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## Research and Applications

# A technology-based patient and family engagement consult service for the pediatric hospital setting

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## ABSTRACT

**Objective:** The Vanderbilt Children's Hospital launched an innovative Technology-Based Patient and Family Engagement Consult Service in 2014. This paper describes our initial experience with this service, characterizes health-related needs of families of hospitalized children, and details the technologies recommended to promote engagement and meet needs.

**Materials and Methods:** We retrospectively reviewed consult service documentation for patient characteristics, health-related needs, and consultation team recommendations. Needs were categorized using a consumer health needs taxonomy. Recommendations were classified by technology type.

**Results:** Twenty-two consultations were conducted with families of patients ranging in age from newborn to 15 years, most with new diagnoses or chronic illnesses. The consultation team identified 99 health-related needs (4.5 per consultation) and made 166 recommendations (7.5 per consultation, 1.7 per need). Need categories included 38 informational needs, 26 medical needs, 23 logistical needs, and 12 social needs. The most common recommendations were websites (50, 30%) and mobile applications (30, 18%). The most frequent recommendations by need category were websites for informational needs (39, 50%), mobile applications for medical needs (15, 40%), patient portals for logistical needs (12, 44%), and disease-specific support groups for social needs (19, 56%).

**Discussion:** Families of hospitalized pediatric patients have a variety of health-related needs, many of which could be addressed by technology recommendations from an engagement consult service.

**Conclusion:** This service is the first of its kind, offering a potentially generalizable and scalable approach to assessing health-related needs, meeting them with technologies, and promoting patient and family engagement in the inpatient setting.

**Key words:** patient engagement, patient activation, information needs, consumer health informatics, health information technology

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## BACKGROUND AND SIGNIFICANCE

Patient engagement is a critical component of the solution to the cost and quality crisis in health care.<sup>1</sup> From the patient perspective, this term is defined as “actions individuals must take to obtain the greatest benefit from the health care services available to them.”<sup>2</sup> From the health care organizational perspective, it is described as “a set of behaviors by patients, family members, and health professionals and a set of organizational policies and procedures that foster both the inclusion of patients and family members as active members of the health care team and collaborative partnerships with providers and provider organizations.”<sup>3</sup> A patient’s involvement in his or her care can be considered an important intervention – it has even been termed a “blockbuster drug.”<sup>4</sup> There is growing evidence that patients who take an active role in their health care have improved health outcomes, better understanding of care, and greater satisfaction with care, with decreased costs.<sup>5–8</sup> The Institute of Medicine put forth goals for achieving safe, effective, and patient-centered health care and enumerated principles for achieving them. They require patient engagement, including care that is customized by patients’ needs and values, patient-based control, shared information and decision making, transparency, and cooperation among clinicians.<sup>9</sup> Electronic health records, patient access to health information, and other health information technologies have been identified as valuable, if not critical, tools in achieving these goals.<sup>10–13</sup>

Despite the advantages of patient engagement, a recent systematic review identified a paucity of research about approaches to fostering engagement in the inpatient setting.<sup>14</sup> With >36 million inpatient admissions in the United States each year,<sup>15</sup> hospitals may be ideal settings for administering interventions that promote engagement. Understanding the unique needs of hospitalized patients is an important first step in promoting engagement in this setting, but little research has been done to assess the health-related needs of hospitalized patients and their caregivers. The few studies addressing this topic have revealed significant unmet needs.<sup>16–20</sup> Kendall et al. identified several common unmet information needs in the inpatient setting, including questions about medications, timing of provider visits, and results of tests or imaging studies. They observed that current technologies to support patient and caregiver engagement, such as patient portals, did not address such needs.<sup>18</sup> Kaziunas et al.<sup>20</sup> also observed a wide variety of unmet needs hospitalized pediatric hematopoietic stem cell transplantation patients and their caregivers had, and they noted the potential for supporting the caregiver experience and meeting needs with appropriately designed health information technologies. In a study of patients and health care providers, Caligian elicited bedside information needs that included logistical themes, such as information about daily schedules, as well as a wide variety of informational and patient-specific medical needs.

