

ORIGINAL RESEARCH

Disparities in Use of Patient Portals Among Adults in Family Medicine

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Objective: This study examined patient portal utilization by analyzing the pattern of time and feature use of patients, and thus to identify functionalities of portal use and patient characteristics that may inform future strategies to enhance communication and care coordination through online portals.

Methods: We conducted a retrospective study of patients at 18 family medicine clinics over a 5-year period using access log records in the electronic health record database. Dimensionality reduction analysis was applied to group portal functionalities into 4 underlying feature domains: messaging, health information management, billing/insurance, and resource/education. Negative binomial regression analysis was used to evaluate how patient and practice characteristics affected the use of each feature domain.

Results: Patients with more chronic conditions, lab tests, or prescriptions generally showed greater patient portal usage. However, patients who were male, elderly, in minority groups, or living in rural areas persistently had lower portal usage. Individuals on public insurance were also less likely than those on commercial insurance to use patient portals, although Medicare patients showed greater portal usage on health information management features, and uninsured patients had greater usage on viewing resource/education features. Having Internet access only affected the use of messaging features.

Conclusion: Efforts to enroll patients in online portals do not guarantee patients will use the portals to manage their health. When considering the use of patient portals for improving telehealth, clinicians need to be aware of technological, socioeconomic, and cultural challenges faced by their patients. (J Am Board Fam Med 2022;35:559–569.)

Keywords: Digital Divide, Family Medicine, Health Information Management, Minority Groups, Patient Portals, Patient-Centered Care, Primary Health Care, Regression Analysis, Retrospective Studies, Telemedicine

Introduction

Virtualized medicine and asynchronous care are an ever-more popular care-delivery option in modern health care systems.¹ Since 2017, most health care organizations in the United States have offered online portal access, enabling patients to view their

health information, exchange care messages with clinicians, or transmit biometric data back to a health system's electronic health record (EHR) database.² Patient portals are an important telehealth mechanism providing innovative ways to coordinate and deliver care services through online communications and store-and-forward features, allowing health data (eg, messages, images, videos) to be collected, interpreted, and responded at different time points between patients and clinicians.³ Online portals have contributed to better patient experience, care quality, and cost control in the rapidly evolving health care environment.^{4,5} Since the emergence of the COVID-19 pandemic, use of patient portals has also increased significantly across health care organizations to facilitate care management with increased social distancing

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and concerns in in-person visits.⁶ As more health systems transform to patient-centered primary care models, telehealth services via online portals play a vital role in helping patients become better informed, engaged, and involved in their care.

Despite an increase in patient portal enrollment in the past decade, only a fraction of patients have regularly used online portals due to lack of broadband internet access and intuitive user interfaces.^{5,7} The use of online technology has been unevenly distributed among the elderly, ethnic minorities, socioeconomically disadvantaged, and rural communities. Those disparities are often linked to the digital divide phenomena.^{8,9} Low usage of portals in vulnerable populations can cause inequity in obtaining care information or treatments, inadvertently exacerbating existing health disparities rather than improving them.¹⁰ Yet, very little is known about emerging disparities in portal usage.

Learning about usability and acceptability of online patient portals in real-world practice is a critical first step to gain insight into factors that enable or impede patients' telehealth adoption. Prior research examined the extent to which a virtual care feature is utilized through patient interviews,¹¹ self-assessment surveys,¹² and billing codes.¹³ However, because those measures relied on patient memory and personal perceptions, they were subject to recall or social desirability bias, or in the case of billing data, may lack granularity. This study elucidated current portal usage by examining the pattern of time and features accessed by patients, using portal access logs in EHRs. The first objective was to identify common virtual care features that can serve as core measures for tracking use of online portals. The second objective was to evaluate the effects of patient, clinician, and system characteristics on patients' time use of online portals.

Methods

Study Setting and Population

This retrospective study examined patient use of an online portal at 18 family medicine clinics in a large academic health care center from January 2014 through December 2018. To be included in the study, patients must have a primary care provider (PCP) for at least 12 months during the study period with at least 1 office visit and 1 nonface-to-face encounter (eg, telephone call or e-visit) to ensure

that patients were actively managed by a PCP in the context of ongoing care. Patients who died, resided in long-term care facilities, or lived outside the state were excluded. Clinical and patient data for the study were extracted from an enterprise EHR database (Epic System, Verona, WI). This study was approved by the academic medical center's Institutional Review Board.

Patient Portal Feature Type

Modern patient portals have incorporated various functionalities to facilitate appointment tracking, care consultation, and population health management. Prior research in patient portals has summarized portal functionalities into 13 common feature types (Appendix).^{5,14–16} The study grouped those feature types with similar functionalities into a small set of domains to ensure a more interpretable and meaningful analysis. Essentially, we speculate that individuals who read their health summary on the portal may be more likely to view their visit summary information, which would make it difficult to understand use patterns by analyzing individual feature type or by assessing all feature types in 1 model, thus having a smaller number of feature types that share identifiable similarities may help to facilitate the pragmatic utility of the study findings for future interventions.

