

Assessment of Heart Rate Variability derived from Blood Pressure Pulse Recordings in Intensive Care Unit Patients

Maximiliano Mollura¹, Edoardo M. Polo^{1,2}, Li-wei H. Lehman³,
Riccardo Barbieri¹

¹ Politecnico di Milano, Milano, Italy

² DIAG, Sapienza University of Rome, Italy

³ Massachusetts Institute of Technology, Cambridge, Massachusetts

Introduction - In the last decades, the role of Pulse Rate estimated from blood pressure pulse when used as a surrogate for Heart Rate Variability (HRV) studies has been addressed under different conditions in healthy subjects. However, there is a lack of validation in studies involving patients admitted in the Intensive Care Unit (ICU). The presence of arterial blood pressure (ABP) and photoplethysmogram (PPG) signals may help in tracking physiology-related features as HRV measures, whenever the ECG, is not available.

This study aims at validating pressure-derived surrogates for the tachogram and their ability in tracking autonomic changes.

Methods - The validation is performed using waveforms in MIMIC-III matched subset belonging to 79 patients, quantifying the ability of surrogates in estimating the most commonly used HRV measures. We selected 10 minute recordings of ECG, ABP and PPG vital signs and we extracted occurrences of R-peaks, from the ECG, and onset (O), systolic (S) and diastolic (D) fiducial points from both ABP and PPG.

AR modelling of tachogram and its surrogates allowed for the extraction of spectral components in addition to AVNN and SDNN indices.

Results - Bland-Altman analysis shows high agreement (>90% of patients within 95% confidence interval limits) between ECG-, ABP- and PPG-derived HRV measures.

In addition, ventilated and sedated subjects show accountable differences in estimating HF power from PPG-derived onset ($p < 0.01$) and systolic ($p < 0.05$) time interval series, which are not present with diastolic ones, indicating diastolic time intervals as less affected by such procedures.

Lastly, results from sub-populations of patients that showed increases (and decreases) in such measures show a good ability of these surrogates in tracking autonomic changes ($p < 0.01$ for all surrogates).

Conclusions - HRV measures derived from blood pressure recordings can be considered as good proxy for estimating significant autonomic changes in ICU patients.