

Characterizing the Users of Patient Portal Messaging: A Single Institutional Cohort Study

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Abstract—This work studied message communications on patient portals and examined both the longitudinal trends and the correlations with characteristics of message senders. We analyzed over 5.6 million secure messages sent on the Mayo Clinic patient portal between February 18, 2010, and December 31, 2017. We studied the longitudinal changes in the number of portal messages, patient senders’ demographics and medical conditions (PheCodes), and provider senders’ care settings (e.g., primary or specialty) and practice roles (e.g., physician, nurse practitioner, and registered nurses). When compared to non-message-senders, patient message senders had a significantly higher proportion of the demographics: age 41-60, female, married, white, and English-speaking. From 2010-2017, an individual patient sent an average of 9.8 messages per person while a provider sent 418.4. The average number of PheCodes for all patients regardless of portal usage increased from 7.5 +/- 6.9 in 2010 to 10.7 +/- 10.1 in 2017. The Pearson correlation coefficient between average PheCodes per patient and average messages per patient was 0.273 ($p < 0.0001$). Physicians were the largest proportion of message composers in both primary and specialty care (36.20% of primary, 37.54% of specialty). Starting 2013 onwards, specialty providers comprised the majority of portal providers while primary care providers remained stable around 20-22%. Our results show that patient portals are playing an increasingly significant role in supporting patient-provider communications. The longitudinal growth also sheds light on the possible challenge of communication overload for providers and the healthcare system.

Keywords—patient portal, asynchronous communication, electronic health record (EHR), health information technology (HIT)

I. INTRODUCTION

Asynchronous patient portal platforms are a health information technology (HIT) infrastructure that closely integrates with the electronic health records (EHR) system and connects patients with their providers through information exchange and communication. Their initial purpose was to make it easier for patients to communicate with and receive updates from their care team. Ever since the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2008[1] that required hospitals to demonstrate meaningful use of the EHR[2], patient portals have witnessed a proliferating usage from and engagement with patients[3]. Previous studies have noted a rapid adoption of patient portals especially in the outpatient setting: from 2008 to 2019, the proportion of outpatient communication through portal messaging increased from 13% to 40%[4, 5]. Another study shows that over 90% of healthcare organizations had provided patient portal services to their patients[6]. Early adopters of the patient portal system included Kaiser Permanente and the Veteran’s Affairs health systems[7].

A popular vital feature of these portals is “secure messaging,” a type of asynchronous communication between the patient and provider outside of an in-person visit[8, 9]. Patients and providers can use this feature to handle administrative tasks, ask and answer clarifying questions, and even bring up and solve medical concerns. For example, patients send secure messages to request medical appointments and medication refills[10, 11]. Providers send patients appointment reminders and promote timely

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preventative care[12, 13]. Patients and providers communicate back and forth on complex situations such as new symptoms, disease follow-ups, and care concerns[14]. An essential characteristic of patient communications through the portal is the logistical, social, and medical communications[8, 15-17].

Portals are seen as a necessary component for hospitals to maintain and improve patient experience[7, 18, 19]. With the help of portals, patients can easily view notes and lab results to stay informed about their care and can intuitively explore their data with an interactive interface[20]. The convenient access to both personal health information and providers has been shown to improve patient self-management of diseases, as it promotes patients’ awareness and knowledge of diseases, health status, and care progress[21]. Additionally, there is a potential to reduce administrative costs on the side of the hospital[22] while increasing the quality of patient experience[41]. However, the existing literature has mainly focused on specific departments within an institution and thus has a limited patient population from which to determine usage patterns and demographics of patient portal users[11, 23-29]. It is important to understand common patterns in patient-provider communications across the portal and to relate patient demographics with patient portal usage, regardless of department type.

To date, there is limited literature about patient portals as this is a growing area in medical practices and has been evolving mainly in recent years to integrate augmented healthcare intelligence telehealth tools for asynchronous and synchronous communications. Particularly, during the COVID-19 pandemic, COVID-19 is transforming the delivery of healthcare and catalyzing rapid adoption of patient portals and other telehealth services[30]. The current literature focuses on specific patient populations in an attempt to draw conclusions about clinical outcomes[12, 14, 27, 31-35]. Few studies described the demographics and characteristics of portal messaging users[25]. In order to further study specific patient populations and outcomes, it is critical to first clearly define basic information about portal use and features of those using it, as we have done herein. Thus, our study analyses over 5.6 million secure messages sent by a patient portal from 2010-2017 at Mayo Clinic, a large multi-specialty academic health system, and represents the largest data set of these types of messages that we are aware of.

