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ORIGINAL ARTICLE

Adherence to Chronic Kidney Disease Screening Guidelines Among Patients With Type 2 Diabetes in a US Administrative Claims Database

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Abstract

Objective: To examine the screening rates for kidney damage and function among patients with type 2 diabetes (T2D) and chronic kidney disease stage at diabetes diagnosis using a US administrative claims database.

Patients and Methods: This cohort study used a claims database enriched with laboratory results data. Patients with T2D (defined as 1 inpatient or 2 outpatient claims for diabetes), aged 18 years or older, and with at least 1 year of follow-up enrollment were identified. Patients with type 1 diabetes, kidney disease, or other related conditions at baseline were excluded. We estimated screening rates using laboratory orders for serum creatinine and estimated glomerular filtration rate (eGFR) measurement and urine albumin to creatinine ratio (UACR). Chronic kidney disease severity was reported using the Kidney Disease: Improving Global Outcomes classification based on laboratory results.

Results: A total of 1,881,447 patients with T2D were eligible for analysis. Mean ± SD age was 63.1±13.1 years; 947,150 patients (50.3%) were male. Serum creatinine tests were ordered within 14 days of the index date among 290,722 patients of 622,915 (46.7%) patients with newly-recognized T2D. Overall, 1,595,964 patients (84.8%) had at least one serum creatinine test ordered during the 1-year follow-up period. Fewer patients received a UACR test during follow-up (814,897 [43.3%]). Less than half of all patients with T2D received a laboratory test order for both serum creatinine and urine albumin measurements during the follow-up period.

Conclusion: Physicians treating patients with diabetes are selectively adhering to chronic kidney disease screening guidelines, as indicated by high rates of eGFR testing, but less frequent UACR testing. Despite recommendations to monitor both eGFR and UACR, less than half of patients were screened for albuminuria during the 1-year follow-up.

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Chronic kidney disease (CKD) occurs in 20% to 40% of patients with type 2 diabetes (T2D) and may be present at the time of T2D diagnosis.[1-3] Delays in diagnosis and appropriate treatments yield higher rates of disease progression and poor clinical outcomes.[4,5] Patients with T2D and CKD are at elevated risk of cardiovascular disease and death.[6-9] Overall, CKD is underdiagnosed, and CKD awareness appears to be low among both clinicians and patients. Advanced stages of CKD appeared to be more readily recognized by clinicians than mild CKD stages.[4] Underutilization of CKD screening by health care professionals is the primary reason for delayed CKD detection and treatment, causing the identification of CKD in later disease stages.[6]

Reduced glomerular filtration rate markers of kidney damage, including

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albuminuria, are established criteria for CKD.[6] Current guidelines from the American Diabetes Association (ADA) recommend screening patients with T2D for CKD beginning at the time of diagnosis and annually thereafter using measurements of kidney damage (urine albumin to creatinine ratio [UACR]) and function (estimated glomerular filtration rate [eGFR]).[10] Confirmation of CKD diagnosis with 2 or more test results at least 90 days apart are recommended.[1,9,11] Monitoring kidney damage and function in patients with T2D enables timely diagnosis of CKD, prevents the onset of disease progression, and informs decisions on treatment initiation and/or intensification.

Despite the clinical guidelines put forth by the ADA, clinicians differ in their knowledge of elevated CKD risk and the management of diabetic nephropathy in this population. To better understand the real-world adherence to CKD screening guidelines among patients with T2D, this study sought to examine the screening rates for kidney damage and function among patients with T2D in the United States using administrative claims data. We also evaluated CKD severity at the time of diagnosis among patients with available results for UACR and eGFR laboratory tests.

PATIENTS AND METHODS

Data Source

In this retrospective cohort study, we used deidentified data from the Optum® Clinformatics® Data Mart (CDM).[12] CDM is a large administrative claims database representative of the commercially insured population and Medicare Advantage patients in the United States. Data were collected between January 1, 2007, and September 31, 2018, and contained comprehensive, longitudinal information from medical claims, pharmacy claims, and laboratory results. Laboratory orders were available for all patients; only a subset of patients had laboratory results available in the data.

Study Population

We included patients with T2D (defined as 1 inpatient or 3 outpatient claims for diabetes in any site 30 to 365 days apart) identified between January 1, 2008, and December 31, 2016 (index date). Patients were required to be at least 18 years of age and have at least 1 year of continuous health plan enrollment for 365 days prior to the index date (baseline period) and 365 days after the index date (follow-up period). Patients were considered to have newly recognized T2D if they had no claims with diagnosis codes for diabetes and were not using second-line therapy for diabetes during the baseline period. Patients with baseline claims for type 1 diabetes, kidney disease as indicated by *International Classification of Diseases, Ninth and Tenth Revision* codes, or other conditions that may cause kidney disease (eg, glomerulonephritis) were excluded (Figure 1).

