Predicting Transthoracic Defibrillation Shock Outcome in the Cardioversion of Atrial Fibrillation Employing Support Vector Machines

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Transthoracic DC cardioversion is a commonly performed procedure for the restoration of normal sinus rhythm in patients with atrial fibrillation (AF) with a reported efficacy of 88-95%. There is a variation in the number of shocks required for successful cardioversion and in some cases failure to cardiovert. Although there are several clinical predictors for success such as duration of AF, left atrial diameter and the presence of structural heart disease, there are no electrical predictors available at the time of the procedure. We studied the use of support vector machines (SVM) to predict if transthoracic defibrillation is likely to be successful or not in the cardioversion of persistent AF in patients. The ECG signals of 47 patients undergoing DC cardioversion were collected at the Royal Victoria Hospital in Belfast. An incremental defibrillation energy protocol was delivered until successful cardioversion or up to a maximum level of 200J or up to four shocks. Signal processing was performed on ECG segments (between 55 and 60 seconds) prior to each shock. Residual atrial activity signal (RAAS) was derived by using bandpass filtering and ventricular activity cancellation. Three electrocardiographic indexes were extracted and used as input: the dominant atrial fibrillatory frequency, estimated from the RAAS power spectrum as the dominant frequency within the 3-12 [Hz] band, the mean and the standard deviation of the R-R interval time series of the ECG segments. A total of 41/47 patients were successfully cardioverted with a total of 107 shocks. SVM could predict the outcome of 89% of low-energy shocks (100J), with a sensitivity of 87.50%, specificity of 98.8% and positive predictive value of 80.77%. The outcome of higher energy shocks (150J) could be predicted with 100% accuracy. In conclusion, non-invasive electrocardiographic parameters can be useful in predicting AF transthoracic cardioversion outcome by means of SVM.