Derived Respiration: Comparison and New Measures for Respiratory Variability

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Respiration can be measured in different ways, by using impedance sensors, pressure sensors or just by a thermistor in the nose. However, respiration can often also be extracted from the pure ECG signal having the advantage that no extra equipment is needed. This study first examines which ECG derived respiration (EDR) method is the most accurate.

Simple ECG filtering, R or RS amplitude based techniques and information in QRS areas are compared with each other. Data of simultaneously recorded ECG and respiration during a stress test were obtained for this analysis. The mean-squared error (MSE) quantified the difference between the obtained breath-to-breath intervals of the EDR signals and the actual respiratory signal. The R peak amplitude (MSE = 0.63) and the RS amplitude (MSE = 0.72) gave the best approximation and have the advantage over the filtered ECG (MSE = 1.53) and QRS areas (MSE = 2.15) that even sighs can be detected.

In a second part of the study, this R peak amplitude based respiration signal is now used to investigate respiratory variability (RV). Analogously to HRV, some new measures (rMSSD, SDSD, pNN1 and pNN2) for breath-to-breath interval analysis are proposed. These parameters were applied on data coming from a 25 minute stress test, being 5 minutes of rest alternated with 5 minutes of arithmetic tasks. These new measures showed that RV was significantly lower during rest than during arithmetic tasks. Also, significant differences were found between the first resting period and the 5 minutes following the arithmetic tasks. The standard deviation of successive differences (SDSD) also managed to differentiate between the 2 arithmetic tasks ($p < 0.01$).

To conclude, breath-to-breath intervals can be extracted accurately based on the R peak amplitude in the ECG and new efficient measures for respiratory variability are proposed.