Interpretable Multimodal Stratification of Chagas Disease Patients Using RR-Interval Features from Low- and High-Frequency Bands

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Background

Cardiac autonomic dysfunction is central to Chagas disease, and heart rate variability (HRV) offers a low-cost, noninvasive way to quantify this impairment. Prior work has shown that disease progression is reflected in altered short-term HRV, abnormal power-law behavior, and nonlinear RR-interval dynamics, suggesting that combining complementary HRV descriptors is more useful than relying on a single marker.

Objective

To stratify Chagas disease patients into Control, CH1, and CH2 groups using interpretable features from 24-hour RR-interval recordings, preserving low computational cost and clinical interpretability.

Methods

24-hour RR-interval series from 83 controls, 102 CH1, and 107 CH2 patients were processed through a Pan–Tompkins pipeline, segmented into 5-minute windows, and transformed into the frequency domain to derive LF, HF, and LF/HF series. Statistical and geometric descriptors were computed at the patient level, and a decision-tree classifier was trained on 80% of the cohort and evaluated on the remaining 20%.

Results and Expected Improvements

The baseline model achieved accuracy above 70%, supporting the feasibility of HRV-based screening in Chagas disease. To strengthen these results, future work should incorporate nonlinear descriptors — DFA α1, sample entropy, and Poincaré-plot indices — replace the single train/test split with repeated stratified cross-validation, and apply SHAP-based feature importance to identify the most stable biomarkers. Time-frequency features from wavelet analysis could further capture the nonstationary behavior of 24-hour HRV.

Conclusion

A simple decision-tree model built from LF/HF-based features achieves meaningful group stratification. The most promising next step is to enrich the model with nonlinear HRV markers and stronger validation, improving discrimination between early and advanced cardiac involvement while preserving interpretability.