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

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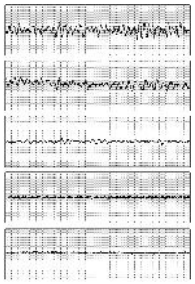
Background

- 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 success[2,3]



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[4-7]

Amplitude Spectrum Area

$AMSA = \sum_{4}^{48} A_i \, x \, f_i$

Centroid Frequency

$CF = \frac{\sum_{4}^{48} PSD(f_i) \, x \, f_i}{PSD(f_i)}$

Median Slope

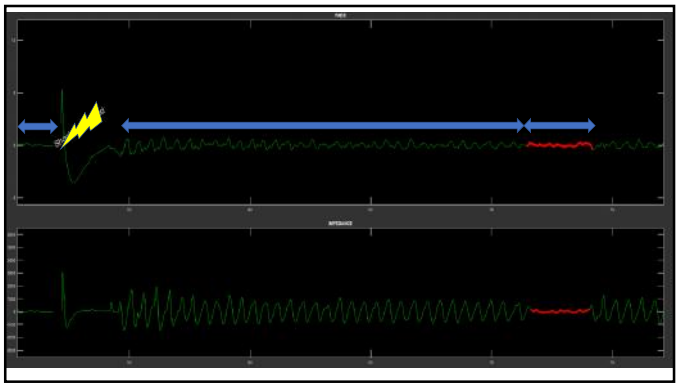
Median Slope = $median(ecg_i - ecg_{i-1})$

Detrended Fluctuation Analysis

$F(n) = \sqrt{\frac{1}{N} \sum_{k=1}^{N} (y(k) - y_n(k))^2}$

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

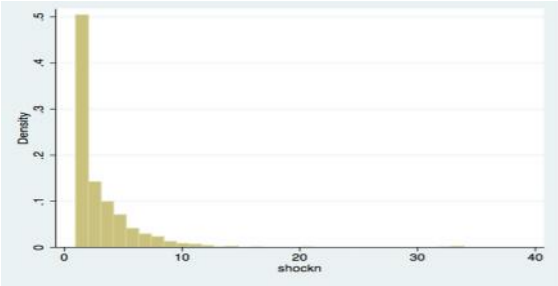
5,195 Total Shocks

1,399 Analyzable Shocks

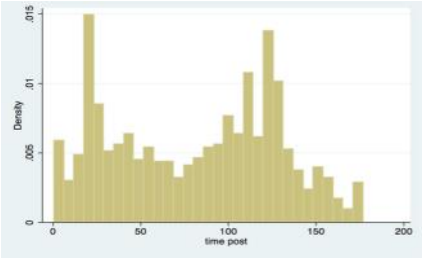
681 unique patients
520 first shocks

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

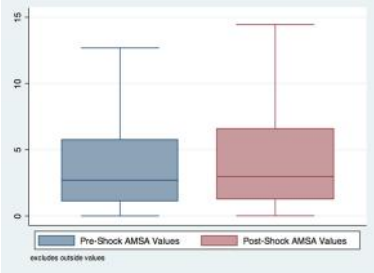


QECG results

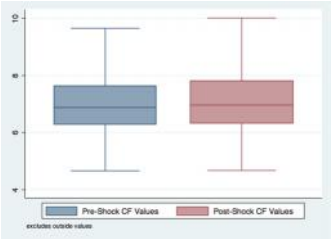
	Before	After
AMSA*	4.83	5.60
CF*	7.05	7.16
DFA	1.28	1.27
MS*	2.36	2.44

* = significant at p = 0.01

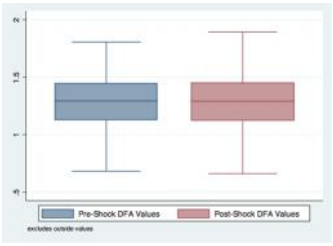
AMSA results*



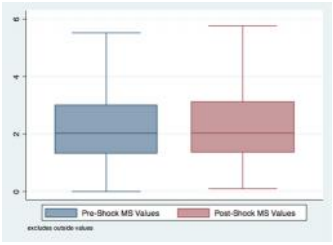
CF results*



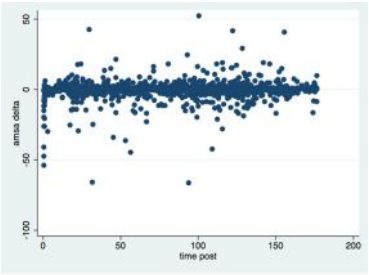
DFA results



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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