Automatic Diagnosis of Cardiovascular Disease: 12-Lead Electrocardiogram and Elucidating Sex Differences via Deep Learning

Pahlavan, Natalia (School: Jericho High School)

Electrocardiograms (ECGs) are the fundamental tool to diagnose the leading cause of death globally–cardiovascular disease. Cardiac signals inputted into computerized algorithms can exploit ECG automation for accurate and rapid diagnosis while discerning sex differences in arrhythmias. This study aimed to develop a deep neural network (DNN) suitable for classifying unidimensional signals, evaluate the effectiveness of the DNN on complex cardiac abnormalities for a 12-lead ECG protocol compared to a 3-lead, and elucidate sex differences in arrhythmia diagnosis. A DNN incorporating four residual blocks was designed using PhysioNet's PTB-XL database containing 21,837 records from 18,885 patients to classify three cardiac rhythms (normal, myocardial infarction, and hypertrophy). Arrhythmia comparison analysis of 3-lead and 12-lead ECGs produced a micro-average precision-recall curve area of 84% and 91%, respectively. The 12-lead DNN obtained an area under the receiver operating characteristic curve of 94%, 92%, and 89% for normal, myocardial infarction, and hypertrophy, respectively. A sex-based analysis of male and female subjects produced a micro-average F1-score of 90% and 88%, respectively, as underlying physiological differences may result in less aggressive diagnosis in women. The proposed model indicated ECG analysis based on DNNs, previously studied in a single-lead setup, generalizes well to 12-lead exams and outperforms previous state-of-the-art studies. Future investigations include the development of a graphic user interface as an alert system to notify at-risk patients undergoing cardiac arrest prior to sudden cardiac death.

Awards Won:

Third Award of $1,000

American Statistical Association: In-Kind membership to ASA for all winners, including honorable mentions

American Statistical Association: Honorable Mention