Development and Validation of a Computable Phenotype to Identify and Characterize Kidney Health in Adult Hospitalized Patients

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Purpose

The kidney health of any patient can be characterized by the presence of chronic kidney disease (CKD), any acute kidney injury (AKI) and any recovery from that injury, with these conditions staged using consensus clinical criteria. We developed and validated an electronic phenotype to identify and stage CKD, AKI and AKI recovery in adult hospitalized patients using an integrated clinical database.

Methods

We used the University of Florida Integrated Data Repository to develop, validate and test the phenotype. This database includes demographic information, clinical data and diagnosis and procedure codes. We developed a five-part algorithm to identify CKD, AKI and AKI recovery based on Kidney Disease: Improving Global Outcomes (KDIGO) and Acute Disease Quality Initiative (ADQI) criteria. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the CKD and AKI diagnoses produced by the algorithm were compared to clinical adjudication of CKD and AKI performed by clinician experts on 300 selected cases.
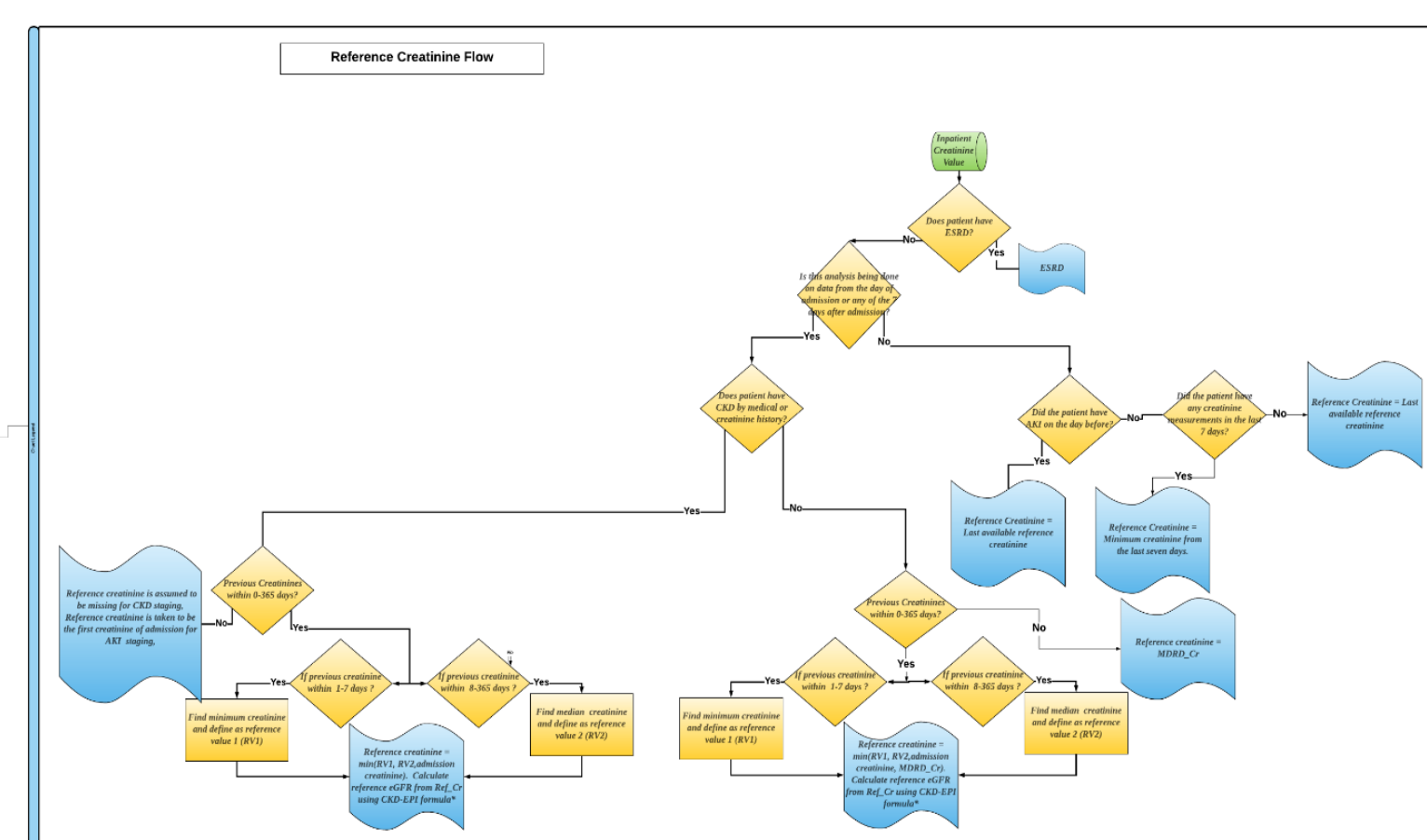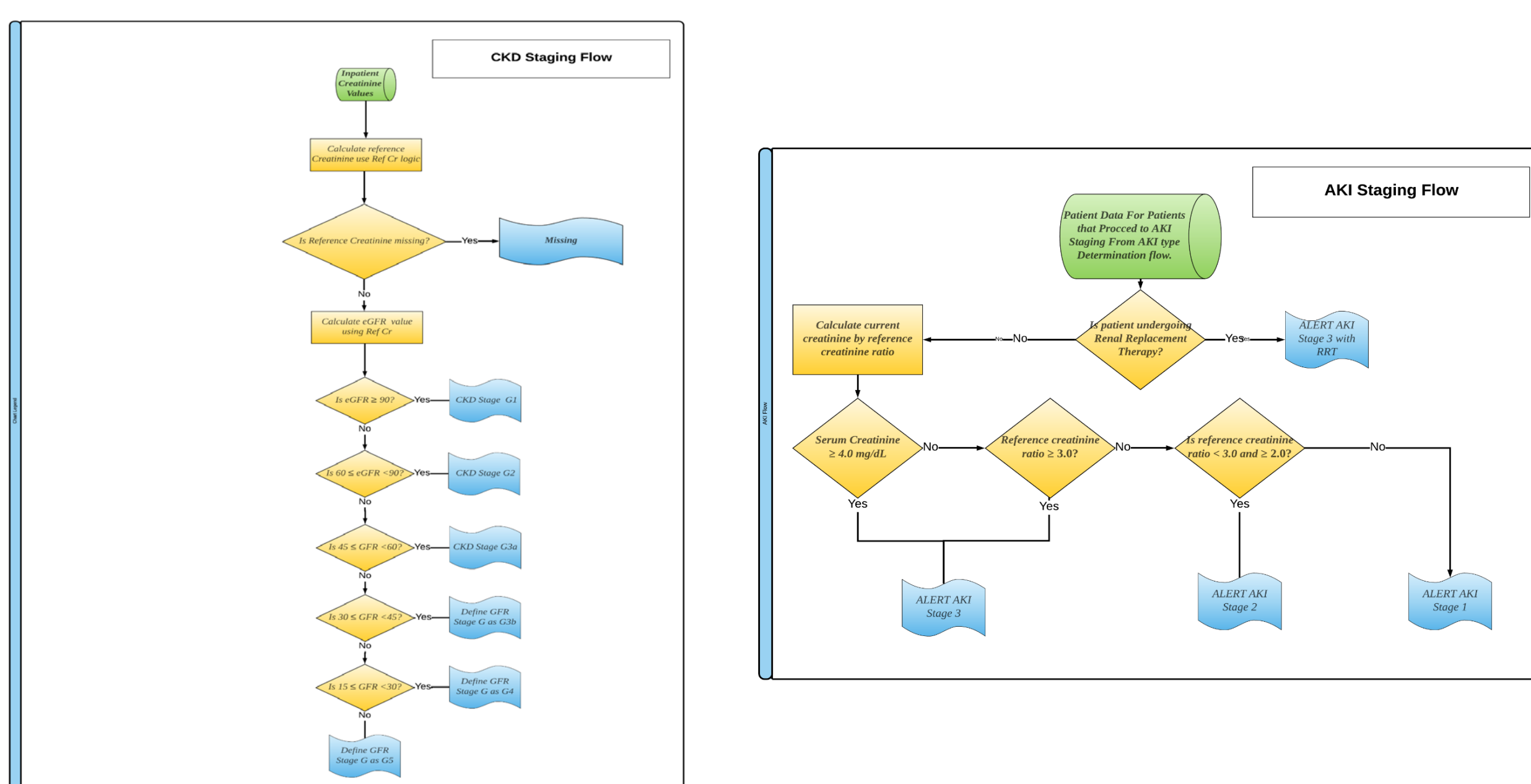
The Phenotype

