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ORIGINAL ARTICLE

Midwest rural-urban disparities in use of patient online services for COVID-19

Ming Huang PhD[1] | **Andrew Wen MS**[1] | **Huan He PhD**[1] | **Liwei Wang MD, PhD**[1] | **Sijia Liu PhD**[1] | **Yanshan Wang PhD**[1] | **Nansu Zong PhD**[1] | **Yue Yu PhD**[1] | **Julie E. Prigge MA**[2] | **Brian A. Costello MD**[2] | **Nilay D. Shah PhD**[1] | **Henry H. Ting MD, MBA**[1,3] | **Chyke Doubeni MBBS, MPH**[4] | **Jung-Wei Fan PhD**[1] | **Hongfang Liu PhD**[1] | **Christi A. Patten PhD**[5,6]

[1]Department of Artificial Intelligence and Informatics, Mayo Clinic, Rochester, Minnesota, USA

[2]Center for Connected Care, Mayo Clinic, Rochester, Minnesota, USA

[3]Department of Cardiovascular Medicine, Mayo Clinic, Rochester, Minnesota, USA

[4]Department of Family Medicine, Mayo Clinic, Rochester, Minnesota, USA

[5]Center for Clinical and Translational Science, Community Engagement Program, Mayo Clinic, Rochester, Minnesota, USA

[6]Department of Psychiatry and Psychology, Mayo Clinic, Rochester, Minnesota, USA

Correspondence
Christi A. Patten, Center for Clinical and Translational Science, Community Engagement Program, Mayo Clinic, 200 First Street SW, Rochester, 55905 MN, USA.
Email: Patten.Christi@mayo.edu

Abstract

Purpose: Rural populations are disproportionately affected by the COVID-19 pandemic. We characterized urban-rural disparities in patient portal messaging utilization for COVID-19, and, of those who used the portal during its early stage in the Midwest.

Methods: We collected over 1 million portal messages generated by midwestern Mayo Clinic patients from February to August 2020. We analyzed patient-generated messages (PGMs) on COVID-19 by urban-rural locality and incorporated patients' sociodemographic factors into the analysis.

Findings: The urban-rural ratio of portal users, message senders, and COVID-19 message senders was 1.18, 1.31, and 1.79, indicating greater use among urban patients. The urban-rural ratio (1.69) of PGMs on COVID-19 was higher than that (1.43) of general PGMs. The urban-rural ratios of messaging were 1.72-1.85 for COVID-19-related care and 1.43-1.66 for other health care issues on COVID-19. Compared with urban patients, rural patients sent fewer messages for COVID-19 diagnosis and treatment but more messages for other reasons related to COVID-19-related health care (eg, isolation and anxiety). The frequent senders of COVID-19-related messages among rural patients were 40+ years old, women, married, and White.

Conclusions: In this Midwest health system, rural patients were less likely to use patient online services during a pandemic and their reasons for its use differ from urban patients. Results suggest opportunities for increasing equity in rural patient engagement in patient portals (in particular, minority populations) for COVID-19. Public health intervention strategies could target reasons why rural patients might seek health care in a pandemic, such as social isolation and anxiety.

KEYWORDS
COVID-19, health care delivery, patient portals, portal messaging, rural health

INTRODUCTION

The fast spread of the infectious coronavirus disease-2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), led to a worldwide pandemic with high morbidity and mortality rates since December 2019.[1–3] Rural populations are disproportionately affected by COVID-19 and vulnerable to its impacts similar with other health disparity populations.[4,5] People in rural areas are particularly vulnerable to severe outcomes from COVID-19 infection due to their demographics and lack of health care resources.[6] Rural culture leads to special barriers to accessing care, including avoidance of asking for help and lack of social support, but also facilitators to care access, such as resilience.[7–9] In addition to physical health issues, mental health impacts resulting from COVID-19, including loneliness, reduced "access to" and "availability of" social support, worsening stress, anxiety, and depression[10–12] may be exacerbated in rural communities.[13]