Variables

Patient demographic characteristics, comorbidities, and medication use were assessed during the 365-day baseline period prior to the index date. Laboratory variables included serum creatinine and urine albumin test orders based on Current Procedural Terminology/Healthcare Common Procedure Coding System codes and laboratory results for eGFR and UACR identified with Logical Observation Identifiers Names and Codes for a subset of patients. Patients with T2D were considered to have CKD if they met the following criteria: eGFR of less than 60 mL/min per 1.73m^2 and/or UACR of 30 mg/g or greater. Chronic kidney disease was staged using the Kidney Disease: Improving Global Outcomes (KDIGO) classification, which uses both eGFR and albuminuria to classify severity.[13] Chronic kidney disease stage 1 to 2 was defined as an eGFR of 60 mL/min per 1.73m^2 or greater and evidence of kidney damage (albuminuria); CKD stage 3 to 5 was defined as an eGFR of less than 60 mL/min per 1.73m^2 with or without evidence of albuminuria.[13] Estimated glomerular filtration rate values reported in the databases were used, which were calculated from serum creatinine using the validated Modification of Diet in Renal Disease.[14]

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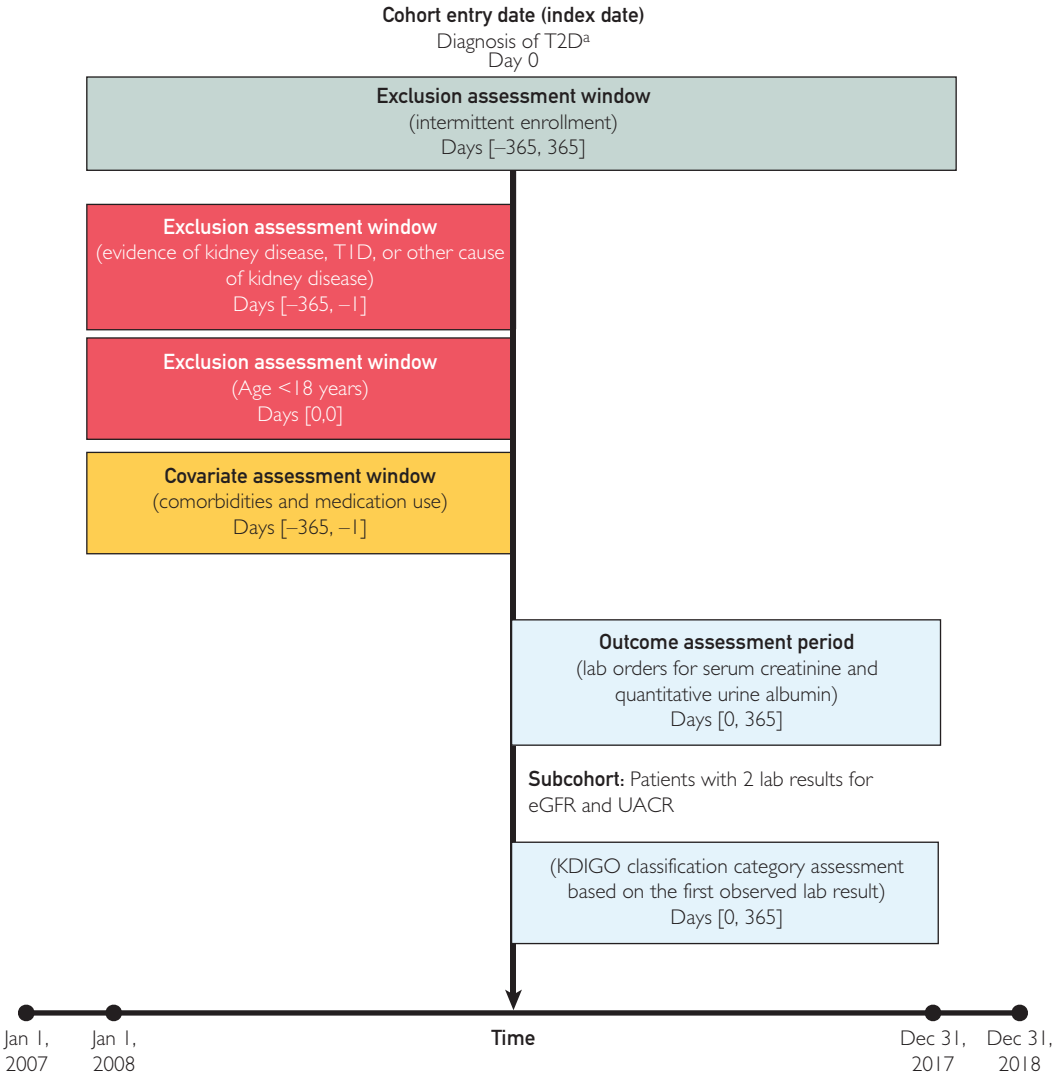

