



ELSEVIER

Contents lists available at ScienceDirect

Healthcare

journal homepage: www.elsevier.com/locate/hjdsi

Into Practice

From development to implementation—A smartphone and email-based discharge follow-up program for pediatric patients after hospital discharge

Israel Green Hopkins^{a,*}, Kelly Dunn^b, Fabienne Bourgeois^b, Jayne Rogers^b, Vincent W Chiang^b

^a Division of Pediatric Emergency Medicine, UCSF Benioff Children's Hospital, San Francisco, United States

^b Department of Medicine, Boston Children's Hospital, United States

ARTICLE INFO

Article history:

Received 17 August 2015

Received in revised form

13 November 2015

Accepted 22 November 2015

Keywords:

Mobile health

Care transitions

Design thinking

Patient-centered care

ABSTRACT

The purpose of this case study was to investigate opportunities to electronically enhance the transitions of care for both patients and providers and to describe the process of development and implementation of such tools.

We describe the current challenges and fragmentation of care for pediatric patients and families being discharged from inpatient stays, and review barriers to change in practice. Care transitions vary in the complexity of the clinical and social scenarios and no one-size-fits-all approach works for every patient, provider or hospital system. A substantial challenge that providers who are designing and implementing digital tools for patients surrounds the complexity in building such tools to apply to such broad populations.

Our case study provides a framework using a multidisciplinary approach, brainstorming and rapid digital prototyping to build an in-house electronic discharge follow-up platform. In describing this process, we review design and implementation measures that may further support digital tool development in other areas.

© 2015 Elsevier Inc. All rights reserved.

1. Background

Care transitions from the inpatient to outpatient setting are frequent yet may represent challenging periods for caregivers and patients with failures in communication and coordination.^{1,2} Healthcare providers continue to search for optimal ways to provide continuity and improve communication to patients amid care transitions.

Electronic communication tools, including mobile messaging, smartphone applications and email are increasingly being studied in patient self-management and follow-up care as potential solutions.^{3–5} In pediatrics, recent studies on patients and caregivers provide early evidence that their utilization of electronic tools including email and text-enabled phones is frequent.^{6,7} Research has also shown that the use of text-message communication is independent of age, sex or socioeconomic status.⁸ Furthermore, a wide variety of patients across socioeconomic status, ethnicity and educational background demonstrate interest in using internet and mobile technology to receive healthcare information from providers.^{7,9,10}

While short-message service (SMS), or text messaging, has

been studied in adult care transitions,⁵ questions remain about how to best design and develop these programs; there remain no absolute guidelines on the process and examples in the literature vary widely.^{4,11} Properly designed and implemented, electronic communication strategies may provide a better alternative to perform outreach and follow-up to patients recently transitioning from inpatient to outpatient care.

In this report, we describe the development of an automated, SMS-text and email-based follow-up system for pediatric patients discharged from an inpatient hospital stay. From concept to design and implementation, we explore our lessons learned by this electronic follow-up tool for discharged patients and explore the utility in similar clinical settings

2. Organizational context

This case study took place within a general medicine inpatient unit at Boston Children's Hospital. Boston Children's Hospital is a tertiary care, academic pediatric hospital with 395 inpatient beds and 18,000 admissions annually, serving a socioeconomically diverse population in the Boston area, as well as a significant number of out-of-state and international patients.

The medical center has a primary responsibility to provide patients with appropriate follow-up options and strives to meet

* Corresponding author.

E-mail address: Israel.green-hopkins@ucsf.edu (I.G. Hopkins).

the demands of a heterogeneous population. Furthermore, it is a leader in pediatric care and embraces opportunities to design and investigate new systems of care and to understand their effect on the population served.

3. Personal context: concept and design

The nearly ubiquitous presence of mobile technology among our patients and families coupled with the idea to make post-discharge communication an electronic “push” from the caregivers (rather than a “pull” from patients) resulted in the structure for the case study. The clinical team was composed of three physicians, a nurse practitioner, and a nurse manager. Our technical team consisted of two software engineers and a program manager well-versed in the development of healthcare technology tools. We held serial meetings with our technology group, orchestrated by our in-house Innovation Acceleration Program to review and strategize on the design and content. The opportunity to embark on this project was supported by the creation of small seed grants to promote in-house development of software solutions to common challenges in our hospital environment. Our primary goal was to build a program to push follow-up questions to patients while minimizing workflow disruption for follow-up nurses and to evaluate the feasibility of this design and development process.

