Computable Phenotyping to Identify and Characterize Kidney Health in Adult Hospitalized Patients

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Introduction

- Acute kidney injury (AKI) is one of the most common complications among hospitalized patients and is central to the subsequent development of chronic kidney disease (CKD) and increased mortality. [1,2]
- It is associated with up to five-fold increases in risk for both other serious complications and hospital death, and an increase in hospital cost of up to $28,000 per hospitalization. [3]
- Timely detection of AKI and progression of AKI could avoid further injurious practices, and increase the chance for offering more effective preventive or therapeutic measures.
- Electronic phenotyping refers to a characterization of a clinical condition determined via a computerized algorithm to a data repository using a defined set of data elements and logical expressions.
- The objective of this study is to develop and validate an electronic phenotype algorithm to identify patients with CKD and AKI.

Methods

- We created a database with electronic health records data from a retrospective study cohort of 84,355 adult patients hospitalized at UF Health between 1/1/2012 and 4/1/2016
- We developed algorithms to identify CKD and AKI based on the Kidney Disease: Improving Global Outcomes (KDIGO) criteria.
- We identified presence and stage of AKI by running algorithms each time a new creatinine measurement was detected.
- Diagnostic performance of the algorithms for 300 selected cases was compared to clinical adjudication by physicians, which is the gold standard for diagnosis.
- Cases were selected from the groups No CKD and CKD by Medical History.
- Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the CKD and AKI labels were calculated as a measure of diagnostic performance.

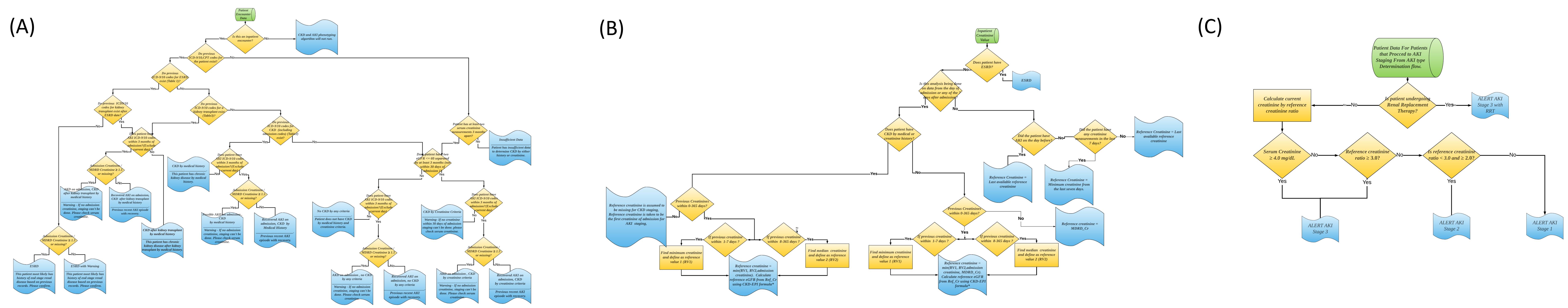

Figure 1. Phenotyping flow charts A) CKD Identification B) Reference Creatinine Determination C) AKI Staging

Results

- Among 149,136 encounters, 12% had CKD by medical history, which is based on ICD-9/10 codes. (Table 1)
- Using creatinine criteria, percent of patients with CKD identified increased to 16%. (Table 1)
- Among 130,081 encounters who had sufficient data for AKI phenotyping after excluding those with end-stage renal disease on admission, AKI during hospitalization was identified in 21% of encounters. (Table 2)
- CKD and AKI phenotyping algorithms performed well with diagnostic performance measures above 0.90. (Tables 3, 4)
- The CKD algorithm performed well and missed very few cases of CKD that manual adjudication captured. (Tables 3)
- The AKI algorithm had a much higher sensitivity for screening and detecting AKI in hospitalized patients than using ICD-9/10 codes, as AKI seems to be greatly underreported and not included in billing codes. The use of creatinine criteria for the AKI algorithm made its sensitivity far superior to that of ICD-9/10 codes. (Table 4)

Table 1. Distribution of chronic kidney disease groups

	N=149136
CKD, n (%)	25238 (16.9)
CKD by Medical History	18557 (12.4)
CKD by Creatinine Criteria	4937 (3.3)
CKD after kidney transplant	1744 (1.2)
No CKD, n (%)	123268 (82.7)
Insufficient Data, n (%)	630 (0.4)

Table 2. Renal characteristics among encounters with no end-stage renal disease on admission

	N=130,081
No AKI during hospitalization, n (%)	103089 (79.2)
AKI during hospitalization, n (%)	26992 (20.8)
Maximum AKI Stage, n (%)	
Stage 1	16949 (62.8)
Stage 2	5236 (19.3)
Stage 3 (with or without RRT)	4807 (17.8)
RRT, n (%)	1306 (4.2)
Recurrent AKI, n (%)	3310 (12.3)
AKI duration, days, median (25th, 50th, 75th)	2 (1, 5)

Table 3. Comparison of CKD Phenotyping to manual chart review

	Manual chart review		
Phenotyping Algorithm	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)		

Table 4. Comparison of AKI Phenotyping algorithm and ICD-9/10 codes to manual chart review

	Manual chart review				Manual chart review		
Phenotyping Algorithm	Case	Control	Total	ICD-9/10 codes	Case	Control	Total
Case	198	2[a]	200	Case	99	28	127
Control	5[b]	95	100	Control	104	69	173
Total	203	97	300	Total	203	97	300
PPV (95% CI)	0.99 (0.96, 1.00)			PPV (95% CI)	0.78 (0.70, 0.85)		
NPV (95% CI)	0.95 (0.89, 0.98)			NPV (95% CI)	0.40 (0.33, 0.48)		
Sensitivity (95% CI)	0.98 (0.94, 0.99)			Sensitivity (95% CI)	0.49 (0.42, 0.56)		
Specificity (95% CI)	0.98 (0.93, 1.00)			Specificity (95% CI)	0.71 (0.61, 0.80)		
Accuracy (95% CI)	0.98 (0.95, 0.99)			Accuracy (95% CI)	0.56 (0.50, 0.62)		

Conclusions & Discussion

- We developed phenotyping algorithms that yielded high performance in identification of patients with CKD and AKI in validation cohort.
- Limitation of CKD algorithm when there are incorrect or missing ICD-9/10 codes
- AKI algorithm provides autonomous kidney health assessment that can capture AKI status and severity in a timely manner.
- This tool can be useful in identifying kidney disease in large populations, 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.

References

1. Ozrazgat-Baslanti T, Thottakkara P, Huber M, et al. Acute and chronic kidney disease and cardiovascular mortality after major surgery. Annals of Surgery. 2015.
2. Korenkevych D, Ozrazgat-Baslanti T, Thottakkara P, et al. The Pattern of Longitudinal Change in Serum Creatinine and 90-Day Mortality After Major Surgery. Ann Surg. 2015 Jul 15.
3. Lewington AJ, Cerda J, Mehta RL. Raising awareness of acute kidney injury: a global perspective of a silent killer. Kidney Int 2013;84:457-67.

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