
<th>End Tidal CO2 without CPR</th>
<th>Ultrasound</th>
</tr>
</thead>
<tbody>
<tr>
<td>“False PEA”</td>
<td>Positive (usually &gt; 20 mm Hg)</td>
<td>+ cardiac wall motion</td>
</tr>
<tr>
<td>“True PEA”</td>
<td>No ETCO2</td>
<td>No cardiac wall motion</td>
</tr>
</tbody>
</table>
Questions

- What are the factors associated with good outcomes in PEA cardiac arrest?
- Why the increase in survival?
CARES: Cardiac Arrest by Presenting Arrest Rhythm 2016 vs 2017

- 2016
- 2017

PEA 53%
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asystole</td>
<td>1.8%</td>
<td>1.1%</td>
<td>2.4%</td>
<td>3%</td>
</tr>
<tr>
<td>PEA</td>
<td>16.67%</td>
<td>19.8%</td>
<td>17.4%</td>
<td>12.3%</td>
</tr>
<tr>
<td>VF</td>
<td>38.6%</td>
<td>34.6</td>
<td>41.1%</td>
<td>37.1%</td>
</tr>
<tr>
<td>Overall</td>
<td>16.1%</td>
<td>17.17%</td>
<td>20.8%</td>
<td>14.25%</td>
</tr>
</tbody>
</table>
## Survival to Discharge Alive
### MCEMS VS National CARES 2016 - 2017

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asystole</td>
<td>1.7%</td>
<td>1.7%</td>
<td>1.8%</td>
<td>3%</td>
</tr>
<tr>
<td>PEA</td>
<td>7.1%</td>
<td>7.1%</td>
<td>16.1%</td>
<td>12.3%</td>
</tr>
<tr>
<td>VF</td>
<td>24.6%</td>
<td>24.2%</td>
<td>35.7%</td>
<td>37.1%</td>
</tr>
<tr>
<td>Overall</td>
<td>8.44%</td>
<td>8.01%</td>
<td>16.9%</td>
<td>14.25%</td>
</tr>
</tbody>
</table>
What is the Neurological Functional Status of Survivors from PEA OHCA?
# MCEMS OHCA PEA Survival Neurological Outcome

<table>
<thead>
<tr>
<th>Status</th>
<th>CPC Level</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Cerebral Performance</td>
<td>1</td>
<td>30</td>
<td>52.6</td>
</tr>
<tr>
<td>Moderate Cerebral Disability</td>
<td>2</td>
<td>18</td>
<td>31.6</td>
</tr>
<tr>
<td>Severe Cerebral Disability</td>
<td>3</td>
<td>5</td>
<td>8.8</td>
</tr>
<tr>
<td>Coma, vegetative state</td>
<td>4</td>
<td>4</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57</strong></td>
<td><strong>57</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
MCEMS Case Presentation
PEA Cardiac Arrest
PEA Arrest
Clinical Case on 38 yo female with breathing difficulty

- 38 yo female
  - s/p kidney transplant, SLE (lupus) recent ICU admission for pneumonia
  - shortness of breath 1 hour ago, last 20 minutes increasing in severity.
- severe respiratory distress non verbal
- BP 179/82, pulse 60, RR 36, O2 sat 68%
PEA Arrest
Clinical Case on 38 yo female with breathing difficulty

- During lung sound assessment patient started to slump over. Patient repositioned and appeared to have a decreased level of consciousness.

- While starting to administer oxygen therapy patient became unresponsive and did not have a pulse at that time.
## Clinical Course

<table>
<thead>
<tr>
<th>Time</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>01:10:00</td>
<td>Initial assessment severe respiratory distress, “tripoding, unable to speak</td>
</tr>
<tr>
<td>01:11:00</td>
<td>Vital Signs : BP 179/82, pulse 60, RR 36, O2 sat 68%</td>
</tr>
<tr>
<td>01:13:00</td>
<td>Oxygen NRB 100%</td>
</tr>
<tr>
<td>01:14:00</td>
<td>Patient collapse, CPR initiated, PEA</td>
</tr>
<tr>
<td>01:15:00</td>
<td>Intubated (without paralytics)</td>
</tr>
<tr>
<td>01:18:00</td>
<td>EZIO</td>
</tr>
<tr>
<td>01:18:00</td>
<td>Epinephrine 1 mg 1:10,000</td>
</tr>
<tr>
<td>01:19:00</td>
<td>Rhythm Asystole</td>
</tr>
<tr>
<td>01:21:00</td>
<td>Sinus tachycardia</td>
</tr>
<tr>
<td>01:22:00</td>
<td>ETCO2 54, O2 saturation 73%</td>
</tr>
<tr>
<td>01:30:00</td>
<td>BP 221/132, HR 111, RR 8, O2 sat 81%, ETCO2 51</td>
</tr>
</tbody>
</table>
PEA Arrest

Age: 38
4/25/2017

Sex: F

Initial Rhythm

Paddles x1

20
CO2 Filter Line Off
CO2 (mmHg)

Physio-Control Inc.
Post Resuscitation

Age: 36
4/25/2017
Sex: F

Vital Signs ▼

Paddles x1.0

CO2 Autozero
CO2 (mmHg)

Physio-Control, Inc.