FIGURE 1. Study design overview. [a]Type 2 diabetes (T2D) was defined as 2 outpatient diagnoses of T2D at least 30 days apart and at most 365 days apart or 1 inpatient diagnosis of T2D from January 1, 2008, onward. Newly recognized diagnosis was defined on index date as patients meeting a 365-day event-free period during which no diagnoses of T2D and no use of second-line glucose-lowering agents were observed. Patients who did not meet this event-free period were classified as having a prevalent T2D diagnosis on the index date. eGFR = estimated glomerular filtration rate; KDIGO = Kidney Disease: Improving Global Outcomes; Lab = laboratory; T1D = type 1 diabetes; UACR = urine albumin to creatinine ratio.

Screening for albuminuria was calculated using UACR in a random spot urine collection. Normal UACR was defined as less than 30 mg/g; increased urinary albumin excretion was defined as 30 mg/g creatinine or greater. Three categories of albuminuria were specified based on UACR values: A1, normal to mildly increased (<30 mg/g); A2, moderately increased (30 to 300 mg/g); and A3, severely increased (>300 mg/g).[13] Due to expected biological variability of UACR, at least 2 specimens of UACR collected at least 90 days apart had to be elevated before considering a patient to have albuminuria. Variable definitions are available in the Supplemental Material (available online at http://www.mayoclinicproceedings.org).

