

PATIENT-CLINICIAN COMMUNICATION: A DESIGN INTERVENTION FOR PATIENTS' COMPREHENSION OF THEIR CARE

By: Ji Youn Shin

M.Des. Industrial Design, Ewha Womans University, Seoul, 2013

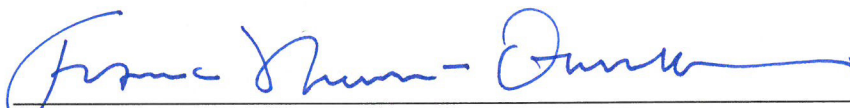
B.F.A. Environmental Design, Ewha Womans University, Seoul, 2011

Thesis Submitted in Partial Fulfillment of the Requirements of the Degree of Master of Design in Integrative Design

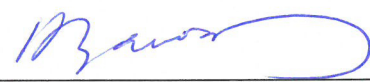
Penny W. Stamps School of Art and Design
University of Michigan
Ann Arbor, Michigan

April 25, 2017

Approved by:



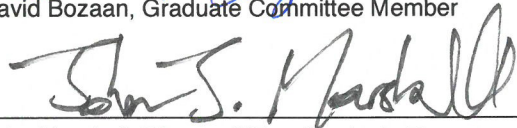
Franc Nunoo-Quarcoo, Graduate Committee Chair



Sunyoung Park, Graduate Committee Member



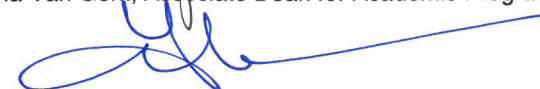
David Bozaan, Graduate Committee Member



John Marshall, Director MDes Graduate Program



Elona Van Gent, Associate Dean for Academic Programs



Gunalan Nadarajan, Dean, Stamps School of Art and Design

Date Degree Conferred: April 27, 2017



UNIVERSITY OF MICHIGAN



21ST CENTURY HEALTHCARE

Patient-Clinician Communication: A Design Intervention for Patients' Comprehension of Their Care

Ji Youn Shin, MDes '17

Ji Youn Shin

Candidate, Master of Design in Integrative Design
University of Michigan
Spring 2017



UNIVERSITY OF MICHIGAN

21ST CENTURY HEALTHCARE

PATIENT-CLINICIAN COMMUNICATION: A DESIGN INTERVENTION FOR PATIENTS' COMPREHENSION OF THEIR CARE

Ji Youn Shin

Candidate, MDes
University of Michigan
Spring 2017

Acknowledgements

First and foremost I would like to thank my thesis committee, especially my advisors Franc Nunoo-Quarcoo and John Marshall for helping me and guiding me throughout my graduate studies. Without you both, I may not have made it to the end. I will always remember what I learned from you throughout my life as a researcher.

I would also like to thank all of patients, caregivers, and clinicians who shared invaluable insights and experiences on my study. A huge thank you to Dr. David Bozaan for your generous help and importantly time to share your medical culture. Your guidance allowed me to have numerous conversations with all the patients and clinicians in Michigan Medicine, and made this thesis project happen.

I would like to say thank you to the first MDes cohort for listening and offering me advice through these last two years. Each of you gave me wonderful support in different ways. It was not easy, but not a lonely journey either because of our strong teamwork. I will miss our chats in the studio.

Finally, I want to thank to my parents, in-laws, and sister for all their support from the other side of the world. I am very lucky to have parents who understand and give me unlimited support in following my dreams. Thank you to my husband, Dukhan for believing in me even when I was irritable

and depressed. These last two years would not have been possible without your continued patience and endless support.

I dedicate this thesis to my beloved daughter, Yena Kim, who started her life as I started my graduate studies. We made it happen together.

Contents

Abstract

Keywords

Introduction	10
Design Process and Approach	17
Preliminary Work	21
Literature Review	27
Problem Statement	34
Fieldwork	36
Insight Generation	58
Problem Redefinition	66
Design Development	68
Design Prototype	77
Discussion and Future Work	92
Conclusion	98
Works Cited	102

Abstract

While patients rely on in-person interaction with their clinicians to know more about their care, frequent in-person interactions with clinicians are rarely available to patients due to time constraints. Limited in-person interactions can result in passivity and frustration for patients and can negatively impact the quality of patient satisfaction.

