Compressions during defibrillator charging shortens shock pause duration and improves chest compression fraction during shockable out of hospital cardiac arrest

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DISCLOSURE

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Co-Investigators

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Resuscitation Outcomes Consortium

ROC Funding Partners

Background

- Previous research has shown significant association between shock pause duration and survival from shockable out of hospital cardiac arrest
- Peri-shock benefit driven almost exclusively by pre-shock pause interval
- Post-shock pause results inconsistent and not statistically significant
- Defibrillator mode significantly impacts pre-shock pause
**Peri-shock Pause Impact during ROC PRIMED**

<table>
<thead>
<tr>
<th>Pre-Shock (sec)</th>
<th>Median Pre- and Post-Shock Pause</th>
<th>Unadjusted OR</th>
<th>95% CI</th>
<th>Adjusted OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 20 Reference</td>
<td>Reference --</td>
<td>1.25 (0.99, 1.59)</td>
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<td></td>
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<tr>
<td>10 - 19.9</td>
<td>1.34 (1.09, 1.66)</td>
<td>1.25 (0.99, 1.65)</td>
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<td>&lt; 10</td>
<td>1.73 (1.36, 2.19)</td>
<td>1.52 (1.09, 2.15)</td>
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<td></td>
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<tr>
<td>Post-Shock (sec)</td>
<td>Reference --</td>
<td>1.09 (0.86, 1.37)</td>
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<td></td>
</tr>
<tr>
<td>&gt; 10</td>
<td>Reference --</td>
<td>1.02 (0.75, 1.38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 9.9</td>
<td>1.25 (1.05, 2.10)</td>
<td>1.04 (0.84, 1.30)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5</td>
<td>2.02 (1.38, 3.07)</td>
<td>1.34 (0.94, 1.90)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Peri-Shock (sec)</td>
<td>Reference --</td>
<td>2.01 (1.58, 2.55)</td>
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<td></td>
<td></td>
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<tr>
<td>&gt; 40</td>
<td>Reference --</td>
<td>1.34 (0.94, 1.90)</td>
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<tr>
<td>20 - 39.9</td>
<td>1.22 (0.88, 1.71)</td>
<td>1.16 (0.76, 1.76)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>1.17 (0.96, 1.42)</td>
<td>1.04 (0.84, 1.30)</td>
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</tbody>
</table>

CI = Confidence Interval. OR = Odds Ratio.

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**Plot of Peri-Shock Pause Intervals by Shock Number**

- Previous simulation studies have shown that technique of compressions during defibrillator charging (CDC) shortens shock pause duration.
- Edelson et al. (2010) was able to demonstrate significant reductions in pre-shock pause (2.6 secs vs. 13.3 secs, p < .001) and hands off time (10.3 secs vs. 14.8 sec, p < .001) using CDC.
- Despite ultra-short pre-shock pauses, no harm to providers.
Background

- Edelson study took place in 3 academic US teaching hospitals
- Providers were staff physicians or residents/fellows
- No study to date evaluating the impact and safety of CDC during prehospital care when provided by paramedics
Compressions During Defibrillator Charging

Purpose
To determine the impact of compressions during defibrillator charging on shock pause duration and CPR quality measures during shockable OHCA

Hypothesis
Compressions during charging is associated with shorter shock pause duration and higher CCF when employed by paramedics during shockable OHCA

Methods

Included:
- Retrospective review of prospectively collected data on out-of-hospital non traumatic cardiac arrest Region of Peel/Halton for one year period beginning August 1, 2011
- Presented with VF/VT
- Had CPR process measures for up to the first three shocks of the resuscitation
- Excluded EMS witnessed, age <18 and PAD defibrillation prior to EMS arrival

Training
- Importance of shortening shock pauses stressed during CME
- Technique and science around “compressions during charging” taught during CME
- Mannequin based resuscitation scenarios in which technique stressed
Data Collection and Statistical Analysis

- Pre-, post- and peri-shock pause abstracted from impedance channel measures of defibrillator files
- Each file independently reviewed by two investigators to determine whether compressions during charging had occurred
- If majority of shocks during resuscitation had compressions during charging case was considered CDC
- Confounding-limited analysis to first three shocks

