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Care Delivered by Pediatric Surgical Specialties Through Patient Portal Messaging

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ABSTRACT

Background: Patient portals are online applications that typically allow users to interact with providers using secure messaging. Portal messaging use and content have not been studied in pediatric surgical specialties.

Materials and methods: We obtained all message threads initiated by pediatric patients/caregivers and sent to pediatric surgical providers through the Vanderbilt University Medical Center patient portal from June 1, 2014 to December 31, 2014. We collected patient demographics and providers' surgical specialties. We determined the number of message threads and individual messages sent by patients/caregivers and providers by specialty. Message content was analyzed by semantic types using a validated consumer health taxonomy.

Results: Most threads were about male (176, 60.3%), white (239, 81.8%), non-Hispanic (278, 95.2%) patients with a median age of 6 y (range: 0-21 y). A total of 292 message threads containing 1679 individual messages were sent with mean 5.8 (standard deviation [SD] 5.0) messages per thread. Messages were sent more frequently regarding younger patients ($P = 0.001$). Physicians directly contributed to 161 (55%) message threads. Otolaryngology received the most threads (123, 42.1%) and messages (790, 47.1%). Specialties exchanging the most messages per thread were cardiac surgery (mean 7.0, SD 11.7), and dermatology (7.0, SD 6.9). Most message threads (273, 93.5%) involved delivery of medical care with 123 (42.1%) involving appointments/scheduling; 99 (33.9%) medical problems; 81 (27.7%) treatments; 68 (23.3%) testing; and 29 (9.9%) referrals.

Conclusions: Pediatric surgeons deliver substantial care within portal messages exchanged with pediatric patients and caregivers. Institutions adopting portals should consider effects on provider workload and potential disparities in access to care.

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Introduction

Patient portals are secure online applications that allow patients and their caregivers to access personal health information and to interact with healthcare providers and systems.[1-3] Adoption of patient portals by healthcare institutions has increased with regulatory pressures such as meaningful use and consumer demands.[4] Through most patient portals, users can exchange secure messages with providers, access electronic health record (EHR) information, schedule appointments, receive personalized health information, and pay bills.[5-7]

Systematic reviews about the effects of patient portal usage for adult patients have found some evidence for improvements in clinical outcomes, usually in the context of case management programs, and also showed increased medication adherence, patient safety, disease awareness and self-management, uptake of preventative care, satisfaction, and decreased office visits.[5-8] While most studies about patient portals have focused on usage in adult populations, a systematic review in pediatrics provided some support for the positive effects of portal usage by pediatric patients and their parents.[9] Recent studies about the use of patient portals for pediatric patients have found high parental satisfaction rates, convenience, ease of use, increased feelings of parents' abilities to manage chronic medical conditions, and improved health outcomes in children with chronic diseases.[10-16]

Patient-provider messaging is consistently one of the most popular functions of patient portals for both adult and pediatric populations, but most studies about patient portal messaging have been done in primary care or medical specialties.[5-8,16-19] At our institution, we have observed rapid adoption of portal messaging across all clinical specialties after deployment of our patient portal with surgical specialties receiving the second (to medicine) highest volumes of patient-initiated portal messages.[20,21] Our research team has also demonstrated that surgeons deliver medical care of varied complexity in most messages.[22] In the 3 y after creation of portal access for pediatric patients, we observed that specialists in gastroenterology and endocrinology received more messages than pediatric primary care providers. This is in contrast to what was observed for adult patients, where primary care providers received the largest volumes of messages.[20,23] To our knowledge, the uptake of patient-provider messaging in pediatric surgical specialties has not been examined.

The objective of this study was to characterize the adoption of patient portal messaging and to describe the content of messages exchanged with pediatric surgical specialists at an academic medical center with a broadly deployed patient portal with accounts for pediatric patients and their parents or legal guardians. We examined the demographic characteristics of the children for whom messaging was utilized as well as the volume and content of messages by pediatric surgical specialties.

Material and methods

This study was conducted at Vanderbilt University Medical Center (VUMC) and approved by the Vanderbilt University Institutional Review Board. VUMC is an academic, nonprofit institution located in central Tennessee consisting of Vanderbilt University Hospital and Monroe Carell Jr. Children's Hospital at Vanderbilt (MCJCHV). MCJCHV is a free-standing, high-volume pediatric regional referral and pediatric level one trauma center with 16 operating rooms and 267 inpatients beds.[24] In 2017, the center provided 52,183 emergency room visits, 15,977 inpatient discharges, and 325,233 outpatient clinic visits, as well as 17,205 surgical procedures completed across 10 pediatric surgical specialties.[24]

My Health at Vanderbilt (MHAV) is an online patient portal launched by VUMC in 2005 and promoted in adult outpatient clinics, with subsequent expansion to the pediatric patient population in 2007.[25] Although a locally developed system, MHAV offers the standard functions of most commercial patient portals; users are able to send secure messages to providers, access selected portions of the EHR, schedule appointments, receive personalized health information, and pay bills.[25] For a pediatric population, MHAV offers accounts for patients greater than age 13 y themselves and accounts for surrogates (i.e., parents or guardians) and delegates (i.e., other individuals authorized to communicate on behalf of the patient). Secure patient-provider messaging allows portal users to send messages to providers with an expected turn-around time of 1 to 2 business days. MHAV messages are handled by clinical groups; some providers answer their own messages directly, and others allow their messages to be triaged and managed by administrative assistants or clinical staff. MHAV messages are audited to ensure that messages are received by patients and answered by providers. Messages not read by patients can be returned to the sender to allow them to contact the patient by another means. Provider messages that are not answered are also addressed through other communication channels depending on specialty.