4. The problem

The current follow-up system for inpatient medical discharges is non-standardized and fragmented: staff nurses and/or physicians call patients if they deem a call necessary and this outreach is not concretely tracked or recorded in a standard fashion within the medical service. While cost data for our current hospital program is not available, similar programs report costs upward of \$60,000 to employ nursing personnel for follow-up outreach.¹²

Our primary aims were to provide an alternative means for communication at discharge between patients and discharging providers, via electronic messaging, and improve the triaging of follow-up needs. To accomplish this, we had to balance the heterogeneity of clinical environments with care transitions as well as limitations in what could be technologically accomplished and implemented.

5. The solution

Early on, we utilized a modified “design thinking” approach to help explore the potential solutions. This approach, which is used primarily in the product design and business industry, organizes the problem solving process into five steps: Empathize, Define, Ideate, Prototype and Test.¹³ Essentially, when initially considering a solution to a problem, a group must first evaluate the needs of the user (empathy), use this work to determine which processes are important for users (define), explore a large quantity of possible solutions (ideate), transform those ideas into a physical form (prototype) and lastly, test the prototypes out with your users. The model has many similarities to conventional quality improvement studies in medicine. We modified the process slightly as we did not have the opportunity to perform extensive user research, but rather relied on available literature and experience of the professionals in our group.

Our end-users included the patient and/or caregiver, the follow-up nurse, the discharging physician and in some cases, the primary care physician. Our clinical team brainstormed challenges existing in the current follow-up structure. Though we did not

hold focus groups or standardized interviews with end-users, our diverse clinical team brought numerous reflections from each individual's practice. In addition, we reviewed available literature detailing patient, caregiver and clinician frustrations with current follow-up systems.

Because our goal was to design a simple and automated follow-up tool, our aim was to keep our follow-up questions brief yet purposeful. As such, we were unable to conduct extensive pre-implementation surveys on what variables should or should not be included in electronic follow-up. However, we developed questions based on prior literature surrounding post-discharge communication and follow-up. While there have been numerous studies on discharge preparedness and improvement, Project RED remains one of the most widely successful programs.¹⁴ The study identified multiple domains upon which improvements in education and communication could be made, including but not limited to: discussion of pending tests, follow-up appointments, medication instructions, discharge instruction comprehension and a review of a discharge plan.

As our goal was to make a relatively simple text application that parents could use, we aimed to prioritize questions asked. Recent studies on phone follow-up after discharge have identified key variables at follow-up that are frequently sought after by patients, though data exist from adults.^{12,15} The most commonly encountered issues are 1) difficulty with or questions regarding follow-up appointments, 2) challenges to obtaining a discharge medicine and 3) questions about discharge medicine.^{12,15} We utilized this prior research to develop our main goals for our follow-up system and narrowed them to 1) performing or attempting outreach to the patient and/or family, 2) ensuring that medicines were obtained, 3) ensuring that follow-up appointments were obtained and 4) determining if any parental or patient concerns were present. These goals, abstracted from prior research on patient concerns and challenges with discharge as noted, formed the basis for our follow-up questions. The process, however, started with consideration of a more simplified outreach – a single message inquiring if the patients had any questions regarding the recent discharge. This was abandoned as our team felt more targeted questions may improve response. We additionally considered adopting a more detailed approach such as that used in Project RED. Questions considered here included querying whether patients knew about pending tests, the degree of comprehension of discharge instructions, had questions about medications or side effects and to establish parent knowledge of return precautions. We elected to prioritize brevity with an open-ended response that would elicit a callback from a follow-up provider rather than include more comprehensive questions that may deter patients from completing the tool.

During ideation we considered various possible mechanisms for follow-up, not limited to electronic mediums. The process allowed for further refining of our goals and we frequently circled back to the needs of the users including patients, clinicians and the hospital system. For example, we initially considered email-only deployment, or deployment via a newly-developed patient-portal, but eventually decided that scalability may be easier with an email and SMS-based system, though this was not based on literature review. In addition, while considering possible expansion capability of the system we designed, we hypothesized the multiple other environments that such a follow-up tool could be used. This process involved unstructured interviews with other discharging services to determine what their potential needs might be. For example, while our tool was designed for follow-up, we also conceptualized its use as a pre-operative outreach tool to enhance the surgical preparation process for families.