25mm/sec
ECG 1-30Hz  Paddles 2.5-30Hz
N = 377
- N=57 Survivors
- N=320 Non Survivors
<table>
<thead>
<tr>
<th>Category</th>
<th>Survivors #</th>
<th>Survivors %</th>
<th>NON Survivor #</th>
<th>NON Survivor %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>1</td>
<td>1.8</td>
<td>11</td>
<td>3.4</td>
</tr>
<tr>
<td>Presumed Cardiac Etiology</td>
<td>33</td>
<td>57.9</td>
<td>220</td>
<td>68.5</td>
</tr>
<tr>
<td>Respiratory/Asphyxia</td>
<td>23</td>
<td>40.4</td>
<td>66</td>
<td>20.6</td>
</tr>
<tr>
<td>Trauma</td>
<td>16</td>
<td></td>
<td></td>
<td>5.0</td>
</tr>
</tbody>
</table>
MCEMS CARES PEA Non Survivors vs Survivors Age

**SURVIVORS**

**NON SURVIVORS**
MCEMS
Differences between Survivor vs Non Survivors in PEA OCHA

- NO Differenced between Survivors
  - Witnessed Arrest
  - EMS Witnessed Arrest
  - CPR prior to Arrival
  - Advanced Airway
  - IV Access

- Differences
  - Age
  - Higher proportion of NON Cardiac underlying Etiology in Survivor Group
What does the Literature tell us about Factors in Survival from PEA OHCA?
Outcomes of Non Shockable OHCA in Australia 2003 to 2013

Resuscitation 85 (2014) 1633–1639

Clinical paper

Outcomes following out-of-hospital cardiac arrest with an initial cardiac rhythm of asystole or pulseless electrical activity in Victoria, Australia

E. Andrew a,b,*, Z. Nehme a,b, M. Lijovic a,b, S. Bernard a,b,c, K. Smith a,b,d

a Department of Research and Evaluation, Ambulance Victoria, Doncaster, Melbourne, VIC, Australia
b Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Prahran, Melbourne, VIC, Australia
c Intensive Care Unit, Alfred Hospital, Prahran, Melbourne, VIC, Australia
d Discipline of Emergency Medicine, School of Primary, Aboriginal and Rural Health Care, University of Western Australia, Crawley, Perth, WA, Australia
Study Design and Results

- Retrospective Analysis of Victoria Australia Cardiac Arrest Registry
- Dates: 1 July 2003 to 30 June 2013
- Results
- Total: 38,378 non-shockable OHCA
  - 88.0% were asystole (survival 1.1%)
  - 11.6% were PEA (survival 5.9%)
Outcomes of Non Shockable OHCA in Australia 2003 to 2013
Survival to DC Variables

<table>
<thead>
<tr>
<th></th>
<th>Survival to Discharge OR Ratio</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.97</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EMS Response Time</td>
<td>0.96</td>
<td>0.008</td>
</tr>
<tr>
<td>Public Location</td>
<td>1.85</td>
<td>0.001</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>0.78</td>
<td>0.025</td>
</tr>
<tr>
<td>Non Cardiac Etiology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td>0.25</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Respiratory</td>
<td>2.83</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Overdose</td>
<td>1.85</td>
<td>0.042</td>
</tr>
<tr>
<td>Other</td>
<td>0.54</td>
<td>0.043</td>
</tr>
<tr>
<td>Shockable Rhythm</td>
<td>0.30</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Effects of Epinephrine in OHCA with PEA

Clinical paper

Dynamic effects of adrenaline (epinephrine) in out-of-hospital cardiac arrest with initial pulseless electrical activity (PEA)∗

Trond Nordseth a,b,c,*, Theresa Mariero Olasveengen d, Jan Terje Kvaløy e, Lars Wik d, Petter Andreas Steen d,f, Eirik Skogvoll a,b,c

a Dept. of Circulation and Medical Imaging, Faculty of Medicine, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway
b The Norwegian Air Ambulance Foundation, NO-1441 Drobak, Norway
c Division of Critical Care, Oslo University Hospital, PB 4556 Nydalen, NO 0424 Oslo, Norway
d St.Olavs University Hospital, NO-7006 Trondheim, Norway
e Division of Critical Care, Oslo University Hospital, PB 4556 Nydalen, NO 0424 Oslo, Norway
f Department of Mathematics and Natural Sciences, Faculty of Science and Technology, University of Stavanger, N-4036 Stavanger, Norway

* Division of Critical Care, Faculty of Medicine, University of Oslo, NO 0424 Oslo, Norway
Dynamic Effects of Epinephrine in OHCA with PEA Study Design

- City of Oslo, Norway
- Randomized Control Trial
  - May 2003 to April 2008
  - Initial Rhythm PEA
  - Randomized to
    - NO IV access or Epinephrine
    - IV access with Epinephrine
- Monitor : LP12
Dynamic Effects of Epinephrine in OHCA with PEA