To examine adoption of messaging by pediatric surgical patients and providers, we obtained all message threads initiated on behalf of pediatric patients and sent to pediatric surgical providers through MHAV from June 1, 2014 to December 31, 2014. *Message threads* are sets of messages exchanged between portal users and healthcare providers. For pediatric patients, MHAV users include patients greater than age 13 y (i.e., self), surrogates, and delegates. All pediatric specialty surgeons, allied health professionals, nurses, and other administrative staff who responded to MHAV messages as a clinical care team will be referred to as "providers" in this article. Message threads were reviewed for direct physician (M.D., D.O., or O.D.) contribution to the surgical provider response(s). Messages sent to pediatric surgical providers for patients aged 21 y and younger were included in analysis to examine the period of transition to adulthood, during which time many patients continue to see pediatric surgical providers.

From usage logs and message content for the study period, we determined the number of message threads and number of messages per thread. For each message thread, we collected the demographics of the patient about whom the message was sent (i.e., sex, race, ethnicity, age), the role of the sender (i.e., self, surrogate, or delegate) and the surgical specialty receiving the initial message. Pediatric surgical specialties were organized by departmental structure as follows: cardiac

surgery, dermatology, general surgery, neurosurgery, ophthalmology, oral surgery, orthopedic surgery, otolaryngology, plastic surgery, and urology.

To qualify the message content of portal messages, we manually analyzed all message threads during the study period for semantic content using a previously validated consumer health taxonomy (Fig. 1).[21,22,26] The taxonomy classifies the semantic content of consumer health information questions (i.e., needs) and answers to those questions (i.e., communications) into five main categories: informational, medical, logistical, social, and other. Informational needs are requests for clinical knowledge, such as questions about the etiology of a medical problem or complication of a treatment. Medical needs are requests for delivery of care, such as report of a new or worsening medical problem or plan to order a test or intervention. Logistical needs are requests for pragmatic or administrative information, such as contact information for a clinic or questions about insurance coverage. Social needs are interpersonal requests or gestures, such as appreciation for or complaints against healthcare workers or the need for emotional support. The other category covers communications that do not fall within the other four categories. Portal message threads usually contain several types of needs and communications. All messages were independently classified by at least two members of the research team who assigned all applicable taxonomy codes to each thread. All discrepancies in codes for each thread were discussed by the team to achieve consensus.

We completed summary statistics and described distributions of the patient demographics, messaging volumes by specialty, and semantic types of needs or communications within the message threads. We used linear regression to explore associations between number of message threads and patient age. We also determined the number of threads involving a physician response and delivery of medical care (i.e., containing one or more medical needs or communications), as well as the number of threads delivering each subtype of medical care. We used R version 3.4.3 for statistical analyses.

Results

During the study period, a total of 292 message threads were sent to pediatric surgical providers on behalf of pediatric patients (Table 1). Surrogates (i.e., parents or guardians) initiated 288 messages threads (98.6%) about pediatric patients, whereas only three message threads (1.0%) were initiated by the patients themselves and 1 (0.3%) by a delegate. These message threads contained a total of 1679 individual messages with an average of 5.8 (standard deviation [SD] 5.0) messages per thread and range of 1 to 57 messages per thread. Twelve message threads contained only one patient or surrogate message without a response from a provider. Because MHAV messages are audited, these were likely answered through another communication modality. Of note, 9 of these

I. Clinical Information Need or Communications
- ***A. Normal Anatomy / Physiology***
- ***B. Problems***
  1. Definition
  2. Epidemiology
  3. Risk factors
  4. Etiology
  5. Pathogenesis/Natural history
  6. Clinical presentation
  7. Differential diagnosis
  8. Related diagnoses
  9. Prognosis
- ***C. Management***
  1. Goals/Strategy
  2. Tests
  3. Interventions
  4. Sequence/Timing
  5. Personnel/Setting
- ***D. Tests***
  1. Definition
  2. Goals
  3. Physiologic basis
  4. Efficacy
  5. Indications/Contraindications
  6. Preparation
  7. Technique/Administration
  8. Interpretation
  9. Post-test care
  10. Advantages/Benefits
  11. Costs/Disadvantages
  12. Adverse effects
- ***E. Interventions***
  1. Definition
  2. Goals
  3. Mechanism of action
  4. Efficacy
  5. Indications/Contraindications
  6. Preparation
  7. Technique/Administration
  8. Monitoring
  9. Post-intervention care
  10. Advantages/Benefits
  11. Costs/Disadvantages
  12. Adverse effects