6. Prototyping the solution

During the build phase, we were faced with limitations of time and availability of software engineers. We had approximately a six month period during which the electronic communication tool had to be built, thus goal prioritization and rapid prototyping was critical. We broke the build process into two components: the patient-facing and the clinician-facing. For the patient-facing component, we considered how and how often notifications should be sent to patients. After a number of considerations, we determined that patients would receive a text or email-based message from our automated platform, depending on the patient preference. If they chose text, the text contained a link directing them to a mobile version of the questions. Their answers would be routed back to the platform and based on their responses, the platform would flag them as “Requires Follow-up” or “Follow-up not Required”.

The email-based version of initial questions supplied to the families is depicted in Fig. 1. The interface appears in a similar, mobile-friendly format on mobile devices while the SMS-based version refers users to a web-based link. As can be seen, guardians can select answers and have a recognizable source of the information. Furthermore, a disclaimer on the same screen as the questions notifies the guardian of what to do in the need of an emergency and reminds them that their responses are not monitored in real time. We determined that the set of three questions provided more substantial information for our follow-up providers, though these questions are not based on prior research.

The literature is scant with respect to how and when email or SMS-based notifications should be sent to patients, though some examples do exist.^{16–18} We used available literature and prior experience of team members to create this set of rules for messages sent to patients:

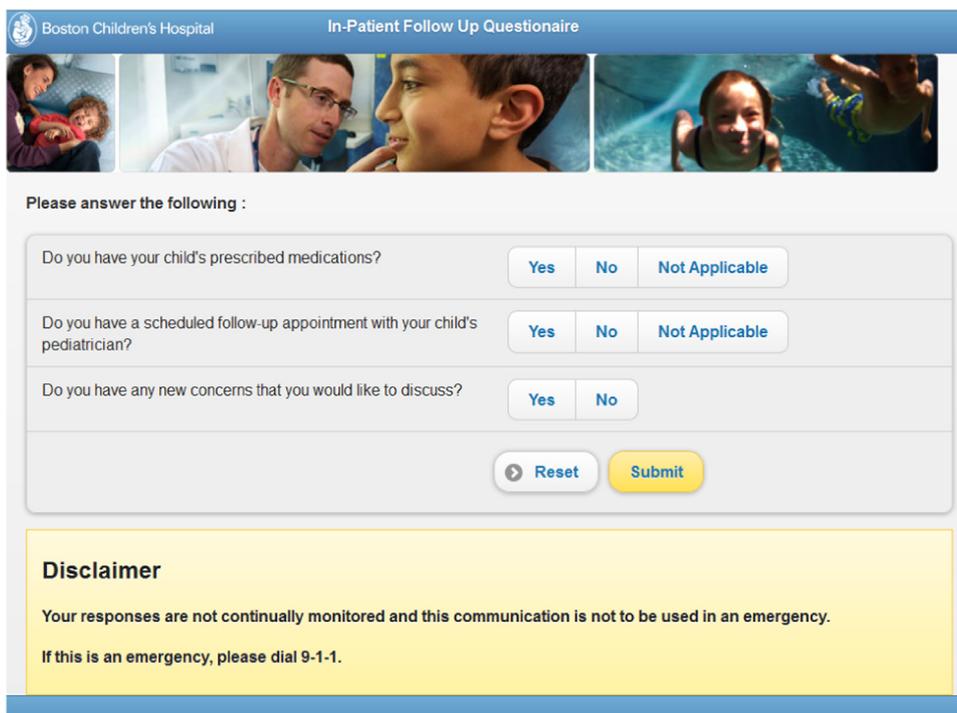
1. Messages are sent the following business day after discharge between the hours of 8 a.m and 7 p.m.
2. Text messages would not be sent on holidays that would delay prompt triage of participants' responses to the text or email.

3. Parents or caregivers would receive a maximum of one follow-up message after the initial message to ask for completion of the questions, after which point no further messages were sent and the patient was categorized as a non-responder.

The structure of the provider-facing platform carried more complexity and even less published literature to draw insights from. For example, when we initially set out to have responses displayed on a provider platform, we considered the platform would be primarily an information feed without the ability for providers to customize the information. As such, the responses would be displayed and would alert the follow-up clinician of the patient answers. When this initial prototype was built and reviewed by our follow-up clinician (the NP), suggestions to create a more interactive framework were incorporated as discussed below.

