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Designing Inpatient Technology to Meet the Medication Information Needs of Cardiology Patients

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Abstract

As patients are encouraged to become active participants in their own care, recent research has begun to explore the direct sharing of electronic health information with patients during hospital visits. The design of patient-facing views of clinical information is, however, a relatively recent line of inquiry. Research is needed to further understand guidelines for communicating specific types of information to hospital patients. In this work, we focus on cardiology patients' information needs related to their hospital medications. We assessed these needs to inform the design of interactive, electronic views of medication information for cardiology inpatients. We present results of in-situ interviews with 11 inpatients and 6 nurses in a cardiology step-down unit. Our findings suggest that cohesive trends in medication information needs exist across cardiology inpatients. We discuss interview results and their implications for the design of inpatient-facing information technology. We also discuss key ways in which electronic medication information, formatted for inpatient use, differs from that formatted for outpatient or transitional medication-management use.

Categories and Subject Descriptors
H.5.m [**INFORMATION INTERFACES AND PRESENTATION**]: Miscellaneous; J.3.5 [**LIFE AND MEDICAL SCIENCES**]: Health, Medical information systems

Keywords

Healthcare; Design; Inpatient medication information needs; Human Factors

1. INTRODUCTION

Patient participation in health care is increasingly being encouraged as a means to improve patient safety, care continuity, and healthcare process [7]. In response, research in health services, medical informatics, and human–computer interaction has begun to explore new ways to engage and communicate with patients during hospital visits [2,11,15]. In particular, recent work has started to investigate the presentation of patient-centric views of information [15] in the electronic health record (EHR) to hospital patients. Hospital patients could use these views to access information on their care status and progress, and the identities of their care-team members. Such sharing of information can also provide opportunities for patients and their family members to become educated about post-discharge care planning [2], to actively monitor their health in the hospital [11], and to clarify health information relevant to the hospital visit with care-team members, within the care context. One important type of clinical information to present to patients in the clinical setting is medication information [7]. While there is evidence that hospital inpatients would like a timely, electronic view of the inpatient medications that have been administered to them during their care [11,15], electronic patient-facing views of medication information in the hospital have only recently begun to emerge [13]. In this paper, we explore cardiology patients' information needs related to their hospital medications. We assessed these needs to gain insights that can inform the design of interactive, electronic views of medication information for cardiology inpatients. We report on results of in-situ interviews with 11 inpatients and 6 nurses in a cardiology step-down unit of a large, urban hospital. Our interviews were designed to examine medication information needs that are shared among cardiology inpatients, how these needs translate into design goals for technology that delivers medication information to cardiology inpatients during hospital care, and how such inpatient medication information differs from that designed for outpatient or transitional contexts. We discuss related research, describe our interview topics and key findings, and conclude by exploring some key implications of the results.

2. BACKGROUND AND RELATED WORK

Recent research on medication information needs has focused on assessments of needs related to medication management in outpatient or home settings [1,5,8,9], and several tools have been developed to support medication management based on information needs [6,14]. Khan and colleagues report on an application to support medication management among older adults during care transitions [6] and address several important design considerations for such transitions. Their information-needs assessment focuses on older adults and caregivers, and their findings relate to medication education and information concerning medication regime (i.e., reasons for complex medication regimes, opportunities for alternative medications, and ways to maintain autonomy).

However, the inpatient care setting differs from transitional settings, and the differences have important implications for technology design. For example, in the inpatient setting, medications are more often provided for only a short time and then discontinued as new medications are started. Forms of medications are more diverse and include titrated intravenous medications in addition to other more familiar injections, pills, powders, and liquids. Furthermore, responsibility for medication administration and adherence is shifted to care-team members, rather than patients themselves.

Few existing technologies support direct, automatic information sharing with hospital patients *during* their care, so analysis of the electronic information needs of inpatients is, in general, a relatively new area of study [2]. A comprehensive understanding of the inpatient experience is required in order to successfully extend the current paradigm of patient information access to this setting. Skeels and Tan [11] describe a hospital study focusing on a variety of present-day needs of hospital patients, and find that patients desire timely access to a variety of information in their medical records, including medication information, during their hospital care.

While previous work has identified clinical information types that are of interest to inpatients, more research is needed to explore patient needs concerning details of specific information drawn from the hospital EHR. Studies are needed to further understand design guidelines for presenting clinical information and supporting the interactive review of information throughout a hospital stay. In particular, understanding the specific medication information needs of hospitalized patients at the point of care is an essential precursor to designing technology to meet those needs. These information needs can influence the design of techniques for careful formatting, presentation, and timing of the ongoing delivery of detailed medication information to patients during a hospital stay.

