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Development and Validation of an Artificial Intelligence Model for the Prediction of Acute Kidney Injury, Acute Kidney Disease, and Chronic Kidney Disease After General Anesthesia Surgery

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Objectives : To develop a machine learning-based prediction model for postoperative acute kidney injury (AKI), acute kidney disease (AKD), and chronic kidney disease (CKD).

Methods : We included 239,267 noncardiac surgeries performed between 2009 and 2019 at 7 university hospitals for model development. External validation was performed for 18,523 surgeries at another university hospital in the same period. Postoperative AKI was defined as an increase of serum creatinine at least 1.5 times the baseline value or initiation of renal replacement therapy occurring over 7 days or less after surgery; AKD was defined as persistent AKI over 7 and 90 days; CKD was defined as persistent AKD beyond 90 days. Data imbalance was adjusted using the SMOTE algorithm, and four machine learning prediction models were tested: deep neural networks, decision tree, random forest, and light gradient boosting machine (GBM). Thirty-two variables including demographic, laboratory, and medical characteristics were included in the model. Model performance was compared using the area under the curve (AUC) of the receiver-operating characteristic, accuracy, and F1 score.

Results : Among 239,267 surgeries, 2,716 postoperative AKI (1.14%), 97 AKD (0.04%), and 1,203 CKD (0.5%) events occurred. While the model run on random forest exhibited a higher AUC (0.80) than light GBM (0.77), accuracy (0.95), weighted F1 score (0.94), micro-average F1 score (0.95), and macro-average F1 score (0.31) were highest in the model run on light GBM. In external validation, the AUC was higher in random forest (0.58) than light GBM (0.53), but accuracy (0.93), weighted F1 score (0.95), micro-average F1 score (0.93), and macro-average F1 score (0.27) were highest in light GBM.

Conclusions : In our comprehensive comparison of machine learning approaches, light GBM demonstrated the best performance to predict postoperative AKI, AKD, and CKD. The current model



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may be implemented in clinical practice to predict short- and long-term kidney outcomes after surgery.