At the same time, COVID-19 accelerated a change in health care delivery from in-person visits to virtual care.[14,15] Patient online services (patient portals) could serve as an attractive virtual platform and resource for patients from rural areas to seek support from their providers for COVID-19 and nonCOVID-related issues. Prior to COVID-19, research found disparities in patient portal use for health care access among rural residents compared to urban residents.[16–18] In this study, we performed a disparity analysis of portal messaging utilization for COVID-19 by urban-rural locality among patients within a midwestern US health system during the first wave of the pandemic.[19] We assessed portal messages associated with COVID-19 generated by patients from February 1, 2020 to August 31, 2020. We summarized reasons for patient utilization of portal messages for accessing COVID-19-related care, such as diagnosis, testing, and treatment, and seeking support for various issues, including appointment postponement and other health care issues due to COVID-19. In addition, we describe the patient users with respect to sociodemographic factors. The findings could shed light on the engagement of rural patients in patient portals to access their health care remotely and reduce potential COVID-19 risks and impacts.

MATERIALS AND METHODS

Mayo Clinic

Mayo Clinic is a large multispecialty academic medical center focused on integrated patient care, education, and research. Mayo Clinic has 3 main medical sites in Minnesota, Florida, and Arizona, and a Mayo Clinic Health System (MCHS) in the Midwest. MCHS is a network of community-based medical services and consisted of more than 40 hospitals and clinics serving 73 communities in Minnesota, Iowa, and Wisconsin.[20]

Patient online services

Mayo Clinic's patient portal (patient online services) has been operational since 2010.[21] The patient portal gives patients convenient access to personal health information and enables timely communications with their providers for various medical issues via portal messaging.[22–26] Specifically, patients could access to their health information (eg, clinical visits, lab test results, medications, and discharge summaries) at anytime from anywhere with Internet connection through a web browser or mobile app. A significant function in the patient portal is patient-clinician secure messaging, which enables patients and clinicians to timely communicate on a wide spectrum of issues.[27,28] Patients use secure messaging to request medical appointments and refill prescriptions online.[23] Clinicians send patients education materials, appointment reminders, and questionnaire before and after medical services.[24] Patients can use a symptoms assessment tool and express care online (E-visit) to evaluate their symptoms by answering a series of questions and to receive care options based on the responses. Patients and clinicians can communicate back and forth on complex situations, such as new symptoms, disease follow-ups, medication concerns, and other medical questions between office visits.[27,28]

With the functionalities of the patient portals, during the pandemic, patients can receive educational information on COVID-19 preventive care measures. Additionally, patients can access express care online (E-visit) for COVID-19 symptom assessment by an advanced practice provider, send and receive secure messages related to their COVID-19 diagnostic tests and test results. Patients may interact with their providers about their care plan and seek support from them on the health care issues, such as mental health conditions due to COVID-19 via portal messaging.

Data collection

We collected more than 1.4 million portal messages generated by patients in the midwestern US between February 1 and August 31, 2020. We then filtered the patient-generated messages (PGMs) associated with COVID-19 using relevant keywords (eg, COVID-19, Pandemic, Coronavirus, SARS-CoV-2, and 2019-nCoV) and their synonyms and morphological variations. We removed the PGMs with empty message bodies and the PGMs requested by providers, such as messages for preappointment COVID-19 screening and postdischarge COVID-19 symptom check. A total of 118,166 portal messages on COVID-19 generated by 68,296 patients were retained for statistical analysis. Each of those messages has a unique message identifier (ID), source message ID, sender, recipient, the timestamp when it was created, message type, message subject, and message body.

Statistical analysis

We performed descriptive statistics on the acquired PGM data set and examined the following 4 aspects of patient utilization of portal messaging for COVID-19 in the Midwest:

Patients and their sociodemographic characteristics

We calculated the number of patients in the electronic health records (EHRs) and patient portal at the 3 Mayo Clinic sites (Minnesota, Florida, and Arizona), the midwestern area, and midwestern urban and rural areas between February 1 and August 31, 2020. We analyzed the patient counts in terms of 5 different roles of the patient: (1) patient involved in the EHR, (2) patient involved in portal, (3) portal user, (4) portal message sender, and (5) COVID-19 message sender. The 5 patient roles reflect different levels of patient engagement in the use of the patient portal during the pandemic. The patient involved in EHR is the EHR subject in the study period. Similarly, the patient involved in the portal is the patient subject of portal messages created in the study period. The portal users are patients who sent and/or received a portal message to and/or from their providers, respectively. A portal user may not send a portal message to his/her provider. The portal message sender is the patient who sends messages of any types, including the portal messages on COVID-19. The COVID-19 message sender is the patient who sent at least a portal message related to COVID-19.

