Performance of VF Detection Parameters in an Algorithm Design Scenario and in a Real Resuscitation Scenario

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Early detection of ventricular fibrillation (VF) is essential to increase the probability of survival from cardiac arrest. VF detection algorithms are tested within the framework established by the American Heart Association (AHA). Spectral parameters have been shown to be more robust than time-domain or complexity parameters, particularly when adult and paediatric rhythms are considered. The aim of this study is to compare the performance of four well-known VF detection parameters for rhythms mentioned in the AHA framework and real out-of-hospital cardiac arrest (OHCA) rhythms.

We created a database of testing rhythms from public databases, including the CU-DB, AHA database and various MIT-BIH databases. The database contains 135 VF, 400 normal sinus rhythms, and 521 other non-shockable rhythms: bradycardia, blocks, supraventricular tachycardia, premature ventricular contractions and atrial fibrillation. The OHCA rhythms used in this study comprise 83 VF and 204 non-shockable rhythms, including pulseless electrical activity and pulse-giving rhythms.

We analysed four well-know VF detection parameters using 8 seconds per rhythm. Two are related to the spectral concentration of the rhythm, A2 and the VF leakage (VFleak), another is a measure of the complexity of the signal (CM), and finally the threshold crossing interval (TCI), a time-domain estimate of the heart rate. The discrimination power of the parameters was evaluated using the area under curve (AUC) obtained from the standard ROC curve analysis.

For the database of testing rhythms, the AUC values for A2, VFleak, CM and TCI were 0.97, 0.90, 0.78, 0.74 respectively. When evaluated on the OHCA database, the AUC values decreased to 0.81 for A2 and VFleak, but increased to 0.91 for CM and 0.89 for TCI. Although the spectral parameters are very robust when tested within the AHA framework, their performance degrades substantially in a real application scenario.