Encouragingly, research investigating patient access to their own medical information, including medication information, has revealed numerous benefits in various ambulatory and inpatient settings [4,10,16]. Furthermore, hospital patients have responded favorably to both the proposed use of computing technology in the care setting [2,11,13] and the opportunity to read medication information from their charts [3,4,10].

3. INPATIENT FIELD STUDY

We conducted in-situ interviews with 11 cardiology inpatients and 6 cardiac-care nurses to identify patient information related to medication. We used a semi-structured approach for patient and nurse interviews, to better tailor questions and discussion points to the specific situation of each patient, and the specific experiences of the nurses. All interviews were either audio recorded or conducted by two interviewers, with one taking written notes. After transcribing all audio recordings and notes, participant responses were thematically coded and trends in emergent themes were reviewed among the research team.

3.1 Study Setting

The study was performed at Columbia University Medical Center, a large urban academic medical center that is part of NewYork-Presbyterian Hospital (NYP). The medical center is a

Level I trauma center and a major teaching hospital with a busy cardiology service. We conducted interviews with patients and nurses in a 30-bed cardiac step-down unit. The research was approved by the medical center's human subjects institutional review board.

3.2 Patient Participants

After briefing physicians and nurses in the cardiology step-down unit about the study objectives, we asked them to identify eligible patients in the unit. Screening criteria required patients to be able to converse with researchers, and to be medically stable (capable of ambulating with assistance or on their own, and off step-down monitors). If an approached patient was willing, we collected informed consent.

We conducted semi-structured interviews with 11 patients (nine male, ages 23–79, mean = 53) during their stay over the course of approximately two weeks. All patients reported that they used a cell phone on a daily basis. Nine of the patients had computers in their homes with internet access, and used the computer daily. The remaining two used a computer with internet access on a regular, but non-daily basis, outside of the home. Each interview was designed to last thirty minutes. During the course of our study, two patients asked that we cut the interview short due to discomfort. Most patients spoke with us for 30–45 minutes.

3.3 Patient Interview Topics

Patients were asked to describe various experiences related to learning about and taking medication. Each patient was asked questions that explored all of the following discussion points:

1. Managing medication information at home—These questions explored patients' experience managing their medications. Patients were asked to describe the number of medications they took at home, their methods for managing information about those medications, and their interest in accessing information about them through a variety of sources, including the internet.

2. Current medication status—These questions explored strategies patients used to keep track of their medications. Patients were first asked to comment on their level of interest in keeping track of the number and types of medications they received in the hospital. They were asked to indicate whether they thought they had a good idea of the number and types of medications they were currently receiving, and whether they wanted to access a list of current and/or discontinued medications.

3. Medication requests—Patients were asked to describe any requests that they had regarding medications (that a medication be started, stopped, or adjusted) and to describe the circumstances around those requests and how they were handled.

4. Record keeping and interest in archiving—These questions explored whether patients were keeping any personal notes related to their medications, whether they would be interested in accessing information about medication after their visit, reasons they were

keeping or would like to keep a record of their medication list, and barriers they encountered to taking notes.

5. Preferences for medication explanations—These questions explored the ways in which patients received explanations about their medications, whether they found the explanations too detailed or not detailed enough, and what types of information they were curious about related to medication. They were first asked to volunteer any type of information that was important to them. The interviewer then followed up by asking about their interest in several different information types. Patients were asked whether they would look up additional information about their medications if they had internet access in the hospital, and if so, what specific topics they would be interested in reading about in online articles. To gauge interest, they were asked whether, since their admission. they had experienced the desire to search for web content related to medication information that had been explained to them.

6. Questions about medications throughout their care—Patients were asked to recall and recount any questions or concerns they brought to their doctors or nurses about the medications they had received throughout their care. They were asked to comment on their questions and concerns earlier on in their treatment (during and after initial step-down) as well as their current questions and concerns. They were also asked to reflect on how their concerns and questions changed throughout the course of their stay.

7. Attitudes about computing technology at the bedside—Patients were asked to comment on their desire to use technology during their hospital stay.

3.4 Nurse Participants

Six cardiac step-down nurses (all female) in the unit were recruited for our study based on the recommendations of the nurse manager. The nurses had varying amounts of experience in cardiology, ranging from 2 to 12 years (mean = 6). All nurses had experience briefing patients about their medications, and assisting in discharge preparations requiring that medication information be reviewed with patients and family members. Interviews with nurses were conducted in fragments as their work allowed. Each nurse agreed to be shadowed for a period of about two hours, during which time interviewers followed them as they conducted care activities. Interviewers engaged nurses in discussions during breaks and brief downtime periods.

3.5 Nurse Interview Topics

Interviewers sought an understanding of the information needs of patients, as experienced by nurses, and how aspects of the clinical context shaped those needs. Each nurse was asked questions that explored the following discussion points:

1. Strategies for medication explanations—Nurses were asked to describe their strategies for explaining information to patients about hospital medications. They were asked to provide example explanations for common medications given in the cardiology unit, and comment on how they structured the explanations in terms of purpose, type, risks/

benefits, side effects, and procedural information on administration. They were also asked to describe how they explained information on prescription medications patients would take after their stay.

