A Deep Learning-Based Hybrid Neural Network for Enhanced Risk Stratification of Sudden Cardiac Arrest Through Electrocardiographic Signal Analysis

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Sudden cardiac arrest (SCA) remains a significant health concern, accounting for over 436,000 deaths annually in the United States. An electrocardiogram (EKG) signal can help to identify risk factors of SCA. This research tested the hypothesis that deep learning techniques could improve risk stratification of SCA from EKG data. A dataset containing over 16,000 EKGs of patients with and without SCA was obtained, as well as external clinical data. Preprocessing techniques, including dataset merging, EKG time-step standardization, and one-hot encoding, were used to prepare the dataset for model training. A hybrid model architecture was created by developing a convolutional neural network (CNN) to extract and analyze EKG features from raw waveforms while using a dense neural network for patient metadata (age and sex). Both architectures were merged before the output layer. Training and validation sets were used. The model was evaluated based on precision, recall, F1-score, area under the receiver operating characteristic (AUROC) curve, and area under the precision-recall curve (AUC PR). To evaluate clinical applicability, the model's accuracy was tested using external clinical EKG data. Between the two model iterations, AUROC improved from 0.7745 to 0.8151. AUC-PR increased from 0.1871 to 0.8335. External validation achieved an AUROC of 0.7712 and an AUC-PR of 0.7928. These results suggest that the model could distinguish between positive SCA cases and controls, indicating potential utility in early detection and prevention.

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