Portal Use Measure

Previous research used the number of logins and web pages that are clicked on or viewed to evaluate patients' online portal access.^{17,18} Although frequency of logins and clicks is an intuitive measure for online portal usage, the access rate does not always provide accurate indication of usage of the online portal because people often quickly switch from 1 webpage to another without taking time to comprehend content or information presented to them. To better quantify online portal use, we measured the amount of time spent by patients on online portals using the time stamp of the access log record. A longer time spent on 1 functional area was interpreted as being a more engaged visit, thus representing a greater amount of utilization.

Practice and Patient Characteristics

Practice characteristics included site proximity to a densely populated urban area and whether a clinic was a residency teaching site. The site proximity was specified according to geo-population distribution for

urban, suburban, and rural clinics. To account for potential clinician influences on patient portal use, the study included family physician-specific characteristics of clinician status (faculty vs resident physicians) and years of practice. Physician practice experience was measured by the years of practice in 4 categories: <5 years, 5 to 14 years, 15 to 24 years, and 25+ years.

Patient characteristics included sex, age, race/ethnicity, insurance type, PCP-patient empanelment month, overall health complexity, and the numbers of prescriptions and laboratory tests during the study period. The study computed the number of diseases in the Elixhauser comorbidity measure to represent patients' health complexity because the count measurement of unique medical conditions has been considered a reliable predictor of health care utilization along with other complex comorbidity indices.^{19,20} Patients' addresses were also linked to census tracts to identify proximate socioeconomic circumstances, including the percentage of the population below the poverty level, with Internet access, or graduated from either high school or college.

Statistical Analyses

To identify the underlying construct of a large set of feature types, the study began with a dimensionality reduction approach using factor analysis based on the principal component method with varimax rotation. Dimensionality reduction is the process of condensing a large number of variables into a few factors while keeping relevant characteristics and patterns in the original data.²¹ Z-score transformation was performed to scale the value of each feature type to a standardized normal distribution. Then the eigenvalue and the cumulative percentage of variance were estimated for each latent factor to determine the total amount of variance extracted by the factor solution. The loading of the feature type on each latent factor was estimated to indicate the variance accounted for each feature type on a corresponding domain. Latent root criterion and scree test criterion were used to determine the optimal number of latent factors in the analysis. Each latent factor was classified as a feature domain that consisted of 1 or more feature types. Feature types with the rotated factor loading of at least ± 0.45 on a feature domain were included in that feature domain.

Time spent on each feature domain was measured by computing the total amount of time spent by patients on viewing or responding to all feature

types attributed to the domain during the study period. We applied generalized linear modeling to assess the effects of patient, clinician, and practice characteristics on time spent for each feature domain. Because the distribution of the time estimates is expected to be sparse and positively skewed with a long right tail, negative binomial regression with a log link was applied to address the overdispersed nature of time measures with the conditional variance exceeding the conditional mean.²² All statistical analyses were performed using SAS version 9.3 software (SAS Institute Inc., Cary, NC).

Results

Altogether, 102,342 adult patients met inclusion criteria at the 18 family medicine clinics between 2014 and 2018. Of those patients, 73% (n = 74,147) had online portal accounts. Table 1 shows that the percentage of patients with online portal accounts was higher in nonteaching clinics and urban clinics. A greater percentage of online accounts also occurred among patients whose PCP was faculty or in the middle phase of their career. Overall, patients with portal accounts were likely to be female, younger, non-Hispanic white, with commercial insurance, and chronic illness. They received more medications and laboratory tests, compared with patients without online portal accounts.

Overall Time Spent by Patients on the Portal

Of the 74,147 patients with online portal accounts, 95.7% had logged onto the online portal during the study period, which consisted of 4518,017 sessions and 310,098 hours in total. The median and mean time spent per session were 5.1 and 4.7 minutes, respectively, with a standard deviation of 8.6 minutes. Despite the high access rate from patients with online portal accounts, 25.9% of those users accounted for more than 70% of the total portal accessing time.

