Detection of shockable rhythms using convolutional neural networks during chest compressions provided by a load distributing band

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Introduction: Piston-driven and Load Distributing Band (LDB) mechanical chest compression devices are used to treat out-of-hospital cardiac arrest (OHCA) patients. ECG compression artefacts impede a reliable shock/no-shock diagnosis, resulting in compression interruptions to analyze the ECG. The aim of this study was to design an algorithm based on convolutional neural networks (CNN) to accurately detect shockable rhythms while compressions are provided by an LDB-device.

Materials and methods: A cohort of 424 OHCA patients treated by one of the Circulation Improving Resuscitation Care emergency service sites was analyzed. A total of 3424 16-second ECG segments during LDB use were obtained, 2644 corresponded to non-shockable and 780 to shockable rhythms. LDB compression artefacts were removed using a Recursive Least Squares (RLS) filter, and the filtered ECG was fed to a CNN classifier with three convolutional blocks and two fully connected layers for classification. Data were randomly partitioned patient-wise into training (80%) and test (20%). The process was repeated 100 times to statistically characterize the performance metrics for the two class problem, shockable (positive) and non-shockable (negative) rhythms. The following metrics were evaluated: sensitivity (Se), specificity (Sp), total accuracy (Acc) and positive predictive value (PPV).

Results: The median (90% confidence interval) values for Se, Sp, Acc and PPV were 92.1% (85.7-95.3), 96.1% (92.9-98.2), 95.0% (92.8-97.2) and 87.4% (77.7-93.4), respectively. The median values for Se and Sp met the minimum Se (90%) and Sp (95%) target values recommended by American Heart Association for the detection of shockable rhythms using artefact-free ECGs.

Conclusion: A method based on the combination of an RLS filter and a CNN classifier resulted in the accurate detection of shockable rhythms during compressions provided by an LDB-device, allowing the concurrent provision of mechanical CPR and rhythm analysis.

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