II. Medical Needs or Communications
- A. Appointments/Scheduling
- B. Medical equipment
- C. Personnel/Referrals
- D. Prescriptions
- E. Problems
- F. Follow up
- G. Management
- H. Tests
- I. Interventions

III. Logistical Needs or Communications
- A. Contact information/ Communication
- B. Facility/Policies/Personnel
- C. Insurance/Billing
- D. Medical records
- E. Personal documentation
- F. Health information technologies
- G. Tests
- H. Interventions
- I. Transportation
- J. Life Management/Balance

IV. Social Needs / Communications
- A. Acknowledgment
- B. Complaints
- C. Emotional Need or Expression
- D. Relationship communications
- E. Miscellaneous

V. Other

Fig. 1 – Consumer health needs and communication taxonomy. This taxonomy characterizes the consumer health needs and communications into five main semantic categories: (I) informational, (II) medical, (III) logistical, (IV) social, and (V) other.

Table 1 – Portal message volumes.

Message volumes	Total
Total message threads	292
Total messages	1679
Average messages per mo (all providers)	240
Mean messages per thread, *n* (SD, range)	5.8 (5.0, 1-57)
Portal user who initiated message thread	
Patient, *n* (%)	3 (1.0%)
Surrogate, *n* (%)	288 (98.6%)
Delegate, *n* (%)	1 (0.3%)
Total patient messages, *n* (%)	520 (31%)
Total provider messages, *n* (%)	1159 (69%)
Physician involvement in message threads	
Directly involved online, *n* (%)	146 (50%)
Directly involved offline, *n* (%)	15 (5%)
No physician directly involved, *n* (%)	131 (45%)

SD = standard deviation.

Table 2 – Demographics of patients for whom portal messages were sent.

Demographic	Number of patients (%)
Sex	
Female	116 (39.7%)
Male	176 (60.3%)
Race	
White	239 (81.8%)
Black	29 (9.9%)
Other	19 (6.5%)
Unknown	5 (1.7%)
Ethnicity	
Non-Hispanic	278 (95.2%)
Hispanic	8 (2.7%)
Other/unknown	6 (2.1%)
Median age y (IQR, range)	6.0 (3-14, 0-21)

IQR = interquartile range.

12 unanswered messages were weekly ostomy outputs logged by a caregiver as instructed by the medical team.

Within the message threads, patients and their surrogates contributed 520 messages (31%), while providers sent 1159 messages (69%). In total, pediatric surgical providers were managing an average of 240 messages per month.

Physicians directly contributed to messages either themselves online in 146 (50%) or offline (i.e., another provider reported discussed with MD and relayed response in message) in 15 (5%) of the message threads for total direct involvement in 161 (55%) message threads. Providers who were not physicians (i.e., allied health professionals, nurses, other administrative staff) managed 131 (45%) of the message threads with no direct physician involvement.

Most portal message threads were initiated for male (176, 60.3%), white (239, 81.8%), and non-Hispanic (278, 95.2%) patients (Table 2). Median patient age was 6.0 y (interquartile range 3-14, range 0-21 y). Using linear regression, messages were sent more frequently regarding younger patients ($P = 0.001$) (Fig. 2).

Surgical specialties receiving the most message threads were otolaryngology (123, 42.1%) and general surgery (35, 12.0%) followed by ophthalmology (31, 10.6%), neurosurgery (27, 9.2%), orthopedic surgery (23, 7.9%), cardiac surgery (21, 7.2%), urology (14, 4.8%), oral surgery (8, 2.7%), plastic surgery (7, 2.4%), and dermatology (3, 1.0%) (Fig. 3A). Pediatric surgical specialties receiving the most total individual messages were otolaryngology (790, 47.1%) and neurosurgery (182, 10.8%) followed by general surgery (156, 9.3%), cardiac surgery (148, 8.8%), ophthalmology (139, 8.3%), orthopedic surgery (118, 7.0%), urology (51, 3.0%), oral surgery (38, 2.3%), plastic surgery (36, 2.1%), and dermatology (21, 1.3%) (Fig. 3B).

Specialties exchanging the largest average number of messages per thread were cardiac surgery (7.0, SD 11.7) and dermatology (7.0, SD 6.9), with cardiac surgery notably receiving seven times the total number of messages received by dermatology (Fig. 4). The average number of messages per threads were as follows: neurosurgery (6.7, SD 5.6), otolaryngology (6.4, SD 4.4), orthopedic surgery (5.1, SD 3.3), plastic surgery (5.1, SD 2.4), oral surgery (4.8, SD 1.9), general surgery (4.5, SD 4.2), ophthalmology (4.5, SD 1.8), and urology (3.6, SD 2.0).

