Beat-to-Beat Blood Pressure Variability for Long-term Risk Assessment

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Aims: Previous studies investigated the use of Heart Rate Variability (HRV) from Electrocardiogram (ECG) waveforms for risk stratification, as embedded temporal features may associate with post-operative complications and mortality. We aim to test whether beat-to-beat Blood Pressure (BP) Variability (BPV) can predict one-year mortality in Transcatheter Aortic Valve Replacement (TAVR) patients, and if so, which aspects can improve mortality prediction.

Methods: After IRB approval, high frequency (500 Hz) femoral artery BP waveforms from 358 patients undergoing TAVR procedures at Tufts Medical Center (Boston MA) were de-identified and recorded for analysis. On the ACC STS TVT Registry, 285 subjects had one-year outcomes recorded, of which 29 were deceased. Multiple arrhythmia and motion artifact free two-minute intervals were identified from each waveform set and beat-to-beat diastolic and systolic BP were determined using MATLAB 2020A. Within each interval, BPV metrics were determined and then combined across all intervals via the median value. We compared select linear and nonlinear beat-to-beat variability metrics with one-year mortality as the performance metric. Statistical differences in the two populations were verified using a Wilcoxon Rank Sum Test.

Results from MSE Analysis

Metric	P Value
Systolic MSE 1-5 Average	**0.004**
Systolic MSE 1-5 Slope	**0.005**
Systolic MSE 1-5 Average x Slope	**0.012**

Results: Analysis of systolic BPV showed high frequency power percent $p < 0.05$; local dynamic score, $p<0.01$; and density score, $p<0.05$. Nonlinear BPV metrics were derived from Multiscale Entropy (MSE) Scales 1-5 (see table). We found statistical significance in the metric with systolic (sys) values. Differences related to diastolic BPV were not found to be significant.

Conclusion: Beat-to-beat analysis of temporal dynamics showed that high-resolution BP waveforms predicted 1 year mortality. Our study highlights the potential of incorporating temporal dynamics of physiological waveforms to assess the risk of adverse outcomes after treatment. Validation is needed using larger datasets.