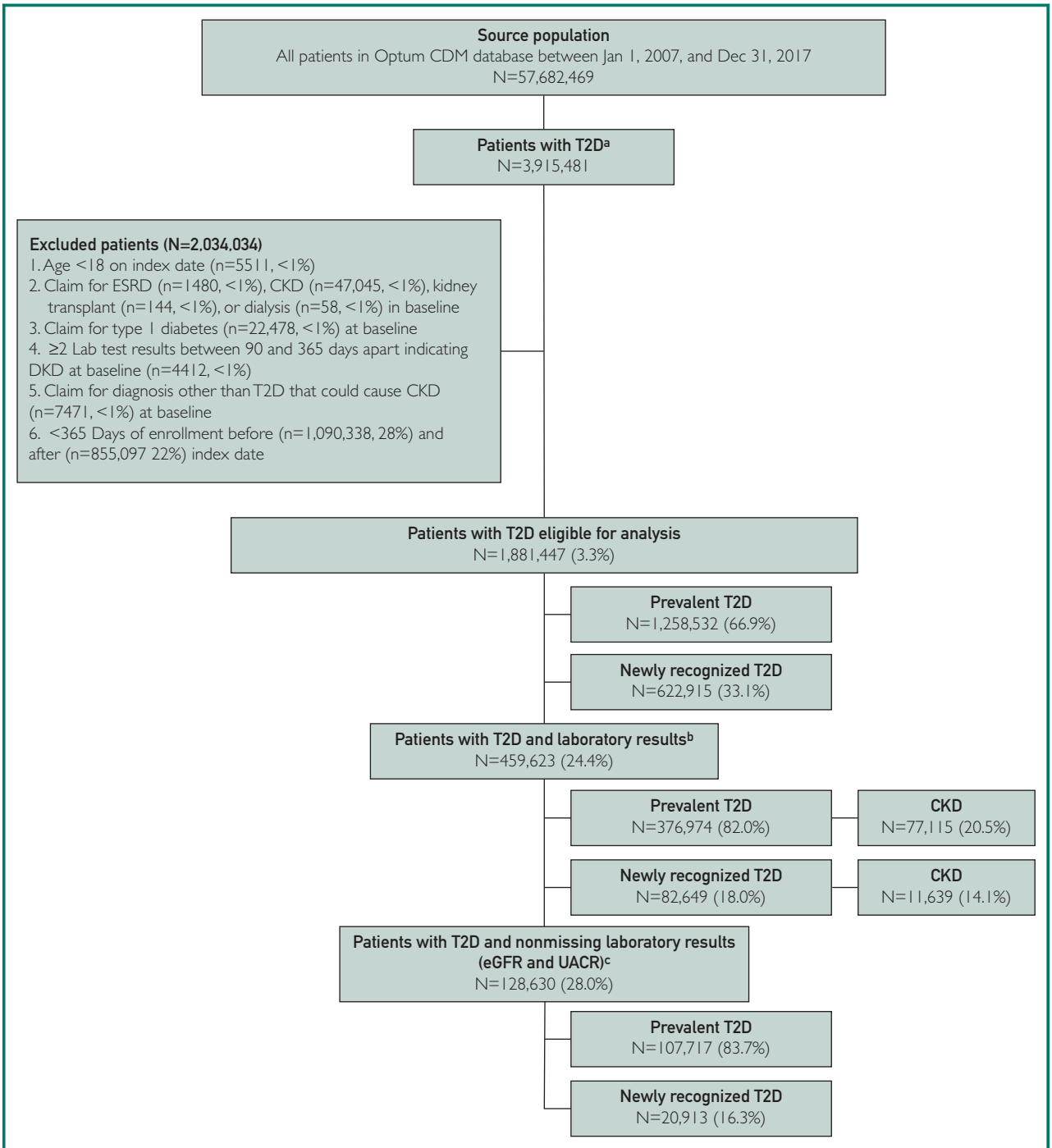

FIGURE 2. Flowchart of selection of patients with type 2 diabetes (T2D). [a]Patients with T2D were defined as those with 2 outpatient diagnoses of T2D at least 30 days apart and at most 365 days apart or 1 inpatient diagnosis of T2D from January 1, 2008, onward. [b]Valid laboratory (Lab) tests were defined as at least 2 valid estimated glomerular filtration rate (eGFR) test results or 2 urine albumin to creatinine ratio (UACR) test results. [c]Patients with nonmissing results for both eGFR and UACR tests. CDM = Clinformatics Data Mart; CKD = chronic kidney disease; DKD = diabetic kidney disease; ESRD = end-stage renal disease.

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TABLE 1. Baseline Characteristics of Patients With T2D Identified in the Optum CDM Data, 2008-2016[a,b]

Patient characteristics	Patients with T2D	
	Prevalent diagnosis[c] (N=1,258,532)	Newly recognized diagnosis[c] (N=622,915)
Age (y)		
Mean ± SD	63.9±12.4	61.4±14.2
Median (IQR)	66 (56-72)	62 (51-72)
Male sex	630,632 (50.1%)	316,518 (50.8%)
Race		
White	746,725 (59.3%)	361,784 (58.1%)
Asian	47,336 (3.8%)	27,010 (4.3%)
Black	150,394 (11.9%)	65,175 (10.5%)
Hispanic	156,026 (12.4%)	82,446 (13.2%)
Comorbidities[d]		
Anemia	156,099 (12.4%)	53,884 (8.7%)
Angina pectoris	211,716 (16.8%)	63,452 (10.2%)
Chronic lung disease	199,580 (15.9%)	86,739 (13.9%)
Depression	113,790 (9.0%)	47,554 (7.6%)
Diabetic retinopathy	145,401 (11.6%)	29, 476 (4.7%)
Fatigue and sleep-related disorders	236,392 (18.8%)	112,153 (18.0%)
Hyperlipidemia	895,557 (71.2%)	284,101 (45.6%)
Hypertension	937,565 (74.5%)	318,912 (51.2%)
Microvascular disease	257,845 (20.5%)	30,353 (4.9%)
Obesity	179,739 (14.3%)	75,737 (12.2%)
Pain disorders	777,217 (61.8%)	325,175 (52.2%)
Peripheral vascular disease	124,225 (9.9%)	41,300 (6.6%)
Resistant hypertension	116,436 (9.3%)	32,873 (5.3%)
Sleep apnea	122,651 (9.7%)	51,444 (8.3%)
Medication use		
Statins	697,440 (55.4%)	215,409 (34.6%)
Antihypertensive agents	904,563 (71.9%)	336,293 (54.0%)
Glucose-lowering agents	933,765 (74.2%)	103,151 (16.6%)
Metformin	610,772 (48.5%)	103,151 (16.6%)
SGLT-2s	12,276 (1.0%)	0 (0.0%)
DPP-4s	121,328 (9.6%)	0 (0.0%)
GLP-1s	44,335 (3.7%)	0 (0.0%)
Sulfonylureas	387,160 (32.5%)	0 (0.0%)
Insulin	206,486 (16.4%)	0 (0.0%)

[a]CDM, Clinformatics Data Mart; DPP-4, dipeptidyl peptidase 4; GLP, glucagon-like peptide 1; IQR, interquartile range; SGLT-2, sodium glucose co-transporter-2; T2D, type 2 diabetes mellitus.
[b]Data are presented as No. (percentage) of patients unless indicated otherwise.
[c]Newly-recognized diagnosis was defined on index date as patients meeting a 365-day event-free period during which no diagnoses of T2D and no use of second-line glucose-lowering agents were observed. Patients who did not meet this event-free period were classified as having a prevalent T2D diagnosis on index date.
[d]Comorbidities with a prevalence of 9% or higher are shown in the table.

