

Development and Validation of an Algorithm to Predict Risk of 90-Day Hospitalization for Patients With Chronic Kidney Disease

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Introduction

- Patients with chronic kidney disease (CKD) are at higher risk of being admitted to the hospital than the general population. ^{1,2}
 Hospitalizations in CKD patients are often associated with higher medical costs, increased morbidity, and increased risk of transition to end-stage kidney disease (ESKD). ³
- Nationally, there seems to be an increasing focus on the management of CKD upstream of ESKD.⁴
- Identification of CKD patients at greatest risk of hospitalization may hold promise to improve clinical outcomes.

Objective

 To create a risk stratification algorithm for near-term hospitalization among CKD patients using only historical medical claims data elements

Methods

- This model was developed using Medicare Part A and Part B claims from calendar years 2017-2018.
- Data from 50,000 unique patients diagnosed with CKD stages 3-5, no evidence of ESKD, or claims for dialysis were split into derivation (n = 40,000) and validation (n = 10,000) sets.

Figure 1. Modeling Approach



- Potential predictor variables were derived up to 12 months prior to scoring.
- The predicted outcome was all-cause hospital admissions 90 days after scoring.
- Overall performance of candidate models was assessed using area under the curve (AUC) of the receiver operating curve in addition to positive predictive value (PPV) and sensitivity across a variety of thresholds.

Results

Patient Sample

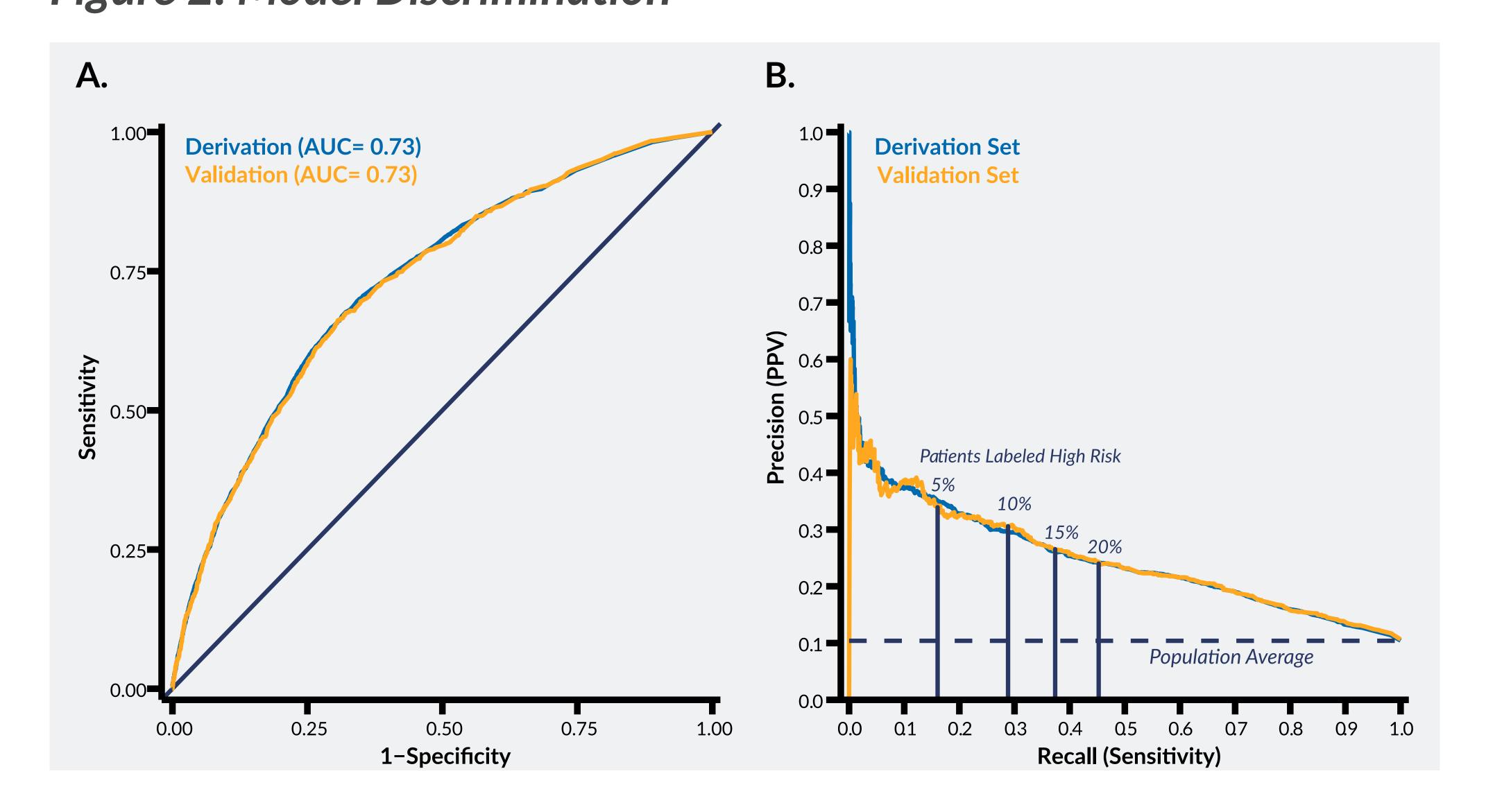
- Characteristics of patients in the derivation and validation sets were balanced (Table 1).
- Mean age was 76 years
- 48.5% of patients were female
- 82% of patients were diagnosed with CKD Stage 3
- 10.4%-10.6% of patients were hospitalized within 90 days