The average number of patient messages per thread per specialty were as follows: otolaryngology (2.0, SD 1.5), general surgery (1.7, SD 1.1), ophthalmology (1.2, SD 0.5), neurosurgery (2.5, SD 2.7), orthopedic surgery (1.5, SD 0.9), cardiac surgery (1.7, SD 1.2), urology (1.4, SD 0 0.8), oral surgery (1.1, SD 0.4), plastic surgery (1.1, SD 0.4), and dermatology (2.3, SD 2.3). The average number of provider messages per thread per specialty are as follows: otolaryngology (4.5, SD 3.4), general surgery (2.7, SD 3.5), ophthalmology (3.3, SD 1.6), neurosurgery (4.3, SD 3.2), orthopedic surgery (3.7, SD 2.6), cardiac surgery (5.3, SD 10.6), urology (2.3, SD 1.6), oral surgery (3.6, SD 1.8), plastic surgery (4.0, SD 2.5), and dermatology (4.7, SD 4.6).

Within the 292 threads initiated by portal users, 925 distinct communication types (i.e., questions and their answers) were identified with an average of 3.2 communication types per thread. Expressed needs or communications included 577 (62.4%) medical, 189 (20.4%) logistical, 113 (12.2%)

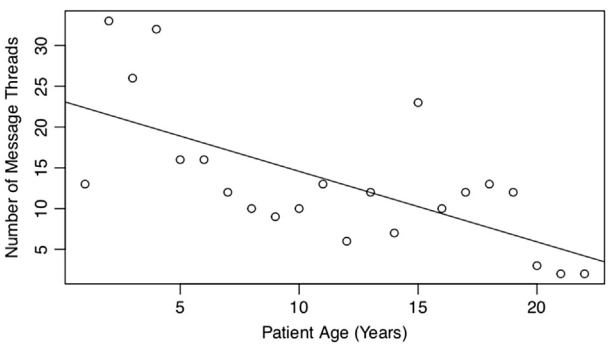

Fig. 2 – Frequency of messaging by patient age. Portal message threads were sent more frequently about younger patients ($P = 0.001$).

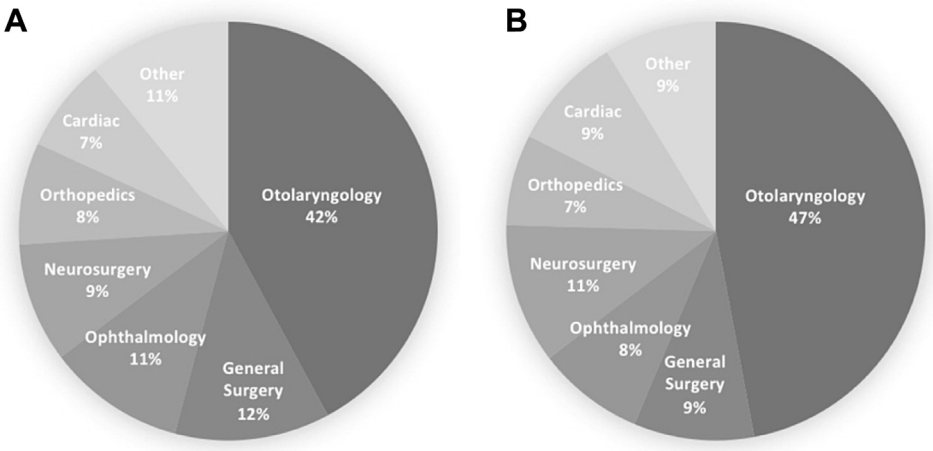

Fig. 3 – (A) Message thread volumes by pediatric surgical specialty; (B) Individual message volumes by pediatric surgical specialty. Otolaryngology received the most message threads and individual messages.

informational, and 46 (5.0%) social communication types. Figure 5A shows the distribution of communication types identified in the message threads, and Figure 5B shows the distribution across subtypes of medical communications. The most common types of medical communications involved appointments/scheduling ($n = 128$) and new or worsening problems ($n = 120$). Logistical communications mostly frequently discussed contact information ($n = 154$) and insurance/billing issues ($n = 12$). A smaller number of messages contained informational needs, with the most common questions involving indications or contraindications for an intervention ($n = 13$), interpretation of a test result ($n = 12$), and sequence or timing of management plans ($n = 12$). Social needs included expressions of thanks ($n = 25$) and emotional needs ($n = 11$).

At least one type of medical need was expressed in 273 threads (93.5%) and therefore, most threads involved the delivery of medical care. Table 3 describes the types of medical needs and care delivered within the patient portal messages. New, worsening, or unaddressed medical problems were reported in 99 (33.9%) threads, and problems were followed up in 70 (24.0%) threads. Interventions or therapies were initiated, modified, or scheduled in 81 (27.7%) threads. Tests were ordered or scheduled in 68 (23.3%) threads. Appointments were scheduled or changed in 123 (42.1%) threads, and referrals or new consultations were made in 29 (9.9%) threads. Prescriptions were modified or renewed in 22 (7.5%) threads. Medical equipment was ordered in 11 (3.7%) threads, and problems were managed without interventions, therapies or tests in only 4 (1.4%) threads.