A variety of approaches to inpatient engagement have been explored, but most studies have been limited in scale, have focused on single technology solutions, and have failed to assess the needs of hospitalized patients before implementing solutions to meet them. For example, several small studies have employed video reality or gaming systems to increase engagement in the inpatient setting, suggesting that these interventions allow creation of a virtual support network.<sup>21,22</sup> The use of smartphone or tablet applications designed for hospitalized patients has also been examined in several studies, which demonstrated high satisfaction rates and the ability to use tools such as educational resources, medication lists, appointment scheduling, and messaging.<sup>23–27</sup> Our research team has demonstrated

substantial use of the Vanderbilt University Medical Center (VUMC) patient portal by hospitalized patients and their caregivers.<sup>28,29</sup> Patient portals have the potential to provide “computer-based memory support” for “situationally impaired” hospitalized patients and caregivers,<sup>30</sup> but many have policies that discourage inpatient adoption, such as delays in reporting of test results.<sup>31</sup> Several portals and personal health records customized for the inpatient setting have shown high adoption and usage rates, an increased ability for patients and caregivers to identify physicians and their roles, and the ability to track medications.<sup>32–37</sup> These studies, however, involved applications specifically designed for the inpatient setting and a limited subset of patients. O’Leary et al.<sup>38</sup> demonstrated that attitudes toward using health information technologies for disease self-management are diverse and unrelated to factors such as race, age, or education, suggesting that approaches to engagement should be tailored to individual characteristics and preferences.

In 2014, the Vanderbilt Children’s Hospital (VCH) launched the Technology-Based Patient and Family Engagement Consult Service, which this manuscript will refer to as the “consult service” henceforth. This consult service offers a framework for identifying health-related needs in the hospital setting and addressing them with information technologies tailored to individual patients and families.

## OBJECTIVE

The objectives of this paper are to describe the initial experience with the consult service, characterize health-related needs of families of hospitalized children, and report the technologies recommended to support engagement and meet health-related needs. We address important gaps in research about patient engagement in the inpatient setting and the information needs of hospitalized pediatric patients and their caregivers.

## MATERIALS AND METHODS

### The technology-based patient and family engagement consult service

The Technology-Based Patient and Family Engagement Consult Service was developed by VUMC faculty from the Department of Biomedical Informatics as a service designed to identify health-related needs of the families of hospitalized patients, recommend technology and educational interventions to address those needs, and deliver interventions during VCH admissions. Consultations are most frequently requested by pediatric hospitalist teams, the neonatal and pediatric intensive care units, the complex care team, and the pediatric surgical and trauma services. With each new consultation, the process begins with one or two team members approaching the family to explain the consultation service and determine interest and willingness to participate. These team members then perform an initial consultation, during which sociodemographic variables, parental characteristics such as literacy and numeracy, parental activation, technology usage and preferences, and health-related needs are assessed using validated surveys and semistructured interviews. The instruments used for consultations are provided in Supplementary Appendix 1. Findings from the initial assessment are discussed with the multidisciplinary team, which develops a strategy to promote engagement and makes personalized recommendations to address each family’s specific health-related needs. The strategy for supporting engagement is based on the caregiver’s level of activation.<sup>39</sup> If a caregiver has a low level of activation and does not know

his or her role is important, appropriate education is provided. Caregivers with higher levels of activation are given tools and a chance to practice so they can gain the knowledge and confidence to take and sustain action to improve or maintain their children's health. Personalized recommendations may include websites and videos on Internet-based or mobile devices, the My Health at Vanderbilt (MHAV) patient portal, or other technologies to assist with education, disease monitoring, behavioral change, or emotional support. The consultation team members vet their recommendations with the primary team and, once these are approved, deliver them to the family, working in a one-on-one manner to help implement proposed solutions during hospitalizations. For example, if a smartphone application is recommended, consultation team members will assist the caregiver in installing the application and navigating the resources within it. After allowing the family sufficient time to use the recommendations, the consultation team meets with them again to assess new or changing needs and to determine the effectiveness of the initial recommendations. The consultations are an interactive and iterative process; new needs are identified when clinical conditions change, and recommendations are modified and changed as parents provide feedback on their usefulness. Standardized forms for initial assessment, progress note, discharge, and follow-up encounters are used; the instruments employed are provided in Supplementary Appendix 1.

During each consultation, the team works with the family to enumerate their health-related needs and then makes one or more technological or educational recommendations for each need. For example, the parent of a child with a new cancer diagnosis needed to communicate with multiple specialty services, including surgery, oncology, and radiation oncology, during and after a hospital stay. The consultation team assisted the parent with MHAV registration, providing the parent with access to the child's health information and scheduled follow-up appointments. Specialty providers sent secure messages to the parent through the MHAV portal, so the parent could use the messages for reference or to respond with questions. Technology-savvy parents of a child with a rare disease in need of emotional support were introduced to an online support group for that disorder. Parents living far from the hospital were given an app to find inexpensive gasoline.

