Kidney Medicine

Patient Electronic Health Record Portal Use and Patient-Centered Outcomes in CKD

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Rationale & Objective: Electronic health record portals are increasingly emphasized in chronic kidney disease (CKD). However, associations of portal use with clinical and patient-centered outcomes remain unknown.

Study Design: Cross-sectional survey (April 2015 to March 2018).

Setting & Participants: Nondialysis patients with CKD from nephrology clinics within 1 academic medical center.

Exposures: Patient demographics (age, sex, race, ethnicity, education, and income), kidney function.

Outcomes: Association between portal use as an outcome and exposures. Additionally, associations of portal use and patient demographics with 4 patient–centered outcomes (CKD-specific knowledge, stress, and 2 self-ratings of health).

Analytic Approach: Logistic regression to examine associations between patient portal use, demographics, and kidney function. Linear regression to examine associations between portal use and patient-centered outcomes.

Results: Of 245 participants, mean age was 60 ± 17 (SD) years, 182 (77%) were White, 121 (49%) were women, 230 (96%) had a high school education or higher, and 96 (45%) had <$50,000 annual income. Examining portal use, 159 (65%) used the portal as follows: checking laboratory test results, 157 (99%); managing appointments, 133 (84%); messaging providers, 131 (82%); viewing medical history, 127 (80%); reviewing educational resources, 113 (71%); and renewing prescriptions, 98 (62%). African Americans (OR, 0.34; 95% CI, 0.16-0.72 vs White patients), patients with less formal education (OR, 0.06; 95% CI, 0.01-0.36), and those with lower income (OR, 0.28; 95% CI, 0.13-0.60; and OR, 0.26; 95% CI, 0.12-0.54 comparing income < $25,000 and $25,000-$50,000, respectively, with ≥$50,000) had lower odds of using the portal. In adjusted analysis, only lower income predicted lower portal use. Examining patient-centered outcomes in univariable analysis, portal users had higher knowledge (β = 4.89; $P = 0.02$), higher ratings of current health (β = 0.28; $P = 0.03$), and lower CKD-related stress (β = −0.18; $P = 0.05$). In adjusted analysis, only patient demographics and/or kidney function remained independent predictors of patient-centered outcomes.

Limitations: Cross-sectional study design, cannot determine causality.

Conclusions: Interventions are needed to ensure that all patients have access to portals to mitigate disparities in care.

Visual Abstract included

Complete author and article information provided before references.

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Chronic kidney disease (CKD) is highly prevalent and contributes to substantial morbidity and mortality.[1] However, many patients are not fully engaged in their care and remain unaware of their diagnosis and its implications.[2] There exist opportunities to strengthen management by educating patients about CKD and increasing engagement through effective patient-provider communication.[3,4] Electronic health record (EHR) patient portals may provide one strategy to enhance patient-provider communication, optimize information sharing, and allow patients to be more engaged in CKD care.[5,6]

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Patient portals have substantial heterogeneity across health systems but most commonly they are embedded within a health system's EHR to offer patients a way to access their personalized health records online through a unique login on a computer or telephone.[7-9] Some portals also offer summary information for patients reviewing their chart and additional links to vetted educational resources. Two prior studies showed that African Americans, older patients, and patients whose primary insurance is Medicaid were less likely to use portals compared with White patients, younger patients, and those with other forms of insurance. However, these studies were single center and did not examine proximal outcomes that are critical in chronic disease management.[10,11]

Per the US Food and Drug Administration a Patient centered outcome is, "important to patients' survival, functioning, or feelings as identified or affirmed by patients themselves"[12] and may include patient knowledge, perceptions about their disease, and current health status. Although giving patients an increased connection to information through a portal could support these areas and optimize communication and reassurance from providers,[13,14] there is a paucity of data examining whether associations exist between portal use and any patient-centered outcomes in CKD.[15] Additionally, the association of health portal use and clinical outcomes remains poorly characterized, particularly with respect to kidney

PLAIN-LANGUAGE SUMMARY

On-line resources to support patients are increasingly emphasized in chronic kidney disease (CKD). We examined whether patient use of an electronic health record portal was associated with demographics or kidney function and whether portal use predicted patient-centered outcomes (CKD-specific knowledge, stress, and self-ratings of health). A cross-sectional survey was administered to adults with nondialysis CKD (April 2015 to March 2018). African Americans, those with less formal education, and those with lower incomes had a lower likelihood of portal use. Portal users had higher knowledge, higher ratings of current health, and lower CKD-related stress. In adjusted analysis, only patient demographics and/or kidney function remained independent predictors of patient-centered outcomes. Interventions are needed to ensure that all patients have access to portals to mitigate disparities in care.

function. As portals are increasingly adopted and promoted, it is important to understand how portal use may associate with clinical and patient-reported outcomes that are important to patients.

