Automated algorithm for QRS detection during pulseless electrical activity in cardiac arrest patients

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Introduction: QRS detection is a fundamental step in many ECG processing applications. However, most common detection algorithms were designed for stable regular cardiac rhythms, and they have not been evaluated in cardiac arrest patients. Pulseless electrical activity (PEA) is an organized cardiac arrest rhythm, and can be analysed when chest compressions are paused. In addition, its QRS morphology is often distorted and difficult to evaluate, and the available ECG segments free of artefacts are short. The aim of this study was to develop an automatic algorithm to detect QRS complexes during PEA.

Materials and methods: From 262 arrest patients we extracted 5128 noise free PEA segments, lasting 3-6 s and containing 19085 QRS complexes. Instants of QRS complexes were manually annotated by expert clinicians.

Each ECG segment was decomposed using a 8-level stationary wavelet transform. A peak detector was applied in the third detail coefficients, in order to identify potential QRS complexes, and they were confirmed in the fourth and fifth detail coefficients. QRS complexes were deemed as correctly identified when they fell within 100 ms from clinical annotation. The performance was assessed in terms Sensitivity (Se), positive predictive value (PPV) and F1-score (F1).

Results: The proposed algorithm showed a mean (SD) Se of 92.4 (15.2), PPV of 88.5(15.4) and F1 of 88.8(15.6). Compared with state of the art algorithms, it outperforms all of them for more than 5 points of F1.

Conclusion: A reliable algorithm to detect QRS complexes was proposed for short duration PEA rhythm. The algorithm could be used to process ECG segments during cardiac arrest.