Dimensionality Reduction

Results of the dimensionality reduction analysis suggest that the 13 feature types could be captured by 4 latent domains whose eigenvalues were greater than or equal to 1 and, together, accounted for 64.4% of the total variance (Table 2). Essentially, the "messaging" domain consisted of 4 feature types representing communication activities for exchanging general and medical messages. The "health

Table 1. Patient Characteristics by Online Portal Access Status

Characteristics	With Account n (%)	Without Account n (%)	Chi-square Statistics
Total population	74,147 (72.5)	28,195 (27.5)	
<i>Practice-Level</i>			
Residency Clinic	17,256 (23.3)	7,970 (28.3)	274.4**
<i>Clinic Location</i>			
Urban	44,856 (60.5)	15,225 (54.0)	505.0**
Suburban	13,766 (18.6)	5,290 (18.8)	
Rural	15,525 (20.9)	7,680 (27.2)	
<i>PCP-Level</i>			
Faculty	68,980 (93.0)	24,959 (88.5)	551.0**
<i>Years of Practice</i>			
< 5	5,482 (7.4)	3,313 (11.8)	1045.7**
5-14	26,152 (35.3)	7,757 (27.5)	
15-24	22,856 (30.8)	8,173 (29.0)	
25+	19,657 (26.5)	8,952 (31.8)	
<i>Patient-Level</i>			
Female	43,739 (59.0)	12,823 (45.5)	1508.1**
<i>Age Group</i>			
18-39	25,377 (34.2)	8,262 (29.3)	1528.0**
40-64	19,758 (26.6)	8,082 (28.7)	
65+	5,743 (7.7)	4,325 (15.3)	
<i>Race</i>			
White	68,209 (92.0)	23,981 (85.1)	1400.9**
Black	2,128 (2.9)	2,085 (7.4)	
Asian	1,899 (2.6)	836 (3.0)	
Hispanic	2,119 (2.9)	2,275 (8.1)	
Other	1,911 (2.6)	1,293 (4.6)	
<i>Payer Category</i>			
Commercial	62,372 (84.1)	17,964 (63.7)	5285.8**
Medicaid	3,564 (4.8)	3,601 (12.8)	
Medicare	7,501 (10.1)	5,648 (20.0)	
Uninsured	710 (1.0)	982 (3.5)	
Comorbidity	58,653 (79.1)	21,964 (77.9)	
<i>Prescriptions</i>			
0-10	22,246 (30.0)	10,356 (36.7)	444.3**
11-20	14,644 (19.7)	5,038 (17.9)	
21-30	9,744 (13.1)	3,096 (11.0)	
31+	27,513 (37.1)	9,705 (34.4)	
<i>Lab Tests</i>			
0-10	19,843 (26.8)	11,326 (40.2)	1788.2**
11-20	16,571 (22.3)	5,681 (20.1)	
21-30	11,586 (15.6)	3,430 (12.2)	
31+	26,147 (35.3)	7,758 (27.5)	

* $p < 0.05$; ** $p < 0.01$.

information management” domain included feature types designed to help patients access their health/medical data and manage visits. The “billing and insurance” domain included health plan and payment-related features allowing patients to update

insurance information and check billing processes. The “resource and education” domain included functions designed to help patients download authorized documents and search for health education and other resource information.

Table 2. Factor Loadings of Patient Portal Features on Each Feature Domain

Feature	Feature Domain ^a			
	Messaging	Health Info Management	Billing/Insurance	Resource/Education
Messaging - view	0.789	0.373	0.096	0.021
Messaging - write	0.851	0.302	0.059	0.007
Messaging - view medical	0.833	0.139	0.073	0.142
Messaging - write medical	0.879	0.224	0.088	-0.034
Appointment access	0.197	0.740	0.164	0.253
Appointment scheduling	0.188	0.574	0.146	0.092
Record access	0.269	0.688	0.075	0.045
Record management	0.105	0.510	0.078	-0.366
Visit Summary	0.188	0.783	0.103	0.118
Insurance and payment - View	0.102	0.349	0.675	0.035
Insurance and payment - Write	0.083	0.001	0.893	-0.007
Documentation	0.196	0.472	-0.005	0.501
Resource	0.104	0.142	0.036	0.889
Sums of squares (eigenvalue)	4.88	1.42	1.06	1.01
Percent of trace	37.5	10.9	8.2	7.8

^aNumbers are rotated factor loadings which are correlations between feature types and feature domains. Factor loadings are marked bold for features assigned to a corresponding domain.

Time Usage by Feature Domain

Table 3 summarizes results from the negative binomial regression analysis of the association between practice, PCP, and patient-level characteristics on the amount of time spent on each feature category. The overall goodness of fit showed that the negative binomial models fit well (deviance: 1.29 to 1.42) with almost no overdispersion (Pearson χ^2 : 0.69 to 0.82). Individuals having a longer empanelment period with their PCP were likely to spend more time viewing and interacting with the portal. Compared with patients at nonresidency clinics, patients at residency clinics showed almost 13% greater tendency to use features in the messaging domain (OR=1.127, 95% CI, 1.089–1.167), yet those residency clinic patients were 7.5% less likely to use the billing/insurance domain (OR=0.925, 95% CI, 0.883–0.968). Patients at the urban and suburban clinics were 1.19–1.60 times more likely to use the online portal versus patients in rural area. Patients at the urban and suburban clinics were more likely than patients in rural areas to use messaging (OR=1.29–1.60), health information management (OR=1.19–1.23), billing/insurance (OR=1.27–1.36), and resource/education features (OR=1.22–1.25).

