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Development of Available Prediction Model for in-hospital Acute Kidney Injury

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Objectives: Several prediction models for acute kidney injury (AKI) have been developed. However, they have not yet been implemented in clinical practice. For clinical decision support, we developed an available machine learning-based model for real-time prediction of in-hospital acute kidney injury.

Methods: Patients admitted to the Soonchunhyang University Cheonan Hospital between March 2016 and December 2020 were enrolled. Patients hospitalized for more than three days and at least 19 years old were included in the study population. Electronic health record data during the hospitalization were collected. The principal outcome was the incidence of AKI within 72 hours. We applied our model using missing indicator methods if there were missing values. For the development of the models, eXtreme Gradient Boost (XGB) with RandomUnderSampler was utilized. Regarding the explainability of our models, partial dependence plot (PDP) and Shapley additive explanations (SHAP) values were utilized.

Results: 51,407 patients representing 90,018 admissions were included. Approximately 6.2% of all hospitalized patients experienced AKI at least once. On the first day of hospitalization, the model could be applied to 67% of all patients using a missing indicator. In contrast, when the strategy was not implemented, the model could only be applied at 1% and a separate imputation was necessary for further application. The model's area under the receiver operating characteristic curve (AUC) for AKI was 0.79. And our model's accuracy, precision, recall, and F1 were 0.98, 0.20, 0.35, and 0.26, respectively. When referring to the SHAP, the most important features in the model were creatinine, albumin, and the number of vital signs measured.

Conclusions: Our machine learning-based prediction model has the potential to assist clinicians quickly and accurately detecting AKI. Additionally, the feature importance results can be utilized to make decisions regarding the prevention of AKI.

Figure 1. Receiver operating characteristics of predicting AKI

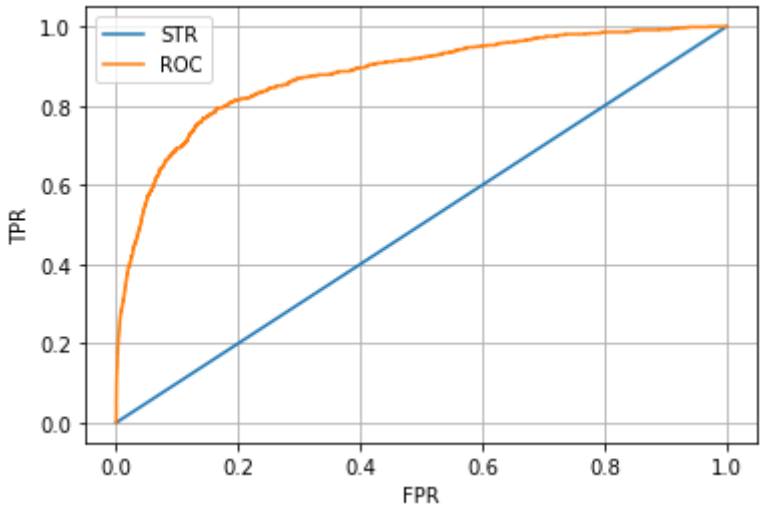
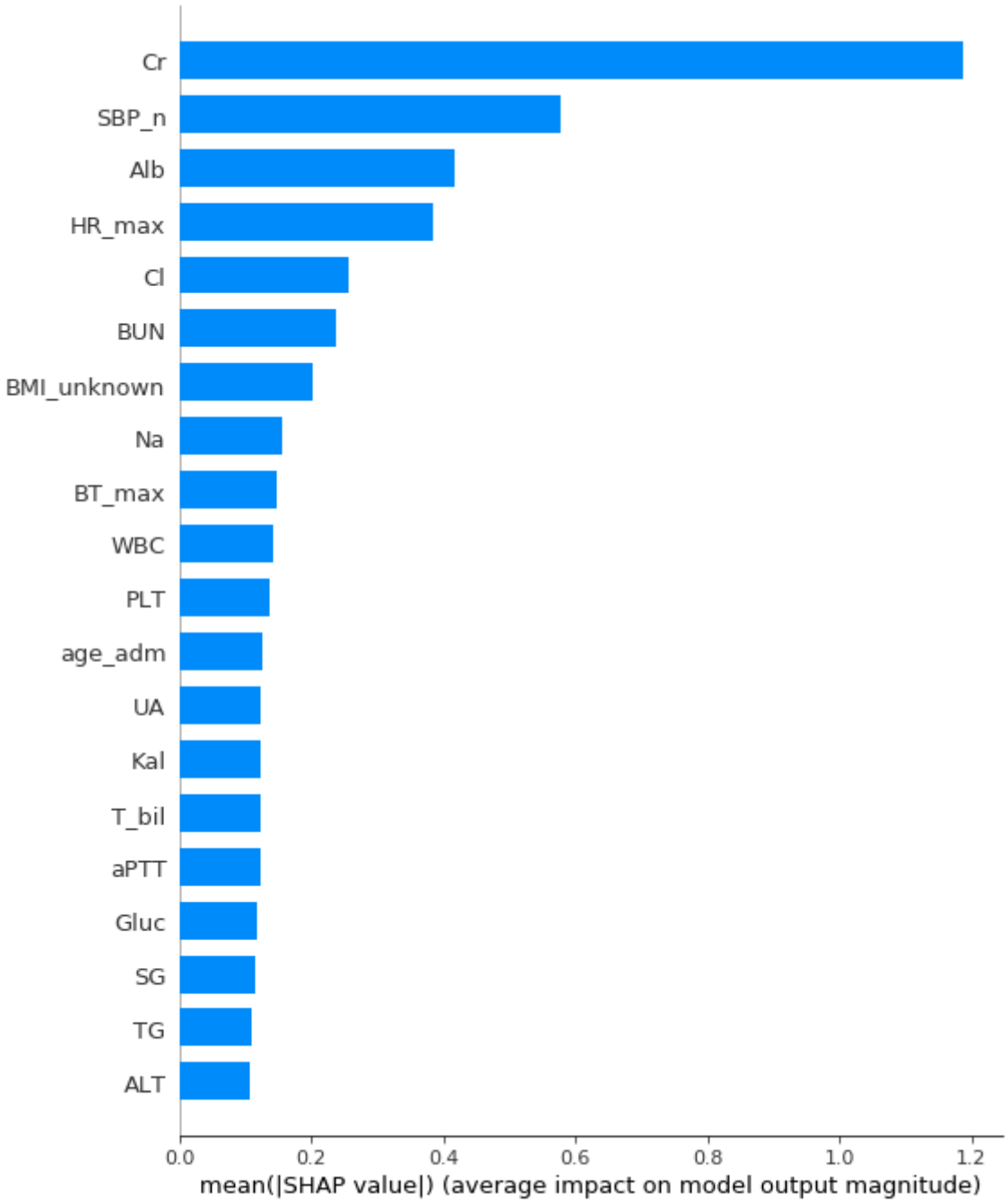


Figure 2. Feature importance, mean(|SHAP value)


Cr
SBP_n
Alb
HR_max
Cl
BUN
BMI_unknown
Na
BT_max
WBC
PLT
age_adm
UA
Kal
T_bil
aPTT
Gluc
SG
TG
ALT
0.0
0.2
0.4
0.6
0.8
1.0
1.2
mean(|SHAP value|) (average impact on model output magnitude)