ORIGINAL RESEARCH ARTICLE

A Quality Improvement Initiative Targeting Chronic Kidney Disease Metrics Through Increased Urinary Albumin Testing

Ken J Park, MD[1]; Robert S Unitan, MD[2]; Micah L Thorp, MPH, DO[1]

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ABSTRACT

Introduction: Achievement of quality metrics in chronic kidney disease (CKD), specifically urinary albumin testing and angiotensin-converting enzyme inhibitor (ACEi) or angiotensin receptor blocker (ARB) use, remained lower in Kaiser Permanente Northwest compared with other Kaiser Permanente regions. We were interested if more frequent testing of urine albumin (ACR) improved CKD quality metrics.

Methods: We implemented a quality improvement project automating ACR testing using an informatics tool in patients with stage 3 CKD linked to an electronic health record (EHR) alert recommending ACEi or ARB initiation in patients with renal indication.

Results: At 1 and 2 years after implementation of ACR testing, ACR testing increased from 26.9% prior to implementation to 83% at 1 year and 77% at 2 year after implementation ($p < 0.001$). However, ACEi or ARB use did not increase significantly (65.8% vs 65.7% vs 66.4%, $p = 0.54$). There was also no significant change in other quality metrics, including diabetes control, hypertension control, and comanagement of higher-risk CKD patients.

Discussion and Conclusion: In patients with stage 3 CKD, increased ACR testing via automated testing linked with EHR alert did not result in an improvement in CKD quality metrics.

INTRODUCTION

Chronic kidney disease (CKD) affects about 15% of the US population. CKD has been associated with adverse outcomes, including end-stage renal disease and cardiovascular morbidity and mortality, and is the ninth leading cause of death in the US.[1-3] Although high-quality evidence shows that blood pressure control, angiotensin-converting enzyme inhibitor (ACEi) or angiotensin receptor blocker (ARB) use, and diabetes mellitus (DM) control delay CKD progression, the overall number of CKD patients meeting these metrics remains suboptimal.[4,5] For example, Murphy et al[6] examined trends in ACEi or ARB use from 1999 to 2014 and found that the trends remained flat after an initial increase from 25.5% from 1999 to 2002 to 39% from 2007 to 2010. Tummalapalli et al[4] examined blood pressure control and diabetes control in CKD using data from the National Ambulatory Care Survey and noted uncontrolled hypertension in 26% of patients and uncontrolled DM in 24% of patients.

The Chronic Kidney Disease Interregional Group consists of nephrology leaders from the different regions in Kaiser Permanente who regularly evaluate CKD quality metrics across the different regions. They had adopted ACEi or ARB use and albumin creatinine (ACR) testing in CKD as important quality metrics. The Northwest region was noted to have the lowest performance for annual assessment for urinary albumin at 35% in 2017. Use of ACEi or ARB was also lower compared with other regions. We identified that patients who had not been assessed for urinary albumin were significantly less likely to be on an ACEi or ARB compared with patients who had been assessed for urinary albumin (67% vs 60.1%, $p < 0.001$). We implemented a quality improvement project using existing informatics tools targeting increasing urinary ACR testing in CKD patients with the expectation that improvement in assessment in urinary albumin in CKD would also improve quality metrics, including ACEi or ARB use, control of hypertension and diabetes, and comanagement of higher-risk CKD patients.

METHODS

Context

The quality improvement project was conducted in Kaiser Permanente Northwest (KPNW), a large integrated health care system serving Oregon and Washington. KPNW serves around 600,000 members and is comprised of 1200 physicians, 60 medical offices, and 4 medical centers. Health information, including demographics, clinical encounters, medications (along with dosages and dispense dates), and laboratory results, are stored in a comprehensive electronic health record (EHR) (Epic, Verona, WI). Providers are supported by several informatics tools integrated into the EHR, including disease registries, tools identifying care gaps and alerting provider to best practice recommendations, tools automating ordering of certain laboratoriess based on care gaps, and decision support tools.