II. METHODS

A. Message collection and preprocessing

Mayo Clinic is a large multi-specialty academic medical center focused on integrated patient care, education, and research. Mayo Clinic’s patient portal (Patient Online Services)[36] started in 2010 for primary care practice and later extended to specialty practices in 2013. We collected more than 5 million secure messages generated by patients and providers from the patient portal between February 18, 2010 and December 31, 2017 at Mayo Clinic - Rochester. Each message has a unique identifier (ID), previous message ID, initial message ID, sender ID, recipient ID, the timestamp when it was created, message subject, and message body. We applied three filters to preprocessing these secure messages: 1) Exclude messages with empty message bodies; 2) Exclude messages sent by mockup patients and clinicians that were created for testing; 3) Exclude messages sent by a clinician group where the sender uses a shared ID, usually for

impersonal communication. The final datasets contain a total of 5,654,514 secure messages generated by both patients and clinicians for sequential analysis.

B. Demographic characteristics of patients

We calculated the distribution of different patient populations that used secure messaging in the patient portal by stratifying the patients with respect to their personal and social conditions including age, gender, marriage, ethnicity, race, language, and residence. The patients include message senders and portal viewers (those who use the portal but do not compose messages). We then analyzed demographic distribution of message senders over years.

C. Medical conditions associated with patient senders

We linked the patient senders to their EHRs via patient IDs to extract their primary diagnosis codes (ICD-9 or ICD-10) [36] in the EHRs. We extracted about 35 million diagnosis codes for 201,423 (93%) patient senders during the study period. We then associated these primary diagnosis codes to the 1,868 phenome-wide association study codes (PheCode) [37, 38] with their mapping table, which represents clinically meaningful phenotypes used by providers. The PheCode were further grouped into 708 root PheCode for statistical analysis. We calculated the number of medical conditions coded by the root PheCode associated with each patient who sent secure messages during the 8 years. We analyzed the distribution of medical conditions per patient per year and correlated it with messages per patient per year.

D. Specialty categories of providers

We classified the providers into 9 categories in terms of their care settings and practice roles (See **Table 1**).

TABLE I. PROVIDER CATEGORIES WITH RESPECT TO THEIR CARE SETTINGS AND PRACTICE ROLES.

Care	Role ^a			
	Physician	NP/PA	RN	Other
Primary Care	primary care - physician	primary care - NP/PA	Primary care - RN	primary care - other
Specialty	specialty - physician	specialty - NP/PA	specialty - RN	specialty - other
Other	-	-	-	other care - other

^a NP/PA denotes nurse practitioner/ physician assistant and RN is registered nurse.

The main care setting includes primary care and specialty. The main practice roles were physician, nurse practitioner/physician assistant (NP/PA), and registered nurse (RN). Besides physicians, NPs, PAs, and RNs, there are other supporting staff who communicated with patients via secure messaging, such as patient appointment service specialists, social workers, and financial counselors who work outside of the primary and specialty care setting. The supporting staff is classified as “Other” in the role category. We then examined the proportion of each provider category using portal messaging per year.

III. RESULTS

A. Patient demographics from 2010 and 2017, cumulatively

The characteristics of frequent message sender in this cohort were age 41-60, female, married, white, and English-speaking. For the patients aged 18-60, the percentage of message senders was larger than that of message viewers by more than 3%. Conversely, in the younger (age<18) and older

TABLE II. DEMOGRAPHIC DISTRIBUTION OF UNIQUE SUBSET OF MESSAGE SENDERS AND MESSAGE VIEWERS

Demographics		Patient message senders (N=216,734)		Patient message viewers (N=119,036)	
		Count	%	Count	%
Age*	<18	12,028	5.55	16,440	13.81
	18-30	29,717	13.71	12,178	10.23
	31-40	32,781	15.12	11,578	9.73
	41-50	34,870	16.09	14,486	12.17
	51-60	45,891	21.17	21,309	17.90
	61-70	38,487	17.76	22,141	18.60
	71+	22,120	10.21	20,432	17.16
	Unknown/declined/missing	840	0.39	472	0.40
Age*	<65	172,534	79.61	85,047	71.45
	65+	43,360	20.01	33,517	28.16
	Unknown/declined/missing	840	0.39	472	0.40
Gender	Female	127,363	58.76	60,381	50.72
	Male	88,526	40.85	58,182	48.88
	Unknown/declined/missing	845	0.39	473	0.40
Marriage	Married or Life Partner	145,896	67.32	71,657	60.20
	Not married or Legally Separated	68,327	31.53	45,861	38.53
	Unknown/declined/missing	2,511	1.16	1,518	1.28