Table 1. Patient Characteristics by Data Set

	Derivation Set	Validation Set
	N = 40,000	N = 10,000
Age, years, mean ± SD	76.2 ± 10.5	76.3 ± 10.7
Female sex, %	48.5	48.5
CKD Stage, %		
3	82.3	82.2
4	16.0	15.9
5	1.6	1.9
Hospitalization within 90 days, %	10.4	10.6

Abbreviations: CKD, Chronic Kidney Disease; SD, standard deviation

Figure 2. Model Discrimination



Model Details and Performance

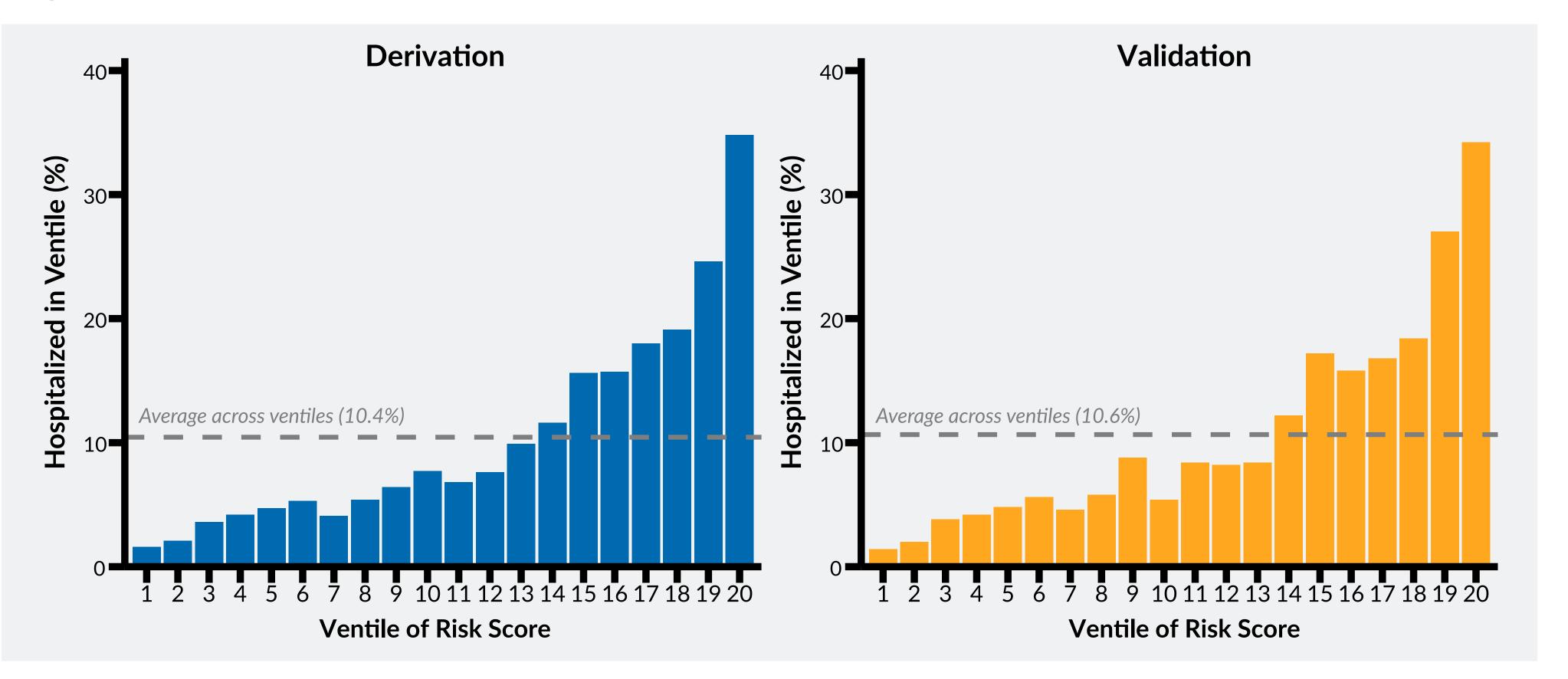
- We tested >100 candidate models and selected that with the best and the most consistent performance.
- The best model included:
- 399 input terms
- 147 unique clinical constructs based on diagnostic claims
- ROC curves for the derivation and validation data sets are displayed in Figure 2A.
- The model demonstrated good ability to discriminate (AUC = 0.73), which was stable when tested in a validation set (AUC = 0.73)
- Precision-recall curves are displayed in Figure 2B and Table 2 displays PPV and sensitivity at various thresholds.
- The PPV in the validation set was 30.6%, 24.0%, and 21.6% at the 10%, 20%, and 30% thresholds, respectively.
- The sensitivity in the validation set was 28.8%, 45.3%, and 60.9% at the 10%, 20%, and 30% thresholds, respectively.
- Observed hospitalization ranged from 35% in the top predicted risk ventile to 1% in the lowest predicted risk ventile: 35-fold risk gradient (Figure 3).

Table 2. Model Performance at Various Thresholds

	Derivation Set	Validation Set
Top 10% threshold		
PPV	29.6%	30.6%
Sensitivity	28.5%	28.8%
Top 20% threshold		
PPV	24.0%	24.0%
Sensitivity	46.6%	45.3%
Top 30% threshold		
PPV	21.2%	21.6%
Sensitivity	61.3%	60.9%

Abbreviations: PPV, positive predictive value

Figure 3. Model Risk Stratification



Conclusions

- We developed an algorithm that uses only information derived from historical medical claims to identify CKD 3-5 patients at highest risk of being hospitalized in the near-term.
- This algorithm could be used as a decision support tool for clinical programs focusing on the management of CKD patient populations.

References

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