Intervention and Design

We targeted patients enrolled into a CKD registry in which a web-based tool would automatically order an ACR

Author Affiliations

[1] Department of Nephrology, Kaiser Permanente Northwest, Portland, OR

[2] Department of Medical Informatics, Kaiser Permanente Northwest, Portland, OR

Corresponding Author

Ken J Park, MD (ken.j.park@kp.org)

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in patients with CKD stage 3 (defined as estimated glomerular filtration rate [eGFR] < 60 mL/min or stage 3 CKD on problem list) who did not have an ACR or urine protein creatinine ratio checked within the past year. Patients were enrolled in a CKD registry if they had an active diagnosis of CKD in their EHR problem list based on ICD10 codes (N18.x) or had 2 eGFR < 60 mL/min calculated using the Chronic Kidney Disease Epidemiology Collaboration equation at least 90 days apart and no more than 2 years apart. Because the CKD registry only included active members, patients were removed from the registry if they lost Kaiser insurance or died or entered the registry if given a new diagnosis of CKD 3. We estimated that there was about a 20% turnover in the registry from year to year. In patients with a renal indication for ACEi or ARB not on an ACEi or ARB (active diagnosis of hypertension and an ACR > 30 mg/g with DM or an ACR > 300 mg/g without DM), primary care providers would receive an EHR alert at time of office visit recommending initiation. The intervention was implemented in May 2018. Education sessions were provided from May to September 2018 to individual primary care clinics regarding best practice interventions in patients with abnormal ACR. These include initiation of ACEi or ARBs, blood pressure and diabetes control, and guidelines for referral to nephrology. Further outreach was done in June 2019 via a department-wide presentation and email communication promoting use of a 5-year renal replacement therapy (RRT) risk calculator in the EHR and guidelines for referral to nephrology.

Measurement and Analysis

The primary objective of this project was to increase ACR testing done within 1 year in patients with stage 3 CKD. Our secondary objectives were to increase overall ACEi or ARB use in patients with renal indications, to improve DM control, to improve hypertension control, and to increase comanagement of higher-risk stage 3 CKD patients with nephrology. We chose these outcomes based on studies showing that control of DM and hypertension slow the progression of CKD.[5,7] Several studies have shown that earlier referral to nephrology was associated with decreased mortality and possibly a slower decline in eGFR.[8,9]

Data were obtained from a CKD registry at baseline and over 2 years at yearly intervals: April 2018 (1 month prior to implementation of automated ACR testing), April 2019, and April 2020. Patients were defined as having hypertension if they had an active diagnosis of hypertension on their problem list based on ICD10 codes (I10.x, I11.x, I12.x, I13.x, I15.x, I67.4, H35.03). Patients were defined as having diabetes if they had an active diagnosis of diabetes on their problem list based on ICD10 codes (E10.x, E11.x). For our analysis, we excluded patients younger than 18 or older than 85 years of age, patients with last measured eGFR < 30 mL/min or ≥ 60 mL/min, or last eGFR measurement > 1 year from the time point of interest. We defined DM control as last HgbA1c < 8% within 1 year, hypertension control as blood pressure < 140/90 mmHg within 1 year, and nephrology comanagement as patients who had been seen by a nephrologist either in office or virtually (defined as video or phone appointment) within 1 year. We defined higher-risk stage 3 CKD patients as having a 5-year risk for RRT > 5% based on the 4-variable Kidney Risk Failure Equation.[10,11]

Changes in continuous variables were compared using Student's *t*-test. Changes in categorical variables were compared using Pearson's χ^2 test. Statistical significance was defined as $p < 0.05$. Statistical analysis was done using R Version 3.6.2 (The R Foundation, Free Software Foundation, Boston, MA). This quality improvement project was reviewed by the institutional review board of KPNW and deemed not to require institutional review board approval and oversight because no Patient Health Information was collected for this study.