Master Flow Algorithm
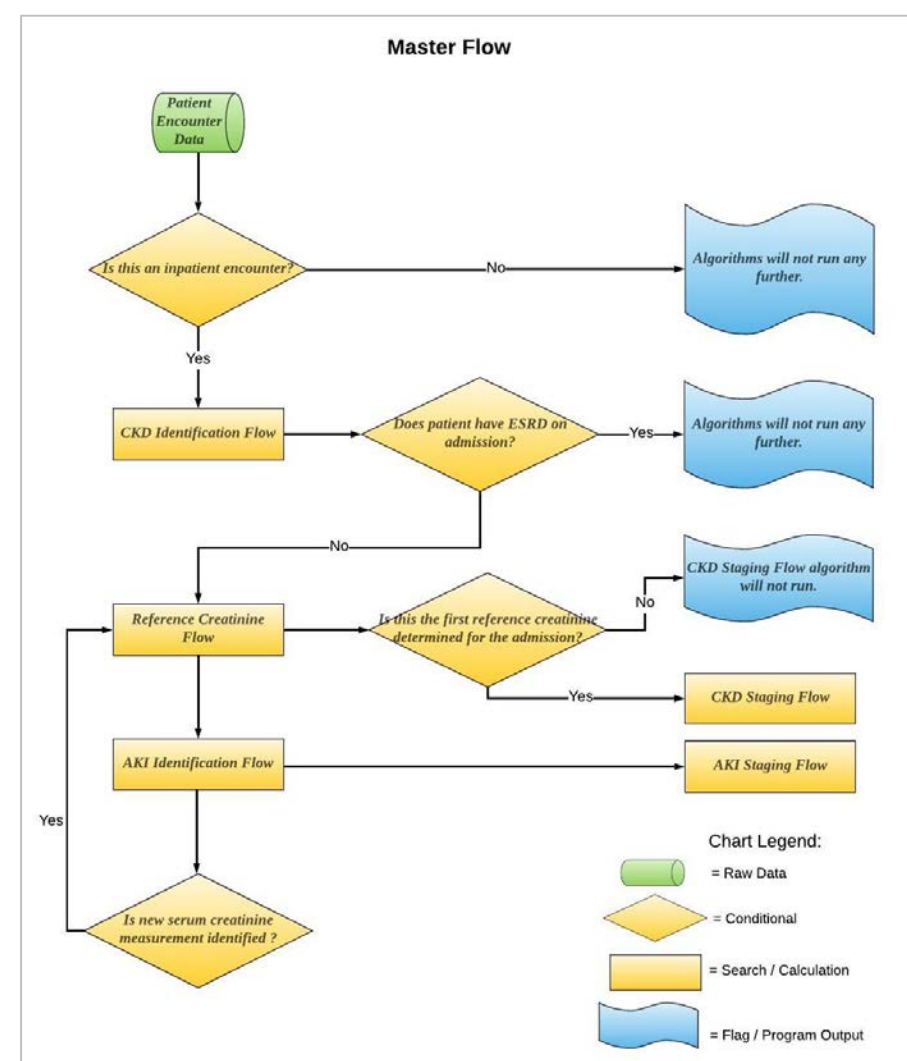
CKD Identification Algorithm
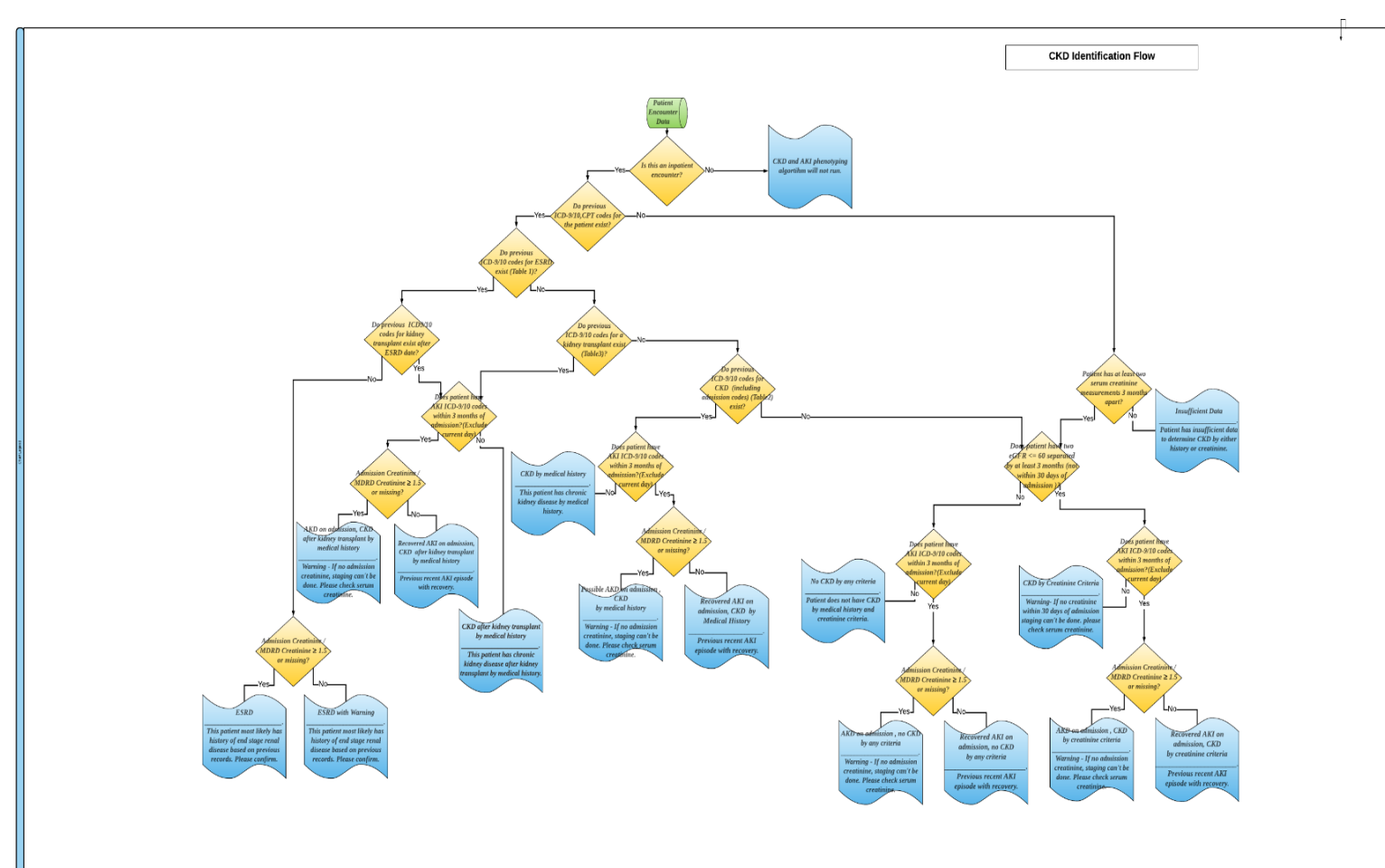
Reference Creatinine Algorithm

