Kidney Failure Risk Equation Prediction in a Real-World Population with Chronic Kidney Disease

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Background and Study Aim

Risk prediction helps to identify patients with chronic kidney disease (CKD) who may benefit from awareness, detection, and intervention to preserve kidney function.

The purpose of this study was to externally validate the Kidney Failure Risk Equation (KFRE) using the 4-variable (4-KFRE) and 6-variable (6-KFRE) equations to predict end stage renal disease (ESKD; eGFR <15 mL/min/1.73 m^2) over 2- and 5-year periods in a real-world population with moderate-to-severe CKD.

Methods

CURE-CKD Registry
- >3.2 million adults with CKD stages 3 and 4 (2009-2021)[1,2]
- Laboratory, vitals, and administrative diagnostic data

Study Duration
- Entry: identification of diabetes, hypertension, and CKD in 2009
- Baseline: entry through next 2-5 years

Inclusion Criteria
- 4-KFRE: and 6-KFRE (Tangri et al.):
  - Adults, ≥18 years
  - Log-normalized uACR values
  - eGFR between 15 – 60 mL/min/1.73 m^2
  - Race and Ethnicity, Sex, Age
  - Diabetes and Hypertension were included for the 6-KFRE, but omitted for 4-KFRE

Exclusion Criteria
- CKD Stages <3
- eGFR values below 15 mL/min/1.73 m^2 or above 60 mL/min/1.73 m^2
- Missing data on race and ethnicity, sex, or age
- For the 4-KFRE specifically: presence of diabetes and hypertension

Outcome
- Patients who were flagged with an eGFR of <15 and were between 2 and 5 years at risk

Primary Analysis
- Multivariable, 4-KFRE, 6-KFRE to predict probabilities of end-stage renal disease within a 2-and 5-year period, respectively.

Results

Table 1. Characteristics of Patient Demographics (N=20,947)

Demographics at entry		Characteristics at baseline	
Sex, n (%)		**Hypertension, n (%)**	8,796 (42.0)
Men	10,085 (48.1)	**eGFR, mL/min/1.73 m^2**	
Women	10,862 (51.9)	mean, SD	45.4, 10.9
Race and ethnicity, n (%)		**SBP, mm Hg**	
American Indian or Alaska Native	109 (0.5)	mean, SD	133.9, 13.7
Asian	1,534 (7.3)	**HbA1c, %**	
Black	1,221 (5.8)	mean, SD	7.1, 1.3
White, Hispanic or Latino(a)	616 (2.9)	**UACR, mg/g**	
White, Non-Hispanic or Latino(a)	12,848 (61.3)	mean, SD	269.2, 795.7
Native Hawaiian or Pacific Islander	198 (0.9)	**UPCR, g/g**	
Unknown	2,474 (11.8)	mean, SD	1.4, 0.5
Other[a]	1,947 (9.3)	**ESKD Prevalence**	
Age, mean, SD	70, 12	2-year outcome	
Site, n (%)		n (%)	1,393 (6.7)
UCLA Health	3,599 (17.2)	5-year outcome	
Providence Health	17,348 (82.8)	n (%)	2,228 (10.6)

[a]includes patients that did not identify with main census categories

Figure 1. AUC ROC (2-Year and 5-Year Outcomes)

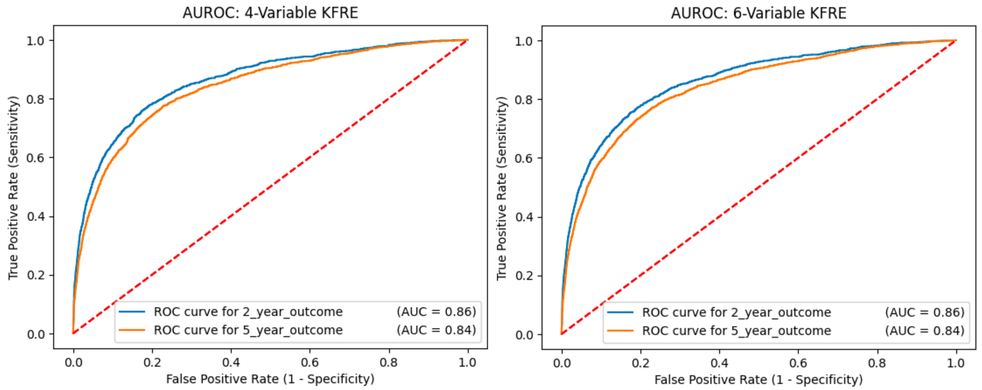


Table 2. Predictive Performance of 4-KFRE (UCLA Health + Providence Health)

