Treatment patterns and healthcare resource utilization in patients with chronic kidney disease with and without type 2 diabetes

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BACKGROUND

- The Kidney Disease: Improving Global Outcomes (KDIGO) guidelines recommend assessment of albuminuria at least annually in adults with chronic kidney disease (CKD), or more frequently for individuals at higher risk of CKD progression, as changes in urine albumin-to-creatinine ratio (UACR) may indicate early CKD progression.[1]
  - Despite KDIGO recommendations, previous studies have demonstrated deficiencies in UACR testing.[2]
- Preventing or slowing CKD progression could significantly improve patient quality of life, survival rates, and economic burden.[3]

OBJECTIVE

- To describe UACR testing and healthcare resource utilization (HRU) among individuals diagnosed with CKD with or without type 2 diabetes (T2D) in the United States.

METHODS

- This was a 4-part, retrospective cohort study using Cleveland Clinic electronic health record data to analyze adult individuals from 12/1/11 to 8/1/24 with a CKD diagnosis, defined as 2 impaired estimated glomerular filtration rate (eGFR) (i.e., <60 mL/min/1.73 m^2) or elevated UACR (i.e., ≥30 mg/g) measurements taken 90 to 365 days apart.
- Eligible individuals were assigned an initial risk category (moderate or high) according to KDIGO heat map criteria.
- Individuals were followed from the index date (earliest record of 2 consecutive and consistent risk categories) to CKD progression (first transition from initial risk category to any higher risk category), end of data availability, or death. The baseline period was 6 months prior to the index date.
- Individuals were further compared based on T2D status, defined using the modified version of the EMERGE algorithm[4] (based on the presence of diagnostic International Classification of Diseases [ICD] codes, abnormal glucose levels, and T2D medication use).
- Outcomes analyzed included treatment patterns, incidence of UACR testing (tests ordered vs tests completed), and HRU (i.e., physician encounters, emergency department visits, hospitalizations, dialysis).

RESULTS

Population and baseline characteristics

- In total, 29,985 individuals were analyzed and divided into 2 cohorts (initial moderate risk, n=20,501; initial high risk, n=9,484).
- Demographics and baseline characteristics for the study population are described in **Table 1**.