During my ethnographic fieldwork, I identified major issues that caused patients to remain passive communicators and prioritized patients' needs in inpatient settings. Through an iterative design process, including multiple conversations with patients and clinicians, I developed a tablet-based platform for patients. This platform aims to maximize limited time by fostering valuable communication between clinicians and patients. Also, by rebalancing the current asymmetrical status of communication, this platform leads to greater active engagement and transparent information exchange during patients' hospitalization. I concluded the study with feedback from pilot tests of the design prototype. The pilot test suggests that having a tablet-based platform could provide patients with better hospital experiences.

Keywords

patient-centered care, patient-provider communication, user-centered design, patient participation, inpatients





Introduction & Background

Active engagement by patients in a hospital setting has been shown to have an impact on both health outcomes and patient satisfaction (Hutchins 1995; Prey et al. 2014; Stewart 1995). However, currently, there is an informational and temporal asymmetry in the communication between clinicians and patients (Stewart 1995, 1424). Informationally, patients have limited access to information sources while clinicians have access to vast amounts of information using

multiple communication artifacts. Temporally, patients have adequate time to communicate with clinicians, but clinicians have limited time to manage a broad range of tasks related to patient care, including the time needed to tend to their patients. During their hospital stays, patients are often considered passive recipients of treatment, rather than active communicators who have a voice in making decisions about their treatment. Patients have limited accessibility to their medical information and knowledge as well as a limited amount of time (Longtin et al. 2010, 54). Active patient engagement produces many opportunities to improve patient satisfaction with their healthcare experiences (Baker 2001) and contributes to higher responses on the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, a patient satisfaction survey. HCAHPS was developed by the Agency for Healthcare Research and Quality (AHRQ) and the Centers for Medicare & Medicaid Services, and was initiated in October 2006. It measures patients' satisfaction using 27 questions. Results of the HCAHPS survey are shared online and impact the government's reimbursement and additional incentives for improvement (Giordano et al. 2010, 35).

In addition, even though patients are in a vulnerable situation regarding their state of mind and physical condition, they are still expected to understand, remember, and report their symptoms appropriately when they interact with clinicians (Kendall et al. 2015, 1957). To support patients' improved understanding of their hospital stay, many educational materials about medication, treatment processes, and discharge summaries have been designed. Unfortunately, since information packets are rarely tailored to each patient (Di Marco et al. 2006, 195), and traditional information materials, such as printed materials make dynamic delivery difficult, existing information packets are not frequently used (Pratt et al. 2006, 54). Although patients may have access to various information materials, it is difficult to prioritize their needs. Ironically, information resources designed to aid patients' hospital stays often overwhelm them, and thereby encourage patients

to be passive communicators.

By definition, clinicians are required to verbally communicate complex medical information such as patients' symptoms, treatment plans, and medication protocols in a limited amount of time. Since there is no systematic way of sharing information across the hospital (Di Marco et al. 2006, 195), and hospitalized patients cannot easily leave their rooms, patients expect to have an in-person conversation with clinicians to answer their questions. Without the clinician's verbal explanation, patients often remain uninformed about their care team, treatment procedure, and laboratory results conducted during their stay in the hospital. Unfortunately, due to the pressure of time constraints, such in-person interactions are not always available for patients.

There is also the issue of the patients perceiving a lack of care because the majority of clinicians' efforts are invisible from the patients' perspective (Wilcox et al. 2011, 29). To interact with each patient during their rounds, clinicians have to put lots of time and energy into reviewing patients' medical records through an Electronic Medical Record (EMR) system and work collaboratively with other clinicians across the hospital to make medical decisions (Anderson and Funnell 2005, 153). However, most of the clinician's work is poorly understood by and less visible to their patients. In other words, from the patients' perspective, a large part of clinicians' work is considered background work where the clinicians themselves are quite visible, but the work they carry out is invisible or hidden by complex situations (Star and Strauss 1999, 15). In the hospital, clinicians' work is protected because patients don't have access to their medical information. This invisibility causes patients both stress and anxiety, and eventually reflects in poor patient satisfaction (Park, Chen, and Raj 2017, 2183).

