An Accurate Shock/No-shock Decision Algorithm for use during Piston-Driven Chest Compressions

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Introduction: Mechanical chest compression (CC) devices are increasingly used for cardiopulmonary resuscitation in out-of-hospital cardiac arrest (OHCA). However, CC-artifacts impede a reliable shock/no-shock decision based on the ECG. The aim of this study was to develop a method for a reliable shock-advice during piston-driven mechanical CCs.

Materials and methods: The dataset contains 1045 15-s segments, 201 shockable and 844 non-shockable, obtained from 230 OHCA patients treated with LUCAS-2 mechanical CC-device by the emergency services in Oslo (Norway). First, CC-artifacts were removed using a recursive least-squares filter. Then, 59 ECG features were computed, and samples were classified using a support vector machine with radial basis function kernel. Patient-wise 10-fold cross-validation was used for model optimization (feature selection and SVM hyperparameter tunnig) and assessment of the method. A supervised filter approach based on 50 Nearest Neighbors was used for feature selection. The procedure was repeated 50 times to estimate the distributions of the performance metrics. The balanced accuracy (BAC) was used as objective function, that is the average of the sensitivity (Se) and the specificity (Sp). The results were compared to those obtained when using a proprietary shock advice algorithm from a commercial defibrillator to diagnose the filtered ECG (baseline performance).

Results: The best performance was obtained for a 25 feature classifier. Mean (95% confidence interval) values for BAC, Se and Sp were 95.9% (95.4-96.4), 94.8% (93.5-96.0) and 97.1% (95.2-97.7). The baseline BAC, Se and Sp obtained for a commercial algorithm were 92.6%, 98.1% and 87.0%, respectively. The minimum performance goals of the American Heart Association of 90% Se and 95% Sp were met when more than 5 features were used.

Conclusion: Machine-learning decision algorithms for the filtered ECG allow an accurate shock/no-shock diagnosis during piston-driven mechanical CCs.