

Classification of Cardiac Rhythms during Load-Distributing Band Cardiopulmonary Resuscitation

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Introduction: Chest compressions (CCs) during out-of-hospital cardiac arrest (OHCA) induce artefacts in the electrocardiogram, hindering the automatic heart rhythm analysis. Pausing the CCs is required to analyze the cardiac rhythm, reducing the probability of survival. Reliable rhythm analysis during CCs would reduce the CC pauses and increase survival rates. The aim of this study was to develop an automatic multiclass algorithm to discriminate asystole (AS), organized (OR) and shockable rhythms (SH) as ventricular fibrillation or tachycardia, during cardiopulmonary resuscitation (CPR) provided by a load distributing band (LDB) device.

Materials: The study dataset comprised 5813 ECG segments obtained from 880 OHCA patients treated with the LDB device from the Circulation Improving Resuscitation Care trial. They correspond to 1616 AS, 3043 OR and 1154 SH. Each segment comprised 16 s long ECG signals which included 6 s without CCs used for annotating the cardiac rhythm.

Methods: LDB artefacts were first removed from the ECG using a Recursive Least Squares filter based on the multiharmonic modelling of the artefact. The Wavelet decomposition of the ECG provided different sub-band components and the denoised ECG. A total of 83 features were computed and fed into a Random Forest (RF) classifier that made the multiclass decision. Ten-fold cross-validation was used to train and evaluate the RF algorithm. Sensitivities (Se) and F_1 scores were calculated per class, and also the specificity (Sp) for the SH class.

Results: Using $N = 50$ harmonics and a forgetting factor of 0.9902, The Se/ F_1 per class were 82.6%/76.9%, 80.2%/83.7%, and 90.8%/90.1% for AS, OR and SH, respectively, resulting in an unweighted mean of sensitivity of 84.5% and a mean F_1 of 83.6%. The Sp for SH class was 97.3%.

Conclusions: An algorithm to discriminate three different OHCA rhythms during the use of a LDB device was proposed. The algorithm meets the performance recommendations given by the American Heart Association for SH class (Se > 90%, Sp > 95%).