Outcome Measures

- Primary Outcome: impact of compressions during charging on shock pause durations
- Secondary Outcomes: impact of compressions during charging on chest compression fraction (CCF), compression rate and compression depth
- Clinical outcomes: impact of compressions during charging on return of spontaneous circulation (ROSC) and survival to hospital discharge
- Underpowered for clinical outcomes

RESULTS
### Study Population Baseline Characteristics

#### Table 1: Study Population Baseline Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No CDC</th>
<th>CDC</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>59</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Age (years) (mean)</td>
<td>63.78</td>
<td>64.47</td>
<td>0.793</td>
</tr>
<tr>
<td>Male [%]</td>
<td>77.97</td>
<td>74.29</td>
<td>0.628</td>
</tr>
<tr>
<td>Public Location [%]</td>
<td>30.51</td>
<td>32.86</td>
<td>0.777</td>
</tr>
<tr>
<td>Bystander Witnessed [%]</td>
<td>71.19</td>
<td>70.00</td>
<td>0.889</td>
</tr>
<tr>
<td>Bystander CPR [%]</td>
<td>50.85</td>
<td>52.86</td>
<td>0.822</td>
</tr>
<tr>
<td>Response Time [s] (mean)</td>
<td>353.25</td>
<td>318.14</td>
<td>0.249</td>
</tr>
</tbody>
</table>

### Primary Outcome Measures

#### Table 2: Primary Outcome Measures

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No CDC</th>
<th>CDC</th>
<th>p value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-shock Pause [s]</td>
<td>24.31</td>
<td>8.69</td>
<td>&lt;.001</td>
<td>[12.74, 18.53]</td>
</tr>
<tr>
<td>Post-shock Pause [s]</td>
<td>6.00</td>
<td>3.85</td>
<td>0.002</td>
<td>[0.82, 3.47]</td>
</tr>
</tbody>
</table>

Diagram of Study Cohort

All Cardiac Arrests [n=747]

VF / VT [n=149]

PEA / Asystole [n=565]

Cannot Determine [n=13]

Non-CDC [n=55]

CDC [n=70]

No Data [n=20]
Table 3: Secondary Outcome Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>No CDC</th>
<th>CDC</th>
<th>p value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPR Fraction</td>
<td>0.71</td>
<td>0.77</td>
<td>0.003</td>
<td>[0.026, 0.11]</td>
</tr>
<tr>
<td>Comp. Depth [cm]</td>
<td>5.03</td>
<td>5.36</td>
<td>0.066</td>
<td>[-0.020, 0.68]</td>
</tr>
<tr>
<td>Comp. Rate [cm/min]</td>
<td>104.57</td>
<td>106.73</td>
<td>0.366</td>
<td>[-2.43, 6.75]</td>
</tr>
</tbody>
</table>

Table 4: Clinical Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No CDC</th>
<th>CDC</th>
<th>p value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSC</td>
<td>0.63</td>
<td>0.63</td>
<td>0.987</td>
<td>[-0.17, 0.17]</td>
</tr>
<tr>
<td>Survival to hospital discharge</td>
<td>0.25</td>
<td>0.27</td>
<td>0.827</td>
<td>[-0.14, 0.17]</td>
</tr>
</tbody>
</table>

Limitations

- Small sample size (rate of VF/VT), lack of inclusion of shocks from other presenting rhythms
- Incomplete penetration (54.2%) of compressions during charging technique, lack of run in period post training
- Optimized EMS systems for CPR quality
- Observational data - association vs. causal relationship
Conclusion

- Pre-, post- and peri-shock pause duration were all significantly shortened by compressions during charging when performed by paramedics.
- Chest compression fraction was significantly increased by compressions during charging.
- No significant association between ROSC and survival to hospital discharge through compressions during charging (underpowered).
- Further study in other jurisdictions with larger sample size (for clinical outcomes) required to assess impact of technique.

Clinical Implications

Training (different techniques)
- Focus on compressions during defibrillator charging phase.
- Focus on pre-charging defibrillator during last cycle of CPR.
- Focus on voice prompts in defibrillator to prompt “compressions during charging.”

Defibrillator Manufacturers
- Development of “turbo charged” defibrillators in AED mode.
- Technology to charge defibrillator in background based on current rhythm.
- What about PAD defibrillators?
Thank You!