Spectral Algorithm for Chest Compression Rate feedback during Cardiac Arrest based on Cerebral Oximetry

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Introduction: Near-infrared spectroscopy (NIRS) is used to monitor brain oxygenation during cardiopulmonary resuscitation (CRP) in out-of-hospital cardiac arrest (OHCA). Chest compressions during CPR produce changes in cerebral haemoglobin concentrations. The objective of this study was to develop an algorithm to measure chest compression rate (CC_{rate}) using cerebral oximetry signals.

Materials and methods: A cohort of 31 OHCA cases treated by the Basque Emergency Services were analysed. The cases contained concurrent recordings of high time-resolution (20Hz) cerebral oximetry (NIRO, Hammamatsu) measured in the left and right frontal lobes, and chest impedance (LifePak15, Stryker) used as ground truth. Intervals with concurrent impedance and total haemoglobin (tHb) concentration signals were extracted. CC_{rate} was computed using spectral analysis of the bandpass filtered (1.25-7Hz) tHb in overlapping (50%) 10-sec segments. A signal quality index (SQI) based on the tHb signal envelope and its spectrum was defined, and feedback was only computed for good quality segments. Bland-Altman plots and 90% levels of agreement (LOA) were used for evaluation.

Results: A total of 292 analysis intervals, median (interdecile range, IDR) duration of 85 (48-119) s, were extracted. The 5253 segments of 475 min of CPR showed a CC_{rate} of 104.9 (99.3-148.6) min^{-1}. For the right and left lobes, 97.7% and 96.2% of feedbacks were given, with a LOA of (-7.96, 3.70) min^{-1} and (-6.02, 3.83) min^{-1}, respectively. When both channels were used in combination, feedbacks were given for 99.2% of the segments with a LOA of (−3.79, 2.63) min^{-1}.

Conclusion: An accurate algorithm was demonstrated to provide the CCrate using the cerebral oximetry signals obtained with NIRS. The reliability and accuracy of the method improved when both, right and left, lobes were considered.