To rebalance the active nature of clinicians' work and the passiveness of the patients' situation, much work has been done in Human-Computer Interaction (HCI), Health Informatics, and also in the medical

context. Prior research has shown that technology can help patients' education and understanding about their treatment and health status while staying in the hospital (Bickmore, Pfeifer, and Jack 2009). Also, there is an important set of medical informatics studies that pursue effective communication of patients' care information including efforts to enhance EMR systems (Ash, Berg, and Coiera 2004; Hersh 1995). Other studies have also been focused on the patients' limited medical knowledge or the clinician's verbal and nonverbal interpersonal communication skills during their interaction (McCarthy et al. 2013; Patel et al. 2013; Schillinger et al. 2003). However, most of the existing EMR systems are designed for clinicians and healthcare administrators, rather than for patients. Little has been done to explore patients' needs relevant to their treatment process and situation in inpatient settings. Also, current interventions are lacking in a patient-friendly and interactive way of presenting critical information. Therefore, a more patient-centered perspective is needed to investigate the current problems that may cause a significant imbalance between clinicians and patients, and improve both patients' understanding of their process of care delivery and the clinician's work.

To identify the major issues that cause patients to remain passive communicators, I conducted ethnographic field observations and interviews. The identified issues are: (1) Repetition of information, (2) Invisibility of clinicians' work, (3) Limited access to information artifacts, and (4) Patients desire human interaction. Through storyboards and multiple conversations with patients, clinicians, and peer designers, I presented a tablet-based platform for maximizing use of the limited resource of time by improving valuable communication between clinicians and patients. This support tool could rebalance the current asymmetrical status of communication and also lead to greater active engagement and clearer information exchanges during patients' hospitalization. I concluded the study with feedback based on pilot tests of the design prototype and discussion of further design opportunities.

Aims of the Project

The goal of this thesis project is to help patients have better hospitalization experiences by allowing them better comprehension of information related to their hospital stay. To achieve that purpose, I aimed to clarify information relevant to patients' hospital stay, such as identities of their care team members, a summary of the day's activities, and a way to report more accurate needs within the care context by designing a platform that can be given to patients during their hospitalization. The successful completion of this project identified:

- The essential needs of patients to address barriers in the current patient-clinician communication practices.
- The types of relevant information that could be provided during the patients' hospital stay and how this information influences patient satisfaction.
- Clinicians' attitudes on sharing information with patients during their hospitalization and the types of information that could be directly shared with patients.

Based on the insights gained through ethnographic field observations and interviews, I developed and prototyped a tablet-based platform that seeks to rebalance the asymmetry in patient-clinician communication. The goal of this was to allow patients to prepare conversations with their clinicians to more efficiently use in-person time with clinicians and reduce repetition. I discovered that a tablet-based platform was the most appropriate method because it allows patients to share information with their caregiver or medical assistant if they need any help. It also allows patients to adjust text sizes as

they need. Enhanced patient satisfaction would be an end-goal of the project.

Important Terminology

- **Patient-Centered Care**

“Patient-centered care is a philosophy of care delivery in which services are arranged around the needs of the patient.” (Ozkaynak et al. 2013, 1)