In this study we examined whether kidney function was associated with portal use at 1 large medical system and whether characteristics that predicted use of portals in prior studies were similar in our cohort. We also examined whether health portal use was associated with 4 patient-centered outcomes (disease knowledge, disease-related stress, and 2 patient self-ratings of health). We hypothesized that use of the health portal would be associated similarly with patient demographics as with prior work and that its use would also be associated with higher CKD knowledge, lower CKD stress, and better self-reported health status.[16-18]

METHODS

Study Setting and Design

Adult patients with non–dialysis-dependent CKD were invited to participate during nephrology clinic follow-up visits between April 2015 and March 2018. Nephrology clinics spanned general nephrology practices at 1 large medical system, including those focused on care for patients with advanced CKD. Surveys were administered immediately after the clinic visits. Specifically for this study, patients were asked about: (1) whether they used the portal and if so, how they used it (8 questions); (2) kidney knowledge (28 questions); (3) disease-related stress (8 questions); and (4) physical health (2 questions).[19,20]

Study Population

Study inclusion criteria were patients with non–dialysis-dependent CKD stages 1-5 as defined by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) guidelines, age of 18 years or older, completion of at least 1 other visit with their clinic nephrologist before enrollment, and ability to understand and/or speak English (consent forms and surveys were available only in English).[21] Exclusion criteria were new patients, those receiving dialysis or who had a current functioning kidney transplant, and patients with severe cognitive or visual impairment. All participants were approached after a routine nephrology visit and provided written informed consent. The study was approved by the University of Michigan Institutional Review Board (HUM00071797).

Patient Characteristics and Exposures

Health System Portal Use

To explore patient EHR portal use, we asked patients whether they used the patient portal: "Do you use (the specific health system name) portal? Yes, No, I don't know." We left an option for "I don't know" because our prior work revealed that some patients do not want to skip questions but may not know an answer. For those responding yes, we then asked what they used the portal for, whereby patients could choose more than 1 response option. First we examined characteristics at baseline for all participants. We then analyzed associations of patient characteristics with portal use, using only respondents who were sure whether they used the portal, that is, responded yes/no.

Baseline Demographics and Covariables

Additional survey questions inquired about sociodemographic characteristics (age, sex, race, ethnicity, educational attainment, and income). In addition, estimated glomerular filtration rate was collected from the EHR by trained study personnel and was taken from data points closest to the time of enrollment, most often on the same day. Estimated glomerular filtration rate was extracted from the chart and the laboratory equation used was calculated using the Modification of Diet in Renal Disease (MDRD) Study equation[22] and was then categorized into severity stage of CKD using NKF-K/DOQI criteria.

Patient-Centered Outcomes

Portal use was examined as a potential predictor of 4 patient-centered outcomes. To measure patient kidney disease knowledge, the Kidney Knowledge Survey was used.[19] This is a validated 28-item test that measures objective knowledge acquisition about CKD in patients. The knowledge test is standardized to represent percent of correct responses (eg, 0.68 is equivalent to 68% correct on a scale from 0%-100%).

Disease-specific stress was measured using an adapted scale derived from The Memorial Anxiety Scale, an anxiety scale for men with prostate cancer.[23] This scale was adapted from a large prostate cancer survey to measure

psychological stress in patients.[20] Other CKD-specific scales emphasize the physiologic, logistical, and psychosocial stressors experienced by patients during dialysis or after transplantation. Instead, the Memorial Anxiety Scale items most closely matched our objective of evaluating how patients think and feel about their diagnosis. Ratings are made on a scale of 0 to 3 for worrying, with 0 representing "not at all" and 3 representing "often." The summarized average of scores on 6 questions comprise a level of general anxiety that patients felt about their condition. Two additional questions were added related to specific questions about kidney disease for our study, asking patients to estimate how much time they spend worrying about their kidney disease getting worse and how much time they worry about possibly needing dialysis.

Patients' evaluations of their health were measured using 2 questions: "In general, would you say your health is" with response options for excellent, very good, good, fair, or poor derived from the 36-Item Short Form Health Survey quality-of-life measures, with the scale only adjusted from 0 to 4 from the original scale of 1 to 5.[24,25] A second question asked patients to compare their health to 1 year ago, using a scale from much worse (−2) to much better (+2). The association of portal use and the 4 patient-centered outcomes was performed using linear regression.

Although data are limited on portal use and associations with outcomes in CKD, we used available prior studies and research in other conditions to inform a model of hypothesized relationships between independent variables and outcomes.[26] Figure 1 illustrates our hypothesized model of how patient characteristics may be associated with portal use and how portal use may affect patient-centered and clinical outcomes.