We analyzed the distribution of different patient populations who used portal messaging for COVID-19 in the Midwest by stratifying the unique patient senders with respect to their personal and social conditions, including age, gender, marriage, ethnicity, race, language, and residence. We compared the distribution of the patients in the urban and rural Midwest and tested the consistency of patient distribution between patients in the urban and rural areas.

Number of PGMs on COVID-19 and unique patient senders

We calculated the daily number of PGMs on COVID-19 and unique patient senders in the Midwest and its urban and rural areas. Since the daily message counts and unique patient counts exhibit a week periodicity (typically with a maximum on Monday and a minimum on weekend), we calculated and reported their weekly smoothing averages as the number of PGMs on COVID-19 and unique patient senders over time for the following analysis. Comparing the number of PGMs on COVID-19 and unique patient senders between the urban and rural areas could provide us an overall disparity of portal messaging between urban and rural patients in the Midwest for addressing the COVID-19 pandemic over time.

Message use for COVID-19-related care

We analyzed the PGMs used for assessing COVID-19 symptoms and discussing COVID-19 diagnostic tests and results and care plan in the Midwest, including urban and rural areas. We filtered the PGMs on COVID-19 symptom assessment by searching the relevant phrase––"COVID-19 (Coronavirus) Symptom Assessment" and calculated the number of the PGMs on COVID-19 symptom assessment. Similarly, we identified the PGMs on COVID-19 diagnostic tests and results and care plan using relevant keywords, such as "test" and "result" for diagnostic tests, and results and "care plan," "monitoring," and "interactive care" for care plan. Analyzing portal messaging for COVID-19 between urban and rural areas could help us to understand the disparity of message use for COVID-19 diagnosis and treatment in urban-rural locality.

Message use for other health care issues caused by the COVID-19 pandemic

We examined other health care issues related to COVID-19 reported in the portal messages to understand COVID-19 impacts on health services and patients. We calculated the number of PGMs explicitly mentioning the phrase "due to COVID-19" and its synonyms to examine patient-reported health care issues caused by COVID-19 pandemic. We also computed the number of PGMs on COVID-19 that discussed rescheduling or cancelling events, isolation, and mental health using relevant keywords (eg, "cancel" and "reschedule" for event administration, "isolation" and "quarantine" for isolation, and "anxiety" and "depress" for mental health) and their synonyms. Examining the message use for other health care issues resulted from COVID-19 pandemic in the urban and rural areas offers us useful information on the disparity of COVID-19 impact on health services and patients between urban and rural patients.

The keywords used to filter the patient portal messages are listed in Table S1.

Evaluation

We recruited 2 medical students for annotating the binary code for each studied topic in portal messages–whether a portal message is linked to COVID-19, COVID-19-related care, or other health care issues due to COVID-19. We randomly sampled 1,900 portal messages for annotation and the results are shown in Table S2. The first 100 portal messages (10 each topic) were sampled and labeled by both annotators and their overall interagreement score is 0.91. After that, the 2 annotators worked together to complete the rest annotation. More

TABLE 1 Patients in the EHR and patient portal at Mayo Clinic during February 1-August 31, 2020