Statistical Analyses

We estimated screening rates as the number and proportion of patients with T2D who had laboratory orders for serum creatinine and urine albumin measurements, used to estimate eGFR and UACR, respectively, on the date of the diabetes claim (index date) and during the 365 days thereafter. The time in days to first and second laboratory orders were also evaluated. Among a subset of patients with available laboratory results for eGFR and/or UACR, we estimated the

TABLE 2. Screening Rates for Serum Creatinine and Urine Albumin Among Patients With T2D in the 365 Days After Identification in Optum CDM, 2008-2016[a,b]

Laboratory test	All patients with T2D (N=1,881,447)	Patients with prevalent T2D[c] (n=1,258,532)	Patients with newly recognized T2D[c] (n=622,915)
Serum creatinine, test ordered:			
During baseline	1,254,832 (66.7%)	920,884 (73.2%)	333,948 (53.6%)
Within 14 d of index	865,778 (46.0%)	575,056 (45.7%)	290,722 (46.7%)
During 365 d of index	1,595,964 (84.8%)	1,085,329 (86.2%)	510,635 (82.0%)
At least 2 tests ordered during follow-up	1,170,276 (62.2%)	816,570 (64.9%)	353,706 (56.8%)
Time in days from index to first test in follow-up, mean ± SD	73.4±95.4	69.4±93.4	81.9±98.9
Quantitative urine albumin, test ordered:			
During baseline	440,380 (23.4%)	404,492 (32.1%)	35,888 (5.8%)
Within 14 d of index	300,122 (16.0%)	210,284 (16.7%)	89,838 (14.4%)
During 365 d of index	814,897 (43.3%)	583,099 (46.3%)	231,798 (37.2%)
At least 2 tests ordered during follow-up	246,395 (13.1%)	180,176 (14.3%)	66,219 (10.6%)
Time in days from index to first test in follow-up, mean ± SD	115.7±114.3	116.5±114.1	113.4±114.7
Serum creatinine and quantitative urine albumin			
Time (d) between first laboratory result indicating DKD and second laboratory result indicating DKD, mean ± SD	169.80±68.61	167.31±66.92	196.83±79.95
Both tests ordered during follow-up	763,630 (40.6%)	551,458 (43.8%)	212,172 (34.1%)

[a]CDM, Clinformatics Data Mart; DKD, diabetic kidney disease; T2D, type 2 diabetes mellitus.
[b]Data are presented as No. (percentage) of patients unless indicated otherwise.
[c]Newly recognized diagnosis was defined on index date as patients meeting a 365-day event-free period during which no diagnoses of T2D and no use of second-line glucose-lowering agents were observed. Patients who did not meet this event-free period were classified as having a prevalent T2D diagnosis on the index date.

presence of CKD at 1 year, defined as at least 2 laboratory results within 90 to 365 days apart for eGFR of less than 60 mL/min per 1.73m^2 and/or UACR of 30 mg/g or greater. Chronic kidney disease severity was reported using the KDIGO classification and was calculated using the first recorded value of eGFR and UACR in follow-up after meeting the criteria for diabetes among a subset of patients with nonmissing laboratory results for both eGFR and UACR.

RESULTS

Study Participants

Among patients available in the Optum CDM database (N=57,682,269), 1,881,447 patients with T2D (3.3%) were eligible for analysis. The analysis included patients with prevalent T2D (n=1,258,532 [66.9%]) and patients with newly recognized T2D (n=622,915 [33.1%]). A subset of 459,623 patients with T2D (24.4%) had laboratory tests results (ie, at least 2 valid eGFR test results or 2 valid UACR test results), of which 128,630 patients with T2D (28.0%) had nonmissing results for both eGFR and UACR (Figure 2).

Baseline Characteristics

Among all eligible patients with T2D (n=1,881,447), the mean ± SD age was 63.1±13.1 years, and 947,150 patients (50.3%) were male. Patients with prevalent T2D were slightly older and had a higher prevalence of most comorbidities than patients with newly recognized T2D (Table 1). Microvascular disease was 4 times more frequent and diabetic retinopathy was twice as frequent in the 1,258,532 patients with prevalent T2D compared with the 622,915 patients with newly recognized T2D (257,845 [20.5%] vs 30,353 [4.9%] and 145,401 [11.6%] vs 29,476 [4.7%], respectively). Common comorbidities for both patients with prevalent and newly recognized T2D included hyperlipidemia, hypertension, and pain disorders. The most commonly

Albumin stage (UACR, mg/g)	Patients with prevalent T2D and laboratory results for eGFR and UACR (N=107,717)						
	eGFR stages (mL/min/1.73 m2)						
	G1 (≥90)	G2 (60-89)	G3a (45-59)	G3b (30-44)	G4 (15-29)	G5 (<15)	Overall
A1 (<30)	25.20	34.81	9.95	2.14	0.23	0.05	72.38
A2 (30-300)	6.76	10.29	4.16	1.36	0.22	0.03	22.83
A3 (>300)	1.07	1.87	1.11	0.56	0.16	0.03	4.79
Overall	33.04	46.97	15.21	4.06	0.61	0.11	100.00