Table 1. Characteristics of stage 3 Chronic Kidney Disease registry at 3 time points[a]

Characteristic	April 2018	April 2019	April 2020
Number	10,418	10,312	10,206
Mean age, y	72.7	73	73.4
Sex, % male	44.3	43.9	44.3
Diabetes, %	38.5	37.6	36.7
Hypertension, %	80.2	79.7	79.7
eGFR, mL/min (mean)	46.7	47.2	47.2
Comanaged by nephrology, %	17.2	18.3	19.8
Albuminuria stage,[b] %			
A1	24	61.4	61.5
A2	10.1	21.4	23.7
A3	7.1	9.9	10.2
Not measured	58.8	7.3	4.7

[a] Automated urinary albumin testing was implemented May 2018. The second and third time points followed implementation of automated urinary albumin testing.
[b] A1 defined as urinary albumin creatinine ratio < 30 mg/g, A2 as urinary albumin creatinine 30-300 mg/g, and A3 was urinary albumin creatinine > 300 mg/g looking up to 3 y back.
eGFR = estimated glomerular filtration rate.

RESULTS

The number of patients with stage 3 CKD in the registry remained similar at around 10,000 patients at the 3 times points. Baseline characteristics were similar at all 3 time points; average age was around 73 years, 80% of patients had hypertension, 37% had DM, and 44% were male (Table 1). Compared with April 2018, there was an increase in the number of patients with stage A2 and A3 albuminuria

Table 2. Quality metrics of stage 3 Chronic Kidney Disease registry after implementation of automated urinary albumin testing[a]

Quality Metric	April 2018	April 2019	April 2020	p value
Albuminuria testing within 1 y, %	26.9	83	77	< 0.001
Albuminuria testing within 3 y, %	41.2	92.7	95.3	< 0.001
ACE inhibitor or ARB use, %	65.8	65.7	66.4	0.54
ACE inhibitor or ARB use with renal indications,[b] %	77.7	80.4	80.5	0.10
Hgba1c < 8%, %	79.3	79.5	78.2	0.28
BP < 140/90 mmHg, %	75.2	75.4	73.3	0.003

[a] Automated urinary albumin testing was implemented May 2018.
[b] Renal indication for ACE inhibitor or ARB defined as active diagnosis of hypertension and random urinary albumin creatinine ratio > 30 mg/g in diabetics or random urinary albumin creatinine ratio > 300 mg/g in nondiabetics.
ACE = angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP = blood pressure; Hgba1c = hemoglobin A1c.

in April 2019 and April 2020, which was expected with increased ACR testing.

Compared with April 2018, we were able to achieve a significant increase in ACR testing done within 1 year from 26.9% at baseline to 83% in April 2019 and 77% in April 2020 ($p < 0.001$; Table 2). We attributed the slight decline in ACR testing from April 2019 to April 2020 due to the COVID-19 pandemic, which limited patients' ability to come to laboratory. The percentage of patients who had ACR testing done within 3 years also increased significantly from 41.2% in April 2018 to 92.7% in April 2019 and 95.3% in April 2020 ($p < 0.001$).

Despite the significant increase in ACR testing, overall ACEi or ARB use remained unchanged at the 2 dates after implementation of automatic ACR testing (65.8% vs 65.7% vs 66.4%, $p = 0.54$; Table 2). There was a slight increase in ACEi or ARB use among patients with renal indications, but this was not significant. There was no significant change in DM control in April 2019 and April 2020 compared with April 2018. There was a slight but significant worsening of blood pressure control in April 2020 compared with April 2018 (73.3% vs 75.2%, $p = 0.003$). The COVID-19 pandemic likely resulted in fewer opportunities to manage hypertension in patients with uncontrolled hypertension.

We examined whether ACR testing and ACEi or ARB use differed based on DM status (Table 3). We saw that ACR testing increased significantly at the 2 follow-up periods in CKD patients with and without DM. We did not see a significant increase in ACEi or ARB use divided by DM status after implementation of ACR testing. Overall, patients with CKD without DM were less likely to be on an ACEi or ARB, which persisted despite the increase in ACR testing. However, when restricted to patients with renal indication, the difference in ACEi or ARB use was much smaller.