Table 1. Baseline demographics stratified by initial CKD risk and T2D diagnosis

	Initial moderate risk			Initial high risk		
	CKD before T2D n=2,434	T2D before CKD n=15,581	No T2D n=2,486	CKD before T2D n=1,614	T2D before CKD n=6,268	No T2D n=1,602
Age at index date, years, median (IQR)	70 (64, 76)	70 (63, 77)	72 (65, 79)	72 (65, 79)	71 (63, 79)	75 (66, 82)
Female, n (%)	1,184 (49.0)	7,537 (48.0)	1,256 (51.0)	825 (51.0)	3,087 (49.0)	788 (49.0)
Died, n (%)	607 (25.0)	5,791 (37.0)	883 (36.0)	570 (35.0)	3,112 (50.0)	685 (43.0)
Race, n (%)						
American Indian or Alaska Native	1 (<0.1)	16 (0.1)	0 (0.0)	2 (0.1)	4 (0.1)	3 (0.2)
Asian	25 (1.0)	186 (1.2)	19 (0.8)	22 (1.4)	74 (1.2)	18 (1.1)
Black	405 (17.0)	3,070 (20.0)	372 (15.0)	297 (18.0)	1,447 (23.0)	290 (18.0)
Caucasian	1,868 (77.0)	11,582 (74.0)	2,006 (81.0)	1,188 (73.6)	4,437 (71.0)	1,232 (77.0)
Native Hawaiian or other Pacific Islander	1 (<0.1)	2 (<0.1)	0 (0.0)	1 (0.1)	2 (<0.1)	0 (0.0)
Other or not stated	134 (6.0)	725 (5.0)	89 (3.6)	104 (6.4)	304 (4.9)	59 (3.7)
Clinical characteristics, median (IQR)						
Systolic BP, mmHg	130 (120, 141)	130 (118, 141)	130 (118, 142)	130 (120, 144)	131 (120, 145)	130 (118, 142)
Diastolic BP, mmHg	71 (64, 80)	70 (61, 78)	71 (63, 80)	70 (62, 79)	70 (60, 78)	70 (62, 79)
HDL, mg/dL	46 (37, 55)	44 (36, 55)	51 (42, 64)	44 (36, 55)	43 (35, 54)	51 (41, 63)
LDL, mg/dL	72 (55, 93)	69 (52, 90)	82 (62, 104)	71 (53, 93)	69 (51, 90)	80 (61, 104)
Triglyceride, mg/dL	119 (86, 165)	116 (83, 166)	98 (73, 136)	121 (85, 168)	115 (81, 166)	99 (74, 138)
Total cholesterol, mg/dL	146 (124, 174)	143 (120, 170)	158 (133, 187)	146 (122, 172)	141 (118, 170)	158 (132, 187)
HbA1c, %	6.5 (6.0, 7.3)	6.9 (6.2, 7.8)	5.6 (5.4, 5.9)	6.5 (6.0, 7.4)	6.8 (6.1, 7.7)	5.6 (5.4, 5.9)
Potassium, mEq/L	4.3 (4.0, 4.7)	4.4 (4.0, 4.7)	4.3 (4.0, 4.6)	4.4 (4.0, 4.7)	4.4 (4.1, 4.8)	4.4 (4.0, 4.7)
eGFR, mL/min/1.73 m^2	52 (42, 63)	51 (39, 65)	50 (42, 61)	40 (30, 50)	38 (26, 50)	38 (29, 49)
UACR, mg/g	27 (5, 85)	50 (14, 173)	17 (0.1, 62)	62 (20, 243)	105 (29, 476)	41 (11, 153)
Medication prescriptions by class, n (%)						
ACEis/ARBs	918 (38.0)	11,727 (75.0)	1,284 (52.0)	519 (32.0)	4,644 (74.0)	823 (51.0)
Antiplatelets	690 (28.0)	6,895 (44.0)	800 (32.0)	451 (28.0)	2,951 (47.0)	525 (33.0)
GLP-1RAs	3 (0.1)	1,021 (6.6)	1 (<0.1)	7 (0.4)	302 (4.8)	1 (0.1)
MRAs	98 (4.0)	1,022 (6.6)	107 (4.3)	65 (4.0)	416 (6.6)	78 (4.9)
SGLT2is	3 (0.1)	383 (2.5)	0 (0.0)	0 (0.0)	82 (1.3)	0 (0.0)
Statins	879 (36.0)	11,194 (72.0)	1,176 (47.0)	529 (33.0)	4,408 (70.0)	687 (43.0)

Key: ACEi – angiotensin-converting enzyme inhibitor; ARB – angiotensin receptor blocker; BP – blood pressure; CKD – chronic kidney disease; eGFR – estimated glomerular filtration rate; GLP-1RA – glucagon-like peptide-1 receptor agonist; HbA1c – hemoglobin A1c; HDL – high-density lipoprotein; IQR – interquartile range; LDL – low-density lipoprotein; MRA – mineralocorticoid receptor antagonist; SGLT2i – sodium glucose cotransporter-2 inhibitor; T2D – type 2 diabetes; UACR – urine albumin-to-creatinine ratio.

Treatment patterns

- More patients diagnosed with T2D before CKD received statins, angiotensin-converting enzyme inhibitors (ACEis) or angiotensin receptor blockers (ARBs), antiplatelets, glucagon-like peptide-1 receptor agonists (GLP-1RAs), sodium glucose cotransporter-2 inhibitors (SGLT2is), and mineralocorticoid receptor antagonists (MRAs) than those who were diagnosed with CKD before T2D.
- Statin and renin-angiotensin-aldosterone system inhibitors (ACEi/ARBs) were underutilized in patients diagnosed with CKD prior to T2D, regardless of initial KDIGO risk category (**Table 1**; **Figure 2**).

UACR testing and HRU

- UACR and other HRU measures were generally comparable across groups (**Table 2**). Individuals were more likely to be diagnosed with end-stage renal disease if they were previously diagnosed with T2D (initial moderate risk: 74%; initial high risk: 37.7%) compared to those without a T2D diagnosis (initial moderate risk: 0.9%; initial high risk: 5.7%).
- Individuals who were not diagnosed with T2D had a higher rate of incomplete UACR orders (initial moderate risk: 41.0%; initial high risk: 43.3%) compared to individuals previously diagnosed with T2D (initial moderate risk: 31%; initial high risk: 32%).