Recommendations are selected from reputable sources of consumer health information or tools that have worked well for other families with similar needs and preferences. They are vetted by relevant primary or consulting clinical providers, along with patient education experts on the engagement consultation team. Recommendations are customized using a wide variety of variables, including parental characteristics, preferences, and technologies available. For example, parents with limited health literacy have been given videos to assist with gastrostomy and tracheostomy care. One mother requested printed materials while her child was hospitalized but online resources for use at home; another preferred only smartphone apps or mobile-enabled websites. Recommendations for families with limited data plans have included static websites with simple content along with printed materials.

To our knowledge, this inpatient engagement consult service is the first of its kind, and it has evolved in several phases. During phase I, the consult service was launched as a medical student clerkship in May 2014, supported by clinical informaticians and a human factors engineer. During phase II, from January through May 2015, the consult service was also offered during medical student research rotations, and a limited prospective pilot study was done. In phase III, beginning in June 2015, the consultation team expanded to a

multidisciplinary service that meets regularly, offers services outside of student experiences, and is supported by clinical informaticians, workflow experts, behavioral change psychologists, nurses, patient education specialists, complex-care team members, neonatologists, undergraduate and biomedical informatics graduate students, and patient and family representatives. Two clinical informatics faculty (GPJ and RMC) manage the team and run its weekly meetings. New participants and rotating students are trained and supervised directly by senior clinical informatics faculty and experienced members of the group.

### Study population

We retrospectively reviewed all notes for the consult service during 2014 and 2015, corresponding to phases I and II. Consultation notes were available from 2 sources. In phase I, deidentified consultation notes from medical students participating in clerkships were maintained by the course director. In the phase II prospective pilot study, deidentified initial consultations, progress notes, discharge assessments, and follow-up assessments were available. This prospective study was offered to English-speaking adult caregivers (parents or legal guardians >18 years of age) of hospitalized children at VCH and involved 4 participants. Written informed consent was obtained from the parent participants. The research protocol for the prospective study required obtaining assent from pediatric patients  $\geq 13$  years of age, but none of the parents enrolled had children who met this criterion. Although initially prepared by medical students, all notes were reviewed and thoroughly revised with faculty input during phases I and II, thus the content reviewed for this study reflected the work of the multidisciplinary team. This study was approved by the VUMC Institutional Review Board.

### Data collection

Two members of the research team (GPJ and JRR) reviewed all consultation notes and collected patient sex, race, and diagnosis information; all reported health-related needs of patients and families; and the technology and educational recommendations made by the consult service.

### Data analysis

Descriptive statistical and qualitative analyses were performed for patient demographics, health-related needs, and consultation recommendations. Patients were assigned to 1 of 4 categories to characterize the clinical context at the time of consultation: newborn with a new diagnosis, previously healthy child with a new diagnosis, child with a chronic disease with exacerbation, and chronically ill child with a new diagnosis. These categories were developed based on the illness trajectory framework of Corbin and Strauss, a model of the course of illness over time.<sup>40,41</sup> Health-related needs were classified using a taxonomy of consumer health information needs. This taxonomy was developed by the research team and has been applied to consumer health questions and patient portal messages.<sup>42,43</sup> It divides health-related needs into 5 categories (Figure 1): informational, medical, logistical, social/communication, and other. This taxonomy has been employed to characterize both health-related needs (eg, patient questions from journals) and communications that address them (eg, the answers). *Informational* needs are needs for medical knowledge and include questions that could be answered by a medical textbook or consumer health resource.<sup>44</sup> *Medical* needs require the delivery of medical care, such as a new symptom warranting management or a request for a test result.



**Figure 1.** Consumer health needs and communications taxonomy

*Logistical* needs involve practical information, such as the location of a clinic or contact information for a provider. *Social* needs include personal exchanges or the need for emotional support. Informational, medical, and logistical needs share common subcategories, such as interventions and tests. An informational need involves general knowledge, such as “What is considered a normal cholesterol level?” whereas a medical need tends to involve information specific to a patient and involved in the delivery of care, such as “What is my cholesterol level?” A logistical need addresses the pragmatics of care, such as “How do I get my cholesterol level checked?”