Mayo Clinic patients	Patients involved in EHR	Patients involved in portal		Portal users (sent/received a msg)		Portal message senders (sent a msg of any types)		COVID-19 message senders (sent a msg re: COVID-19)	
		Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
All sites	1,851,097	1,055,319	57.01	713,271	38.53	384,922	20.79	102,470	5.54
Midwest	1,215,512	752,984	61.95	483,800	39.80	257,381	21.17	68,296	5.62
Urban	622,302	380,282	61.11	262,024	42.11	146,084	23.47	43,855	7.05
Rural	593,210	372,702	62.83	221,776	37.39	111,296	18.76	24,441	4.12

specifically, we randomly sampled 100 portal messages on COVID-19 and 900 portal messages not related to COVID-19, which were identified by using the keyword searching for labeling. The precision, recall, and F1-score of the COVID-19 keyword searching is over 0.99. We randomly sampled 100 portal messages on COVID-19 linked to each topic, such as "isolation." The F1-scores range from 63.1% to 94.9% except "symptom assessment" (100%). The portal message on symptom assessment has a special phrase, "E-Visit Submission: COVID-19 (Coronavirus) Symptom Assessment," to accurately filter.

RESULTS

Patients and their characteristics

Table 1 lists the number of patients in the EHRs and patient portal at all 3 Mayo Clinic sites combined, the Midwest site, and Midwest urban and rural areas from February 1 to August 31, 2020. Overall, 65.67% of patients involved in the EHR were Midwest residents in the Midwest and 66.86%-71.35% of patients with portal roles were the Midwestern residents. Similarly, the percentage of patients with portal roles in the Midwest area was higher than that of patients with portal roles at all sites by 0.28%-4.95%. The ratio of patients involved in the portal by urban-rural locality was 1.02, which is less than that of patients involved in EHR (1.05). However, the urban-rural ratio of portal users, portal message senders, and COVID-19 message senders is 1.18, 1.31, and 1.79, respectively. These data suggest that the urban-rural disparity exacerbated as the patient role changed in the order of portal users, portal message senders, and COVID-19 message senders.

Among Midwest patients who created portal messages on COVID-19, we examined sociodemographic characteristics overall and by urban and rural locality (Table 2). Overall, almost two-thirds (63.9%) were in the 40-49, 50-64, and 65+ age groups. About 60% were women and married/partnered. Patients were predominantly (>92%) of non-Hispanic/Latino ethnicity, White, and English as their primary language.

Rural patients had a significantly different sociodemographic distribution from urban patients in terms of age, sex, marriage, race, and language (Table 2). Specifically, the proportion of rural patients in the 40-49 (or 50-64, 65+) age groups was 0.24% (or 1.86%, 3.02%) more than that of urban patients in the corresponding age group. Compared to the percentage of women (or married) urban patients, the proportion of women (or married) rural patients was larger by 1.97% (or 3.55%). The percentage of rural White patients or rural patients who spoke English was significantly more than (4.07% or 0.51%) that of the urban White patients or urban patients who spoke English, respectively. The percentage of rural patients who were Native American was slightly (0.13%) larger than that of urban patients.

Patient-generated messages on COVID-19 and unique patient senders

From February 1 to August 31, 2020, patients in the Midwest created a total of 1,418,328 general portal messages and 118,166 portal messages associated with COVID-19 (Table 3). The ratio of PGMs on COVID-19 between urban and rural areas was 1.69, which was higher than that (1.43) of general PGMs between urban and rural areas. These data indicate that rural patients were less likely to send portal messages on COVID-19 than urban patients.

Figure 1 shows the number of PGMs on COVID-19 and involved unique rural and urban patient senders in the Midwest. We observed that the message volumes and patient counts declined around holidays (ie, Memorial Day-May 25, 2020 and Independence Day-July 4, 2020). We excluded the decline of message volumes around national holidays for subsequent analysis. The number of PGMs on COVID-19 in the Midwest started to increase in late February 2020 and quickly reached to a maximum of 1418.86 on March 21, 2020. Shortly after, the number of PGMs on COVID-19 in the Midwest constantly declined. However, the curve considerably fluctuated up and down during May 3-June 15 and June 15-August 3, 2020. The local peak on May 14 (or July 12) increased by 28.85 (or 108), compared with the closest local minimum on May 3 (or June 15). The May and July peaks were 47.27% and 44.40% of the March peak. The trend of PGMs on COVID-19 in the urban Midwest was in excellent agreement with that of PGMs on COVID-19 in the Midwest. The local peak on May 14 (or July 11) was larger than the closest local minimum on May 3 (or June 15) by 29.57% (or 76.71%). The PGMs on COVID-19 in the rural Midwest also had an overall similar trend to PGMs on COVID-19 in the Midwest. However,