- **Patient Satisfaction**

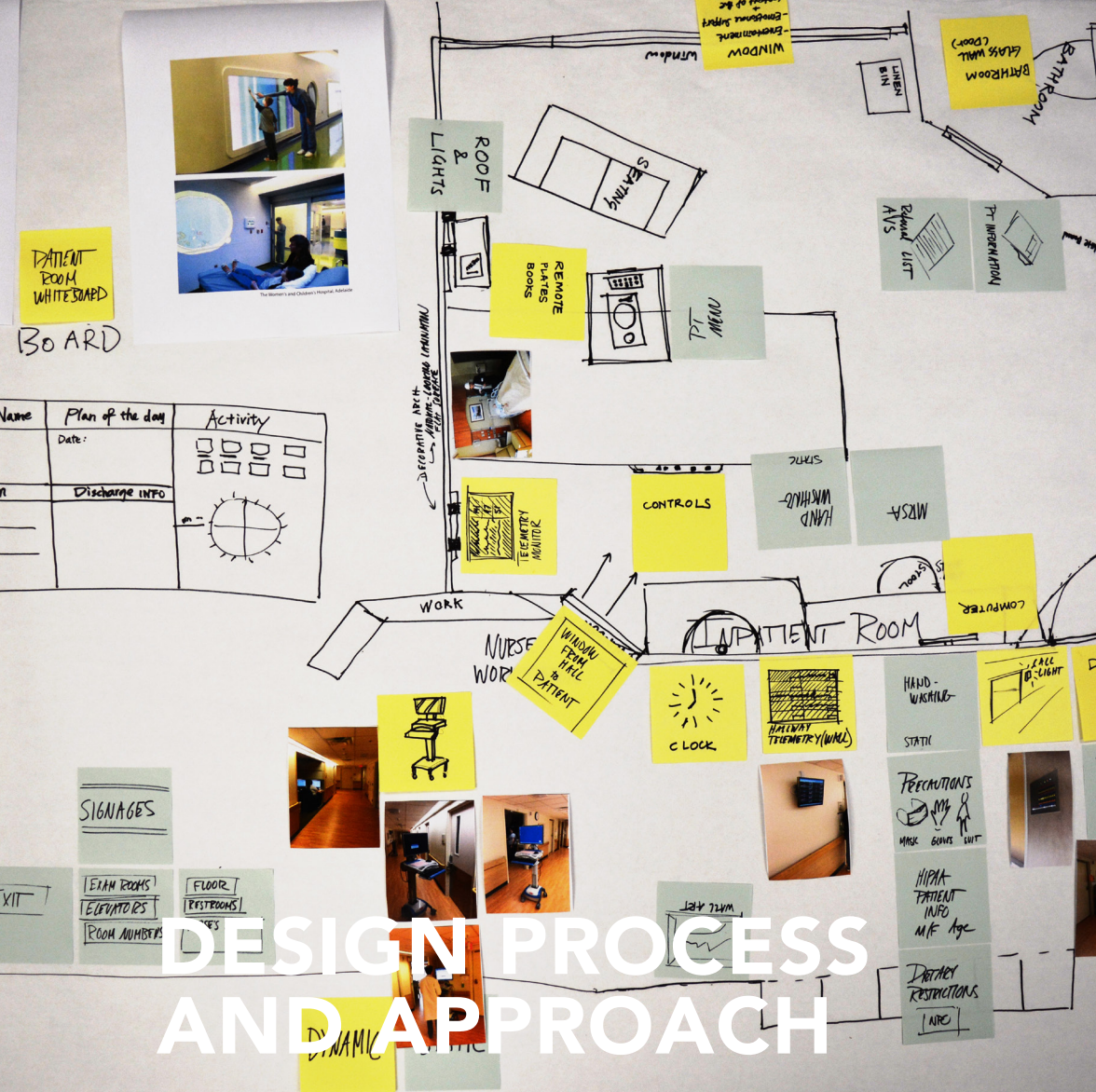
“Patient satisfaction is an important and commonly used indicator for measuring the quality in healthcare. Patient satisfaction is thus a proxy but a very effective indicator to measure the success of doctors and hospitals.” (Prakash 2010, 151)

- **Communication Artifacts in Healthcare**

Communication artifacts are the tools that are used to collect and communicate patients’ health information, such as pagers, phones, and medical charts.

- **Electronic Medical Record (EMR)**

Electronic medical record (EMR) is a digital form of a paper chart which includes all medical history from health institutions for a given patient. EMR is mostly generated and exchanged by medical providers for diagnosis and treatment.