Statistical Analysis

Standard descriptive statistics were used to describe patients' sociodemographic characteristics, clinical measurements, and CKD stage. Patient characteristics were expressed as mean ± standard deviation for continuous variables and frequency and percentage for categorical variables. The Kidney Knowledge Survey, disease-specific stress, and 2 self-ratings of health were summarized into average scores and presented as mean ± standard deviation along with the median, 25th, and 75th percentiles.

Logistic regression was used to examine factors associated with portal use. In unadjusted analyses, we examined the association of portal use (binary dependent variable) with age, sex, race, education, income, and CKD stages as independent variables, using simple logistic regression. In the multivariable-adjusted analysis, we modeled patient portal use while adjusting for age, sex, race, education, income, and CKD stages. CKD stage 3 was used as the reference group because it represented most patients in this study.

Linear regression was used to examine factors associated with the patient-centered outcomes of CKD knowledge, CKD disease-specific stress, and the 2 patient self-reported health ratings. Age, self-rating of health, disease-specific stress, and CKD knowledge scores were modeled as continuous variables while sex, race, education, income, and CKD stage were modeled as categorical variables.

The statistical analysis used RStudio, version 1.2.5019 (RStudio), with R, version 3.6.1 (R Foundation), released July 5, 2019. This analysis implemented linear and logistic regressions using the *lm* and *glm* functions, respectively.

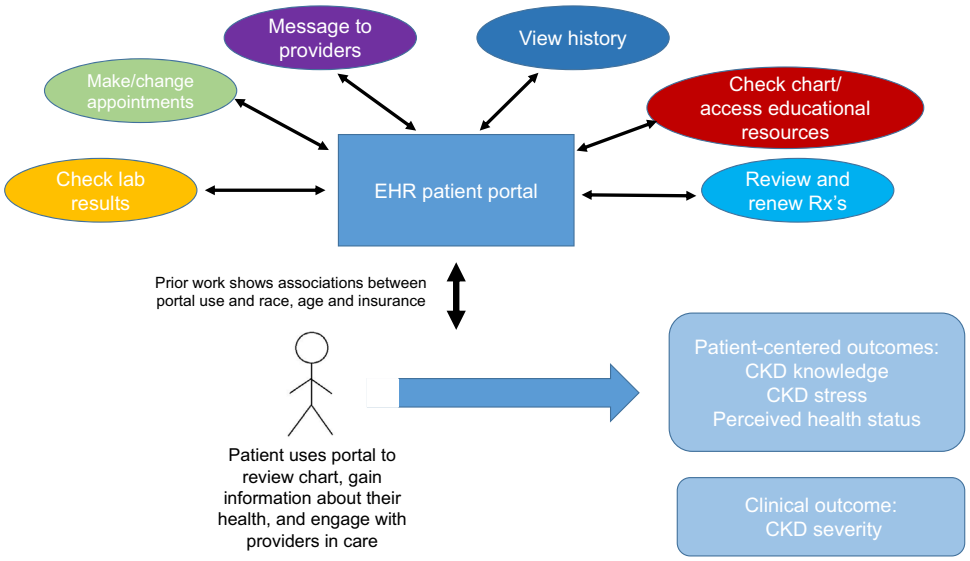

Figure 1. Model of patient electronic health record (EHR) portal use, uses to patient, prior work association with some demographics, and how it may associate with patient-centered and clinical outcomes. Abbreviations: CKD, chronic kidney disease; lab, laboratory.

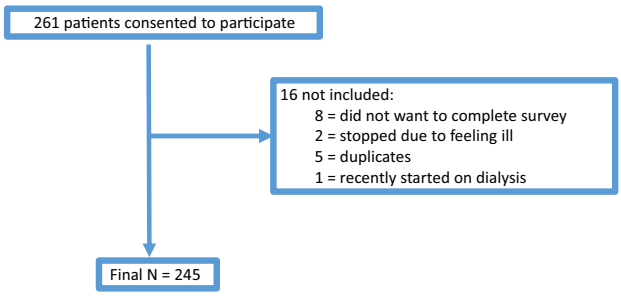

Figure 2. Study flow diagram.

RESULTS

Two hundred sixty-one patients consented to participate. Sixteen were not included in analysis for the following reasons: patients not wanting to complete the survey = 8, reported feeling ill and did not want to continue = 2, duplicates = 5, and 1 who was not eligible (had recently started dialysis). A final number of 245 patients were analyzed. A flow diagram is included in Fig 2. Mean participant age was 60 ± 17 years, 182 (77%) were White, 121 (49%) were women, 230 (96%) had a high school education or higher, and 96 (45%) had <$50,000 annual income (Table 1).

