Automatic classification normal ECGs based on normal PathECG and WaveECG features

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Introduction: Classification of an ECG to normal or abnormal is important to the non-experienced ECG-reader. In this study we used a subset of the normal classified ECGs from the PTB-XL database to create a normal distribution of the waveform (WaveECG) and its PathECG positions. The aim of this study was to use these distributions to classify an ECG as either normal or abnormal.

Methods: In this study, 15617 human validated 12-lead ECG from the Physionet PTB-XL database ECGs were used, with normal (7247) and abnormal (8370) classification (8353 females, age[62±19], and 7264 males, age[60±17]). Six Path/WaveECG features were computed, comparing the QRS, ST and remaining STT segment to the distribution of a subset of the normal ECGs (3681 females, 2834 males). From these normal distributions, female (FD) and male (MD), outlier amplitudes and positions (0.5%) were removed. Univariate and multivariate logistic regression was used to evaluate discrimination between normal and abnormal ECG signals for each model, with ROC analysis used to define the cut-off point (CP) for the selected features.

Results: The combined features showed a slightly higher AUC for the female data of distribution MD over FD. DeLong's test showed a significantly different (p<0.05) AUC for distribution MD (AUC 0.879; CI:0.871-0.887; CP:Se/Sp,0.140:0.749/0.892) compared to FD (AUC 0.855; CI:0.846-0.863; CP:Se/Sp:0.126:0.719/0.881). For the male ECGs using MD the AUC showed significant better results, p< 0.05, (AUC 0.862; CI:0.854-0.871; CP:Se/Sp -0.152:0.725/0.879) compared to FD (AUC 0.824; CI:0.815-0.834; CP:Se/Sp -0.293:0.665/0.844).

Discussion: Our results show that the Wave/PathECG distributions can distinguish between normal and abnormal amplitudes in different ECG segments and detect abnormalities that may not be easily identifiable by the non-ECG expert. The results suggest that the outlier (0.5%) removal was not beneficial to the female distribution. More databases and further studies are needed to evaluate this promising and simple method.
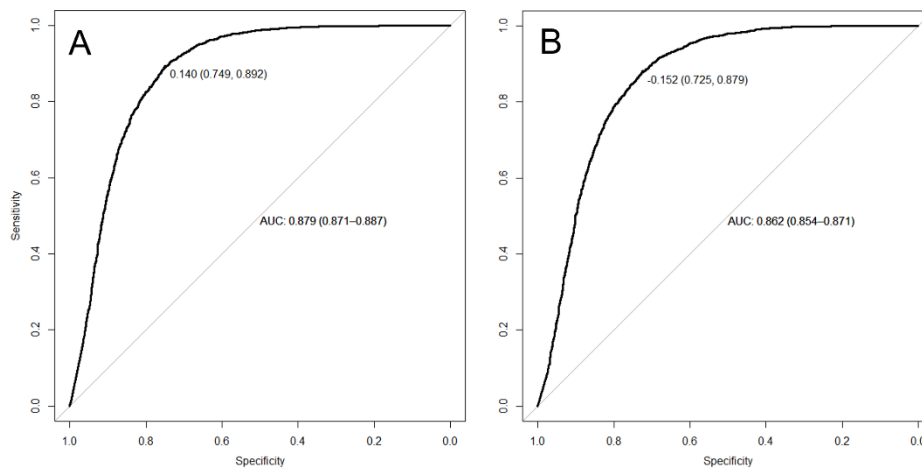
Figure 1. Examples of ROC curves for combined features A: female data of MD; B: male data of MD