A machine learning model for personalised heparin dosing optimisation in hospitalised patients

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Introduction: Unfractionated heparin (UFH) therapy entails cautious dose administration due to narrow therapeutic window, where under-dosing risks thrombotic events and over-dosing causes bleeding complications. Current weight-based nomograms do not account for inter-patient variability in anticoagulation response.

Aims: To develop and validate a machine learning model that predicts activated partial thromboplastin time (APTT) response to heparin dosing and recommends personalised dose adjustments to achieve therapeutic targets.

Methods: We developed a LightGBM ensemble model using 3,779 APTT measurements from MSH patients (2017-2024 data). The model incorporated 33 features including heparin dosing history, patient demographics, vital signs, and pathology results. Temporal validation was performed on 185 APTT measurements from January-June 2025. For dose optimisation, we generated 140 bolus-maintenance combinations per patient and selected doses predicted to achieve APTT close to the target of 85 seconds.

Results: The model achieved mean absolute error (MAE) of 24.4 seconds on temporal validation data, with best performance (MAE of 14.3 seconds) achieved in the therapeutic range. Dose recommendation validation demonstrated clinically appropriate behaviour, where for sub-therapeutic patients 60% of bolus recommendations were higher than clinically-administered doses, while 74% were lower for supra-therapeutic patients.

Conclusions and Relevance: Temporal validation demonstrates stable model performance for future data. The model exhibits appropriate clinical reasoning in dose recommendations across APTT ranges. Limitations include a small validation cohort and lack of external validation. Next steps include external validation on Gold Coast Hospital data and prospective silent trial to assess performance and clinical utility in a live environment.