Three members of the research team (GPJ, JRR, and RMC) evaluated each need independently and assigned a category from the taxonomy in [Figure 1](#). Consensus was achieved by discussion with the entire research team when there were disagreements. Interrater reliability was not measured, as this was the first application of this taxonomy to inpatient health-related needs, and the taxonomy evolved during this process. Further additions to the taxonomy may occur as the consultation team gains experience with inpatient health-related needs.

## RESULTS

### Patient demographics

The consult service delivered 22 consultations (7 in 2014 and 15 in 2015; 18 in phase I and 4 in phase II; [Table 1](#)). The mean age of involved patients was 5.5 years (median 2.5, range 0–17). Of the 22 patients, 12 were female and 10 were male, and 9 families out of 11 with known race/ethnicity were Caucasian. Eight consultations (36%) were for families with a previously healthy child with a new diagnosis, and 8 (36%) involved children with chronic diseases, of whom 6 presented with an exacerbation and 2 with a new diagnosis. Six consultations (27%) involved newborns with a new diagnosis, the majority of whom were premature. Diagnoses varied and

**Table 1.** Patient demographics and illness trajectories

Characteristic	N (%) Total = 22 patients
Age (mean)	5.5 years
Sex	
Male	10 (45)
Female	12 (55)
Race and ethnicity	
Caucasian non-Hispanic	9 (40)
Caucasian Hispanic	1 (5)
Black	1 (5)
Asian	0 (0)
Not reported	11 (50)
Illness trajectory	
Healthy child with new diagnosis	8 (36)
Chronic disease with exacerbation	6 (27)
Newborn with new diagnosis	6 (27)
Chronic disease with new diagnosis	2 (9)

included systemic onset juvenile idiopathic arthritis, anti-N-methyl D-aspartate receptor encephalitis due to ovarian teratoma, Hirschsprung’s disease, congenital central hypoventilation syndrome, Wilm’s tumor, neuroblastoma, multisystem trauma, seizures, traumatic brain injury, chylothorax, chronic renal insufficiency, and asthma.

### Health-related needs

The consultation team identified a total of 99 health-related needs (4.5 per consultation) during the 22 consultations: 38 informational, 26 medical, 23 logistical, and 12 social ([Table 2](#)). The most frequent subtypes of informational needs included unanswered questions about interventions, with topics such as indications and adverse effects ( $n = 19$ ), and informational needs about the patient’s medical

**Table 2.** Classification of health-related needs

Need type	Needs (total = 99)
Informational needs	38
Interventions: adverse effects	2
Interventions: technique/administration	2
Interventions: indications/contraindications	1
Interventions: unspecified	14
Problem: clinical presentation	2
Problem: prognosis	2
Problem: etiology	1
Problem: risk factors	1
Problem: unspecified	13
Medical needs	26
Management	8
Interventions	6
Personnel/referrals	5
Appointments/scheduling	4
Follow-up	2
Problem	1
Logistical needs	23
Contact information or communication	13
Medical records	6
Facilities/policies/personnel	3
Insurance/billing	1
Social needs	12
Emotional	11
Complaint	1

problems, including questions about presentation, etiology, and prognosis ( $n = 19$ ). Many parents had poorly defined or unspecified informational needs about medical problems ( $n = 13$ ) or interventions ( $n = 14$ ). These individuals typically had questions in several subcategories, but did not know enough about the new diagnosis, device, or treatment to ask a well-defined question. The most common medical needs related to management ( $n = 9$ ) or interventions ( $n = 7$ ). The need to contact health care providers was most common in the logistical category ( $n = 13$ ). Most social needs identified during consultations were for emotional support ( $n = 11$ ).

### Consultation recommendations

The consult service made 166 technological and educational recommendations (7.5 per consultation and 1.7 per need). Of these recommendations, 121 (72.9%) were for health information technologies and 45 (27.1%) were for nontechnology resources. Recommendations varied widely and included educational websites, YouTube videos, online support groups, mobile applications, video chat tools, and patient portals (Table 3). The most frequently recommended technologies were health-related websites (50, 30%) and mobile applications (30, 18%). The most commonly recommended nontechnology resource was customized educational packets from the VCH Family Resource Center.