Demographics		Patient message senders (N=216,734)		Patient message viewers (N=119,036)	
		Count	%	Count	%
Ethnicity	Not Hispanic or Latino	200,527	92.52	108,679	91.30
	Hispanic or Latino	4,273	1.97	2,758	2.32
	Unknown/declined/missing	11,934	5.51	7,599	6.38
Race	White	195,613	90.25	105,164	88.35
	Asian	5,407	2.49	3,375	2.84
	Black or African American	2,613	1.21	2,312	1.94
	American Indian/Alaskan Native	823	0.38	474	0.40
	Native Hawaii/Pacific Islander	127	0.06	82	0.07
	Other	4,712	2.17	3,439	2.89
	Unknown/declined/missing	7,439	3.43	4,190	3.52
Language	English	207,449	95.72	112,060	94.14
	Arabic	1,430	0.66	1,524	1.28
	Spanish	735	0.34	581	0.49
	Other	1,338	0.62	1,298	1.09
Unknown/declined/missing	5,782	2.67	3,573	3.00	

*Two different age distributions were analyzed.

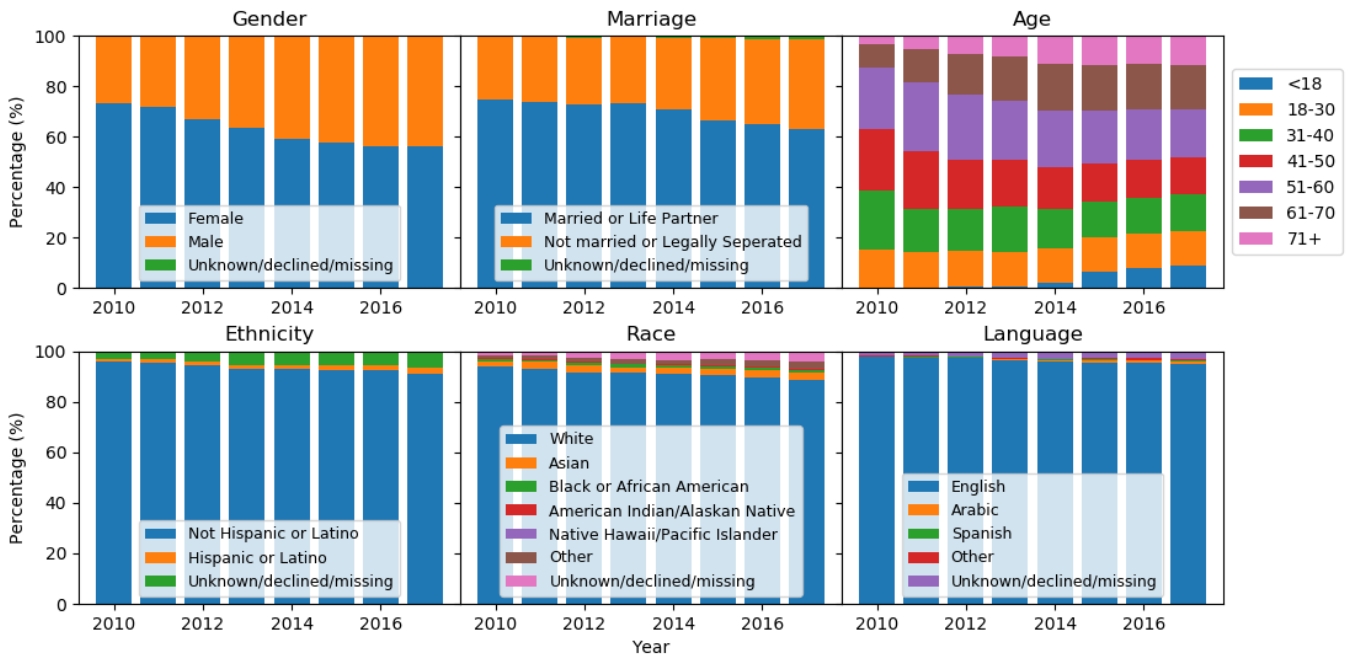


Fig. 1. Demographics of unique message senders over years

(age>70) age groups, message viewers were more common than message senders by 7-8%.

