

Finger Photoplethysmography to Monitor Chest Compression Rate during Out-of-Hospital Cardiac Arrest

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Background: Resuscitation guidelines emphasize the quality of Cardiopulmonary Resuscitation (CPR), including the delivery of chest compressions (CC) with rates between 100-120 min^{-1} . During CPR CCs are visible in the photoplethysmogram (PPG) signal, which can be recorded by a finger pulse oximeter in out-of-hospital cardiac arrest (OHCA) settings.

Aim: To analyze the feasibility of using the finger PPG to monitor the presence and rate of CCs in OHCA.

Materials and methods: A total of 112 segments (46 patients) of at least 60 s comprising the PPG and compression depth signals were extracted from Zoll E-Series defibrillator records acquired by the DFW Center for Resuscitation Research (UTSW, Dallas) and the Emergency Medical Service (EMS) agencies affiliated with OHSU (Portland). The PPG signal was filtered (1-3.2Hz) and the power spectral density was computed using 10 s Kaiser windows with 50% overlap to detect the presence of CCs (power concentration criterion) and to compute the CC-rate (maximum slope criterion). The compression depth signal (acquired by the CPR-pad-z) was used to simultaneously compute the rate and presence of CCs and served as the gold standard.

Performance metrics for the algorithm were: sensitivity (SE) and positive predictive value (PPV) for presence of CCs, mean (standard deviation) error in CC-rate, and percentage of errors above 10% (Pe_{10}). Data were randomly split patient-wise into training/test sets (60/40%), to optimize the criteria and validate the method, respectively. This procedure was repeated 50 times to obtain statistically meaningful results.

Results: 2907 windows were analyzed with mean CC-rate 118(12) min^{-1} . The algorithm showed mean SE/PPV of 87.8/98.1%, CC-rate error of 2.4 (5.4) min^{-1} , and Pe_{10} of 2.4% for the training set, and 85.2/98.1%, 2.8 (6.8) min^{-1} , and 3.4% for the test set.

Conclusions: The finger PPG shows potential to compute CC-rate in OHCA and could be useful to guide EMS personnel to improve CC-rates.