The summary score for patient current self-reported health status was 2.7 ± 0.9 (between fair and good), difference in self-reported health status (current vs 1 year prior) was 0.2 ± 1.0 (between the same as 1 year ago and somewhat better than 1 year ago), accuracy score for CKD knowledge was 0.67 ± 0.17, indicating 67% correct on a scale from 0% to 100%, and for CKD disease-specific stress was 1.1 ± 0.7, with 0 to 3 for worrying, with 0 representing "not at all" and 3 "often" (Table 1).

Overall, 159 (65%) participants indicated that they used the EHR patient portal. Figure 3 summarizes how these patients reported using the portal, with 157 (99%) using the portal to check laboratory test results; 133 (84%), to make or change clinic appointments; 131 (82%), to send messages to providers; 127 (80%), to view their medical history; 113 (71%), to check information including patient educational resources; and 98 (62%), to review or renew prescriptions (Fig 3).

In the unadjusted analysis, African Americans (odds ratio [OR], 0.34; 95% CI, 0.16-0.72), those with less formal education (OR, 0.06; 95% CI, 0.01-0.36), and those with lower income (OR, 0.28; 95% CI, 0.13-0.60

Table 1. Baseline Characteristics of Cohort, Total and by Response to Whether They Used the Electronic Health Record Portal

	Total (N = 245)	Use Portal (n = 159; 65%)	Do Not Use Portal (n = 76; 31%)	Nonresponse or "I Don't Know" (n = 10; 4%)
Age, y	60 ± 17	59 ± 16	61 ± 17	60 ± 24
Sex				
Male	117 (48%)	76 (48%)	37 (49%)	4 (40%)
Female	121 (49%)	80 (50%)	38 (50%)	3 (30%)
No response/other/transgender	7 (3%)	3 (2%)	1 (1%)	3 (30%)
Race/ethnicity				
White	182 (77%)	128 (82%)	49 (68%)	5 (71%)
African American	35 (15%)	16 (10%)	18 (25%)	1 (14%)
Other	18 (8%)	12 (8%)	5 (7%)	1 (14%)
Education				
<HS graduate	10 (4%)	1 (1%)	7 (9%)	2 (25%)
≥HS graduate	230 (96%)	156 (99%)	68 (91%)	6 (75%)
Income				
<$25,000	47 (22%)	23 (17%)	21 (31%)	3 (43%)
$25,000-<$50,000	49 (23%)	23 (17%)	23 (34%)	3 (43%)
≥$50,000	113 (54%)	89 (66%)	23 (34%)	1 (14%)
eGFR, mL/min/1.73 m^2	34 (16)	35 (16)	32 (15)	38 (23)
Stage 1-2	30 (12%)	20 (13%)	9 (12%)	1 (10%)
Stage 3a	28 (11%)	23 (14%)	4 (5%)	1 (10%)
Stage 3b	75 (31%)	49 (31%)	22 (29%)	4 (40%)
Stage 4-5	112 (46%)	67 (42%)	41 (54%)	4 (40%)
CKD knowledge, % correct (n = 245)	67 (17)	69 (15)	65 (16)	46 (30)
CKD stress (n = 244)	1.1 (0.7)	1 (0.6)	1.2 (0.8)	1.3 (0.8)
Health status (n = 240)	2.7 (0.9)	2.8 (0.9)	2.5 (0.9)	2.6 (1.2)
Current health compared to 1 y ago (n = 239)	0.2 (1)	0.1 (1)	0.1 (1)	0.5 (0.5)

Note: Values expressed as mean ± standard deviation or number (percent). CKD knowledge: 67 = 67% correct on a 28-item knowledge test; CKD stress, 6 items: on scale of 0 to 3, how often patients worry or think about CKD (0, not at all; 3, often); health status: in general would you say your health is: poor, fair, good, very good, excellent (1-5); health status compared to prior: on scale from −2 to +2 (−2, much worse now than 1 year ago, much better now than 1 year ago).
Abbreviations: CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; HS, high school.

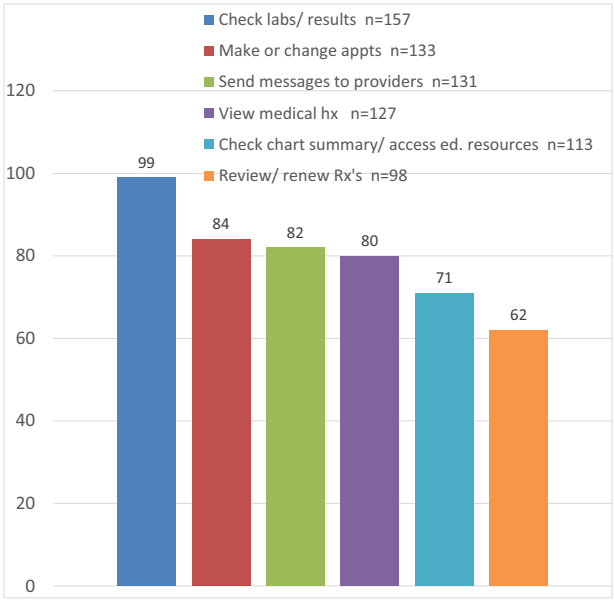

Figure 3. Proportion of patients reporting how they use portal, N = 159. Abbreviations: appt, appointment; hx, history; lab, laboratory; Rx, prescription.