Discussion

Patient portals are increasingly popular consumer health tools now offered at most large healthcare organizations. To our knowledge, this study is the first to examine comprehensively the adoption and content of patient portal messaging across pediatric surgical specialties. Our findings demonstrated that pediatric surgical specialties exchanged moderate to large volumes of portal messages with surgical patients and their caregivers, with message volumes varying across surgical

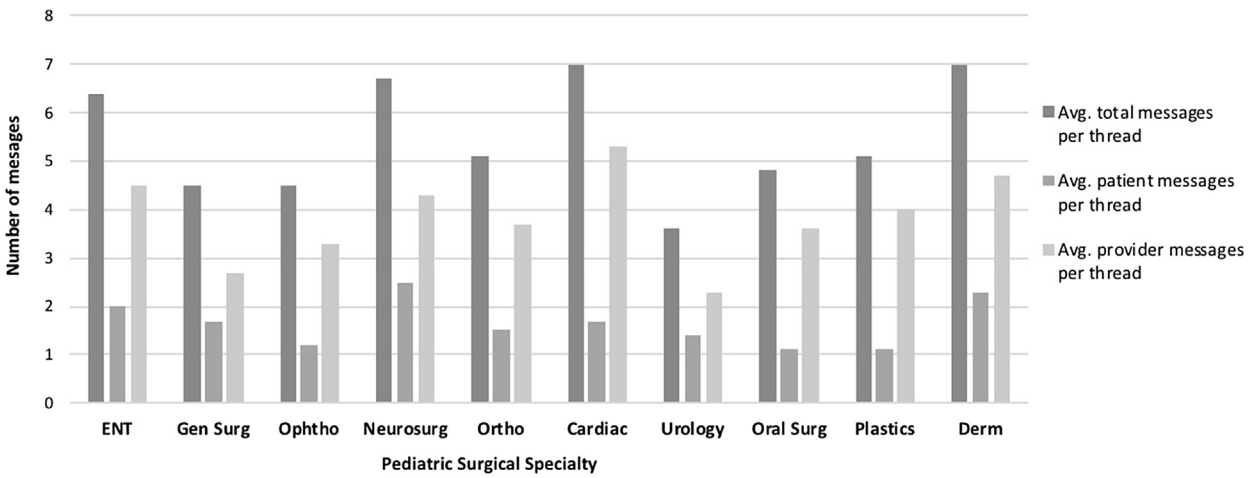

Fig. 4 – Average messages per thread by patient and provider by surgical specialty. Across all specialties, providers contributed on average to greater than two-thirds of the individual messages within message threads.

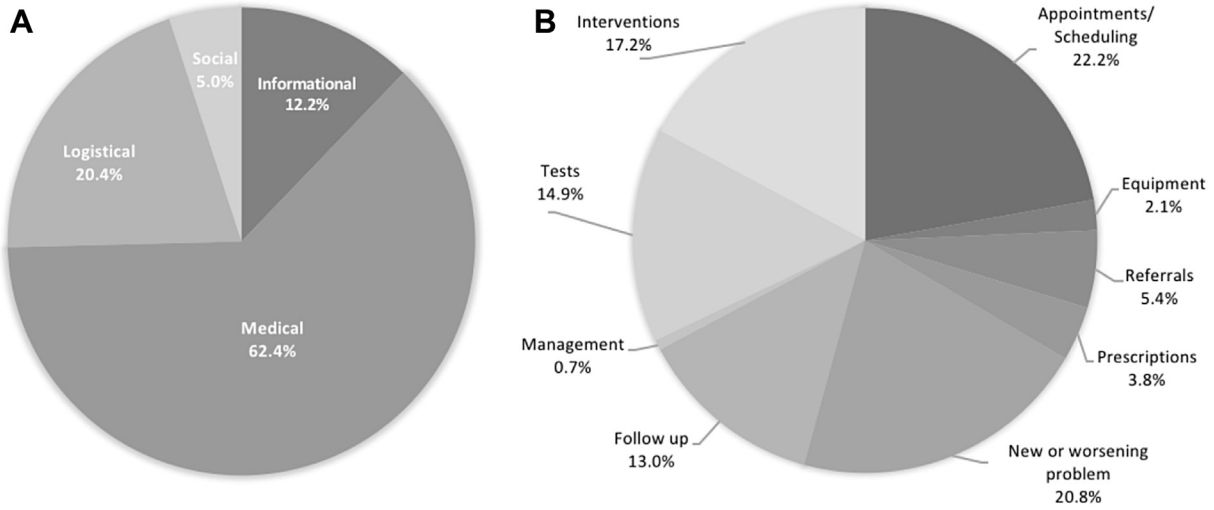

Fig. 5 – (A) Types of needs or communications in portal messages to surgical providers. Most communication types in portal messages were medical; (B) Subtypes of medical needs or communications in portal messages to surgical providers. The most common types of medical communications in portal communications were about appointments/scheduling and new or worsening problems.

specialties. In previous research about the early phases of portal adoption at our institution, we observed rapid growth in volumes of messages sent to surgical specialties, but limited use of messaging by surgeons for pediatric patients.[21] This prior study was conducted in the first 3 y after implementation of accounts for pediatric patients, and thus, represented the initially slow uptake by pediatric providers, patients, and their caregivers. Our present study reveals subsequent growth in portal message usage by pediatric surgical specialists and illustrates an increased volume of portal messages after the early adoption period across surgical specialties at a major academic children's hospital. For hospitals that implemented patient portals in the last few years to achieve Meaningful Use criteria, these data about portal adoption during the stabilization phase can help providers and administrators anticipate long-term changes in workload from this technology.