There was a 20% increase in the odds of using the resource/education features for patients who

had nonresident PCPs versus patients managed by resident PCPs. The effect of the PCP's years of practice varied by feature domain. Patients with PCPs in their midcareer phase spent significantly more time using features in the messaging and health information management domains versus patients with PCPs whose years of practice were less than 5 years or greater than 25 years. Patients with PCPs in their early and middle career phase generally showed a 7 to 21% greater likelihood of using online features in the billing/insurance domain and the resource/education domain, compared with patients whose PCP had more than 25 years of practice. In general, patients with a PCP who had fewer practice years were more likely to use billing/insurance and resource/education features.

Female patients were more likely than their male counterparts to use online care features, especially the resource/education domain (OR=1.326, 95% CI, 1.292–1.360). Compared with patients aged ≥ 65 , younger patients showed greater tendency to use most of the online features, except for the resource/education domain. Individuals aged 40 to 64 were 11% less likely than the older group to use resource/education features (OR=0.888, 95% CI, 0.861–0.914). The online usage of patients with Hispanic heritage tended to be less than their non-

Table 3. Effects on Time Spent on the Patient Portal by Feature Domain

Characteristics	Messaging, OR (95% CI)	Health Info Management, OR (95% CI)	Billing/Insurance, OR (95% CI)	Resource/Education, OR (95% CI)
Panel Months	1.007** (1.006–1.008)	1.010** (1.154–1.224)	1.003** (1.202–1.336)	1.004** (1.173–1.267)
Residency Clinic	1.127** (1.089–1.167)	1.015 (0.989–1.042)	0.925** (0.883–0.968)	1.036* (1.002–1.072)
Clinic Location (ref: rural)				
Urban	1.599** (1.534–1.666)	1.232** (1.194–1.271)	1.363** (1.288–1.442)	1.252** (1.203–1.304)
Suburban	1.293** (1.243–1.345)	1.188** (1.154–1.224)	1.267** (1.202–1.336)	1.219** (1.173–1.267)
Faculty	1.121 (0.955–1.315)	0.966 (0.861–1.083)	1.184 (0.980–1.429)	1.204* (1.043–1.39)
Years of Practice (ref: 25+)				
< 5	1.058 (0.906–1.235)	1.019 (0.912–1.138)	1.211* (1.010–1.452)	1.217** (1.060–1.398)
5–14	1.263** (1.221–1.306)	1.152** (1.124–1.181)	1.182** (1.130–1.237)	1.088** (1.053–1.123)
15–24	1.121** (1.084–1.159)	1.066** (1.040–1.093)	1.071** (1.024–1.12)	1.026 (0.993–1.060)
Female	1.145** (1.115–1.175)	1.105** (1.084–1.127)	1.095** (1.057–1.135)	1.326** (1.292–1.360)
Age in years (ref: 65+)				
18–39	1.045* (1.009–1.082)	0.985 (0.959–1.011)	0.983 (0.938–1.031)	0.933** (0.902–0.965)
40–64	1.119** (1.085–1.155)	0.962** (0.939–0.984)	0.965 (0.924–1.006)	0.888** (0.861–0.914)
Race (ref: white)				
Black	0.471** (0.435–0.508)	0.784** (0.740–0.830)	0.625** (0.564–0.692)	1.035 (0.959–1.116)
Asian	0.765** (0.706–0.828)	1.090** (1.027–1.156)	1.123* (1.009–1.249)	0.975 (0.902–1.053)
Hispanic	0.710** (0.657–0.765)	0.921** (0.870–0.974)	0.964 (0.869–1.068)	1.087* (1.009–1.17)
Other	0.841** (0.776–0.910)	0.951 (0.896–1.009)	0.915 (0.821–1.019)	0.968 (0.895–1.045)
Payer Category (ref: commercial)				
Medicare	0.921** (0.880–0.963)	1.055** (1.020–1.091)	0.475** (0.447–0.504)	0.777** (0.744–0.811)
Medicaid	0.765** (0.720–0.812)	0.887** (0.847–0.927)	0.306** (0.282–0.331)	1.037 (0.978–1.100)
Uninsured/Self-pay	0.867* (0.761–0.985)	0.926 (0.841–1.019)	0.798* (0.671–0.948)	1.302** (1.149–1.474)
Comorbidity	1.040** (1.034–1.046)	1.055** (1.050–1.059)	1.016** (1.008–1.024)	1.037** (1.031–1.043)
# Prescriptions (ref: ≤10)				
11–20	1.501** (1.447–1.558)	1.105** (1.075–1.136)	1.151** (1.095–1.21)	1.200** (1.157–1.243)
21–30	1.815** (1.738–1.895)	1.138** (1.101–1.175)	1.192** (1.124–1.264)	1.245** (1.194–1.299)
>30	2.722** (2.614–2.835)	1.355** (1.314–1.397)	1.345** (1.272–1.422)	1.556** (1.496–1.620)
# Lab tests (ref: ≤10)				
11–20	1.512** (1.457–1.569)	1.635** (1.591–1.681)	1.389** (1.321–1.461)	1.244** (1.200–1.290)
21–30	1.884** (1.805–1.967)	2.087** (2.021–2.156)	1.769** (1.668–1.876)	1.385** (1.327–1.445)
>30	2.814** (2.698–2.935)	3.235** (3.134–3.339)	2.280** (2.153–2.414)	1.708** (1.639–1.781)
% Internet Access	1.006** (1.002–1.010)	1.002 (0.998–1.004)	1.002 (0.996–1.007)	0.999 (0.995–1.003)
% HS Degree	1.014** (1.007–1.021)	1.004 (0.998–1.009)	0.997 (0.987–1.006)	1.005 (0.998–1.011)
% Some College Degree	1.016** (1.010–1.022)	1.006** (1.002–1.010)	1.006 (0.998–1.014)	1.005 (0.999–1.011)
% Bachelor Degree	1.019** (1.013–1.024)	1.008** (1.004–1.012)	1.004 (0.996–1.012)	1.004 (0.998–1.010)
% Below Poverty	1.001 (0.997–1.003)	1.003** (1.001–1.005)	1.004* (1.002–1.007)	1.002 (0.999–1.004)
Scaled Deviance	1.40	1.29	1.52	1.42
Scaled Pearson Chi-square	0.82	0.69	0.67	0.77