2. Medication requests—Nurses were asked to describe their experiences with requests by patients to adjust, start, or stop medications, how often these requests occur, and how information is exchanged between patients and care-team members to address these requests.

3. Questions about medications throughout patient care—Nurses were asked to comment on the questions or concerns they frequently encountered from patients, including how these questions and concerns changed throughout a typical patient's stay.

4. Attitudes about computing technology at the bedside—Nurses were asked to comment on the perceived benefits and risks of providing technology to hospital patients that allowed access to detailed medication information and education.

4. FINDINGS

4.1 Patient Interview Responses

Patients discussed a wide range of medication information needs, expressing preferences supported by their experiences learning about medications in the hospital, and their desire to successfully manage prescription medications upon hospital discharge. We found that cohesive trends emerged in information needs across patients. Below, we outline and discuss key themes arising from our thematic coding of patient interview data.

4.1.1 Tracking Changes in Medications—Several patients expressed a desire to be able to keep track of their current medications. Each of the 11 patients we interviewed indicated that they thought having a list of current and discontinued medications in an electronic format, available at the bedside, would be valuable. Many patients also mentioned the importance of a list of home medications to verify that those had been noted. While we suspected that these lists would be useful as a memory aid and monitoring mechanism based on prior work on information needs [6, 8, 11, 14], we found that the inpatient cardiology setting presented specific challenges and needs related to patient monitoring of medication changes.

First, medications change frequently during a patient's care, and while patients are given verbal briefings describing updates to medications, they are not responsible for managing the actual change in medication regime. Medication types, doses, as well as methods and frequency of administration, can change to respond to patient preferences, current problems, and individual responses to drug therapy. The lack of supporting written or electronic materials to describe and explain these changes makes it hard for patients to remember current and previous medications and corresponding doses.

Second, medication changes are often tied to specific problems, procedure results, or clinical goals. The patients we interviewed were aware that close, dynamic relationships existed

between results of their lab tests and other procedures and the prescribing of medication, but had trouble keeping track of the specifics of these relationships.

Finally, medications given in the hospital often relate to medications that patients are taking at home—but the relationships might not be clear to patients. Similarly, patients are unsure whether medications they receive in the hospital are “short term” or “long term”—whether or not an inpatient medication or a similar medication will likely be added to the regimen they manage at home. As P9 stated, “I want to know how long term the problem that the medication is treating will be expected to last—if the medication is a long term thing. And how it relates to the eight to nine medications I was taking before surgery.”

4.1.2 Medication Changes as Signals of Progress—Interestingly, patients inferred changes in dose, type, and names of medications administered as signals of how their health and care were progressing. Three patients volunteered that seeing a record of changes in their medication might help them to “feel better about how they've progressed”. P7 commented that “what I'd like to see is that as you go along, the medicine decreases. Makes it easier for me to do things. Get used to the side effects.”

In this case, P7 was experiencing uncomfortable side effects of a medication that he would receive only in the hospital. Since the medication would be administered only in the hospital, this patient was less concerned with medication alternatives and the discomfort of side effects and more concerned with understanding the relationship between his therapy and his progress toward hospital discharge.

Patients also suggested several benefits to including images of medication (pills, liquid, IV bags) with names in a record of their inpatient medication: to help them to remember their medications, to help them understand changes in their medication regimen, and to assist in identifying medications when vision is compromised. While the use of images to help patients identify medications has been studied [6], the use of images in the inpatient setting has the added benefit of assisting patients in understanding frequent changes to their inpatient medications.

4.1.3 Decision-Making and Education Timeframe—While all patients we interviewed indicated that they received adequate medication explanations from the care staff, most also indicated a desire to read educational information about their inpatient medications while in the hospital. Nine of the 11 patients indicated that they wanted educational content corresponding to each of their inpatient medications to be available. One of the two who did not want such content for himself suggested that making it available in the hospital room would be useful to family members—mentioning that his wife had brought printouts of educational materials, found on the internet, to the hospital when she visited.

Two of the patients we spoke with mentioned the importance of access to educational summaries to assist in making medication decisions. One described wanting information about pain medications before requesting that his current medication be changed. When asked about length of educational content, patients indicated a preference for brief

descriptions of the medications they were taking. They did not feel capable of searching through webpage results or long articles, as they might normally when managing their health information outside of the hospital. One patient commented that a summary be only a paragraph in length, the other preferred two paragraphs.