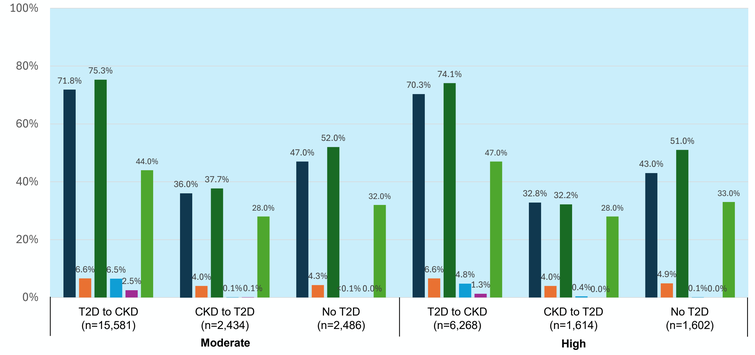
Table 2. UACR testing and HRU stratified by initial CKD risk and T2D diagnosis

	Initial moderate risk N=2,486	Initial high risk N=1,602	Initial moderate risk N=18,015	Initial high risk N=7,882
	No T2D		Has T2D	
Dialysis				
Dialysis, n (%)	98 (3.9)	112 (7.0)	1,061 (5.9)	971 (12.3)
Kidney transplant, n (%)	55 (2.2)	41 (2.5)	228 (1.3)	239 (3.0)
UACR orders				
Labs not completed, n	19,961	17,443	116,531	55,787
Labs ordered, n	48,658	40,273	375, 919	174,462
Proportion not completed vs ordered, %	41.0	43.3	31.0	32.0
Hospital usage				
Physician visit, median (IQR)	49 (25, 84)	46 (23, 78)	54 (26, 92)	61 (33, 98)
ED visit counts, median (IQR)	1 (0, 3)	1 (0, 4)	2 (0, 5)	2 (0, 4)
Hospitalization counts, median (IQR)	2 (0, 4)	2 (0, 5)	3 (1, 7)	2 (1, 6)
Individuals with criteria for KDIGO risk progression				
Progressed to higher risk category, n (%)	2,018 (81.0)	1,218 (76.0)	16,185 (90.0)	6,664 (85.0)
Individuals without criteria for KDIGO risk progression with CKD progression events by diagnosis code[a]				
Did not progress to higher risk category, n (%)	468 (18.8)	384 (24.0)	1830 (10.2)	1,218 (15.5)
ESRD (ICD-9/10, ≥1 event), n (%)	17 (0.9)	22 (5.7)	347 (74.0)	459 (37.7)
eGFR <15 mL/min/1.73 m^2, n (%)	5 (0.0)	7 (2.0)	23 (5.0)	18 (2.0)

[a] Based on diagnosis codes; individuals could have multiple events.

Key: CKD – chronic kidney disease; ED – emergency department; eGFR – estimated glomerular filtration rate; ESRD – end-stage renal disease; HRU – health resource utilization; ICD – International Classification of Diseases; IQR – interquartile range; KDIGO – Kidney Disease: Improving Global Outcomes; T2D – type 2 diabetes; UACR – urine albumin-to-creatinine ratio.

Figure 2. Proportion of individuals receiving medications at baseline by class stratified by initial CKD risk and T2D diagnosis



Key: ACEi – angiotensin-converting enzyme inhibitor; ARB - angiotensin receptor blocker; CKD – chronic kidney disease; GLP1-RA – glucagon-like peptide-1 receptor agonist; SLGT2i – sodium-glucose co-transporter-2 inhibitor; T2D – type 2 diabetes.

STUDY LIMITATIONS

- Data source was a regional integrated delivery network; results may not be generalizable to the broader population.
- The KDIGO heat map may not fully capture worsening kidney function in some individuals, especially those with incomplete or inaccurate UACR testing.
- Based on the timeline of the chart review, some treatment groups may be underrepresented due to availability of medication class and FDA-approved indications.

CONCLUSIONS

- **While HRU was generally similar across groups, the analysis of UACR testing revealed a gap in completion rates of orders, especially for those without T2D, which can contribute to delays in identifying and managing worsening kidney function.**
- **A diagnosis of T2D before CKD increases the likelihood of initiating statins, ACEis/ARBs, MRAs, GLP1-RAs, and SGLT2is compared to those diagnosed with CKD first, most likely due to more frequent screening and specialist care.**
- **Underutilization of UACR testing as confirmed by this study highlights potential issues affecting earlier CKD diagnosis, as well as risk of CKD progression and cardiovascular events, particularly when utilizing the KDIGO heat map.**

REFERENCES

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