* $p < 0.05$; ** $p < 0.01$.

Abbreviations: OR, odds ratio; 95% CI, 95% confidence interval.

Hispanic counterparts, although their respective differences in the resource/education domain were not statistically significant. In general, minority patients were less likely to use online features in both the messaging domain and the health information management domain. Compared with white patients, black patients showed 37.5% lower odds

of using the billing/insurance domain (OR=0.625, 95% CI, 0.564–0.692), whereas Asian patients were 12.3% more likely to use the billing/insurance domain (OR=1.123, 95% CI, 0.761–0.904).

Individuals living in a community with greater Internet access were more likely to use the messaging features of the online portal (OR=1.006, 95%

CI, 1.002–1.010), although Internet availability did not affect time spent in the other feature domains. Patients living in areas with higher graduation rates in high school and college were more likely to use the messaging domain (OR = 1.014–1.019). A small but significant increase in the health information management domain was associated with patients with higher college graduation rates living in the area (OR = 1.006–1.008). The education attainment level did not affect patient usage in the billing/insurance and resource/education domains. Individuals living in the area with greater percentage of households below the federal poverty level tended to spend more time viewing and using the health information management domain (OR = 1.003, 95% CI, 1.001–1.005) or billing/insurance domains (OR = 1.004, 95% CI, 1.001–1.007); however, the sizes of these differences were small.

Discussion

This study provides an innovative approach to examine factors influencing online portal usage by measuring the amount of time patients spent on the portals through EHR access log records. We found that patients accessed a wide range of features in the online portal, and most portal utilization was related to viewing personal health information and care summaries. The finding is consistent with previous literature confirming the growing adoption by patients in using EHRs to track personal health information and manage care activities.^{23,24} Online patient portals not only help patients become more informed about their health conditions; they also make health care more convenient and accessible. However, our study revealed that only a fraction of patients took advantage of their portal's interactive communication features designed to facilitate patient self-management. We speculate that patients may not use these features because they feel hesitant to use too much clinician time, are worried about sending inappropriate messages, or find use of the interfaces difficult.^{15,25} Those challenges may prevent patients from communicating with their care teams effectively through online portals.

Overall Portal Use Pattern

The federal government's meaningful use program requires health care organizations to provide patients with access to their health information

through online portals. Yet, getting patients to sign up for an online portal does not guarantee that they will use the portal to manage their health. Our study showed that patients with more chronic conditions, prescriptions, and laboratory tests spend more time using various features of the online portal. These patients often have higher rate of health care utilization and often require more assistance to manage and monitor their health conditions outside of traditional medical settings.^{12,26}