The final result of our provider-facing platform is depicted in Fig. 2 (of note, patient names here are hypothetical). In this version, a more interactive and potentially more informative framework was decided upon. For example, the follow-up clinician can now determine how many follow-up messages had been sent to each patient and whether they had been opened (columns denoted as M1 and M2). In addition, colors are added to the response boxes in an effort to help the clinician sort answers that required follow-up. In our system, a red flag in any question box deemed the need for a follow-up call. This represents an improvement over an initial prototype which utilized only checkmarks to denote answers not requiring follow-up, while “X” denoted the need for follow-up. The ability to add notes to any patient was added as we considered the scalability of the application to environments with multiple follow-up providers. Our final version offered three features that we considered unique and important to the usability of the application.

1. The ability to sort patients by various categories: time and date of discharge, response status, and text message status.
2. The ability to remove patients from the active follow-up list once text responses have been completed and follow-up is no



Boston Children's Hospital In-Patient Follow Up Questionnaire

Please answer the following :

Do you have your child's prescribed medications? Yes No Not Applicable

Do you have a scheduled follow-up appointment with your child's pediatrician? Yes No Not Applicable

Do you have any new concerns that you would like to discuss? Yes No

Reset Submit

Disclaimer

Your responses are not continually monitored and this communication is not to be used in an emergency.

If this is an emergency, please dial 9-1-1.

Fig. 1. The web-version of the patient survey.

DisCo - Responses										
Enrollment		Registered Users		Responses			Report All		Settings	
Active				Inactive						
10										
Patient Name	Parent/Guardian	Discharge Date	M1	M2	Meds	PCP	Other	Notes	Hospitalization	
[Link]	[Link]	07/09/2013 10:54 AM	[Phone]	[Phone]	[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	07/05/2013 7:54 PM	[Envelope]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/30/2013 5:30 PM	[Envelope]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/28/2013 4:34 PM	[Envelope]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/28/2013 3:50 PM	[Phone]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/27/2013 11:30 AM	[Envelope]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/26/2013 11:17 AM	[Phone]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/24/2013 2:55 PM	[Envelope]		[Green Check]	[Green Check]	[Red X]	Add Note		
[Link]	[Link]	06/24/2013 11:58 AM	[Phone]		[Red X]	[Green Check]	[Red X]	06/25/2013 01:02 PM		
[Link]	[Link]	06/21/2013 5:09 PM	[Phone]	[Phone]				06/24/2013 08:03 AM	06/23/2013 7:44 PM	

Showing 1 to 10 of 73 entries

© 2012 Boston Children's Hospital DisCo v1.0.0

Fig. 2. The provider-facing dashboard. Note, patient names and dates do not correspond to real patients.

longer necessary.

- The option to “pick up” follow-up tasks where another provider left off, which may help in reducing communication pitfalls between providers.

7. Implementation of the solution

The intervention pilot took place over a 7-month period (4/4/2013–10/30/2013). This was a quality improvement project to use text messaging to reduce the need for us to contact all discharged patients. As such, there was not informed consent to participate in the study. The consent was whether or not they would be willing to receive texts from us (which was necessary because on some data plans, the SMS receipt incurs a cost and participants were reminded of such). Caregivers of patients were considered eligible for inclusion if the child was between 3 months and 21 years, they read and spoke English, and had a smart phone with text-enabled messages or an email address. Adolescent patients could assent to enrollment if their guardian provided permission. All patients and caregivers who were deemed eligible were approached for enrollment. Families were initially approached on the day of discharge by one nurse practitioner (NP) who functioned as the sole follow-up clinician on the medical floors for the purposes of this pilot. If they met inclusion criteria and reported interest in participating in the communication pilot, the NP would enter the participant's information into a secure, online database. Participants provided the name of the caregiver to contact (this was typically one caregiver name), the best phone number and/or email to use if further follow up was needed, and whether an email or text message was preferred as the communication modality. This pilot was presented as an alternative to the routine follow-up methods in which caregivers would reach out to the primary care doctor or the discharging floor with any questions. The nature of the communication, including that it is not monitored in real time and not to be used for emergencies, was discussed with the caregivers at enrollment.