Table 3 – Types of medical needs expressed by pediatric surgical patients/caregivers in portal message threads.

Types of medical needs or communications	Total number of medical needs, *n* (% of total 925 needs)	Number of message threads, *n* (% of total 292 threads)
Appointments/ scheduling	128 (13.8%)	123 (42.1%)
New or worsening problems	120 (13.0%)	99 (33.9%)
Interventions ordered or scheduled	99 (10.7%)	81 (27.7%)
Tests ordered or scheduled	86 (9.3%)	68 (23.3%)
Follow-up	75 (8.1%)	70 (24.0%)
Referrals	31 (3.4%)	29 (9.9%)
Prescriptions	22 (2.4%)	22 (7.5%)
Equipment	12 (1.3%)	11 (3.7%)
Management	4 (0.4%)	4 (1.4%)

Pediatric otolaryngology, general surgery, and neurosurgery received the most total messages and message threads, while cardiac surgery and dermatology exchanged the most messages within threads. In earlier phases of portal adoption at our institution, some specialties that tended to have long-term relationships with their patients, such as transplantation and bariatric general surgery, very quickly began conducting more portal message exchanges than face-to-face outpatient clinic encounters.[21] The present study showed significant messaging use in pediatric specialties that perform both minor procedures for self-limited problems (e.g., myringotomies with ear tube placement and hearing tests) as well as specialties that have lifelong relationships with children with major congenital anomalies (e.g., congenital heart disease). Increased portal messaging across pediatric surgical specialties may be due to increased parental experience with portals for their own healthcare as well as increased experience with portal usage by the surgical providers themselves and referring physicians.

Most messages were sent about patients who were male, white, non-Hispanic, and younger in age. For our patient portal, most accounts with access to pediatric health information are created for white patients, which is partially but not completely explained by our referral base.[27] Multiple other studies have demonstrated predominately white users of patient portals for both pediatric and adult patients.[17,20,28-30] Prior studies at our institution in pediatric patients and adult surgical patients found that most portal users were white, non-Hispanic patients, and portal usage was associated with increased health literacy and education.[22,27,31] At other institutions, studies about portal usage for pediatric patients with chronic diseases found disproportionately increased usage by white patients, their families, and those privately

insured, and decreased usage by black patients, Hispanic patients, and those on Medicaid.[28,29,32] While most patient portal research has been done in primary care or medical specialties, our findings add to the growing body of evidence that patient portals may also create disparities for surgical patients.[21,22,33] As patient portal adoption increases and more patients receive care through portal messaging, healthcare institutions must carefully consider whether this technology is exacerbating disparities in access to care.

In our study, most of the message threads were sent by parents or guardians, more frequently for younger patients, which aligns with some prior research in portal usage of pediatric patients.[27,32] However, other studies have found highest message volumes with school aged children from 6 to 9 y.[15,29] Steitz *et al.* investigated portal usage by all pediatric patients since initiation of MHAV and found the greatest usage of portal messaging involved patients who were 0 to 2 y and 15 to 17 y. MCJCHV is the regional referral center for extracorporeal membrane oxygenation and complex neonatal cases, and this specialized infant care may account for the high volumes of portal messages about patients receiving specialty care in this young age group.[27] In this study, only a few message threads were initiated by the patients themselves, with most being sent by parents or guardians. Other studies have demonstrated avid portal usage by adolescent patients, but all have been done in primary care or chronic disease outpatient settings, sometimes with portals specifically designed to address adolescent needs.[19,32,34] The limited use of portal messaging by adolescent patients in this study is likely multifactorial, with the increased role of caregivers for patients with surgical disease, as well as institutional policies and Tennessee laws, which favor parental access to health information over adolescent confidentiality.

Of particular interest was that pediatric surgical providers contributed almost 70% of the total messages within individual threads, with communications often being exchanged across several providers and clinical specialties to address the initial patient or caregiver concern. Physicians themselves directly contributed to half of the message threads and were sometimes noted in the thread to have been involved with offline communications. Specialties with complex medical patients, such as transplant patients in cardiac surgery, had intricate and long collections of messages, with providers from multiple specialties contributing to treatment plans that were developed in the threads. These results suggest that physicians provide substantial volumes and collaborative care to patients using online portal messaging.