for those making <$25,000 annually and OR, 0.26; 95% CI, 0.12-0.54, for those making $25,000-$50,000 annually compared with ≥$50,000) were all significantly less likely to use the portal (Table S1). In adjusted analyses, only lower income (OR, 0.34; 95% CI, 0.14-0.80 for those making <$25,000 annually and OR, 0.29; 95% CI, 0.13-0.62, for those making $25,000-$50,000 compared with ≥$50,000) remained independently associated with portal use. CKD stage was not associated with odds of portal use in unadjusted or adjusted analyses (Table 2).

On examining whether portal use was associated with the 4 patient-centered outcomes, we found that portal use was significantly associated with higher CKD knowledge (β = 4.89; 95% CI, 0.74 to 9.04; P = 0.02), higher ratings of current health status (β = 0.28; 95% CI, 0.02 to 0.54; P = 0.03), and a trend of less CKD stress (β = −0.18; 95% CI, −0.36 to 0.0; P = 0.05). However, on multivariable analyses adjusting for patient demographics (Tables 3-6), these associations with portal use were attenuated. Instead, the 4 patient-centered outcomes were only significantly associated with specific demographics and/or CKD severity as follows. CKD stage 4-5 was associated with higher CKD knowledge (β = 4.67; 95% CI, 0.34 to 9.01; P = 0.03). Younger age (β = −0.01; 95% CI, −0.01 to 0; P = 0.02), African American race (β = 0.35; 95% CI, 0.1 to 0.6; P = 0.01), and CKD stage 4-5 (β = 0.2; 95% CI, 0.01 to 0.39; P = 0.04) were associated with more patient-perceived CKD stress. Lower income, that is, making < $25,000 annually, exhibited a trend of lower self-rating of current health (β = −0.36; 95% CI, −0.73 to 0.0; P = 0.05). Persons of races other than White and African American had higher 1-year health status (β = 0.56; 95% CI, 0.03-1.08; P = 0.04) and those of lower income < $50,000 annually reported a trend as well (β = 0.34; 95% CI, 0.01-0.69; P = 0.05; Tables 3-6).

DISCUSSION

Our study shows that patients use the health portal for many important areas of care and support. We report estimated glomerular filtration rate in baseline characteristics and in the analysis found that portal use was not associated with kidney function. Similar to prior work, we found a lower likelihood of use in African Americans.[11] We also identified lower use in patients with less formal education and those with lower incomes. However, after adjustment including these factors, we found that only income was associated with health portal use.

Table 2. Logistic Regression Model; ORs for Portal Use–Adjusted Analysis

Variable	OR	Lower Bound of 95% CI	Upper Bound of 95% CI	*P*
Age, y	0.98	0.96	1	0.13
Sex (compared to female)[a]				
Male	0.72	0.37	1.37	0.32
Race				
African American	0.5	0.21	1.2	0.12
Other	1.6	0.45	7.08	0.49
Education (compared to ≥HS grad)				
<HS grad	0.2	0.01	1.52	0.17
Income (compared to ≥$5,000)				
<$25,000	0.34	0.14	0.8	0.01
$25,000-<$50,000	0.29	0.13	0.62	< 0.005
Stage (compared to stage 3)				
Stage 1-2	0.83	0.27	2.75	0.76
Stage 4-5	0.63	0.31	1.26	0.2

Abbreviations: HS, high school; OR, odds ratio.
[a]Seven patients for sex had no response/other/transgender, not included due to missing survey data.

Table 3. Association of Portal Use With Patient CKD Knowledge

	Variable	β Estimate	Lower Limit of 95% CI	Upper Limit of 95% CI	*P*
Univariable model	Portal use (yes compared to no)	4.89	0.74	9.04	0.02
	Portal use (yes compared to no)	2.06	−2.47	6.59	0.37
	Age (y)	−0.13	−0.26	0.01	0.07
	Sex (compared to female)				
	Male	−2.44	−6.44	1.55	0.23
	Race (compared to White)				
	African American	1.53	−4.29	7.35	0.6
	Other	1.99	−5.77	9.74	0.61
Multivariable model	Education (compared to ≥HS graduate)				
	<HS graduate	−7.38	−20.54	5.78	0.27
	Income (compared to ≥$50,000)				
	<$25,000	−1.4	−6.94	4.15	0.62
	$25,000-<$50,000	−4.28	−9.38	0.82	0.1
	Stage (compared to stage 3)				
	Stage 1-2	0.48	−6.4	7.36	0.89
	Stage 4-5	4.67	0.34	9.01	0.03

Note: Linear regression model of univariable and multivariable associations between patient-reported outcomes, portal use, and patient demographics. All models exclude patients who responded "I don't know" or who did not respond to the portal use question.
Abbreviations: CKD, chronic kidney disease; HS, high school.