After discharge, caregivers were sent one text or email

containing a link to a survey that asked the three questions depicted in Fig. 1: 1) Were you able to get your medications as prescribed, 2) Did you schedule a follow-up appointment with your PCP or Specialist?, and 3) Do you have any additional concerns or questions regarding your recent admission?. If this message was not responded to within 48 h, a single follow-up message was sent with the same link and a reminder. If the parent indicated a problem with either obtaining medications, arranging follow-up care, or held an additional concern, the subject was automatically flagged by the system in our provider-facing dashboard. As can be seen in Fig. 2, such a flag was clearly visible to the follow-up clinician as a red “X” to indicate that the subject responded in a manner that requires outreach. The follow-up nurse practitioner reviewed the dashboard daily, and phone outreach was attempted for a maximum of two calls per patient. At outreach, the follow-up NP reviewed any problems with the caregiver, and appropriate solutions were performed. Upon discussing and resolving the issue(s), if applicable, the follow-up NP adjusted the patient on the dashboard to reflect this. In these cases, the flagged area was changed to green and specific notes were made by the follow-up NP. As such, any other follow-up clinician could easily note that issues were resolved. Corresponding documentation was performed in the electronic health record for these patients as appropriate.

For all families enrolled who completed the initial questions, a follow-up survey was sent one week after discharge. The questions queried their experience with the discharge communication tool and likelihood to use it in future follow-up encounters. Statistical analyses were performed using Stata v.12.1 (StataCorp, College Station, TX).

8. Results

Of the 160 families approached, 22 were ineligible or declined participation (Fig. 3). The primary reason for ineligibility was the parental preference to solely follow-up with the primary pediatrician (11/22). Similar proportions of families opted for text-based

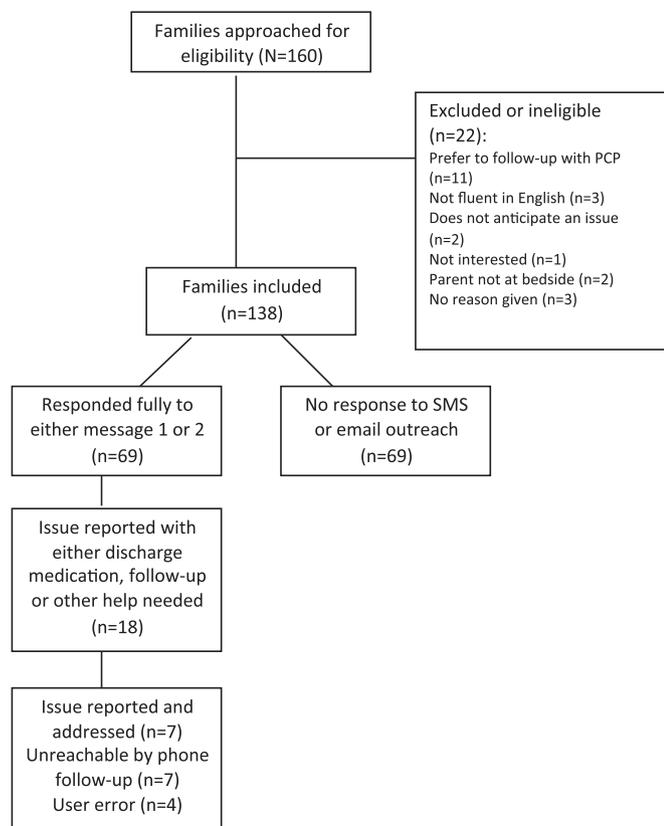


Fig. 3. Patient enrollment flow diagram.

Table 1
Characteristics of study participants.^a

	Responded (N=69) ^b	Did not respond (N=69)
Age (mean, y)	4.4	4.3
Gender (% male)	38 (56)	42 (62)
Insurance (% private)	55 (81)	44 (65)
Race		
Asian	2 (3)	2 (3)
American Indian or Alaskan Native	–	1 (1)
Black or African American	3 (4)	15 (22)
White	46 (68)	31 (46)
Other	9 (13)	15 (22)
Declined to answer	3 (4)	1 (1)
Unable to answer	4 (6)	3 (4)
Unknown	1 (1)	–

^a Data are presented as no. (%) unless otherwise noted.

^b Demographic information was missing or not provided for two patients, one in each group.

vs. email-based communication. Of the 138 families enrolled, 69 (50%) responded to the follow-up questions. Study population characteristics are provided in Table 1.

