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Machine-Learning Enhancement of Urine Dipstick Tests for Chronic Kidney Disease Detection

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Objectives: Screening for chronic kidney disease (CKD) requires an estimated glomerular filtration rate (eGFR, mL/min/1.73 m^2) from a blood sample and a proteinuria level from a urinalysis. We developed machine learning models to detect CKD without blood collection, predicting eGFR less than 60 or 45 from a urine dipstick test.

Methods: The electronic health record data (n=220,018) obtained from university hospitals were used for XGBoost-derived model construction. The model variables were age, sex, and ten measurements from the urine dipstick test. The models were validated using health checkup center data (n=74,380) and nationwide public data (KNHANES data, n=62,945) for the general population in Korea.

Results: The models comprised seven features including 5 measurements of urine dipstick (urine protein, blood, glucose, pH, specific gravity) and age, sex. The internal and external areas under the curve (AUCs) of the eGFR60 model were 0.90 or higher, and a higher AUC for the eGFR45 model was obtained. For the eGFR60 model on KNHANES data, the sensitivity for proteinuric CKD was 0.93 and the specificity was 0.88 in ages less than 65. Non-proteinuric CKD could be detected in non-diabetic patients under the age of 65 with a sensitivity of 0.88 and specificity of 0.71.

Conclusions: Machine learning-enhanced urine-dipstick test might become a point of care testing to promote public health through screening CKD and ranking its risk of progression.