Additionally, we were able to explore whether 4 important patient-centered outcomes were associated with portal use and patient demographics and identified that both knowledge and health status were higher in those using the portal, along with a trend of less disease-related stress. Health portals should be accessible to all, and because CKD disproportionately affects those with fewer socioeconomic resources, this is a particularly vulnerable population for disparities.

Our findings are novel given that prior studies have not concurrently measured these patient-centered outcomes, income, or kidney function.[27,28] Limited research shows that patients who use portals who have cardiovascular disease and diabetes mellitus have higher PAM (Patient Activation Measure; a survey that assesses how activated patients are in care) scores. Higher PAM scores have been linked to lower resource use and improved clinical outcomes in other chronic diseases.[29,30] However, it is unclear whether or how PAM scores associate with outcomes in patients with CKD. We originally hypothesized that use of the health portal would be associated with higher CKD knowledge, less disease-related stress, and higher self-

Table 4. Association of Portal Use With Patient CKD-Specific Stress

	Variable	β Estimate	Lower Limit of 95% CI	Upper Limit of 95% CI	*P*
Univariable model	Portal use (yes compared to no)	−0.18	−0.36	0.00	0.05
	Portal use (yes compared to no)	−0.14	−0.34	0.05	0.15
	Age (y)	−0.01	−0.01	0.00	0.02
	Sex (compared to female)				
	Male	−0.09	−0.26	0.09	0.34
	Race (compared to White)				
	African American	0.35	0.1	0.6	0.01
	Other	−0.07	−0.41	0.27	0.68
Multivariable model	Education (compared to ≥HS graduate)				
	<HS graduate	−0.38	−0.96	0.19	0.19
	Income (compared to ≥$50,000)				
	<$25,000	−0.01	−0.25	0.23	0.93
	$25,000-<$50,000	−0.17	−0.39	0.05	0.13
	Stage (compared to stage 3)				
	Stage 1-2	0.11	−0.19	0.41	0.48
	Stage 4-5	0.2	0.01	0.39	0.04

Note: Linear regression models of univariable and multivariable associations between patient-reported outcomes, portal use, and patient demographics. All models exclude patients who responded "I don't know" or who did not respond to the portal use question.
Abbreviations: CKD, chronic kidney disease; HS, high school.

Table 5. Association of Portal Use With Patient Self-rating of Current Health

	Variable	β Estimate	Lower Limit of 95% CI	Upper Limit of 95% CI	*P*
Univariable model	Portal use (yes compared to no)	0.28	0.02	0.54	0.03
	Portal use (yes compared to no)	0.12	−0.18	0.41	0.45
	Age (y)	0	−0.01	0.01	0.91
	Sex (compared to female)				
	Male	0.03	−0.24	0.29	0.85
	Race (compared to White)				
	African American	−0.15	−0.54	0.23	0.44
	Other	0.13	−0.38	0.64	0.61
Multivariable model	Education (compared to ≥HS graduate)				
	<HS graduate	0.01	−0.86	0.88	0.98
	Income (compared to ≥$50,000)				
	<$25,000	−0.36	−0.73	0	0.05
	$25,000-<$50,000	−0.06	−0.4	0.28	0.73
	Stage (compared to stage 3)				
	Stage 1-2	0.29	−0.17	0.74	0.21
	Stage 4-5	−0.24	−0.53	0.04	0.1

Note: Linear regression models of univariable and multivariable associations between patient-reported outcomes, portal use, and patient demographics. All models exclude patients who responded "I don't know" or who did not respond to the portal use question.
Abbreviation: HS, high school.

reported health and is in line with what we found in the unadjusted analysis.

Possible explanations for higher CKD knowledge with portal use are that the portal gives patients personalized access to their health information in addition to access to a variety of different educational resources.[31] Portal use may also allow patients to derive comfort and in turn lower disease-related stress through viewing laboratory tests or results or by communicating with members of the health care team. Alternatively, because this study is cross-sectional, it may be that portals are simply used by patients who are healthier or more knowledgeable and who have the resources to get access to computers and online information.[32] However, ultimately, in the adjusted analysis, only income and/or severity of CKD independently predicted patient-centered outcomes. Thus there seems to be a larger role outside of portals affecting patient-centered outcomes that we measured. Income specifically may affect a person's ability to access multiple other resources, including transportation, access to care, and family/psychosocial environment. Perhaps these resources are much more important to patient-centered outcomes than portal use.

