Machine Learning Improves the Detection of Misplaced V1 and V2 Electrodes During 12-Lead Electrocardiogram Acquisition

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Introduction:
Electrode misplacement during 12-lead Electrocardiogram (ECG) acquisition can adversely cause false ECG interpretation, diagnosis and subsequent incorrect clinical treatment or lack thereof. The most common misplacement error are V1 and V2 electrodes. The analysis of ECG signals that were recorded from ECGs with vertically misplaced leads V1 and V2 can yield a false diagnosis of Brugada syndrome, myocardial infarction (MI) or left ventricular hypertrophy (LVH). The aim of the current research was to detect lead V1 and V2 misplacement using feature engineered machine learning algorithms to enhance ECG data quality to improve clinical decision making in cardiac care. In this particular study, we reasonably assume that V1 and V2 are concurrently superiorly misplaced together.

Methods:
ECGs for 450 patients, (normal n=150, LVH n=150, MI n=150) were extracted from body surface potential maps. ECG signals were extracted using correct and incorrectly placed electrodes, i.e. leads from the fourth intercostal space (ICS) including: first ICS, second ICS, third ICS and fourth ICS. The prevalence for correct and incorrect leads were 50%. Sixteen features were extracted including: morphological, statistical and time-frequency features. Two feature selection approaches (filter method and wrapper method) were applied to find an optimal set of features that provide a high accuracy when used with a machine learning model. To ensure accuracy, six classifiers were applied including: fine tree, coarse tree, bagged tree, Linear Support Vector Machine (LSVM), Quadratic Support Vector Machine (QSVM) and logistic regression.

Results:
The accuracy of V1 and V2 misplacement detection was 94.3% in the first ICS, 92.7% in the second ICS and 70% in third ICS respectively. Based on accuracy results, bagged tree was the best classifier in the first, second and third ICS to detect V1 and V2 misplacement.