Metric	2-Year Risk of ESKD	5-Year Risk of ESKD
Precision/PPV	0.770	0.696
PR AUC	0.447	0.486
Average Precision	0.447	0.486
Sensitivity	0.070	0.200
Specificity	0.999	0.990
AUC ROC	0.864	0.842
Brier Score	0.052	0.076

Table 3. 4-KFRE 2-Year Performance Stratified by CKD Stage

CKD Stages	Stages 3 & 4	Stage 3a	Stage 3b	Stage 4
ESKD Prevalence (%)	7%	4%	11%	43%
PR-AUC	0.447	0.070	0.190	0.620
AUC ROC	0.864	0.740	0.750	0.740

Figure 2. Kaplan-Meier Curves (2-Year and 5-Year Outcomes)

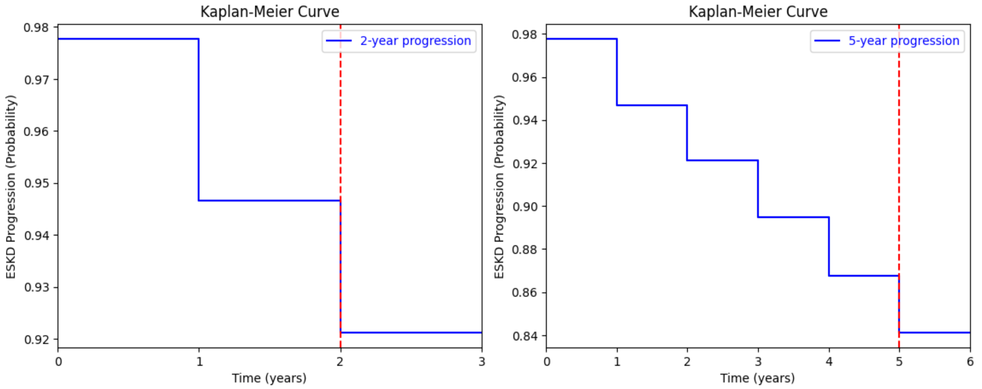
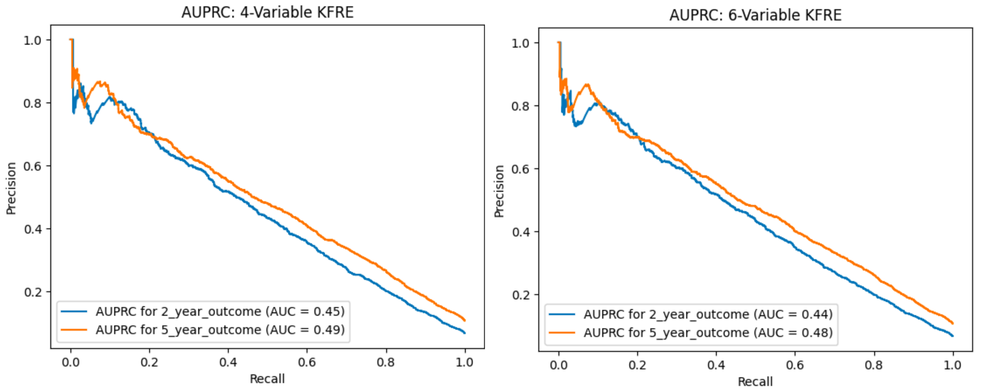


Figure 3. Precision-Recall (2-Year and 5-Year Outcomes)



Conclusions

The KFRE equations depicted high performance when applied to a real-world population with moderate-to-severe CKD. While highly specific for ESKD, it lacked sensitivity, but improved for more advanced CKD stages.

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Reference
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