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Forecasting Acute kidney injury using Machine learning Algorithms

Sejoong Kim
Seoul National University Bundang Hospital, Korea, Republic of

Background and Aims:
Rapidly Increasing electronic health record (EHR) data and recent development of machine learning methods offer the possibility of improvement in quality of care in clinical practice. Machine learning can incorporate a huge amount of features into the model, and enable non-linear algorithms with great performance. Previously published AKI prediction models were simple design without real-time assessment. Major risk factors in in-hospital AKI include the use of various nephrotoxins, repeatedly measured laboratory findings, and vital signs, which are dynamic variables rather than static. Given that the recurrent neural network (RNN) is a powerful tool to handle the sequential data, using the RNN method in the prediction model is a promising approach. Therefore, in the present study, we proposed an RNN-based prediction model with external validation for in-hospital AKI and aimed to provide a framework to link the developed model with clinical decision supports.

Method:
Study populations were all patients aged ≥ 18 years and hospitalized for more than a week at Seoul National University Bundang Hospital (SNUBH) from 2013 to 2017 (training cohort) and at Seoul National University Hospital (SNUH) in 2017 (validation cohort). All demographics, laboratory values, vital signs, and clinical conditions were obtained from the EHR of each hospital. A total of 102 variables included in the model. Each variable falls into two categories: static and dynamic variables; the static variable was time-invariant values during hospitalization, and dynamic variables were daily-updated values. Baseline creatinine was determined by searching the minimum serum Cr level within 2 weeks before admission. We developed two different models (model 1 and model 2) using RNN algorithms. The outcome variable for Model 1 was the occurrence of AKI within 7 days from the present. In Model 2, we constructed a prediction model of the trajectory of Cr values after 24 hours, 48 hours, and 72 hours, using available Cr values from 7 days ago to the present. Internal validation was performed by 5-fold cross-validation using the training set (SNUBH), and then external validation was done using a test set (SNUH).

Results:
A total of 40,552 patients in the training cohort and 4,000 patients in the external validation cohort (test cohort) were included in the study. The mean age of participants was 62.2 years in the training cohort and 58.7 years in the test cohort. Baseline eGFR was 93.8 ± 40.4 ml/min/1.73m2 in training cohort and 88.4 ± 23.2 ml/min/1.73m2 in test cohort. In model 1 for the prediction of AKI occurrence within 7 days, the area under the curve was 0.93 (sensitivity 0.90, specificity 0.96) in internal validation and 0.83 (sensitivity 0.83, specificity 0.82) in external validation. The model 2 predicted the creatinine trajectory within 3 days accurately; root means the square error was 0.1 in the training cohort and 0.3 in the test cohort. To support the clinical decision for AKI manages, we estimated the predicted trajectories of future creatinine levels after renal insult removal, such as nephrotoxic drugs, based on the established model 2.

Conclusion:
We developed and validated a real-time AKI prediction model using RNN algorithms. This model showed high performance and can accurately visualize future creatinine trajectories. In addition, the model can provide information about modifiable factors in patients with a high risk of AKI.