This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike License. Your use of this material constitutes acceptance of that license and the conditions of use of materials on this site.
A Comparative Analysis of Pediatric Resident Performance during High-fidelity Simulated Cardiopulmonary Arrests

Jordan Duval-Arnould
MPH Candidate
Epidemiology / Biostatistics
Overview

• Background
• Metrics
• Delays & Errors
• Enhanced Pediatric Resuscitation Curriculum
• Study Design
• Methods
• Results
• Implications
• Questions
Background

- Emerging data showed quality of CPR was poor.

- In response (and along with new science) guidelines were updated in 2005.

- The implications of these findings and new guidelines are greater for children.

- Despite adult data and some initial pediatric data; belief that providers were/are performing adequately in the management of pediatric arrests persists.

- In order to determine the quality of arrest management and CPR, a study of pediatric resident performance using simulation was conducted (Hunt, et. al., 2005)
Metrics

- Ventilations
- Compressions
- Defibrillation
- Pre-shock pause
- No-blow fraction
- No-flow fraction
Delays & Errors

- 46/70 (66%) failed to initiate compressions ≤ 1 minute
- 23/70 (33%) never started compressions
- Median “no flow fraction” was 74% (49-100%)
Delays & Errors

Time Elapse from Onset of PVT to Successful Defibrillation

Proportion of Residents

Time in Minutes

- Never Defibrillated
- Ever Defibrillated
• Subsequently, an enhanced pediatric resuscitation curriculum (EPRC) was developed based on the findings
  – 1. Interns required to take PALS
  – 2. AHA 2005 guidelines
  – 3. Monthly 2-hour formal resuscitation team training sessions
    • Hands-on hi-fi simulation, feedback & debrief, chest compressions, rapid defibrillation
Study Design

Overview | Background | Metrics | Delays & Errors | EPRC | Design | Methods | Results | Conclusions | Questions

- Prospective pre/post observational cohort design.
- Hi-fidelity simulations for assessment.
Methods

Overview | Background | Metrics | Delays & Errors | EPRC | Design | Methods | Results | Conclusions | Questions

- Simulation review
- Software development
Methods
Methods

• Simulation review
• Software development
• Data abstraction
• Data merge
• Statistical analysis
Methods

• Statistical analysis
  – Baseline
    • PGY, resuscitation training & experience, gender
  – Performance Summary Statistics
    • ABCs & D; ventilated, no-blow fraction, compressed, no-flow fraction, shock success, pre-shock pause, failures
  – Time-to-event / Cox regression
    • Time-to-defibrillation
    • Time-to-compressions
Results

- Baseline
  - Differences:
    - PRE more than POST
      - ACLS Training
    - POST more than PRE
      - Resuscitation using a Simulator
      - PALS Training
    - PRE same as POST
      - Gender
      - PGY
      - Defibrillation experience patient or mannequin
## Results

### Performance Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>2005, n=70</th>
<th>2007, n=51</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airway &amp; Breathing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordered or used BVM</td>
<td>64 (91%)</td>
<td>50 (88%)</td>
<td>0.12</td>
</tr>
<tr>
<td>Time to ordering BVM (s) *</td>
<td>23 (13-88)</td>
<td>19 (11-30)</td>
<td>0.09</td>
</tr>
<tr>
<td>Min – Max (s) *</td>
<td>[5 – 515]</td>
<td>[2-192]</td>
<td></td>
</tr>
<tr>
<td>Total time respirations not performed (s)</td>
<td>196 (144-265)</td>
<td>148 (98-189)</td>
<td>0.004</td>
</tr>
<tr>
<td>“No-Blow” Fraction</td>
<td>39% (22% - 64%)</td>
<td>30% (22% - 41%)</td>
<td>0.013</td>
</tr>
<tr>
<td><strong>Circulation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordered or performed compressions</td>
<td>47 (67%)</td>
<td>46 (90%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Started compressions with-in 1 minute</td>
<td>24 (34%)</td>
<td>36 (71%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Time to first compression (s) *</td>
<td>51 (27-210)</td>
<td>27 (18-80)</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Min – Max (s) *</td>
<td>[6 – 736]</td>
<td>[5 – 461]</td>
<td></td>
</tr>
<tr>
<td>Total time compressions not performed (s)</td>
<td>357(242-573)</td>
<td>141(92-250)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>“No-Flow” Fraction</td>
<td>74% (5% - 100%)</td>
<td>34% (26% - 53%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Defibrillation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successfully delivered a shock</td>
<td>65 (94%)</td>
<td>46 (90%)</td>
<td>0.410</td>
</tr>
<tr>
<td>Successfully delivered shock with-in 3 minutes</td>
<td>38 (54%)</td>
<td>33 (65%)</td>
<td>0.250</td>
</tr>
<tr>
<td>Time to successfully delivering shock (s) *</td>
<td>163 (120-300)</td>
<td>128 (101-209)</td>
<td>0.03</td>
</tr>
<tr>
<td>Min – Max (s) *</td>
<td>[67 – 668]</td>
<td>[53 – 759]</td>
<td></td>
</tr>
<tr>
<td>Pre-shock pause time (s) *</td>
<td>84 (26-162)</td>
<td>6 (4-18)</td>
<td>0.001</td>
</tr>
<tr>
<td>At least one failed defibrillation attempt</td>
<td>34 (49%)</td>
<td>14 (28%)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