TABLE 2 Demographic distribution of COVID-19 message senders in the Midwest

	Demographics	Total (N = 68,296)	Urban (N = 43,855)	Rural (N = 24,441)	P value*
Age	<18	11.06	11.73	9.83	2.95E-50
	18-29	11.36	11.85	10.44	
	30-39	13.90	14.54	12.73	
	40-49	12.65	12.57	12.81	
	50-64	25.81	25.16	27.02	
	65+	25.21	24.15	27.17	
Gender	Female	60.86	60.17	62.14	5.72E-10
	Male	39.14	39.83	37.86	
Marriage	Married or partnered	59.86	58.61	62.16	2.7E-23
	Unmarried or legally separated	40.14	41.39	37.84	
Ethnicity	Non-Hispanic or Latino	97.42	97.39	97.49	.81
	Hispanic or Latino	2.58	2.61	2.51	
Race	White	94.13	92.70	96.77	0
	Asian	1.98	2.77	0.53	
	Black or African American	1.50	1.96	0.66	
	American Indian/Alaskan Native	0.35	0.30	0.43	
	Native Hawaii/Pacific Islander	0.07	0.07	0.06	
	Other	1.97	2.20	1.55	
Language	English	99.30	99.12	99.63	0
	Arabic	0.05	0.07	0.00	
	Spanish	0.19	0.19	0.19	
	Other	0.47	0.62	0.18	

*P-values of chi-square goodness-of-fit tests between rural patients and urban patients.

TABLE 3 Urban-rural differences for number of PGMs and PGMs on COVID-19 among Midwest patients, February 1-August 31, 2020

Location	Total PGMs	PGMs on COVID-19
Midwest	1,418,328	118,166
Urban	835,205	74,270
Rural	583,118	43,896
Urban-rural ratio	1.43	1.69

the fluctuation of the rural curve only occurred in July and the fluctuation was not significant. In addition, we observed a strong correlation between message count and unique patient count and low messaging rate per patient. It suggests the volume of unique patients mainly contributes to the intensive utilization of portal messaging.

Portal messaging for COVID-19-related care and other issues

We analyzed the portal messages sent by patients to their providers for COVID-19 reasons in the Midwest overall and by urban and rural res-