Similar to prior work, in unadjusted analyses, there were lower odds of portal use among African

Table 6. Association of Portal Use With Patient Self-rating of Health Compared With 1 Year Ago

	Variable	β Estimate	Lower Limit of 95% CI	Upper Limit of 95% CI	*P*
Univariable model	Portal use (yes compared to no)	0	−0.28	0.28	0.99
	Portal use (yes compared to no)	0.1	−0.21	0.41	0.52
	Age (y)	0	−0.01	0.01	0.92
	Sex (compared to female)				
	Male	−0.02	−0.29	0.25	0.9
	Race (compared to White)				
	African American	−0.21	−0.61	0.18	0.29
	Other	0.56	0.03	1.08	0.04
Multivariable model	Education (compared to ≥HS graduate)				
	<HS graduate	0.49	−0.41	1.38	0.28
	Income (compared to ≥$50,000)				
	<$25,000	0.11	−0.27	0.48	0.58
	$25,000-<$50,000	0.34	0.01	0.69	0.05
	Stage (compared to stage 3)				
	Stage 1-2	0.03	−0.44	0.5	0.9
	Stage 4-5	−0.27	−0.57	0.02	0.07

Note: Linear regression models of univariable and multivariable associations between patient reported outcomes, portal use, and patient demographics. All models exclude patients who responded "I don't know" or who did not respond to the portal use question.
Abbreviation: HS, high school.

Americans.[33,34] Reasons for this are unclear but have been suggested to be multifactorial due to potential lack of internet or digital device access, potential differences in acceptance or attitudes about portals, and limited e-health literacy.[35,36] Because this association was attenuated in our analysis, our study suggests again that other factors are most important. Namely, education and income may be more impactful contributors and ultimately the reasons for lower portal access. Personal communication remains an integral aspect of care, especially for disadvantaged patients and patients with a preference for this means of communication. An important point is that although many health systems promote patient portals, there remain important subsets of patients who are not receiving the intended gains from portals, which causes concern that although well intended, portals may instead widen disparities in care for those most vulnerable instead of improving access to care for all. Additionally, there may be even more access issues in patients seen in rural communities who may be at risk for limited or less access to consistent widely available internet, for which portals largely depend.[37]

To overcome barriers to uptake and use, perhaps a universal precaution could be used for portals, for example, a pre-assessment emphasized at patient check-in (eg, "Do you use our portal?" and if not, "Would you be interested in receiving some quick reference information or 1-on-1 support so that you can use it if you want to?"). Although universal precautions were initially conceived to support safe care for patients and providers in chronic disease, more recently they have been recognized in literacy efforts, which could include e-literacy, especially given an increasing promotion of patients using technology in the digital age.[38-41] Future research is needed to explore the portal features that nonadopters would perceive as most valuable to help them still get the same information, even if they choose not to use portals. Some patient portals may work better than others because they are complex and dynamic in nature and digital readiness is another important consideration. There may also be creative ways to provide patients who want access but do not have the means to get access to these online resources, either through education or provision of devices to support their information technology needs.

The findings in this study should be interpreted while taking into account limitations. First, this is a cross-sectional study using a convenience sample of patients in enrollment, limiting interpretation of causality. Second, the study size was limited to an analysis of 245 patients who completed the survey, from several clinics across a single health center. Although this sample size is larger than generally recommended for the number of questions we examined and the cohort demographics are similar to those in the United States with CKD, a larger sample size would provide increased statistical power to examine some of the differences among groups in which they were borderline (eg, stress).[42,43] It could also potentially increase generalizability. Given that the patients were specifically enrolled from nephrology practices, this likely means that they may have more severe disease compared with those seen in primary care clinics and thus perspectives may be different if we have more patients enrolled from other disciplines such as primary care practices in the future. We did not capture data for patients approached but refusing to take the survey. In addition, the multivariable model used complete case analysis based on completed observations. Last, by operationalizing the portal as a binary variable, the study did not specifically analyze some portal features that may be more important than others for patients, and we were not able to ascertain whether there are differences in patient outcomes depending on frequency or duration of portal use.

Despite limitations, there are important implications from this study. Although the patient portals can be useful to our patients in many ways, further work is needed to ensure that wide promotion of health portals addresses care needs for all patients and does not instead widen existing disparities in care across the continuum of CKD.[44-46] Investigating and eliminating barriers to patient education is crucial in optimizing health outcomes.[47] Further work is necessary to determine whether other patient-centered or clinical outcomes in CKD may be affected differently depending on how the portal is used prospectively so that we ensure that all patients have the access to communication and care needed to achieve benefits in the long term.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Table S1. Logistic regression model; odds ratios for portal use unadjusted analysis.