Discover, Define, Develop & Deliver

I referred to a design process model called the Double Diamond diagram which was created by the UK Design Council. The Design Council conducted an in-depth study of the design processes used in eleven major design companies and investigated how they addressed complex design problems (Council 2007). Following the Double Diamond diagram, I built my design process into four distinct phases: Discover, Define, Develop and Deliver. These four phases show repeated

divergent and convergent stages of the design process. Each phase led to the next one, influenced each other, and changed based on the outcomes of the other phases. All phases collectively developed the final design prototype. Since I went through several iteration processes during my study, the Double Diamond diagram provided an appropriate process to develop my design prototype. Before discussing the specifics of the project, I will present an overview of the four phases I followed. Details of each phase will be described in each section.

Discover

I started this project by discovering the problem. I broadened my perspective to seek a wide range of problems around the research topic: patient-clinician communication. I also looked at the factors that influence the problems by doing a literature review and ethnographic fieldwork. Specifically, I adopted service design methods, such as ethnographic observations and qualitative interviews. These methods allowed me to expand my views by listening to multiple voices within the healthcare system and discovering many gaps in its current state.

Define

In the Define phase, I mapped out all the findings and insights gathered during the Discover phase and sorted by theme. This phase aimed to see problems in context, find design opportunities, generate problem statements, and build a concrete plan to develop design ideas in the remaining phases. I used an affinity diagram and storytelling to come up with a clear definition of the problem.

Develop

The next phase was to Develop design concepts and examine the

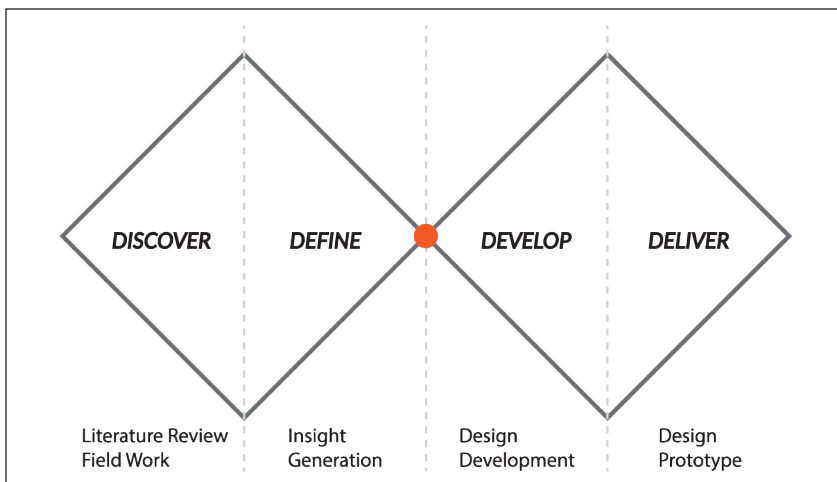


Figure 1. Design process and approach

possible design directions that could address my problem statement. In this phase, I developed low-fidelity (lo-fi) prototypes, considered usability, and received user insights on design contents. Gathering the user insights lead to me refining the existing ideas by accommodating both the status of the current healthcare system and users' points of view.

Deliver

The last phase was to create a prototype of the tablet-based platform based on concepts I developed. This included a lo-fi prototype that went through multiple iterations before creating an early-stage digital prototype. It aimed to address the problems identified during the previous phases. This phase also included the first user pilot test, which provided insights for further development of this study in the future. I concluded this phase by creating a user scenario and gathering feedback from patients and clinicians.

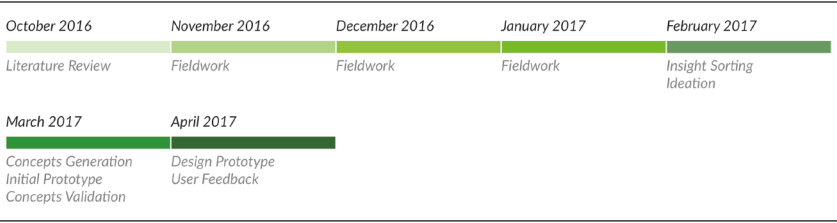


Figure 2. The timeline of the study

Timeline of the Study

This thesis project lasted seven months. It began in October 2016 and was completed in April 2017.