Figure 1 depicts the trend of distribution of messages senders in terms of patient demographics over years. The proportion of female, married, 18-60 years old, non-Hispanic/non-Latino, white, and English-speaking message senders constantly decreased from 2010 to 2017. However, most notably, the proportion of message senders who are age<18 or >60 steadily increased over the 7-year time frame.

B. Patient secure messages and unique message senders

Most of the unique message senders utilizing the portal from 2010-2017 were patients (N = 216,734, M = 2,118,773), while the majority of messages were sent by providers (N = 8,450, M = 3,535,741), where N and M are patient or provider count, and message volume, respectively. The average number of messages in the 8-year span from 2010-2017 sent by an individual patient was 9.8 messages per patient. The average amount of messages sent by an individual provider during that time was 418.4 messages per provider (**Table 3**). The average number of messages sent annually by an individual patient increased from 2.3 in 2010 to 5.8 in 2017, and from 12.6 to 197.3 for individual providers in that same time period.

TABLE III. CUMULATIVE NUMBERS OF SECURE MESSAGES AND UNIQUE MESSAGE SENDERS INCLUDING PATIENTS AND PROVIDERS (2010-2017)

Sender	Unique sender	Secure message	Messages per sender
Patient	216,734	2,118,773	9.8
Provider	8,450	3,535,741	418.4

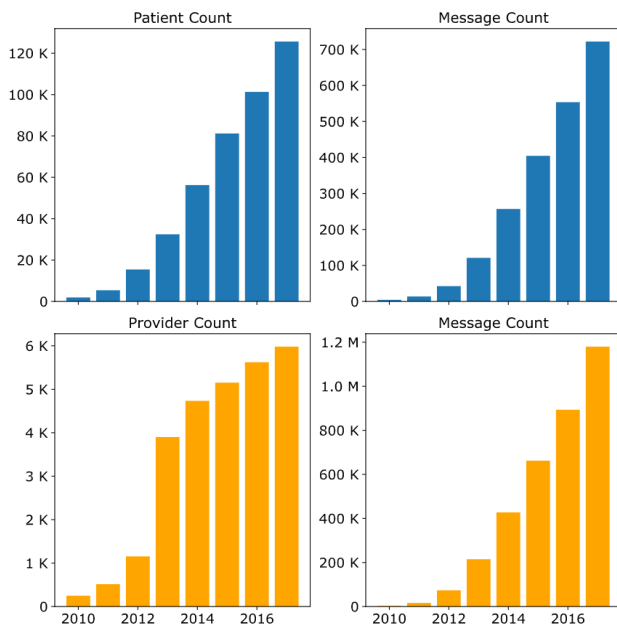


Fig. 2. Numbers of secure messages and unique message senders over years

From 2010 to 2017, the number of messages sent by an individual patient and individual provider both increased (**Figure 2**). Though the number of patient and provider users of the portal increased, the volume of messages from the two groups increased at a faster rate.

C. Patient health conditions

Table 4 presents the average number of diseases per patient listed in their electronic health records for each year from 2010-2017. The average number of PheCodes for all patients regardless of portal usage increased from 7.5 +/- 6.9 in 2010 to 10.7 +/- 10.1 in 2017. For message senders only, the average number was 9.0 +/- 7.5 in 2010 and 11.4 +/- 10.3 in 2017 (**Table 4**). The maximum number of PheCodes for one patient was 134. For message senders only, the average number of PheCodes remained relatively stable over time and were consistently around 10-11 on average.