ARTICLE INFORMATION

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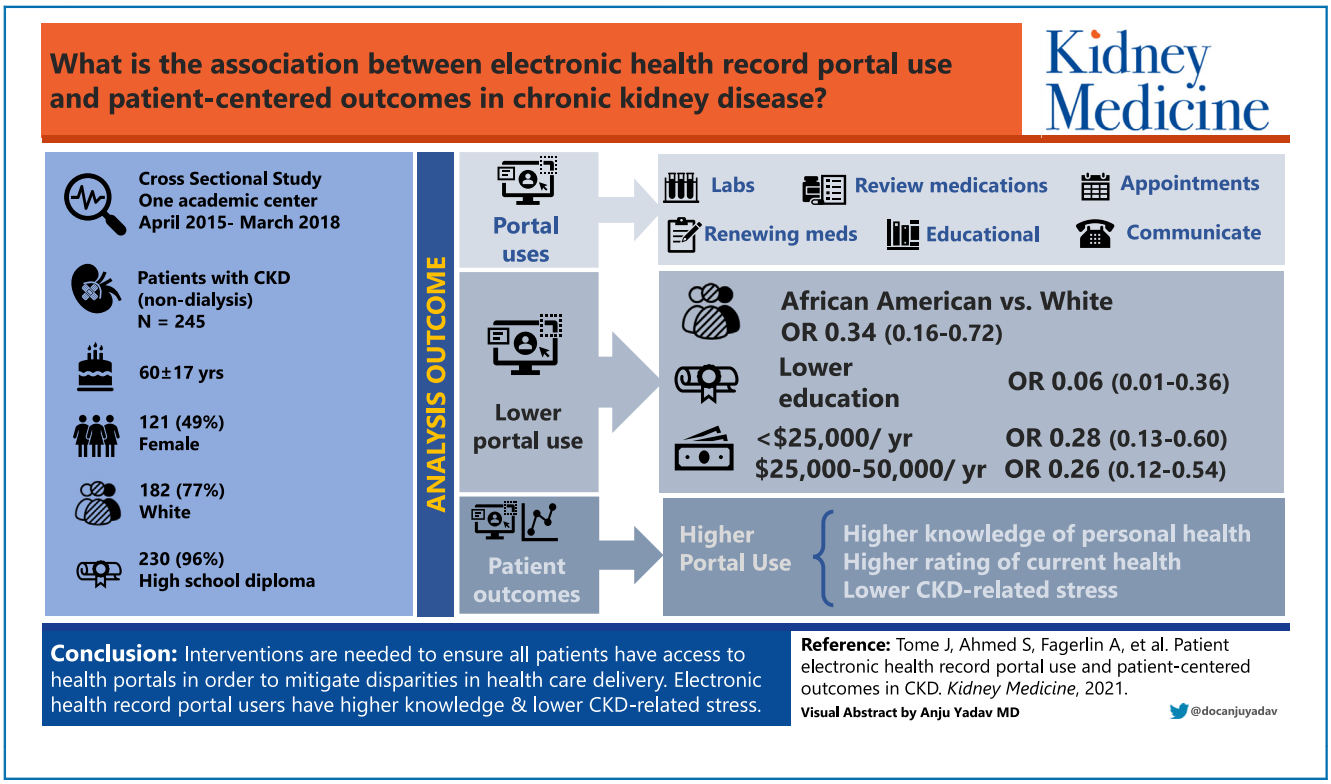
What is the association between electronic health record portal use and patient-centered outcomes in chronic kidney disease?
Kidney Medicine
Cross Sectional Study
One academic center
April 2015- March 2018
Patients with CKD (non-dialysis)
N = 245
60±17 yrs
121 (49%) Female
182 (77%) White
230 (96%) High school diploma
ANALYSIS OUTCOME
Portal uses
Labs
Review medications
Appointments
Renewing meds
Educational
Communicate
Lower portal use
African American vs. White
OR 0.34 (0.16-0.72)
Lower education
OR 0.06 (0.01-0.36)
<$25,000/ yr
OR 0.28 (0.13-0.60)
$25,000-50,000/ yr
OR 0.26 (0.12-0.54)
Patient outcomes
Higher Portal Use
Higher knowledge of personal health
Higher rating of current health
Lower CKD-related stress
Conclusion: Interventions are needed to ensure all patients have access to health portals in order to mitigate disparities in health care delivery. Electronic health record portal users have higher knowledge & lower CKD-related stress.
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