* of those who performed the task; n (Percent); Median (IQR); [Minimum – Maximum]

10 fold decrease!
Results

- Performance Summary

10 fold decrease!
Results

- Time-to-event / Cox regression
## Results

### Time-to-event / Cox regression

#### Table 3

Cox Multivariate Regression Analysis of Time to Compressions & Time to Defibrillation

<table>
<thead>
<tr>
<th>Compressions ≤ 1 minute</th>
<th>Unadjusted Hazard Ratio</th>
<th>95% CI</th>
<th>p-Value</th>
<th>Adjusted Hazard Ratio</th>
<th>95% CI</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Intervention</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>2.03 – 7.17</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Post Intervention</td>
<td>2.94</td>
<td>1.75 – 4.94</td>
<td>&lt; 0.001</td>
<td>3.82</td>
<td>2.03 – 7.17</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Male</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Female</td>
<td>0.69</td>
<td>0.38 – 1.36</td>
<td>0.085</td>
<td>0.31 – 0.89</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>PALS Never</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>0.34 – 2.45</td>
<td>0.002</td>
</tr>
<tr>
<td>PALS Ever</td>
<td>3.33</td>
<td>1.51 – 7.35</td>
<td>0.003</td>
<td>0.92</td>
<td>0.34 – 2.45</td>
<td>0.002</td>
</tr>
<tr>
<td>PGY 1</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>1.56 – 7.08</td>
<td>0.002</td>
</tr>
<tr>
<td>PGY 2</td>
<td>2.74</td>
<td>1.39 – 5.42</td>
<td>0.004</td>
<td>3.33</td>
<td>1.56 – 7.08</td>
<td>0.002</td>
</tr>
<tr>
<td>PGY 3</td>
<td>3.47</td>
<td>1.77 – 6.83</td>
<td>&lt; 0.001</td>
<td>4.29</td>
<td>1.91 – 9.62</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Defibrillation ≤ 3 minutes</th>
<th>Unadjusted Hazard Ratio</th>
<th>95% CI</th>
<th>p-Value</th>
<th>Adjusted Hazard Ratio</th>
<th>95% CI</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Intervention</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Post Intervention</td>
<td>1.41</td>
<td>0.88 – 2.25</td>
<td>0.145</td>
<td>1.65</td>
<td>1.03 – 2.65</td>
<td>0.039</td>
</tr>
<tr>
<td>Male</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Female</td>
<td>0.58</td>
<td>0.36 – 0.92</td>
<td>0.02</td>
<td>0.36 – 0.92</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>PGY 1</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
<td>1.0 (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PGY 2</td>
<td>1.51</td>
<td>1.04 – 3.51</td>
<td>0.037</td>
<td>2.03</td>
<td>1.11 – 3.74</td>
<td>0.022</td>
</tr>
<tr>
<td>PGY 3</td>
<td>2.76</td>
<td>1.52 – 5.00</td>
<td>0.001</td>
<td>2.80</td>
<td>1.53 – 5.11</td>
<td>0.001</td>
</tr>
</tbody>
</table>

* Adjusted for PGY, gender, and having ever taken PALS

* Adjusted for PGY and gender

- ~4x
- ~2x
Conclusions

- The EPRC was effective at improving performance
- Gender differences may exist
- Simulation is an efficient tool to conduct performance analytics
- Feasibility in implementing this training in other institutions