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Routine Laboratory Testing x Bigdata Machine Learning: Building Intelligent Clinical Diagnostic Decision

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With advancements in medical laboratory testing, a vast amount of high-dimensional diagnostic data is generated, encompassing blood, biochemical, and immunological analyses. These data not only record patients' health status but also contain valuable clinical information that can aid in diagnostic and therapeutic decision-making. However, traditional laboratory testing primarily presents single-point data, making real-time integration and analysis challenging, thereby limiting the discovery of predictive potential related to diseases or treatments. In the post-pandemic era, the integration of information science and artificial intelligence (AI) presents a significant opportunity to harness laboratory data for advancing smart healthcare. Recognizing this potential, we utilized routine biochemical and hematological tests to address limitations in emergency medicine, where reliance solely on cardiac troponin T (cTnT) testing for AMI diagnosis often leads to ineffective decision-making regarding hospital admission or discharge, contributing to unnecessary medical resource consumption and patient anxiety. To overcome these challenges, we retrospectively analyzed datasets from two cohorts: 44,000 patients from the NTUH and 12,165 patients from NTUH Hsinchu Branch.

These datasets were used for machine learning training, testing, and validation. Our findings revealed that the XGBoost model achieved the best predictive performance. Compared to using cTnT alone, the model significantly improved diagnostic accuracy. Furthermore, considering practical applications, we established a decision-making framework based on the model. Under this framework, the sensitivity, specificity, PPV, and NPV for AMI diagnosis were substantially enhanced. Notably, the number of safely discharged patients increased by 294%, demonstrating the model's effectiveness in optimizing emergency care decisions. This study highlights the potential of routine laboratory test bigdata in advancing smart healthcare. Unlike emerging omics biomarkers, laboratory data possess high analytical validity, clinical validity, clinical utility, etiological relevance, and feasibility for monitoring. These characteristics make laboratory data particularly suitable for predictive model development, reinforcing their value in AI-driven precision medicine.