Empirical Survey on Occult Atrial Fibrillation Prediction During Sinus Rhythm Through Heart Rate Variability Analysis and Premature Atrial Contractions

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Background and Aim: Atrial fibrillation (AF) has escalated in prevalence over the past five decades, emerging as the predominant sustained heart arrhythmia worldwide. This condition significantly elevates the risk of severe cardiovascular diseases (CVD), particularly with silent paroxysmal atrial fibrillation (PAF). Predicting PAF occurrence in individuals without known history and, hence, maintaining sinus rhythm for long time episodes, is vital for early intervention and averting adverse outcomes. While previous studies predominantly relied on electrocardiogram (ECG) monitoring, heart rate variability (HRV), and premature atrial contractions (PAC) to forecast PAF, the extensive and scattered research calls for a reevaluation on the same dataset and under the same settings. Thus, this study aims to replicate and scrutinize the most pertinent approaches described in the current literature, utilizing a meticulously curated dataset to assess the genuine performance of the generated models.

Materials and Method: The study utilized a controlled subset of the Icentia-11k Dataset from PhysioNet's official repository. This subset comprised 30-minute long, 200 normal sinus rhythm (NSR) ECG recordings from 200 distinct patients, with 100 presenting occult AF and 100 showing no cardiac issues. After filtering the ECG recordings to eliminate baseline wander and high-frequency noise, various common features were extracted from the HRV series across three domains: time, frequency, and complexity. Subsequently, different machine learning classifiers were evaluated on the extracted features, incorporating information on PACs, using an 80:20 training-to-testing ratio. Performance metrics such as accuracy (Ac), sensitivity (Se), and specificity (Sp) were computed.

Results: Average Ac, Se, and Sp were respectively 67.50%, 71.76%, 60.91% for time-domain features, 61.79%, 68.82%, 50.91% for frequency-domain features, 60.36%, 74.12%, 39.09% for complexity-domain features, 68.87%, 39.13%, 82.61% using solely information about PACs, and 68.93%, 68.24%, 70.00% using all available features.

Conclusions: While still open to potential refinements, the study reveals diverse performance across feature domains. Also, while PAC-centric models excel in specificity, they compromise sensitivity.