idence (Table 4). The proportion of PGMs on COVID-19-related care for symptom assessment, diagnostic testing and results, and care plan among urban patients was larger than for rural patients. The urban-rural ratio of portal messages for COVID-19 symptom assessment, testing and results, and care plan was 1.71, 1.84, and 1.86, respectively. The percentage of PGMs for other health care issues related to COVID-19 in the Midwest ranged from 2.21% to 16.31% as shown in Table 4. The 3 top discussed health care issues in the PGMs on COVID-19 were postponement and cancelation (16.3%), anxiety (11.4%), and isolation (6.8%). The percentage of PGMs for these health care issues among urban patients was smaller than for rural patients by 0.09%-1.87%. The only exception was depression and its percentage among urban patients was slight larger (0.06%) than among rural patients. Except for depression (1.74), the urban-rural ratio of portal messages was 1.43-1.67 for most of other health care issues related to COVID-19. Figures S1 and S2 show the patterns in PGM use for COVID-19 health care and other issues. All the curves had an initial upsurge followed by a rapid decrease during March to April 2020. In addition, a small up-and-down fluctuation occurred in July in some curves. For example, PGMs on postponement and cancelation, anxiety, isolation, depression, and care plan.
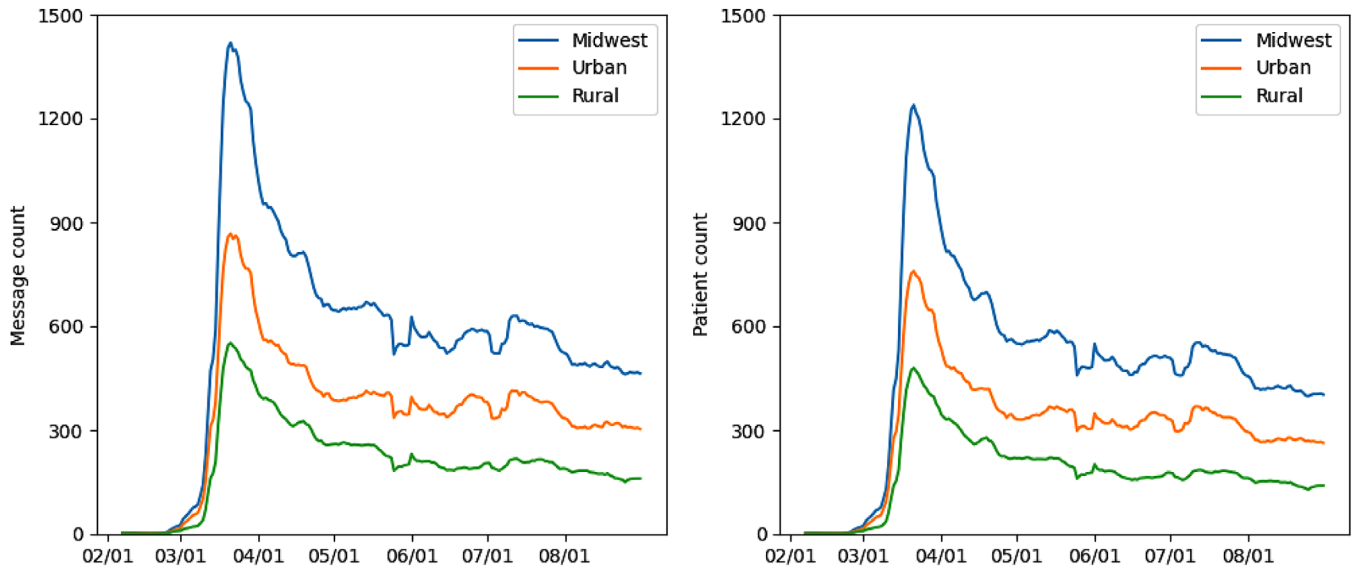
FIGURE 1 Number of patient-generated messages (PGMs) on COVID-19 and involved message senders in the Midwest (blue line) and its urban (yellow line) and rural (green line) areas

TABLE 4 Patient-generated messages (PGMs) for COVID-19-related reasons among Midwest patients by urban-rural locality

Theme	Category	Overall (N = 118,166)		Urban (N = 74,270)		Rural (N = 43,896)	
		#	%	#	%	#	%
COVID-19related care	Symptom assessment	2,473	2.09	1,559	2.10	914	2.08
	Tests and results	60,464	51.17	39,210	52.79	21,254	48.42
	Care plan	2,234	1.89	1,452	1.96	782	1.78
Other issues caused by the COVID-19 pandemic	General issues	7,230	6.12	4,253	5.73	2,977	6.78
	Postponement and cancelation	19,277	16.31	11,884	16.00	7,393	16.84
	Isolation	7,988	6.76	4,995	6.73	2,993	6.82
	Anxiety	13,459	11.39	7,943	10.69	5,516	12.57
	Depression	2,615	2.21	1,660	2.24	955	2.18

DISCUSSION

The COVID-19 pandemic and associated mitigation activities, such as social distancing, rapidly accelerated health care access and delivery to virtual digital care.[14,15] Prior to the COVID-19 pandemic, rural patients were found to have a reduced use of patient portals compared to urban patients.[16–18] This study adds new information on patient use of online services for COVID-19-related care by rural-urban locality in a Midwestern sample. We analyzed the patients at the 3 Mayo Clinic sites and in the Midwest and found that the patients in the Midwest were more inclined to use patient portals. Our findings indicate that there are disparities in rural patients use of the online services for COVID-19-related care. These disparities are important to address because rural patients have barriers to accessing care *in person* due to geographical distance and extended travel to facilities. Even though virtual care may help address these barriers and thus may be appealing