The study also found that the use of online portals is unevenly distributed among populations with different demographic and economic backgrounds. Female and younger patients are active adopters of patient portals, suggesting greater willingness in these populations to use telehealth as part of their usual care. However, male, elderly, minority, and rural patients are less likely to use the online portal. The pattern reflects the digital divide phenomena in health services research.^{8,9} Those individuals often experience economic hardships throughout their life, including long working hours, poor health literacy, inadequate social support, and limited access to computers and the Internet.^{27,28} The gender differences in online portal use reflects greater health care needs of women, suggesting more interest for them in adopting telehealth as part of their usual care. Thus, although health care communities continue to promote the use of virtual health tools to keep their patients connected to their caregivers, clinicians should be sensitive to technological, economic, and cultural barriers faced by many individuals and communities.²⁹

Domain-Specific Usage

Our study used dimensionality reduction methods to group online portal features into 4 domains: messaging, health information management, billing/insurance, and resource/education. The respective influence of clinical practice and patient characteristics on the degree of patient portal usage varied by feature domain. Essentially, we observed large differences in the use of messaging features across most patient, clinic, and community characteristics. The discrepancy may have occurred because features in the messaging domain often involve more complex designs, which in turn require that patients have greater technology proficiency and health literacy to learn how to use messaging interfaces. To reduce gaps in messaging utilization, the

literature suggests that health systems offer patients training on the use of messaging features, as well as enhance interface designs to provide clearer guidance and rules that help patients use appropriate message types and contents to meet their health care needs.^{25,30}

Education and Health Insurance

Our analysis revealed that patients living in neighborhoods with a greater percentage of college-educated residents were more likely to view or interact with features in the health information domain. This finding demonstrates that people with greater education attainment are more engaged in navigating health care services and managing their health conditions.³¹ Individuals living in neighborhoods with higher education levels may also have higher socioeconomic status and other important resources that facilitate portal use.

Health insurance was also identified as an important predictor for portal usage in the study. The health services literature indicates that individuals who are uninsured or on public health insurance are less likely to sign up or use patient portals, due to sociodemographic and economic barriers.^{15,29} Whereas our study consistently showed that a greater percentage of uninsured and public insured patients did not have online portal accounts versus patients with commercial health insurance, we found mixed results in portal usage across different feature domains. Overall, patients with commercial health plans made greater use of most portal features versus individuals who were uninsured or on public insurance. However, Medicare patients were more likely to use features in the health information management domain, possibly to meet increasing needs in managing appointments and care outcomes due to chronic and aging-related health conditions. Medicaid and uninsured patients were also more likely to use online portals to view health education and other resource information, possibly because individuals who are uninsured or on public health insurance may lack resources or social support to find needed health care information. Online portals may become an accessible tool for them to find treatment information and track their health plan enrollment status. Our finding is consistent with recent studies showing that underserved patient

populations seem more willing to accept and use online portals, even though they tend to face challenges in enrolling in virtual care platforms.^{32,33} This further underscores the importance of using patient portals as a mechanism to improve the health literacy of the underinsured population by making all necessary education materials or tailored messages and available to them, leading to better care decisions and less health disparities.

Internet Access

The study found that having Internet access only slightly affected the use of features related to the messaging domain, but not in other feature domains. Access to the Internet has rapidly increased in the past 2 decades. More than 93% of American adults are expected to have Internet access through either home computers or smartphones by the year 2022.³⁴ Increasing ownership in smartphones has made the internet more accessible to individuals who traditionally did not previously have computer-based internet connection.³⁵ Thus, simply having online access may no longer be a reliable predictor for the intention to use patient portals.

Limitations

Our study included several limitations. First, despite a large sample size, the study population was based on a single academic health care center, potentially limiting the findings' generalizability. Second, the time tracking process was terminated after a portal session became idle for 15 minutes. Because there was no way to ascertain when patients stopped viewing or interacting with the portal, the time estimate could be imprecise for sessions that were timed out. Third, because the Internet access and socioeconomic variables were not available in the EHR data, the study used census tract statistics derived from the home location of patients as proxies for these characteristics. Census tract data are aggregated statistics that summarize the overall sociodemographic nature of a small neighborhood area. This data may not capture all the variations among individuals, possibly diluting predictive power.³¹ Fourth, although most virtual care features examined in the study were offered across different EHR systems, each patient's intention to use these features could be

limited to individual experiences of how portal features were implemented and used. Fifth, the study did not examine the patterns of portal usage by young users who could have different needs from their adult counterparts. Sixth, the use of online portals could be affected by patients' attitudes and beliefs toward online technology.^{11,29} Thus, future assessments of socio-psychological characteristics would provide a more comprehensive picture of patients' motivation and acceptance when using online portals.