Of the 69 participants who responded, 18 (26%) reported an issue with their medication, follow-up with the PCP, or some other issue. Of these patients, on attempted phone follow-up, 7 were unreachable and 4 reported that they mistakenly answered the question and actually meant they had no concerns. Thus, seven families, or 5% of the enrolled patients, required assistance with some issue post-discharge. These seven subjects and their specific follow-up concerns and interventions are listed in Table 2. Of the new or worsening symptoms, one patient returned to the hospital for an unplanned readmission related to their initial diagnosis within 7 days of discharge; the child's parents used the

Table 2
Follow-up concerns raised by patients or family members.

Subject concern	Specific concern	Intervention
Appointment assistance (N=3)	Needed rescheduling (2) Scheduling assistance (1)	Assistance and coordination provided
New or progressive symptoms (N=4)	New symptoms (2) Progressive symptoms (1)	Discussed new symptoms and ensured appropriate PCP follow-up
Medication questions	Side effect (1)	Reviewed medicine

communication tool to alert the medical team of their arrival en route. Of the 69 patients who did not respond to the initial text or email, 2 had an unplanned return visit for the same disease process within 7 days; one child re-presented to the ED prior to the first text message being sent to the family by the system.

The follow-up survey was completed by 22 families of the 138 included (16%). The majority (82%) felt the tool was very or somewhat helpful. Most participants stated that they would use the tool again should their child be admitted to the hospital. No recommendations from patients were offered for changes.

9. Key lessons for the field

Opportunities exist to enhance the patient and caregiver communication during transitions of care by targeting various pitfalls in continuity during the care transition process.² In this pilot study, we demonstrate the design, development, and implementation of an automated discharge communication tool and describe the feasibility of implementation in a tertiary care hospital.

Though there is great interest in mobile health, or mhealth, applications, there is limited data to support their use and still fewer examples of the design of such applications in the literature. For example, a Cochrane Review in 2012 found few randomized controlled trials (RCT) using SMS-messaging for patients with chronic diseases, and concluded that while there were some modest benefits in self-management, a number of questions remain regarding the cost effectiveness, safety, acceptability and long-term effects.¹⁹ A recent systematic review of mhealth applications employed in chronic disease management demonstrated only 39% of RCTs that met eligibility requirements demonstrated improvement in disease-specific outcomes.²⁰ Our pilot serves to provide some architecture for the approach to building such an application and to further explore the limitations of such a project and the barriers to success.

There is no comprehensive data we found to suggest average response rate from a text or email-based discharge communication with patients, only data existing from individual trials and case studies. For example, in a recent systematic review on SMS-based patient communication, response rates varied from 22% to 100%, with little indication as to factors that predicted response.²¹ While 50% of our enrolled subjects responded, this number may have been increased through a variety of methods including improvements to the study education/introduction, enhanced understanding of patient preferences through user focus groups or incorporating patients and caregivers in the design process.

In this study, we settled on three initial questions yet still 50% of patients enrolled did not respond. While specifics of question types, length of surveys, and literacy levels of survey questions will be inherently dependent on the care environment they are prescribed to, further research is needed to understand the significance of the frequency, length and nature of mobile electronic communication to patients and families. Evaluating reasons for

non-response will provide important user feedback to guide further redesign of interventions and programs.

A primary question for this type of project is whether an electronic follow-up tool could be a manageable interface for hospitals or departments. While only 10% of responders in this pilot had concerns that required attention, any assertion of manageability would require further rigorous evaluation of follow-up clinician time and variation to the interface. Still, while some research has shown that even extensive efforts to ensure success of standard telephone follow-up fails, our response rate suggests room to build on this method of electronic communication.²² While our single follow-up NP could manage the follow-up communication, further testing of the platform with multiple follow-up providers and patients would greatly improve its redesign.

Our design and implementation process was likely enhanced by the availability of software engineers and programmers who could rapidly prototype our collaborative ideas. In our case, this allowed the offering of real-time suggestions from users in our group to help guide further iteration. While such a team may not be available to other groups, our limited experience in this pilot suggests it a worthwhile consideration. Were we to build this pilot again, we would encourage even more diversity in the team, including insights from key users through the use of focus groups from patients and clinicians. Our use of a modified design thinking process allowed for creative brainstorming sessions within our group, though a more structured format of this methodology with professionals experienced in this approach could potentially improve the process and the outcome.