Albumin stage (UACR, mg/g)	Patients with incident T2D and laboratory results for eGFR and UACR (N=20,913)						
	eGFR stages (mL/min/1.73 m2)						
	G1 (≥90)	G2 (60-89)	G3a (45-59)	G3b (30-44)	G4 (15-29)	G5 (<15)	Overall
A1 (<30)	31.53	36.47	7.70	1.50	0.20	0.02	77.42
A2 (30-300)	7.34	7.94	2.69	0.96	0.15	0.04	19.11
A3 (>300)	1.07	1.23	0.61	0.37	0.15	0.05	3.47
Overall	39.94	45.64	10.99	2.83	0.50	0.11	100.00

FIGURE 3. Chronic kidney disease stages and corresponding severity using the Kidney Disease: Improving Global Outcomes classification according to first recorded laboratory test results (during the 365-day follow-up period) among patients with prevalent type 2 diabetes (T2D) (top) and patients with newly recognized T2D (bottom), in percentages. The heat map represents chronic kidney disease severity with very high-risk patients in red, high-risk in orange, moderate-risk in yellow, and low-risk in green. Patients were classified based on their first recorded laboratory test result during the 365-day follow-up period. Newly recognized (incident) T2D diagnosis was defined on the index date as patients meeting a 365-day event-free period during which no diagnoses of T2D and no use of second-line glucose-lowering agents were observed. Patients who did not meet this event-free period were classified as having a prevalent T2D diagnosis on the index date. eGFR = estimated glomerular filtration rate; UACR, urine albumin to creatinine ratio.

used glucose-lowering agent among all patients with T2D was metformin (610,772 [48.5%] and 103,151 [16.6%] in prevalent and newly recognized T2D, respectively). Sulfonylureas (387,160 [32.5%]), insulin (206,486 [16.4%]), and dipeptidyl peptidase 4s (121,328 [9.6%]) were also used among patients with prevalent T2D. Over half of all patients with T2D were prescribed an antihypertensive agent (904,563 [71.9%] and 336,293 [54.0%] of patients with prevalent T2D and newly recognized T2D, respectively) (Table 1).

Screening Rates

Screening rates for CKD did not dramatically differ between the prevalent and newly recognized T2D groups (1,258,532 and 622,915 patients, respectively). Overall, 1,595,964 patients with T2D (84.8%) had at least one serum creatinine test ordered during the 1-year follow-up period. A serum

creatinine test was ordered within 14 days of the index date in 290,722 patients (46.7%) with newly recognized T2D. Over 80% of patients (510,635) with newly recognized T2D had at least one serum creatinine test ordered during the 1-year period after diagnosis. At least 2 tests were ordered during follow-up for 816,570 patients (64.9%) with prevalent T2D and 353,706 patients (56.8%) with newly recognized T2D.

Fewer patients with T2D received a test for albuminuria during follow-up (814,897 [43.3%]). A total of 89,838 patients (14.4%) with newly recognized T2D were tested within 14 days of T2D diagnosis and 231,798 patients (37.2%) were tested within 1 year after T2D diagnosis (Table 2). At least 2 tests were ordered during follow-up for 180,176 patients (14.3%) with prevalent T2D and 66,219 patients (10.6%) with newly recognized T2D.

Less than half (763,630 [40.6%]) of all 1,881,447 patients with T2D received a laboratory test order for both serum creatinine and urine albumin during the 1-year follow-up period (Table 2). When follow-up was extended to 450 days, the percentage of patients receiving 2 tests (either 2 eGFR [1,228,651 (69.4%)], 2 UACR [331,014 (18.7%)], or both [797,065 (45.0%)]) slightly increased among 1,769,324 patients with 450 days of follow-up.

Among patients with prevalent T2D and newly recognized T2D, the first serum creatinine test was ordered on average within 3 months (69 days and 82 days, respectively) of the index date; the first urine albumin test was ordered on average within 4 months (117 days and 113 days, respectively) (Table 2).

Screening rates among all patients with T2D stratified by region revealed little difference between serum creatinine testing 1 year following T2D diagnosis (range, 81.9% in the western United States to 88.4% in the northeastern United States). However, urine albumin testing at follow-up was lower among patients residing in the southern United States (39.4%) compared with other US regions (Supplemental Figure, available online at http://www.mayoclinicproceedings.org).