We saw a significant increase in the percentage of patients followed by nephrology from April 2018 to April 2019 and April 2020 (17.2% vs 18.3% vs 19.8%, $p < 0.001$). However, among patients at higher risk for RRT, we did not see a significant increase and rather saw a decrease in comanagement with nephrology (Table 4). We also did not see significant improvement in DM control, blood pressure control, or ACEi or ARB use in the 2 follow-up time points after implementation of automated ACR testing compared with prior to ACR testing among patients at higher risk for RRT.

Table 3. Change in quality metrics of stage 3 chronic kidney disease registry based on diabetes status prior to and after implementation of automated urinary albumin testing[a]

Metric	April 2018	April 2019	April 2020	p value
Albuminuria testing within 1 y, %				
Diabetes	38.1	81.7	77.8	< 0.001
No diabetes	20	83.9	75.2	< 0.001
ACE inhibitor or ARB use, %				
Diabetes	78.8	78.7	78.3	0.83
No diabetes	57.6	57.9	59.5	0.07
ACE inhibitor or ARB use with renal indications,[b] %				
Diabetes	78.5	81.3	80.8	0.18
No diabetes	73	76	78.4	0.39

[a] Automated urinary albumin testing was implemented May 2018.
[b] Renal indication for ACE inhibitor or ARB defined as active diagnosis of hypertension and random urinary albumin creatinine ratio > 30 mg/g in diabetics or random urinary albumin creatinine ratio > 300 mg/g in nondiabetics.
ACE = angiotensin-converting enzyme; ARB, angiotensin receptor blocker.

DISCUSSION

Our quality improvement project successfully increased testing for ACR in CKD at 1 and 2 years but failed to result in an increase in CKD quality metrics over 2 years despite additional interventions (ie, educational outreach and incorporation of decision support) to help guide nephrology referrals. We specifically looked at several quality measures, including prescribing of ACEi or ARB's, blood pressure control (< 140/90 mmHg), diabetes control (HgbA1c < 8%), and comanagement with a nephrologist in patients with 5-year risk > 5% for RRT based on Kidney Risk Failure Equations. We expected that a large significant increase in

Table 4. Quality metrics of stage 3 Chronic Kidney Disease registry among chronic kidney disease patients with 5-y risk for renal replacement therapy > 5%[a] after implementation of automated urinary albumin testing[b] and integration of 5-y renal replacement risk score into electronic heath records[c]

Quality Metric	April 2018	April 2019	April 2020	p value
ACE inhibitor or ARB use, %	69.6	73.9	73.2	0.07
ACE inhibitor or ARB use with renal indications,[d] %	75.4	79.4	77.5	0.20
Hgba1c < 8%, %	71.6	71.6	67.3	0.13
BP < 140/90 mmHg, %	67.7	67.3	65.6	0.59
Seen by nephrology within 1 y,%	69.5	59.4	59.9	< 0.001

[a] Five-year risk for renal replacement therapy calculated based on the 4-variable Kidney Failure Risk Equation.
[b] Automated urinary albumin testing was implemented May 2018.
[c] Integration of 5-y renal replacement risk score into electronic heath records was implemented May 2019.
[d] Renal indication for ACE inhibitor or ARB defined as active diagnosis of hypertension and random urinary albumin creatinine ratio > 30 mg/g in diabetics or random urinary albumin creatinine ratio > 300 mg/g in nondiabetics.
ACE = angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP = blood pressure; Hgba1c = hemoglobin A1c.

ACR testing would increase ACEi or ARB prescription and referrals of higher- risk CKD patients to nephrology. In retrospect, the lack of improvement in CKD quality metrics may have been due to the high baseline use of ACEi and ARBs. The lack of improvement in blood pressure and diabetes control may also have resulted from high baseline performance in primary care providers.

