Integrating Clinical Chart and Laboratory Data for Predicting Heart Failure Recurrence

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Introduction: Heart failure (HF) has the highest 30-day rehospitalization rate among all medical and surgical conditions. In this study, we propose a method for HF recurrence prediction using longitudinal chart data along with laboratory measurements of patients hospitalized with HF in the critical care unit (CCU).
Data: We analyzed data from the MIMIC-III database from 7,697 HF patients. We extracted a time series of 5 physiological measurements from electronic charts. From each time series, we further derived 12 statistical features. Additionally, we collected 2 demographic features and 10 laboratory measurements from the day of admission to the ICU, giving us 72 features in total. We split the data into training, validation, and test sets patient-wise.
Method: We predict HF recurrence for 4 different time intervals (week, month, half a year, and a year) using the Random Forest (RF) classifier. Further, we performed a survival analysis based on the probability of HF recurrence from the trained RF model.
Results: For the test set, we received a mean F1 score of 0.59±0.06, Sensitivity of 0.73±0.03, and Specificity of 0.80±0.07 across 4 different time periods for HF recurrence. A combination of 4 features (standard deviation and minimum of SaO2, minimum of systolic blood pressure, and blood urea nitrogen) occurs in the top 5 most important features in each of the 4 time period models according to the Gini importance. The log-rank test shows a significant difference ($p<0.0001$) and a hazard ratio of 2.12 (1.82-2.61). between low and high-risk groups for HF recurrence predicted by the RF model.
Conclusion: The results indicate that HF prediction using a machine learning algorithm applied to chart data from longitudinal monitoring of patients in the CCU together with lab measurements could assist in decisions on whether to release a patient from hospitalization. Furthermore, it could potentially reduce future HF recurrence.