to patients, the COVID-19 pandemic may have only widened such disparities. The urban-rural disparity of portal messaging exacerbated as the patient role changed in the order of portal users, message senders, and COVID-19 message senders. The ratio of COVID-19-related messages sent by urban patients and rural patients was 1.69, which was significantly higher than that (1.43) of general portal messages. For the COVID-19-related care, the ratio of portal messages between urban and rural patients was even larger (1.71-1.84), suggesting that rural patients had sent fewer messages for COVID-19 diagnosis and treatment than urban patients. This finding is consistent with recent studies that when compared to urban regions, COVID-19 testing was far lower and disproportionately fewer positive cases were reported in rural regions.[30–32] Further disparities were observed for care access as the frequent senders of COVID-19-related messages among rural patients were 40+ years old, women, married, and White. These data suggest that efforts to address virtual health care access among men

and minority rural populations are warranted. Another key finding is that among those who do access care online for COVID-19, the reasons were quite different among rural compared with urban patients. These reasons included anxiety and social isolation. These results provide an opportunity to tailor and enhance portal utilization for rural patient-specific concerns.[33]

Multiple factors could contribute to the patient barriers to assess to the health care via patient portal. For example, a key factor for the patient adoption of virtual care, including patient portal among vulnerable populations, is digital divide (access to, utilization of, and easiness with technique).[16] Compared with urban residents, rural residents in the United States are comparable for owning a cell phone (97% vs 94%); but are less likely to own a smartphone (83% vs 71%), computer or tablet (73% vs 69%), or to have home access to broadband Internet (75% vs 63%).[34] Prior research also identified rural cultural and norms as barriers to accessing health care, including self-sufficient lifestyle; stoicism (lower likelihood of disclosing and cognitively processing emotional or physical states or concerns); isolation, loneliness, less reliance on social support; and worry about missing everyday life roles, such as work, parenting, and managing family farms, relative to urban peers.[35,36] The factors have potential to exacerbate the assess barriers to patient portal and other telehealth platforms.[37,38] Thus, it is critical to not amplify or reduce existing health disparities experienced by patients in rural communities.

Future directions

The COVID-19 pandemic and the associated mitigation activities have deeply impacted health care services and patients. Rural populations are disproportionately affected by COVID-19 and vulnerable to its impacts due to limited resources to respond to the pandemic. Millions of nonacute official visits have been postponed, cancelled, or transitioned to online platforms, such as patient portals for continued health care. In this work, we performed a disparity analysis on portal messages generated by patients at Mayo Clinic for COVID-19 between Midwestern urban and rural areas. We then characterized the patient users with respect to their personal and social factors to probe the rural odds of portal messaging utilization for COVID-19. Results suggest several opportunities for enhancing equity in portal adoption and use among rural patients for COVID-19-related health care access and delivery as well as concerns (eg, anxiety). These efforts are pertinent and timely for increasing COVID-19 testing, diagnosis, and treatment as well as for the eventual dissemination of a vaccine for COVID-19. Because rural patients who sent messages were more likely to address health care issues related to COVID-19, including social isolation and anxiety, future work could tailor educational content specific to rural populations to engage them in health care access via the portal. Additional research could assess rural cultural norms, barriers, and facilitators to portal adoption and use. These efforts would be useful for the COVID-19-related care but also provide insights into improving equity in rural patient care access and delivery for other health issues, and any future infectious diseases or pandemics. Such efforts should also focus on engagement of subpopulations of rural patients with less portal utilization, such as men and racial minorities, to understand specific needs or barriers, such as trust in health care.[39]

CONCLUSIONS

In this Midwest health system, rural patients were less likely than urban patients to use a patient portal to access care especially for COVID-19-related care. Rural patients who sent messages were more likely to focus on other health care concerns related to COVID-19, such as social isolation and anxiety. Finding suggests several opportunities to enhance equity in portal adoption and use among rural populations.

ORCID

Ming Huang PhD https://orcid.org/0000-0001-7367-3626

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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