Annual measurement of urinary albumin has been recommended by the Kidney Disease: Improving Global Outcomes society as part of the management of CKD and has been included as a metric in some quality improvement interventions for CKD.[12] It is generally well accepted that measurement of urinary albumin is important in risk stratification of CKD because elevated ACR has been shown to be a strong prognostic marker for progression of CKD, increased cardiovascular morbidity and mortality, and increased risk for acute kidney injury.[13-15] Despite this recommendation, urinary albumin testing remains low in patients with CKD.[16] One important reason for this may be that evidence regarding increased ACR testing resulting in improved renal outcomes is lacking. Perkins et al[17] looked at trends in incident stage G3A CKD patients from 2004 to 2012 and, despite an increase in urinary albumin testing, found no significant increase in ACEi or ARB use. Our study also failed to show any association between increasing urinary albumin testing with CKD quality metrics. In addition, there are several potential harms with increased testing that our study did not address, including increased cost to the patient, increased patient anxiety regarding the meaning of abnormal test results, and increased provider burden responding to those concerns.[18]

Informatics tools are increasingly studied as a promising method to improve CKD care in the primary care setting. However, published studies so far have been inconsistent in showing overall improvement in CKD quality metrics with these tools. Tuot et al[19] randomized 746 patients with CKD to either a CKD registry, which identified and alerted providers to patients not meeting quality metrics including blood pressure control, ACEi or ARB use, and annual ACR testing vs usual care. After 1 year, they found an increase in ACR testing and ACEi or ARB prescribing but no change in blood pressure. Abdel-Kader et al[20] conducted a cluster randomized control trial of 248 patients with eGFR < 45 mL/min in which primary care providers were randomized to receive an EHR alert recommending measurement of ACR and referral to nephrology vs usual care. At 1 year, there was no difference in blood pressure control, ACEi or ARB use, ACR measurement, or nephrology referral. Sequist et al[21] conducted a randomized control trial in which half of 153 primary care physicians caring for around 7500 stage 3 CKD patients were randomized to receive electronic alerts during office visits recommending nephrology referral and ACEi or ARB use if indicated. At 12 months, the authors found a higher percentage of nephrology referrals in the intervention group but no difference in ACEi or ARB use.

We surmise several reasons for the lack of improvement in quality metrics despite the increase in ACR testing. First, the lack of increase in ACEi or ARB use could be attributed to higher use of ACEi or ARBs compared with the national average. Second, the rates of ACEi or ARB use are higher when examining their use in patients with renal indications. This is especially true in patients with CKD with and without DM. The gap in ACEi or ARB use that existed largely disappeared when limiting it to patients with renal indications. Finally, the lack of change in referrals of higher-risk CKD patients to nephrology could be attributed to the uncertainty among primary care providers regarding when to refer to nephrology.[22] Several studies underway using other informatics tools may answer whether that approach may improve CKD quality metrics.[23,24]

Our project had several limitations. First, the design did not allow us to determine causation but rather indicated an association between increased ACR testing with CKD

quality metrics. Second, it is possible that other interventions during that time could have affected the outcome. During the intervening period, American Heart Association Hypertension 2017 Guidelines were adopted by KPNW. However, this would more likely have resulted in better rather than worsening hypertension control. Third, due to the higher use of ACEi and ARBs at baseline and higher blood pressure and diabetes control in our healthcare system, the generalizability of our findings to other healthcare systems may be limited. It is possible that increased ACR testing would have more of an impact in other healthcare systems that perform at a lower level in these metrics. Finally, the design and short follow- up of our study did not allow us to measure change in eGFR, blood pressure control, or ACEi or ARB use at an individual level, which would be a more meaningful measure.

CONCLUSION

In conclusion, in patients with stage 3 CKD, a quality improvement project targeting increasing urinary albumin testing via automation linked with EHR alerts did not result in an overall improvement in CKD quality metrics. Due to the study limitations, future studies are needed to assess if other interventions may result in improvement in CKD quality metrics. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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Authors' Contributions

Ken J Park, MD, Robert S Unitan, MD, and Micah L Thorp, MPH, DO, participated in the design and concept. Ken J Park, MD, participated in the analysis and writing of the manuscript. All authors have given final approval to the manuscript.

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