My graduate study has been a two-year-long journey. Although this particular project has taken seven months to be completed, it built upon three main projects that were completed in the previous academic year, and the projects share three main facets.

First, the projects focused on the U.S. healthcare context both in outpatient and inpatient settings. Second, although one project followed the traditional qualitative method and the others followed mixed methods, all projects adopted ethnographic methods as the

primary data collection method. Third, the projects shared patient-centered care as their core value and goal. All the outcomes from the project aimed to achieve greater patient satisfaction in the healthcare system by creating higher quality communication between patients and clinicians.

These three projects have strongly influenced my graduation work:

Eye Guide (November 2015 – April 2016)

Eye Guide is an accessible computer-based behavior change and education platform that provides medical assistants in the Department of Ophthalmology at University of Michigan Kellogg Eye Center with brief training to support glaucoma patients. The aim of the platform is to improve glaucoma patients' self-management and medication adherence by motivating them with carefully designed content, created to draw more information from each patient. Using the platform, trained medical assistants deliver individualized information and coach each patient on glaucoma self-management.

One of the main features of design intervention is to analyze each patient's personalized barriers, understand their daily routines, and provide an action plan. The Eye Guide project was initiated by conducting observations of patients and clinicians at the outpatient glaucoma clinics. The University of Michigan Penny W. Stamps School of Art & Design Masters of Design (MDes) in Integrative Design graduate students observed the communication practices and activities between patients and clinicians in the clinic visits from patients' arrival to check out. The observations allowed us to understand how the sharing and the exchanging of information happens in clinical situations. MDes students focused on the patients' perspective regarding information received, educational messages, reactions towards the information, and the questions they most frequently asked clinicians.



Figure 3. A participatory design session with Patient Advisory Board

Also, we held participatory design sessions called Patient Advisory Boards where we selected a few of our physician collaborator's patients. The aim of a Patient Advisory Board was for us to gain patients' unique and invaluable perspective about how to improve patients' clinical experiences, including medication management. During the session, we listened to the patients' thoughts on self-management, existing habits, barriers related to medications, and received feedback. The sessions led us to modify and refine the design solution. My role within the team of six designers on this project was to conduct field observations at the glaucoma clinic in the Kellogg Eye Center along with ideation and visualization of ideas.

The project allowed me to consider the possibilities and impact of high-quality communication between patients and clinicians. Since we re-designed contents of the Eye Guide platform and suggested a new structure for enhanced usability, I saw firsthand the importance of motivating patients with more calibrated conversations and visual components.

Supporting Pediatric Patients as Active Communicators (January 2016 – April 2017)

Children who have experienced Bone Marrow Transplant (BMT) went through an extensive treatment procedure from their initial diagnosis of the disease. This experience creates a different lifestyle for them than those of their healthy peers. This experience also creates a different relationship with their caregivers who are often their mothers. However, the current situation at BMT outpatient clinics doesn't adequately involve pediatric patients in the communication with clinicians. Caregivers usually represent patients and dominate the conversation. As a result, this communication asymmetry leads pediatric patients to passivity and causes emotional barriers.

To alleviate the current problem, I investigated pediatric patients' communication barriers during their BMT clinic visit as well as their challenges over the course of their illness. By conducting ethnographic field observations, I aimed to provide design interventions for pediatric patients to have the motivation to talk to their physician and take ownership over managing their health.

I have not yet reached a conclusion, but I have gained valuable insights from field observations, such as patients' coping strategies using toys, caregivers' strategies to encourage their child to talk, and physicians' methods for engaging patients in conversation. The research project is still ongoing with plans for further observations and interviews with caregivers and patients.

This project led me to see positive aspects of ethnographic study methods, such as capturing details of patients' behaviors and emotional reasons for the behavior that are hard to be captured through quantitative research methods.



Figure 4. A group discussion during I-MPACT kick-off

I-MPACT Collaborative Quality Initiative Kick-off (January 2016 – April 2016)

The University of Michigan Penny W. Stamps School of Art & Design Masters of Design (MDes) in Integrative Design graduate students worked with the Integrated Michigan Patient-centered Alliance on Care Transitions (I-MPACT) team. We collaborated with I-MPACT team to create knowledge and metrics about the transition after discharge from the hospital. The project aims to develop new approaches to gathering evidence for user-centered care transitions from hospital to home from the patient-caregiver perspective.