Recommendations varied by need category (Table 4). The most common recommendations for informational needs were websites (39, 50%) and other (26, 33%), the latter of which were usually paper resources from the Family Resource Center. Medical needs were most commonly addressed with mobile applications (15, 40%) and other resources (12, 32%). Many needs in this category involved questions about how to use or care for medical equipment, such as feeding tubes or home ventilators. Online videos were very helpful to caregivers with these needs. The most frequent recommendation to meet logistical needs was the MHAV patient portal

**Table 3.** Technology and education recommendations

Recommendation type	Recommendations (total = 166) N (%)
Websites	50 (30)
Mobile applications	30 (18)
Patient portal	19 (11)
Online groups	9 (5)
Video chat	4 (2)
Blogs	2 (1)
Other social media	1 (1)
Other technology resource	6 (4)
Other nontechnology resource	45 (27)

**Table 4.** Types of recommendations based on need types

Recommendation type	Social (%)	Medical (%)	Logistical (%)	Information (%)
Video chat	2 (5.9)	2 (5.3)	0	0
Websites	19 (55.9)	1 (2.6)	1 (3.7)	39 (50.0)
Online support groups	5 (14.7)	0 (0.0)	0 (0.0)	4 (5.1)
Social media	1 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)
Blogs	2 (5.9)	0 (0.0)	0 (0.0)	2 (2.6)
Mobile applications	0	15 (39.5)	5 (18.5)	7 (9.0)
Patient portal	0	8 (21.1)	12 (44.4)	0
Other	5 (14.7)	12 (31.6)	9 (33.3)	26 (33.3)

(12, 44%), which was typically used to facilitate communication with providers from multiple specialties during stays and after discharge, or to provide access to the patient's health records. Recommendations for social needs were most frequently disease-specific websites with links to or features that included online support groups (19, 56%).

### Lessons learned

The consultation team learned important lessons in this initial experience with inpatient engagement consultations, which can inform other researchers seeking to promote engagement in the hospital setting.

First, we observed that simple interventions sometimes helped caregivers overcome barriers to engagement. For example, one parent whose child had been transferred from a small community health care center was completely overwhelmed by the number of specialists and confusing hierarchy at an academic teaching hospital. By explaining the roles of different specialists and medical trainees, we were able to give this parent confidence to interact on behalf of her child. Second, many caregivers were technology-savvy but had not thought of using technology to support health. A common need was keeping track of questions to ask the health care team on rounds, and the consultation team usually recommended notepads available on the smartphones or tablets used by the families. Also, many families used social media for support in everyday life but had not considered accessing disease-specific support groups to address their emotional needs. Third, by providing encouragement and support while they were in the hospital, we were able to increase their knowledge and confidence in supporting their children's health using technology. One elderly grandmother who was the primary caregiver of a chronically ill child was supported by bookmarking links to videos about tracheostomy care on her smartphone. Although she did not regularly use the Internet browser functions on her smartphone, she

was willing to do so when access to these instructional videos was made easy. Fourth, involving medical students in the consultation process resulted in particularly innovative solutions. For example, one student observed that a nonverbal child might have been experiencing increased agitation due to his inability to communicate and recommended symbol-based communication applications for the tablet he used frequently. The family and primary teams were encouraged by this inventive solution to his primary reason for multiple admissions. Finally, although measuring satisfaction or success was not a goal of this study, anecdotally the service was extremely well received, and several parents commented that they hoped our services could be offered to other families. By interactively working with parents, the consultation team was able to determine whether recommendations were effective in meeting needs and to propose alternative solutions when they were not. As such, most identified needs were met during the consultation process.

## DISCUSSION

This report describes an innovative approach to patient and family engagement through a multidisciplinary Technology-Based Patient and Family Engagement Consult Service. We report a wide variety of health-related needs that arise for the families of hospitalized children and the diverse technological and educational interventions recommended to meet them, expanding knowledge about patient and caregiver needs in the hospital setting and how they can be addressed. The consultation process created an environment where the entire health care team, including students, faculty, patients, and caregivers, both contributed and learned. The primary clinical teams learned about unmet information needs their parents and families had that they had not appreciated. Medical students gained knowledge about social and behavioral determinants of health and barriers to engagement not typically addressed in formal medical education. Students contributed innovative solutions using cutting-edge technologies, sometimes educating the supervising informatics faculty. Finally, by evaluating families' technology usage patterns and respecting their individual preferences, the consultation team was able to make recommendations that promoted engagement in the hospital and could be adopted to support health after discharge. Many needs that were identified remained relevant to the families after discharge, and thus, solutions that could be adopted outside of the hospital were important for sustaining engagement.