This study is the first, to our knowledge, to perform a detailed qualitative analysis of portal message content and to characterize the types of medical care provided in messages between pediatric portal users and surgical providers. For adult surgical patients, our team has previously demonstrated that substantial volumes of care of varying levels of complexity are delivered through portal messages,[22] and this study also revealed rich interactions with delivery of substantial care for the majority of patients. Compared with message threads exchanged for adult surgical patients, pediatric message threads were longer and more involved. In this study, medical care was delivered in nearly all portal message threads, and approximately two-thirds of all communication types within the message threads were medical. Appointments/scheduling and new or worsening medical problems were the most common medical types, and consumer logistical needs, particularly contact information, were also communicated by both patients and providers remotely. There were many complex message threads where decisions were made through portal messaging to order interventions and tests or to make referrals to other specialties. These results suggest substantial care and complex medical decisions are done through portal messaging. One thread reported 10 distinct new or worsening problems that were being expressed by a caregiver. The use of portal systems by patients and healthcare systems may increase convenience, communication, and ease in obtaining medical care over an online platform for both patients and providers. Such decision-making, if done face-to-face in the outpatient setting would generate revenue, and when done through portal messaging potentially constitutes uncompensated care. However, this online care may provide a great benefit to the patients and their families, saving them travel time and missed days at school or work. As portal systems become more popular, the effects on clinician and staff workload and potential for compensation of online care should be considered prior to implementation and after deployment as adoption increases.

Our study has several limitations. First, our organization is a large academic medical center with a locally developed patient portal that is integrated with our EHR. Our findings may not generalize to smaller institutions or other commercial or standalone patient portal systems. Although we examined the demographic characteristics of the patients about whom messages were sent, our study did not consider surrogate or delegate demographic characteristics or other factors that might affect portal adoption, such as patient diagnoses, health literacy, health insurance status, and income. While we have analyzed the qualitative content of the portal messages and quantified types of medical care being delivered, we did not determine whether the care being delivered was within the global period for any surgical procedures, although anecdotally, few messages referenced a recent procedure. Such analysis would be needed to determine whether care delivered through portal messages was resulting in lost revenue for surgical practices.

Conclusions

To our knowledge, this study is the first to examine the adoption and content of patient portal messaging by pediatric surgical providers, their patients, and caregivers. We found that a wide variety of pediatric surgical specialists exchanged moderate to large volumes of portal messages with patients and their caregivers, and nearly all message threads involved the delivery of medical care. Portal messaging volumes varied across surgical specialties and by patient sex, race, ethnicity, and age, with most messages being sent by parents or legal guardians about patients who were white, non-Hispanic, and younger in age. Few adolescent patients initiated messages to surgical providers. Pediatric surgical providers contributed almost 70% of total messages within message threads, with many message exchanges involving input from multiple providers and specialties. Physicians contributed directly to

approximately half of the message threads. The most common topics in message threads between pediatric patients or caregivers and pediatric surgical providers were appointments and scheduling and new or worsening medical problems. Many threads involved long conversations between caregivers and providers and included substantial medical decisions involving testing, medications, surgical procedures, and referrals. Institutions adopting patient portals should consider effects on provider workload and compensation for online care.

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Author contributions: K.M.R. completed the data analysis and prepared the manuscript. J.R.R. completed the statistical analysis, assisted with data analysis, and reviewed the manuscript. K.V.A. reviewed the data and reviewed the manuscript. G.P.J. conceived the work, coded all message data, supervised the project, and assisted in manuscript preparation. All authors participated in some message coding and reviewed and approved the final manuscript.