Results

- 1183 cases of OHCA
  - 233 Initial Rhythm of PEA

- Recordings from 174 cases
  - 101 Epinephrine
  - 73 No Epinephrine
Dynamic Effects of Epinephrine in OHCA with PEA

PEA : Possible Clinical States

Fig. 1. (a) Possible clinical states in advanced life support (ALS). ASY – asystole; VF/VT – ventricular fibrillation/tachycardia; PEA – pulseless electrical activity; tROSC – temporary ROSC; sROSC – sustained ROSC. (b) Example of state transitions in a patient receiving ALS. The patient starts in PEA, achieves tROSC after 3.5 min, relapses to VF/VT at 22 min, is DC-shocked (not illustrated) to PEA at 24 min, and achieves sROSC after 25 min.
Fig. 2. Time-dependent prevalence of clinical states during ALS, in patients who did not receive adrenaline. All patients start in PEA (yellow).
Fig. 3. Time-dependent prevalence of clinical states during ALS, in patients who received adrenaline. All patients start in PEA (yellow).
Time Dependent Clinical States of OHCA
NO Epinephrine vs. Epinephrine

**NO EPINEPRHINE**

**EPINEPRHINE**

![Graph showing time-dependent clinical states of OHCA with or without epinephrine](image)

Fig. 3. Time-dependent prevalence of clinical states during ALS, in patients who received adrenaline. All patients start in
Aalen-Johansen Plots of Time Dependent Probabilities of Transitioning from PEA

![Graphs showing transition probabilities](image)

**Fig. 5.** Aalen-Johansen plots of the time-dependent probabilities of transitioning from PEA, in patients who received (solid line) and did not receive adrenaline (dotted line) during ALS. Given a start in PEA, the figures show the probability of being: (a) declared dead; (b) in asystole; (c) in VF/VT; and (d) in ROSC along the time-axis.
Conclusion Epinephrine in OHCA with PEA

- For OHCA presenting with PEA
- Epinephrine
  - Markedly higher probability of gaining ROSC
  - Slightly higher probability of transitioning to VF/VT
Clinical paper

Incidence and survival outcome according to heart rhythm during resuscitation attempt in out-of-hospital cardiac arrest patients with presumed cardiac etiology

Shahzleen Rajan a,*, Fredrik Folke a,b, Steen Møller Hansen c, Carolina Malta Hansen a,d, Kristian Kragholm e, Thomas A. Gerds f, Freddy K. Lippert b, Lena Karlsson a, Sidsel Møller a, Lars Køber g, Gunnar H. Gislason h, Christian Torp-Pedersen i, Mads Wissenberg b,j
Converting to a shockable rhythm during resuscitation attempt was command and associated with a nearly 3 fold higher odds of 30 day survival compared to non-shockable rhythms.
Time to Epinephrine and Outcome of In Hospital Cardiac Arrest

**BMJ.** 2014; 348: g3028.
Published online 2014 May 20. doi: 10.1136/bmj.g3028

**Time to administration of epinephrine and outcome after in-hospital cardiac arrest with non-shockable rhythms: retrospective analysis of large in-hospital data registry**

Michael W Donnino, director, center for resuscitation science,1,2 Justin D Salciccioli, clinical research coordinator,1 Michael D Howell, associate professor of medicine,3 Michael N Cocchi, director, critical care quality,1,4 Brandon Giberson, clinical research coordinator,1 Katherine Berg, instructor of medicine,2 Shiva Gautam, associate professor of medicine,5 and Clifton Callaway, executive vice chair of emergency medicine6, for the American Heart Association’s Get With The Guidelines-Resuscitation Investigators

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Survival to Discharge vs. Time of Administration

Fig 2 Probability of survival to hospital discharge with delays in time to administration of epinephrine after cardiac arrest, with unadjusted and adjusted odds ratios and 95% confidence intervals. Table A in appendix 1 lists variables used for multivariable adjustments.
Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Time to Epinephrine and Survival After Pediatric In-Hospital Cardiac Arrest

Lars W. Andersen, MD; Katherine M. Berg, MD; Brian Z. Saindon, BS; Joseph M. Massaro, PhD; Tia T. Raymond, MD; Robert A. Berg, MD; Vinay M. Nadkarni, MD; Michael W. Donnino, MD; for the American Heart Association Get With the Guidelines-Resuscitation Investigators

Figure 3. Time to Epinephrine and Survival to Hospital Discharge After Pediatric In-Hospital Nonshockable Cardiac Arrest (N=1558)

Longer time to epinephrine administration was associated with lower risk of survival to discharge in multivariable analysis (risk ratio per minute delay, 0.95 [95% CI, 0.93-0.98]; \(P < .001\)). Error bars indicate exact binomial 95% confidence intervals.
PEA OHCA is a heterogeneous presentation
  - Within the group is a cohort of patients who may survive

Highest survival rates include young patients with witnessed arrest with CPR with NON cardiac etiology

Cornerstone for therapy is the COMBINATION of the following
  - Treatment of the underlying condition
  - Effective CPR
  - EPINEPHRINE
The END