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A Machine Learning Model to Predict estimated Glomerular filtration Rate in chronic Kidney Disease Using Kidney Doppler

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Objectives : Identifying patients at risk for chronic kidney disease (CKD) progression is crucial for optimizing CKD management. While the kidney failure risk equations (KFRE) are used to estimate the risk of end-stage kidney disease (ESKD), it has limitations in capturing the trajectory of kidney function decline. Despite its diagnostic values, kidney ultrasound (US) remains underutilized in predictive models. This study aims to develop a machine learning (ML) model integrating US features to improve eGFR decline prediction in CKD patients.
Methods : Two independent cohorts from Boramae Medical Center (2011–2024) were used to develop a ML model predicting eGFR decline over five years. CKD patients with available kidney US data were enrolled (n=1,784 for development, n=3,528 for validation). Six ML models, including XGBoost and random forest, were trained using clinical and US-derived features. Model performance was evaluated using root mean square error (RMSE) and R^2 and compared to the KFRE predictions.
Results : XGBoost showed the best performance among ML models in predicting eGFR, achieving the highest R^2 (0.80) and the lowest RMSE (13.94). Incorporating US parameters enhanced predictive accuracy, with parenchymal echogenicity and resistive index as the most influential variables. Compared to the KFRE (AUC: 0.78 for 2-year, 0.69 for 5-year), the XGBoost model demonstrated superior performance (AUC: 0.82 and 0.79, respectively) in predicting ESKD outcomes.
Conclusions : Integrating US parameters into ML-based risk prediction models enhances eGFR prediction accuracy, offering a more precise tool for CKD progression assessment beyond traditional equations

Figure1.png

Figure. Evaluation of Risk Equation Performance in Comparison to KFRE