Conclusion

The widespread adoption of patient portals has enabled patients to receive a broad range of medical support outside of brick-and-mortar medical settings. The overall results of the study resonate with findings in prior health services research, notably, that patients experiencing digital divide challenges and poor health literacy have lower rates of portal usage, in addition to already lower portal enrollment rates for these population groups. Interestingly, contrary to popular belief, individuals who have public health insurance or reside in underserved neighborhoods seem more likely to use certain portal features versus other users. Thus, although promoting the use of portals as part of patient-centered care delivery tools, clinicians need to be aware of technological, socioeconomic, and cultural challenges faced by their patients. As more patients have signed up online portals to access telehealth during the COVID-19 pandemic, there is a great need for research to assess the impact of patient portal use on care quality and health outcomes in the future. We hope that this study will help health systems formulate more effective strategies to integrate patient portals into continuity care practices and establish a basis for future virtual care interventions.

To see this article online, please go to: <http://jabfm.org/content/35/3/560.full>.

References

1. Dorsey ER, Topol EJ. State of telehealth. *N Engl J Med* 2016;375:1400.
2. Henry J, Barker W, Kachay L. Electronic capabilities for patient engagement among U.S. non-federal acute care hospitals. *ONC Data Brief* 2019;45:2013-7.
3. Sorondo B, Allen A, Fathima S, Bayleran J, Sabbagh I. Patient portal as a tool for enhancing patient experience and improving quality of care in primary care practices. *EGEMS (Wash DC)* 2016; 4:1262.
4. Nagykaldi Z, Aspy CB, Chou A, Mold JW. Impact of a wellness portal on the delivery of patient-centered preventive care. *J Am Board Fam Med* 2012;25:158-67.
5. Ramsey A, Lanzo E, Huston-Paterson H, Tomaszewski K, Trent M. Increasing patient portal usage: preliminary outcomes from the MyChart Genius project. *J Adolesc Health Off Health* 2018;62:29-35.
6. Johnson C, Richwine C, Patel V. Individuals' access and use of patient portals and smartphone health apps. *ONC data brief*; 2021. Available at 2020;57:Vol : <https://www.healthit.gov/data/data-briefs/individuals-access-and-use-patient-portals-and-smartphone-health-apps-2020>. Accessed January 15, 2022.
7. Neuner J, Fedders M, Caravella M, Bradford L, Schapira M. Meaningful use and the patient portal: patient enrollment, use, and satisfaction with patient portals at a later-adopting center. *Am J Med Qual Off Qual* 2015;30:105-13.
8. Graetz I, Gordon N, Fung V, Hamity C, Reed ME. The digital divide and patient portals: internet access explained differences in patient portal use for secure messaging by age, race, and income. *Med Care* 2016;54:772-9.
9. Perzynski AT, Roach MJ, Shick S, et al. Patient portals and broadband internet inequality. *J Am Med Inform Assoc* 2017;24:927-32.
10. Grossman LV, Masterson Creber RM, Benda NC, Wright D, Vawdrey DK, Ancker JS. Interventions to increase patient portal use in vulnerable populations: a systematic review. *J Am Med Inform Assoc* 2019;26:855-70.
11. Giardina TD, Baldwin J, Nystrom DT, Sittig DF, Singh H. Patient perceptions of receiving test results via online portals: a mixed-methods study. *J Am Med Inform Assoc* 2018;25:440-6.
12. McGrail KM, Ahuja MA, Leaver CA. Virtual visits and patient-centered care: results of a patient survey and observational study. *J Med Internet Res* 2017;19:e177.
13. Gordon AS, Adamson WC, DeVries AR. Virtual Visits for Acute, Nonurgent Care: A claims analysis of episode-level utilization. *J Med Internet Res* 2017;19:e35.
14. Elkind EC, Higgins KM. The patient portal: considerations for nurse practitioners. *Nurse Pract* 2017;42:1-4.
15. Lafata Miller EJ, Shires CA, Dyer D, Ratliff AK, Schreiber SM. M. Patients' adoption of and feature access within electronic patient portals. *Am J Manag Care* 2018;24:e352-e357.
16. Tsai R, Bell EJ, Woo H, Baldwin K, Pfeffer MA. How patients use a patient portal: an institutional case study of demographics and usage patterns. *Appl Clin Inform* 2019;10:96-102.