CKD Confirmation and Severity at the Time of Screening

Among patients with T2D and laboratory results (N=459,623), 77,115 of the 376,974 patients with prevalent T2D (20.5%) and 11,639 of the 82,649 patients with newly recognized T2D (14.1%) met the criteria for CKD during the 365 days of follow-up. Among these patients with T2D and laboratory results, the majority of patients were identified as having CKD stage 3 (Supplemental Table 1, available online at http://www.mayoclinicproceedings.org).

An additional subset of patients with newly recognized T2D and CKD with 2 eGFR laboratory results (9,726 patients of 82,649 [11.8%]) was explored. Using the first eGFR result in the CKD range (<60 mL/min per $1.73m^2$), the second confirmatory test was completed in an average of 195±79.1 days after the first eGFR test. Similarly, a subset of patients with newly recognized T2D and CKD with 2 UACR laboratory results (2,141 patients of 82,649 [2.6%]) was explored. Using the first UACR results in the CDK range (UACR of ≥30), the second confirmatory test was completed in an average of 219±84.7 days after the first UACR test (Supplemental Table 2, available online at http://www.mayoclinicproceedings.org).

Among patients with T2D and nonmissing results for both eGFR and UACR laboratory test results, patients were commonly classified as having low or moderate severity disease (Figure 3).

DISCUSSION

Our analysis of administrative claims data indicates that US physicians treating patients with T2D appear to selectively follow the kidney function screening guidelines proposed by the ADA, as indicated by high rates of eGFR testing but low rates of UACR testing. More than 80% of patients with diabetes (both prevalent and newly recognized) underwent eGFR-based kidney function screening in the 365 days after a physician visit with a diabetes diagnosis claim. Repeated testing for eGFR was performed on average 90 days after the first test, which

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corresponds to the diagnostic criteria for CKD of sustained impaired kidney function that persists 3 months or longer. Quantitative UACR screening rates, an early marker for kidney damage, were much lower or may not be adequately captured in administrative claims data. Although guidelines recommend monitoring both eGFR and UACR among patients with T2D, less than 50% of patients were screened for albuminuria during the 1-year follow-up, whereas more than 80% of patients received laboratory orders for serum creatinine measurement. However, albuminuria screening rates may have been underestimated because of the availability of affordable qualitative tests (eg, dipstick test) administered during office visits that are not being filed for reimbursement. Such tests are not captured in administrative claims. Other laboratory orders that are nonspecific to albumin levels, such as urinalysis, were also not captured in the data. Notably, creatinine is tested routinely as part of a comprehensive or basic metabolic panel, and higher testing rates are expected. Recently, the National Kidney Foundation and the American Society for Clinical Pathology jointly endorsed the kidney profile panel, which bundles eGFR and UACR tests, to simplify the test ordering process for primary care physicians and facilitate earlier CKD diagnosis and risk stratification.[15,16]

Laboratory Assessment Screening Awareness

Our results are consistent with those of previously published studies suggesting suboptimal screening rates and diagnosis of CKD among patients with T2D using both recommended serum creatinine and quantitative urine albumin laboratory assessments. The Translating Research Into Action for Diabetes (TRIAD) study (2000-2001) cross-functionally assessed albuminuria screening among eligible US patients with diabetes (ie, no prior known diabetic kidney disease and untreated with angiotensin-converting enzyme inhibitors and angiotensin receptor blockers) and found that approximately 51% of diabetic patients received albuminuria testing.[17] The authors identified factors associated with albuminuria testing, including patient characteristics (eg, age <65 years, lower hemoglobin A_{1c} levels, no cardiovascular disease, presence of hyperlipidemia) and physician characteristics (endocrinologist).[17] Conversely, Stevens et al[18] performed an analysis using the US-based LabCorp database (2002-2003), a regional laboratory database serving Midwestern states, and observed low rates of creatinine testing among patients with diabetes; 22% of diabetic patients received serum creatinine testing within a 12-month period.[18] However, their lack of eGFR testing may have been due to the inclusion of patients with type 1 diabetes as well as patients with T2D in the study population and the lack of creatinine measurements performed at other laboratories during the study period.[18] In France, the 2007 ENTRED (échantillon National Témoin Représentatif des personnes Diabétiques) survey used medical insurance fund data and similarly revealed higher claims for serum creatinine testing (approximately 83%) than albuminuria testing (approximately 29%) among patients with T2D.[19] The Awareness, Detection and Drug Therapy in Type 2 Diabetes and Chronic Kidney Disease (ADD-CKD, 2011-2012) study documented suboptimal urine CKD testing among US primary care physicians; less than half of patients with T2D received albuminuria testing for urine protein (48.6%) and UACR (47.1%).[4] The ADD-CKD study also observed similar estimates of eGFR testing as our analysis (84.8%).[4] In a more recent study, Diamantidis et al[20] evaluated Medicare data (2011-2012) linked with laboratory values and found a lack of CKD identification by clinicians (using *International Classification of Diseases, Ninth Revision* codes for CKD claims) despite a laboratory-confirmed CKD diagnosis (using serum creatinine and urine albumin values). Factors predicting CKD detection by a clinician included CKD severity, nephrologist visit, ethnicity, multimorbidity with chronic disease, urbanity, and frequent outpatient visits in 2010.[20] Our findings also align with those of a large,