CKD and AKI Staging Algorithms

Validation

In a validation cohort of 71,127 patients approximately 48% of the population were male and the mean age was 56 years old. The algorithm identified CKD of any stage in 16.9% of the admissions in the cohort, and 17.5% had stage G1, 32.1% had stage G2, 39.6% had stage G3, 8.2% had stage 4 and 1.6% had stage G5. The algorithm identified AKI of any stage in 20.8% of the patients, with 62.8% stage 1, 19.3% stage 2 and 17.8% stage 3 AKI. For those patients with AKI 62.3% developed persistent AKI while 37.7% had rapidly reversed AKI. For CKD the PPV of the algorithm was 0.87 (95% CI 0.81-0.92), the NPV was 0.99 (95% CI 0.96-1.00), the sensitivity was 0.99 (95% CI 0.96-1.00) and the specificity was 0.89 (95% 0.83-0.93) compared to chart review. For AKI the PPV of the algorithm was 0.99 (95% CI 0.96-1.00), the NPV was 0.95 (95% CI 0.89-0.98), the sensitivity was 0.98 (95% CI 0.94-0.99) and the specificity was 0.98 (95% CI 0.93-1.00) compared to chart review.

Comparison of CKD Phenotyping to manual chart review

Phenotyping Algorithm	Manual chart review		
	Case	Control	Total
Case	131	19[a]	150
Control	1[b]	149	150
Total	132	168	300
PPV (95% CI)	0.87 (0.81, 0.92)		
NPV (95% CI)	0.99 (0.96, 1.00)		
Sensitivity (95% CI)	0.99 (0.96, 1.00)		
Specificity (95% CI)	0.89 (0.83, 0.93)		
Accuracy (95% CI)	0.93 (0.90, 0.96)		

Comparison of AKI Phenotyping to manual chart review

Phenotyping Algorithm	Manual chart review		
	Case	Control	Total
Case	198	2[a]	200
Control	5[b]	95	100
Total	203	97	300
PPV (95% CI)	0.99 (0.96, 1.00)		
NPV (95% CI)	0.95 (0.89, 0.98)		
Sensitivity (95% CI)	0.98 (0.94, 0.99)		
Specificity (95% CI)	0.98 (0.93, 1.00)		
Accuracy (95% CI)	0.98 (0.95, 0.99)		

Conclusions & Discussion

We developed an electronic phenotype for kidney health that shows excellent performance in identifying patients with CKD and AKI in an integrated clinical database. This tool may be useful in identifying patients with kidney disease in a large population, in assessing the quality and value of care provided to such patients and in clinical decision support tools to help providers care for these patients.