17. Griffin A, Skinner A, Thornhill J, Weinberger M. Patient portals: who uses them? what features do they use? and do they reduce hospital readmissions? *Appl Clin Inform* 2016;7:489–501.
18. Redelmeier DA, Kraus NC. Patterns in patient access and utilization of online medical records: analysis of MyChart. *J Med Internet Res* 2018;20:e43.
19. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care* 1998;36:8–27.
20. Farley JF, Harley CR, Devine JW. A comparison of comorbidity measurements to predict health-care expenditures. *Am J Manag Care* 2006;12: c110–9.
21. Fordellone M. Statistical analysis of complex data: dimensionality reduction and classification methods. Lap Lambert Academic Publishing; 2019.
22. Ver Hoef JM, Boveng PL. Quasi-Poisson vs. negative binomial regression: how should we model overdispersed count data? *Ecology* 2007;88: 2766–72.
23. Antonio MG, Petrovskaya O, Lau F. The state of evidence in patient portals: umbrella review. *J Med Internet Res* 2020;22:e23851.
24. Adler-Milstein J, Holmgren AJ, Kralovec P, Worzala C, Searcy T, Patel V. Electronic health record adoption in US hospitals: the emergence of a digital “advanced use” divide. *J Am Med Inform Assoc* 2017;24:1142–8.
25. Hefner JL, MacEwan SR, Biltz A, Sieck CJ. Patient portal messaging for care coordination: a qualitative study of perspectives of experienced users with chronic conditions. *BMC Fam Pract* 2019;20:57.
26. Otte-Trojel T, Rundall TG, de Bont A, van de Klundert J, Reed ME. The organizational dynamics enabling patient portal impacts upon organizational performance and patient health: a qualitative study of Kaiser Permanente. *BMC Health Serv Res* 2015;15:559.
27. Choi NG, Dinitto DM. The digital divide among low-income homebound older adults: Internet use patterns, eHealth literacy, and attitudes toward computer/internet use. *J Med Internet Res* 2013;15: e93.
28. Sarkar U, Karter AJ, Liu JY, et al. Social disparities in internet patient portal use in diabetes: evidence that the digital divide extends beyond access. *J Am Med Inform Assoc* 2011;18:318–21.
29. Anthony DL, Campos-Castillo C, Lim PS. Who isn’t using patient portals and why? evidence and implications from a national sample of U.S. adults. *Health Aff (Millwood)* 2018;37:1948–54.
30. Sieck CJ, Hefner JL, Schnierle J, et al. The rules of engagement: perspectives on secure messaging from experienced ambulatory patient portal users. *JMIR Med Inform* 2017;5:e13.
31. Davis SE, Osborn CY, Kripalani S, Goggins KM, Jackson GP. Health literacy, education levels, and patient portal usage during hospitalizations. *AMIA Annu Symp Proc* 2015;2015:1871–80.
32. Ancker JS, Barrón Y, Rockoff ML, et al. Use of an electronic patient portal among disadvantaged populations. *J Gen Intern Med* 2011;26:1117–23.
33. Wallace LS, Angier H, Huguet N, et al. Patterns of electronic portal use among vulnerable patients in a nationwide practice-based research network: from the OCHIN practice-based research network (PBRN). *J Am Board Fam Med* 2016;29:592–603.
34. Perrin A, Atske S. Internet/broadband fact sheet. Pew Research Center; 2021. Available at: <https://www.pewresearch.org/internet/fact-sheet/internet-broadband>. Accessed November 28, 2021.
35. Vogels E. Digital divide persists even as lower-income Americans make gains in tech adoption. Pew Research Center; 2021. Available at: <https://www.pewresearch.org/fact-tank/2021/06/22/digital-divide-persists-even-as-americans-with-lower-incomes-make-gains-in-tech-adoption>. Accessed July 11, 2021.

Appendix. List of Commonly Accessed Patient Portal Features

Feature	Feature Type
Health information summary	
Laboratory result ^{5,13,14}	Record access
Diagnostic test result ¹³	Record access
Health summary	Record access
Current health issue ^{13,14}	Record access
Health summary ^{14,15}	Record access
Medical history ^{13,14}	Record access
Problem list ^{14,15}	Record access
Immunization history ^{5,14,15}	Record access
Medication	Record access
History ^{5,13,14}	Record access
Request refill ^{13,15}	Record management
Allergies ^{13,14}	Record access
Preventive care reminders ^{13,14}	Record access
Contraceptive visit reminders ⁵	Record access
STD test reminders ⁵	Record access
Appointment management	
Request or cancel ^{13–15}	Appointment scheduling
Reminders ^{5,13,14}	Appointment access
History log ¹³	Appointment access
Messaging	
View ^{13,14}	Messaging (general or medical) - View
Send to caregivers ^{5,13,14}	Messaging (general or medical) - Write
Patient note and goal	
Notes and biometric upload	Record management
Goal setting	Record management
Questionnaire	Record management
Referral	
Request	Record management
Summary	Visit summary
Visit/admission summaries ¹⁴	Visit summary
Educational materials and Web resources ¹³	Resource
General health-related information ¹⁴	Resource
Document downloading or printing ^{13–15}	Documentation
Billing and insurance	
Insurance benefit	Insurance and payment - View
Billing statement	Insurance and payment - View
Pay online	Insurance and payment - Write
Provider and clinic information	Resource
Account management ¹⁵	Excluded in the analysis

References: ⁵Ramsey et al. (2018); ¹³Elkind et al., 2017; ¹⁴Lafata et al. (2018); ¹⁵Tsai et al. (2019).