The consult service offers a potentially generalizable and scalable framework for promoting engagement, as it engages families by addressing a broad array of health-related needs using a variety of health information technology platforms and applications. As a result, it can easily be replicated at any institution with appropriate consumer health informatics expertise and knowledge of consumer health resources and technologies. The flexibility of the approach is particularly important in an era of rapidly evolving health information technologies. The factors that affect engagement and technology usage are complex.<sup>38</sup> A team that works to understand the needs of families confronted with illness and recommends interventions tailored to each unique clinical situation is more likely to identify barriers that prohibit effective engagement and help overcome them.

Although the consult service focused on engagement through technology, approximately one-quarter of the recommendations involved paper or other educational resources, often due to caregiver preferences or financial constraints that limited smartphone data plans or home Internet access. In many cases, both paper and technology resources were recommended for the same need, and an

ongoing prospective study will evaluate their relative effectiveness. For some needs, the recommendation involved education provided by the primary team or staff. In these cases, the consultation team provided an important service by helping the families articulate unmet needs and bringing them to the attention of appropriate providers.

There are many potential benefits to identifying and addressing the needs of inpatients and caregivers. Even short hospitalizations are considered major life events for most patients and families, and they offer "teachable moments" when otherwise unengaged individuals might consider making important behavioral changes.<sup>45</sup> Introducing technologies tailored to meet needs during hospitalizations can provide tools for patients and families to learn about health problems and engage in their care during the extended periods of waiting that are common in health care environments.<sup>16</sup> Furthermore, hospital staff can provide training and support to assist patients and families with registration and navigation of hospital-based tools, such as patient portals and other educational resources, giving them the knowledge and experience they need to progress through the developmental process of engagement.<sup>39</sup> Familiarity and practice with these technologies in the hospital may increase the likelihood that they will be utilized after discharge.

This study has several limitations. First, it is a retrospective review limited by data recorded in consultation documentation, which evolved as the service developed. During the early phases of the service, initial assessments were thoroughly reviewed by consultation faculty before being finalized, which is a strength. However, the consultation team expanded significantly over the 2-year study period, and the team learned from both experience and additional perspectives as the team grew. Consultations improved in the number and type of needs identified, as well as the quality and diversity of recommendations. The consultation team initially worked with the families while children were hospitalized, but follow-up assessments were limited until a prospective pilot evaluation was started.

This review only includes consultations at a tertiary-care children's hospital. However, the service is beginning to offer consultations at the adult Vanderbilt University Hospital. Consultations have only been offered to English-speaking families, as the current consultation team only speaks English and cannot thoroughly evaluate technology-based resources in other languages. Finally, the degree to which needs were met and the effectiveness of the recommendations were not documented consistently when the service was first offered. Although the consultation team asked families whether their needs were met, and anecdotally they usually were, this information was not consistently recorded in consultation service notes and thus could not be reported as part of this review. The consultation team now formally assesses the degree to which individual needs are met and interventions are effective and documents these measures in follow-up notes. The research team is currently enrolling families in a prospective evaluation of the consult service in which parent activation,<sup>46</sup> perceived health competence,<sup>47</sup> and e-health literacy<sup>48</sup> are measured at baseline, prior to discharge, and 1 month following discharge. Changes in activation and other measures will be correlated with health care utilization after discharge. The research team is also developing a searchable database of needs and recommendations to allow our work to be shared and replicated at other sites.

## CONCLUSION

This manuscript describes a new and potentially generalizable and scalable framework for identifying health-related needs in the hos-

pital setting and deploying health information technologies to meet those needs and promote patient engagement. Our initial consultation experience has identified a rich set of health-related needs that the families of hospitalized pediatric patients have. The consult service shows promise in being able to meet those needs with a variety of technologies or educational resources, tailored to the characteristics, capacities, and preferences of patients and their caregivers. Further research is needed to measure the effectiveness of this approach and to demonstrate its reproducibility in other settings.

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## COMPETING INTERESTS

The authors have no competing interests.

## CONTRIBUTORS

GPJ, EI, MM, CI, DH, SA, and RMC and each made substantial contributions to the conception and design of the work and revising it critically for important content. JRR, GPJ, and RMC each made substantial contributions to the acquisition, analysis, and interpretation of the data and drafting and revising of the manuscript. All authors approve the final manuscript and are accountable for all aspects of the work.

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## SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of the American Medical Informatics Association* online.

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