TABLE IV. AVERAGE PHECODES PER PATIENT FROM 2010-2017 FOR ALL PATIENTS AND FOR ONLY MESSAGE SENDERS

Year	PheCode Count Per Patient (SD) — Message Senders
2010	9.00 (7.47) N = 1748
2011	10.52 (9.47) N = 4842
2012	10.57 (9.32) N = 13710
2013	10.69 (9.53) N = 28965
2014	10.50 (9.54) N = 48532
2015	10.43 (9.69) N = 69978
2016	10.97 (9.62) N = 88138
2017	11.44 (10.27) N = 108920

For message senders who had PheCodes logged in their EHRs, there was a significant correlation observed between the distribution of disease count (specific PheCode counts per patient) and the number of messages sent. For the 364,833 unique patient-year pairs that had both PheCodes and message counts extracted from the institutional database, the Pearson correlation coefficient between average PheCodes per patient and average messages per patient was 0.273 (p < 0.0001), meaning a weak positive correlation between disease burden and message volume.

D. Providers categories

TABLE V. PERCENTAGES OF PROVIDERS AND GENERATED MESSAGES IN TERMS OF PRACTICAL ROLES AND CARE SETTINGS (CUMULATIVE OVER 2010-2017)

Care	Role	% of Total Providers (N=6772)	% of Primary Providers	% of Specialty Providers
Primary	Physician	7.28%	36.20%	-
	NP/PA	1.96%	9.75%	-
	RN	5.66%	28.15%	-
	Other	5.21%	25.91%	-
Specialty	Physician	26.67%	-	37.54%
	NP/PA	5.27%	-	7.42%
	RN	15.25%	-	21.46%
	Other	23.86%	-	33.58%
Other	Other	8.83%	-	-

Table 5 shows that physicians were the largest proportion of message composers in both primary and speciality care (36.20% of primary, 37.54% of specialty). Overall, specialty physicians (26.67%) and primary NP/PAs (1.96%) represented the largest and smallest groups of providers, respectively. Primary physicians represented 7.28% of providers yet had the largest share of messages at 25.79% over the cumulative period. Starting 2013 onwards, specialty providers comprised the majority of providers active on the patient portal (blue bars, **Figure 3**) and the percentage of primary providers remained relatively constant in the range of 20-22% (red bars, **Figure 3**).

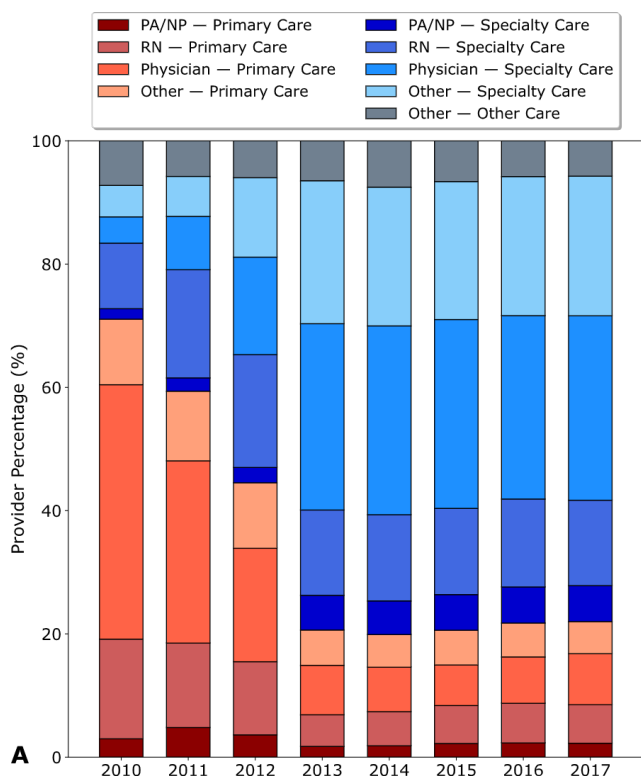


Fig. 3. Percentages of providers in terms of practical roles and care settings by year. Shades of red and blue represent primary and specialty care roles, respectively.

IV. DISCUSSION

This study considers a single institution experience over a period of 8 years of a large cohort of secure patient messages numbering approximately 5.6 million. Further, we report detailed patient demographics and provider categories, and correlate these features with portal utilization in both primary care and specialty care. To the best of our knowledge, there is no prior published data about patient portals and secure messaging in medical practice which reports a single-institution experience having this much breadth and depth.

Overall, more messages are sent by providers and care teams to patients than vice versa (3,535,741 versus 2,118,773, respectively). When patient portals were first being implemented, the goal was mainly to be a tool for patients to communicate with their care providers. Given this case, it is interesting to see the heavy utilization of the patient portal by physicians, advanced practice providers, nurses and other support staff to engage with patients. Responding to questions, sending appointment guides, providing patient education materials, and communicating test results among other things

are ways that secure messaging has been leveraged to enhance non-visit patient care.

