A Method to Suppress Chest Compression Artifact Enhancing Capnography-Based Ventilation Guidance During Cardiopulmonary Resuscitation

Mikel Leturiondo, J.J. Gutiérrez, Sofía Ruiz de Gauna, Jesus Ruiz, Luis A Leturiondo, James K Russell, Mohamud Daya

University of the Basque Country UPV/EHU
Bilbao, Spain

Introduction: Guidance on ventilation rate is valuable during cardiopulmonary resuscitation (CPR). Capnography is widely used by the advanced life support for this purpose but there is a high incidence of capnograms distorted by chest compression (CC) artifact. This artifact decreases the reliability of automated ventilation detection based on the analysis of the capnography waveform.

Aim: To design and test a CC artifact suppression technique to improve real-time ventilation detection while preserving CO_2 concentration values exclusively produced by ventilations.

Materials and methods: Thirty episodes from an out-of-hospital cardiac arrest registry were included in the study. All episodes contained the capnogram and the transthoracic impedance signal. Three biomedical engineers independently annotated each ventilation and classified them as distorted or non-distorted by CC artifact.

The real-time algorithm detects the presence of distorted ventilations in the capnography waveform. It calculates the envelope of the capnogram during the alveolar plateau (extracting local maxima) and removes the artifact during capnogram baseline (extracting the local minima), thus obtaining a non-distorted waveform. The goodness of the method was assessed by comparing the performance of a capnogram-based ventilation detection algorithm before and after applying the suppression method.

Results: From a total of 6387 annotated ventilations, 34% of them were classified as distorted. Global sensitivity and positive predictive value (Se/PPV, %) improved from 77.9/74.0 to 97.0/95.8. Median value of the unsigned error (%) of the estimated ventilation rate decreased from 19.6 to 4.5 and the accuracy for detection of hyperventilation increased with cleaned capnograms.

Conclusions: Capnogram-based ventilation guidance during CPR was enhanced after CC artifact suppression. Our method preserved the tracing of CO_2 concentration caused by ventilations, allowing other clinical uses of capnography during resuscitation.