robust registry-based study, CURE-CKD (Center for Kidney Disease Research, Education, and Hope), which observed low rates (2.6%) of albuminuria testing among all patients at risk for CKD (ie, patients with hypertension, diabetes, and/or prediabetes) in a large US health care system; UACR testing rates for patients with diabetes or prediabetes alone fared only slightly better (approximately 4%).[21] Less than a tenth of patients with CKD (8.7%) had albuminuria recorded at baseline.[21]

Although the published literature reveals suboptimal CKD testing and diagnosis, the variability in screening laboratory tests may reflect a combination of patient preference and physician barriers to CKD screening. One such barrier may be the dissemination of multiple clinical guidelines over the past 20 years with various discrepancies across the recommendations.[6,22-29] A 2018 systematic review identified 9 different clinical guidelines for CKD diagnosis and management of varying quality.[30] Although the guidelines generally agreed on CKD screening for high-risk patients, some guidelines had expanded the definition of "high-risk." Testing with eGFR, serum creatinine, and proteinuria was often recommended for newly diagnosed CKD; testing for albuminuria, UACR, and other measurements and timing of testing, however, varied across the guidelines. In addition, the CKD screening debate also includes arguments for and against targeting albuminuria levels for treatment.[31,32] Further research is needed to document evidence of the value of CKD screening on preventing clinically relevant outcomes, better understanding patient and physician factors associated with CKD screening, and identify barriers to recommended CKD screening efforts. In addition, future research could assess the impact of the kidney profile laboratory panel established in 2018 and whether an increase in CKD screening using both tests ensued.

Among patients with available laboratory results recorded during follow-up, we found that most patients were captured in CKD stage 3. It is worth noting that patients simultaneously diagnosed with T2D and CKD sometimes suggest a CKD manifestation due to other comorbidities or pathophysiology besides diabetes. Using a US-based Veterans Affairs database (2002-2014), Gatwood et al[33] found that approximately 31% of patients with newly diagnosed diabetes had prior CKD (stage 1-5). Differences in CKD prevalence based on race and region were also observed, leading the authors to recommend implementing CKD screening efforts among veterans with risk factors other than diabetes, including minority race and comorbid cardiovascular disease.[33]

Lastly, a relatively small proportion of patients with T2D had available laboratory results for both eGFR and UACR, suggesting that requiring both test results when defining CKD in administrative databases may not fully capture the population and may limit the sample size of future research.

Study Limitations

Our study has several limitations. First, laboratory tests ordered in an inpatient setting may not be adequately captured in claims, underestimating screening rates for kidney function. Additionally, qualitative tests for albuminuria, which are often administered in the physician's office and are not being billed, were not captured; only quantitative albuminuria tests were captured in our analysis. Second, laboratory test results were available for a subset of patients getting tested in participating laboratories, limiting our sample size. Third, eligibility criteria required patients to be continuously enrolled in their health plan for 365 days following the index date, potentially introducing selection bias. Requiring continuous enrollment during follow-up allowed for the uninterrupted evaluation of outcomes such as CKD screening in the 1-year period following the index date. Fourth, misclassification may have existed because of the nature of claims data (eg, patient health history is only captured during the enrolled time). Patients with prevalent T2D may have been misclassified as having newly recognized T2D. Lastly, it is possible that prevalent events were underestimated if the patient with a disease did not incur claims for their condition during the

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1-year baseline assessment period. A 1-year baseline requirement is frequently applied in claims-based studies of T2D to evaluate patient history for chronic conditions, preserve adequate sample size, and reflect patients with a minimum level of regular interaction with the health care system.

CONCLUSION

Our analysis of US-based administrative claims data indicates that physicians treating patients with diabetes selectively adhere to kidney function screening guidelines proposed by the ADA, as indicated by high rates of eGFR testing but low rates of UACR testing. Despite recommendations to monitor both eGFR and UACR, less than 50% of patients were screened for albuminuria during the 1-year follow-up.

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SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mayoclinicproceedings.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: **ADA** = American Diabetes Association; **CDM** = Clinformatics Data Mart; **CKD** = chronic kidney disease; **eGFR** = estimated glomerular filtration rate; **T2D** = type 2 diabetes; **UACR** = urine albumin to creatinine ratio

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