The absolute volume of clinician-sent messages and the growing average of clinician-sent messages per clinician suggests an increase in the time and effort focusing on secure messaging by clinical practice teams[39]. This has implications for staffing as well as roles and responsibilities of care team members. What is uncertain is whether this has added to the efficiency of patient care and, moreover, how it has impacted the clerical burden of the care team members. Despite potential challenges, we note a major transformation in practice models and the paradigms of medical practice, thereby requiring appropriate efforts in the retooling of practice structures.

The portal experience among primary care and specialty care providers exhibits stark differences. Until 2013, the providers on the portal were mainly from primary care services, after which the majority of providers became specialty based. Cumulatively, within primary and specialty sub-cohorts, the distribution of provider types was similar, with physicians being around one-third of providers in each sub-cohort. However, across all total providers from 2010-2017, specialty providers made up the majority of providers active on portal messaging. Specialty providers became the majority of providers on portal messaging beginning in 2012 and maintained their sizeable majority from 2013 onwards. This analysis did not specifically look at messaging volume per provider type and would be a possible future study to determine utilization patterns per provider type in details. Portal utilization patterns can be affected by the departmental organization while understanding such patterns and correlations could shed light on ways to efficiently manage the flow of messages to the provider. The administrative organization and message flow of departments could significantly impact how large of a message load their physicians see. Moreover, this difference could also be due to the types of requests that patients may have from their specialty providers as opposed to their primary care providers. All this provides ample hypotheses for further exploration.

Another motivation of this study is to explore possible associations between disease count and the number of messages sent. In considering patient health conditions since 2010, the message count per patient increased as did the disease count (number of distinct diagnoses) per patient, an indicator of medical complexity. From 364,833 unique patient-year pairs, there seemed to be a slight positive correlation between the number of messages sent and the number of PheCodes registered to a message sender's EHR. This suggests that there might be more reasons for patients with multiple complex medical conditions to utilize the portal more to ensure proper management and communication with their care team. When secure messages were first introduced in the primary care practice, they were mainly geared toward straightforward questions or isolated acute issues. As secure messaging has evolved to include the specialty practice, we postulate that the content of the messages is more detailed as the specialty patients have more complex illnesses and, in the case of the primary care practice, a larger number of chronic medical conditions to manage. This growing complexity and chronicity coupled with the increased number of messages leads to more demands on individual providers and care teams, which will be investigated for a future study.

Understanding the content of these messages would be an important topic of future study as these messages may not only have increased in number, but also potentially in complexity[9]. Assessing the degree of indirect patient care provided using the portal will help with developing appropriate clinical and scheduling models as well as inform appropriate staffing roles and responsibilities. There are limitations to consider in our study. Although we report on a very large number of secure messages, there is little racial or ethnic diversity reflected in our population. Also, English is the predominant language and there is little use of other languages in these messages. To embrace the call of inclusiveness and the trend of globalized healthcare, it is increasingly important to recognize the pluralism of portal users, to study nuanced differences in their experience with health technologies, and to support the underserved and underrepresented populations. Another limitation is that this study does not differentiate the type or the topics of portal messages. Having a more detailed understanding of the content will further inform us about how to most effectively utilize patient portals and integrate them efficiently into medical practices. In this current study, we have provided a comprehensive overview of the patient portal at our institution and this will lay the groundwork for important future studies to come.

V. CONCLUSION

The patient portal is a useful care management tool that allows patients to easily communicate with their care teams. Year after year, there are more patients who utilize the patient portal. While it is beneficial for patients to be more engaged in their own care, providers need to be prepared for an increasing commitment to using this medium to inform their patients and address any medical concerns. Understanding the longitudinal trends of portal utilization as well as the correlations between portal interactions and user demographics will be valuable for the next phase of healthcare in preparing scheduling, staffing, and departmental innovations to handle the incoming message flow and prevent any bottlenecks to this growing form of patient care. Hospital systems must be prepared so that their providers do not become overburdened by increasing message volumes.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

ETHICAL APPROVAL

The Institutional Review Board at Mayo Clinic has reviewed this proposal and approved this work as exempt (19-002211).

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