This pilot has a number of limitations. First, as a feasibility project our efforts were primarily directed toward exploring the build and design process as well as the implementation of the tool. As such, limits around data collection and funding prevented us from analyzing multiple other aspects such as clinician time and workflow pre and post-implementation. Second, because we developed our tool based on brainstorm sessions from experienced professionals, we may have overestimated the importance of certain features of such a tool. For example, our timing for delivery of follow-up notification is only partially based on models in other studies; had we held focus groups with patients we may have identified other preferences of our population. Third, the construction of the provider-facing interface is not based on rigorous user experience (UX) or user interface (UI) testing and thus may not represent the most optimal or efficient system. However, given the time and funding constraints of our project, such evaluation was not feasible. In addition, now that the platform has been built, our time can be invested in user testing for further refinement. Fourth, some authors have employed more extensive user-centered efforts in design of mobile applications for patients,²³ and as we did not include extensive end-user feedback (physician, follow-up nurse, primary care doctor and patient/guardian) we may have overlooked certain design and implementation aspects. Centers that are considering similar projects would be wise to utilize such resources to guide design of initial projects when able. Lastly, our survey regarding acceptability by patients was completed by only a small group of patients, thus we cannot fully understand how acceptable this means of communication was for patients. This, of course, would require a much larger study population.

This project represents the initial stages of efforts to improve follow-up and care coordination for patients and it has a number of possible future directions. At our hospital, the system has been adopted by our procedural sedation unit to assess patients after minor procedures and is being scaled to other medical and surgical services as well. Our next steps involve refining the features of the patient-facing and provider facing interfaces through the use of focus groups as well as analyzing the time spent by follow-up providers. Until further research in electronic discharge

communication can provide recommended design and structure of such tools, this pilot can serve as a reflective example for other centers and groups embarking on similar projects.