4.1.4 Agreement on Medication Information Types—Patients agreed on detailed information types that they valued regarding their inpatient medications. Each of the 11 patients interviewed volunteered that the name, type of medication, and uses or purpose (in terms of what problem the medication solved, or the specific benefit it provided) was important to them. Several of the patients interviewed also mentioned that frequency and dosing of information were important to them. In some cases, having access to this information at the bedside might help patients to tolerate discomfort. P11 stated that "[he and his wife] ask what it's for, how often to expect it, and how it will be used, especially pain medication—I'm interested in when the next dose will be."

4.1.5 Formatting of Side Effect Information—We were surprised to find disagreement among patients about the importance of side effects as an information type to include in a description of inpatient medications. Five of the 11 patients we interviewed did not find the inclusion of side effects to be an important information type when asked about it specifically. For example, when asked about whether having access to information about side effects of medication was important to him, P8 stated, "The risks pertain more to what happens if you *don't* take them. I care about how it will make me feel physically—if it's going to hurt in any way, but not about a list of side effects."

Another patient, P5 commented on the importance of organizing side-effect information by severity of risk. He mentioned that, "I want to know side effects, beforehand. *But* I don't want to see a long list of possible side effects. I'd like them to be separated by risk. I don't care if I have a mild headache. But I want to see that something may be hard on my kidneys or liver." Similarly, P11 mentioned that, "I want to know the types of medications I am getting, what names, and if they are 'life changing'."

4.2 Nurse Interview Responses

Nurses we interviewed commented on a number of patient information needs they experienced through questions they were asked of patients. Below we summarize key themes in their interview responses.

4.2.1 Useful Information Types—We found that nurses agreed with patients on information that they believe patients value. Nurses mentioned that medication name, type and purpose/benefit of the medication were information types that most, if not all, patients would find most valuable for inclusion in a list of inpatient medications.

4.2.2 Criticality of Medication—Nurses mentioned questions from patients that explored the necessity and criticality of medications, especially when the number of medications increases or the side effects of medications are difficult to tolerate. For example, N2 described that stool softeners could be reduced for patients who had success with bowel movements, and that patients often questioned the necessity of this medication. Currently, a

patient's exploration of which medications are critical for their care occurs through questions between patients, nurses, physician assistants, and physicians, which can be a lengthy process.

4.2.3 Alternative Medications and Methods—Nurses commented that patients were often interested in understanding when an alternative medication could be used. Similarly, patients might ask if a liquid form of a medication is available rather than a powder form. Often, patients explore options for alternatives to specific medications and methods of administration through verbal consultation with nurses.

4.2.4 Care-Team Awareness of Drug Administration—Nurses reported that patients asked questions about care providers' knowledge of their medication orders. In some cases, patients did not realize that their attending physician ordered a change in their medications. Patients also expressed the desire to share medication administration details with extended members of their care team. For example, patients may not realize that the cardiologist they see at home was consulted and briefed on their medication list.

4.2.5 Value of Supplementing Verbal Information—Nurses also suggested that verbal briefings by the care staff, delivered without any additional information sources, might make it difficult for patients to keep track of changes in inpatient medication.

5. DISCUSSION AND CONCLUSIONS

Through our interviews, we uncovered several important design insights that can inform the creation of medication information applications intended for inpatient use. In particular, we found that patients and nurses agreed on the value of interactive, patient-facing, inpatient medication information views, available at the bedside. They also agreed on much of the specific medication information that patients value, such as dosage, frequency, and timing of medication administration events. Both patients and nurses also mentioned information needs related to patients' understanding of the criticality of each medication. Nurses discussed common requests by patients to explore possible alternative medications and forms of administration, and to maintain awareness of care provider knowledge of medication orders.

In structuring detailed medication administration information for an electronic view, patients indicated that educational information summaries should be provided to complement this information. Information corresponding to that which patients value most, such as indication(s) (use or uses of the drug) and high-risk side effects, should be given precedence, while other information should be made available through a minimal number of interactions.

In our interviews, many patients commented on a desire for technology to support their understanding of changes in medication therapy throughout their hospital stay. They valued the ability to note the medications that had been discontinued or completed as a way to maintain a sense of health status and care progress, and they desired the ability to see relationships between medication changes and progress toward hospital discharge, as well as relationships between medication changes and other clinical data, such as lab and procedure

results. These findings point toward novel opportunitites to support views of changes in inpatient medication over time, and relationships between medication orders and other data types. Further research is needed to understand how to present these relationships without introducing complexity that diminishes the value of such information.

While our findings lead to important initial insights, our study is limited by both the size of the respondent pool and a focus on the cardiology setting. Further research is needed to examine the generalizability of our findings to other care contexts. Our future work will explore additional hospital environments, study the impact of patient-facing technology on clinician workflow, validate design guidelines formulated based on our interviews, and explore considerations for the design of automated approaches to presenting medication information from the EHR to patients.

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