The Effects of Failed Defibrillation Attempts on Waveform Characteristics of Ventricular Fibrillation

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Background

• 350,000 people experience out-of-hospital cardiac arrest (OHCA) with a total survival rate to hospital discharge of 12%¹

• 25% of presenting rhythms are ventricular fibrillation (VF)

• Early defibrillation with CPR is the first line treatment for VF
Quantitative Electrocardiogram (QECG)

- Waveform pattern of VF changes over the time in arrest
  - Coarse to fine
- Waveform analysis techniques were used to develop measurements that correlate with time in VF and defibrillation success²,³

Our Research Question and Hypothesis

- What is the effect of failed rescue shocks on the electrical pattern of VF?
- We predicted that failed rescue shocks would have a negative effect on QECG values and be reflected in a decrease in QECG values.

Our approach

- Retrospective study using data from the Continuous Chest Compressions (CCC) trial of the Resuscitation Outcomes Consortium (ROC).
- Measure the QECG values of before and after shock for patients in VF with failed shocks
QECG methods used\textsuperscript{4-7}

<table>
<thead>
<tr>
<th>Amplitude Spectrum Area</th>
<th>Centroid Frequency</th>
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</thead>
<tbody>
<tr>
<td>$\text{AMSA} = \sum_{n=0}^{N-1} A_n \times f_i$</td>
<td>$\text{CF} = \frac{\int_{0}^{\infty} \text{PSD}(f) \times f , df}{\int_{0}^{\infty} \text{PSD}(f) , df}$</td>
</tr>
<tr>
<td>Median Slope</td>
<td>Detrended Fluctuation Analysis</td>
</tr>
<tr>
<td>$\text{Median Slope} = \text{median}(\text{ecg}_t - \text{ecg}_t - 1)$</td>
<td>$F(n) = \left</td>
</tr>
</tbody>
</table>

Data Processing

1. Prehospital ECG data extracted from ROC CCC database
2. Patients were screened to select those with a failed shock
   • In VF before and after shock delivery
3. Quality of ECG screened to confirm QECG values could be calculated from data
   • Sufficient time
   • No chest compressions
   • Within 180 seconds of shock
   • No other issues with ECG data quality
4. Selected ECG window input into a custom MATLAB script that calculates QECG values
Results

5,195 Total Shocks
1,399 Analyzable Shocks
681 unique patients
520 first shocks

Excluded
~1000 successful shocks
~3000 excluded for quality reasons:
• No 3 sec window
• Pad disconnections
• Evidence of compressions

Distribution of shock number

Time from shock to post shock QECG measurements
QECG results

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMSA*</td>
<td>4.83</td>
<td>5.60</td>
</tr>
<tr>
<td>CF*</td>
<td>7.05</td>
<td>7.36</td>
</tr>
<tr>
<td>DFA</td>
<td>3.28</td>
<td>1.27</td>
</tr>
<tr>
<td>MS*</td>
<td>2.36</td>
<td>2.44</td>
</tr>
</tbody>
</table>

* = significant at p < 0.01

AMSA results*

CF results*
DFA results

MS results*

Relationship of change in QECG values to time
Discussion

- Results did not match our hypothesis of a negative effect
- Possible explanations:
  - Floor Effect
  - CPR improves QECG values
  - Possible that modern biphasic shocks are not as harmful as earlier monophasic shocks

Limitations

- Use of prehospital data leads to large number of patients being excluded for quality issues
- Length of time between shock delivery and post-shock measurements

Conclusions

- We did not observe a major quantitative effect of failed defibrillation attempts. If anything showed, a slight improvement.
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References