References

1. Woods DM, Holl JL, Angst DB, et al. Gaps in pediatric clinician communication and opportunities for improvement. *J Healthc Qual.* 2008;30(5):43–54.
2. Kripalani S, LeFevre F, Phillips CO, Williams M, Basaviah P, Baker D. Deficits in communication and information transfer between hospital-based and primary care physicians. *J Am Med Assoc.* 2007;297:831–841. (<http://jama.ama-assn.org/content/297/8/831.short>).
3. Zurovac D, Sudoi RK, Akhwale WS, et al. The effect of mobile phone text-message reminders on Kenyan health workers' adherence to malaria treatment guidelines: a cluster randomised trial. *Lancet.* 2011;378:795–803([http://dx.doi.org/10.1016/S0140-6736\(11\)60783-6](http://dx.doi.org/10.1016/S0140-6736(11)60783-6)).
4. Suffoletto B, Calabria J, Ross A, Callaway C, Yealy DM. A mobile phone text message program to measure oral antibiotic use and provide feedback on adherence to patients discharged from the emergency department. *Acad Emerg Med.* 2012;19(8):949–958(<http://dx.doi.org/10.1111/j.1553-2712.2012.01411.x>).
5. Nundy S, Razi RR, Dick JJ, et al. A text messaging intervention to improve heart failure self-management after hospital discharge in a largely African-American population: before–after study. *J Med Internet Res.* 2013;15(3):e53. (<http://dx.doi.org/10.2196/jmir.2317>).
6. Dudas RA, Crocetti M. Pediatric caregiver attitudes toward email communication: survey in an urban primary care setting. *J Med Internet Res.* 2013;15(10):e228. (<http://dx.doi.org/10.2196/jmir.2738>).
7. Dudas RA, Pumilia JN, Crocetti M. Pediatric caregiver attitudes and technologic readiness toward electronic follow-up communication in an urban community emergency department. *Telemed J E Health.* 2013;19:493–496(<http://dx.doi.org/10.1089/tmj.2012.0166>).
8. Ranney ML, Choo EK, Wang Y, Baum A, Clark MA, Mello MJ. Emergency department patients' preferences for technology-based behavioral interventions. *Ann Emerg Med.* 2012;60(2):218–227. (<http://dx.doi.org/10.1016/j.annemergmed.2012.02.026>).
9. Mitchell SJ, Godoy L, Shabazz K, Horn IB. Internet and mobile technology use among urban African American parents: survey study of a clinical population. *J Med Internet Res.* 2014;16(1):1–10. (<http://dx.doi.org/10.2196/jmir.2673>).
10. Saidinejad Mohsen, Teach SJ, Chamberlain JM. Internet access and electronic communication among families in an urban pediatric emergency department. *Pediatr Emerg.* 2012;28(6):553–557 [Accessed October 6, 2014](http://journals.lww.com/pec-online/Abstract/2012/06000/Internet_Access_and_Electronic_Communication_Among.15.aspx).
11. Arora S, Peters AL, Burner E, Lam CN, Menchine M. *Ann Emerg Med.* 2014;63(6):745–754(<http://dx.doi.org/10.1016/j.annemergmed.2013.10.012> e6).
12. Harrison JD, Auerbach AD, Quinn K, Kynoch E, Mourad M. Assessing the impact of nurse post-discharge telephone calls on 30-day hospital readmission rates. *J Gen Intern Med.* 2014;29(11):1519–1525(<http://dx.doi.org/10.1007/s11606-014-2954-2>).
13. Brown T. *Design Thinking.* Harvard Business Review; 2008. Published June (<https://hbr.org/2008/06/design-thinking>).
14. Jack BW, Chetty VK, Anthony D, et al. A reengineered hospital discharge program to decrease rehospitalization: a randomized trial. *Ann Intern Med.* 2009;150(3):178–187.
15. Rennke S, Kesh S, Neeman N, Sehgal NL. Complementary telephone strategies to improve postdischarge communication. *Am J Med.* 2012;125(1):28–30(<http://dx.doi.org/10.1016/j.amjmed.2011.05.011>).
16. Suffoletto B, Callaway C, Kristan J, Kraemer K, Clark DB. Text-message-based drinking assessments and brief interventions for young adults discharged from the emergency department. *Alcohol Clin Exp Res.* 2012;36:552–560(<http://dx.doi.org/10.1111/j.1530-0277.2011.01646.x>).
17. Pop-Eleches C, Thirumurthy H, Habyarimana JP, et al. Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. *AIDS.* 2011;25:825–834(<http://dx.doi.org/10.1097/QAD.0b013e32834380c1>).
18. Petrie KJ, Perry K, Broadbent E, Weinman J. A text message programme designed to modify patients' illness and treatment beliefs improves self-reported adherence to asthma preventer medication. *Br J Health Psychol.* 2012;17:74–84 (<http://dx.doi.org/10.1111/j.2044-8287.2011.02033.x>).
19. de Jongh T, Gurol-Urganci I, Vodopivec-Jamsek V, Car J, Atun R. Mobile phone messaging for facilitating self-management of long-term illnesses. *Cochrane Database Syst Rev.* 2012;12:CD007459(<http://dx.doi.org/10.1002/14651858.CD007459.pub2>).
20. Hamine S, Gerth-Guyette E, Faulx D, Green BB, Ginsburg AS. Impact of mHealth chronic disease management on treatment adherence and patient outcomes: a systematic review. *J Med Internet Res.* 2015;17(2):e52(<http://dx.doi.org/10.2196/jmir.3951>).
21. Kannisto KA, Koivunen MH, Valimaki MA. Use of mobile phone text message reminders in health care services: a narrative literature review. *J Med Internet Res.* 2014;16(10):e222(<http://dx.doi.org/10.2196/jmir.3442>).
22. Menchine M, Oberfoell S, Schriger D, Walker C, Riddell J, Arora S. Improving telephone follow-up for patients discharged from the emergency department: results of a randomized controlled trial. *Acad Emerg Med.* 2013;20(5):456–462

<http://dx.doi.org/10.1111/acem.12128>.

23. Cafazzo JA, Casselman M, Hamming N, Katzman DK, Palmert MR. Design of an mHealth app for the self-management of adolescent type 1 diabetes: a pilot study. *J Med Internet Res*. 2012;14(3):e70, <http://dx.doi.org/10.2196/jmir.2058>.

that might pose a conflict of interest: Consultant arrangements: None. Stock/other equity ownership: None. Patent licensing arrangements: None. Grants/research support: None. Employment: None. Speakers' bureau: None. Expert witness: None

Conflict of interest disclosure statement

All authors have disclosed relevant commercial associations