Disclosure

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

REFERENCES

1. HealthIT.gov. What is a patient portal? Available at: https://www.healthit.gov/providers-professionals/faqs/what-patient-portal. Accessed February 18, 2018.
2. Otte-Trojel T, de Bont A, van de Klundert J, Rundall TG. Characteristics of patient portals developed in the context of health information exchanges: early policy effects of incentives in the meaningful use program in the United States. *J Med Internet Res*. 2014;16:e258.
3. Patient portal. Available at: https://en.wikipedia.org/wiki/Patient_portal. Accessed February 18, 2018.
4. Shapochka A. Providers turn to portals to meet patient demand, meaningful use. *J AHIMA*. 2012. Available at: http://journal.ahima.org/2012/08/23/providers-turn-to-portals-to-meet-patient-demand-meaningful-use/. Accessed February 18, 2018.
5. de Lusignan S, Mold F, Sheikh A, et al. Patients' online access to their electronic health records and linked online services: a systematic interpretative review. *BMJ Open*. 2014;4:e006021.
6. Goldzweig CL, Orshansky G, Paige NM, et al. Electronic patient portals: evidence on health outcomes, satisfaction, efficiency, and attitudes: a systematic review. *Ann Intern Med*. 2013;159:677–687.
7. Goldzweig CL, Towfigh AA, Paige NM, et al. *Systematic Review: Secure Messaging Between Providers and Patients, and Patients' Access to Their Own Medical Record: Evidence on Health Outcomes, Satisfaction, Efficiency and Attitudes*. Washington (DC): Department of Veterans Affairs (US); 2012:1–63. VA evidence-based Synthesis program reports.
8. Kruse CS, Bolton K, Freriks G. The effect of patient portals on quality outcomes and its implications to meaningful use: a systematic review. *J Med Internet Res*. 2015;17:e44.
9. Bush RA, Connelly CD, Fuller M, Perez A. Implementation of the integrated electronic patient portal in the pediatric population: a systematic review. *Telemed J E Health*. 2016;22:144–152.
10. Ahlers-Schmidt CR, Nguyen M. Parent intention to use a patient portal as related to their children following a facilitated demonstration. *Telemed J E Health*. 2013;19:979–981.
11. Bergman DA, Brown NL, Wilson S. Teen use of a patient portal: a qualitative study of parent and teen attitudes. *Perspect Health Inf Manag*. 2008;5:13.
12. Britto MT, Hesse EA, Kamdar OJ, Munafo JK. Parents' perceptions of a patient portal for managing their child's chronic illness. *J Pediatr*. 2013;163:280–281.e1-2.
13. Britto MT, Jimison HB, Munafo JK, Wissman J, Rogers ML, Hersh W. Usability testing finds problems for novice users of pediatric portals. *J Am Med Inform Assoc*. 2009;16:660–669.
14. Byczkowski TL, Munafo JK, Britto MT. Family perceptions of the usability and value of chronic disease web-based patient portals. *Health Inform J*. 2014;20:151–162.
15. Fiks AG, Mayne SL, Karavite DJ, et al. Parent-reported outcomes of a shared decision-making portal in asthma: a practice-based RCT. *Pediatrics*. 2015;135:e965–e973.
16. Tom JO, Mangione-Smith R, Solomon C, Grossman DC. Integrated personal health record use: association with parent-reported care experiences. *Pediatrics*. 2012;130:e183–e190.
17. Crotty BH, Tamrat Y, Mostaghimi A, Safran C, Landon BE. Patient-to-physician messaging: volume nearly tripled as more patients joined system, but per capita rate plateaued. *Health Aff (Millwood)*. 2014;33:1817–1822.
18. Haun JN, Lind JD, Shimada SL, et al. Evaluating user experiences of the secure messaging tool on the Veterans Affairs' patient portal system. *J Med Internet Res*. 2014;16:e75.
19. Thompson LA, Martinko T, Budd P, Mercado R, Schentrup AM. Meaningful use of a confidential adolescent patient portal. *J Adolesc Health*. 2016;58:134–140.
20. Cronin RM, Davis SE, Shenson JA, Chen Q, Rosenbloom ST, Jackson GP. Growth of secure messaging through a patient portal as a form of outpatient interaction across clinical specialties. *Appl Clin Inform*. 2015;6:288–304.
21. Shenson JA, Cronin RM, Davis SE, Chen Q, Jackson GP. Rapid growth in surgeons' use of secure messaging in a patient portal. *Surg Endosc*. 2016;30:1432–1440.
22. Robinson JR, Valentine A, Carney C, Fabbri D, Jackson GP. Complexity of medical decision-making in care provided by surgeons through patient portals. *J Surg Res*. 2017;214:93–101.
23. Masterman M, Cronin RM, Davis SE, Shenson JA, Jackson GP. Adoption of secure messaging in a patient portal across pediatric specialties. *AMIA Annu Symp Proc*. 2017;2016:1930–1939.
24. Patient volumes. Available at: https://www.childrenshospital.vanderbilt.org/guide.php?mid=9497. Accessed February 15, 2018.
25. Osborn CY, Rosenbloom ST, Stenner SP, et al. MyHealthAtVanderbilt: policies and procedures governing patient portal functionality. *J Am Med Inform Assoc*. 2011;18(Suppl 1):i18–i23.
26. Cronin RM, Fabbri D, Denny JC, Jackson GP. Automated classification of consumer health information needs in patient portal messages. *AMIA Annu Symp Proc*. 2015;2015:1861–1870.

27. Steitz B, Cronin RM, Davis SE, Yan E, Jackson GP. Long-term patterns of patient portal use for pediatric patients at an academic medical center. *Appl Clin Inform*. 2017;8:779–793.
28. Byczkowski TL, Munafo JK, Britto MT. Variation in use of Internet-based patient portals by parents of children with chronic disease. *Arch Pediatr Adolesc Med*. 2011;165:405–411.
29. Fiks AG, DuRivage N, Mayne SL, et al. Adoption of a portal for the primary care management of pediatric asthma: a mixed-methods implementation study. *J Med Internet Res*. 2016;18:e172.
30. Weingart SN, Rind D, Tofias Z, Sands DZ. Who uses the patient internet portal? The PatientSite experience. *J Am Med Inform Assoc*. 2006;13:91–95.
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;2015:1871–1880.
32. Ketterer T, West DW, Sanders VP, Hossain J, Kondo MC, Sharif I. Correlates of patient portal enrollment and activation in primary care pediatrics. *Acad Pediatr*. 2013;13:264–271.
33. Robinson JR, Davis SE, Cronin RM, Jackson GP. Use of a patient portal during hospital admissions to surgical services. *AMIA Annu Symp Proc*. 2017;2016:1967–1976.
34. Hannan A. Providing patients online access to their primary care computerised medical records: a case study of sharing and caring. *Inform Prim Care*. 2010;18:41–49.