As an outcome of the project, we designed kick-off activities and ran a participatory design event. For example, we designed a board game which simulated the current healthcare system to share our findings from the ethnographic observations instead of reporting our data numerically in a chart. There were approximately 60 participants engaged in the participatory design workshop, including healthcare

professionals, patients, and designers. The intended primary impact of the event was to uncover barriers and issues relating to care transitions in the healthcare system. We ran a panel discussion with patients to set the tone for the day, facilitated problem generation and targeting of potential intervention sessions, and wrapped up with a feedback session across the clusters.

During this project, I gained an understanding of general healthcare system concepts from the pilot observations and the kick-off event. Also, conversations with patients and clinicians led me to frame each person's role in the healthcare system and contributed to the clear understating of the structure of patient-clinician communication.



LITERATURE REVIEW

The literature review focused on three main themes: a theory of visible and invisible work by Anselm Strauss, patient engagement in the patient room, and potential impacts of sharing information between patients and clinicians. As technology has developed, a substantial amount of work has been done in many areas to support patient engagement over the course of their illness. Since design research has a relatively short history, I mainly refer to literature and existing work from Human-Computer Interaction (HCI), health informatics, and health communication because research themes relevant to

my research are well-explored in these fields. Reviewing the existing studies allowed me to find existing gaps and seek opportunities for designers.

To understand the nature of work in the healthcare system and frame what I observed during my fieldwork, I drew upon the theory of visible and invisible work by Anselm Strauss. I then reviewed existing literature that addresses current interventions designed to aid patients' better understanding of their care procedures and medical information. I also examined the study that addresses multiple aspects of sharing medical information in hospitals from both patients' and clinicians' points of view.

Invisible Work

In this study, I referred to the general theoretical framework of Anselm Strauss to understand the concept of information work in a large system. Strauss contributed to many frameworks in the areas of interaction design and Human-Computer Interaction (HCI), the best known of which is articulation and coordination of work (Kaziunas et al. 2015, 1764). He and other researchers suggest the theory of visible and invisible work, to analyze work in Computer Supported Cooperative Work (CSCW) systems.

According to Strauss' theory, no work is inherently either visible or invisible, and people can always recognize work through indicators, such as artifacts, workers, and changed states (Star and Strauss 1999). Strauss introduced the term *disembedding background work* using an example of nurse's work: In the healthcare system, patients can see their nurses, but it is difficult to see the work they perform. In this case, patients could assume that their nurse does work for them, but can't exactly see or know what nurse does for them. Similarly, other clinicians provide care to patients, but patients may not notice clinicians' invisible work, such as the vast amount of medical

information that is generated, stored, and shared during their hospital stay by clinicians. Although this work is crucial during patients' hospital stays, clinicians' efforts, including making medical decisions, a vast amount of paperwork, and conducting medical activities are rarely visible from patients' perspective.

Nardi and Engestrom (1999) extended Strauss' concept. They argued that understanding the nature and structure of invisible work is important when designers create new institutions or structures, including healthcare services. Due to this invisibility, values, benefits, and achievements of invisible work are difficult to recognize. Consequently, when people redesign organizational systems, invisible work is often not considered and easily ignored. In other words, people often think that invisible work is simply replaced by computer systems or technologies and fail to count work when they design a new system or build a new environment. Failure of understanding the value of invisible work can lead to greater loss and dissatisfaction for people.

I included the concept of invisible work in this research to define and explore the contributory factors that lead patients to be passive actors in complex inpatient situations.

Patient Engagement in the Patient Room

The needs and benefits of sharing information with patients in the care process have been well-studied. Although patients' demographic backgrounds shape their different healthcare experiences, Fowles and colleagues (2004) found that many patients are interested in viewing the information about their care, regardless of economic status and the levels of education. Simply improving information about care delivery in the healthcare environment has a positive impact on patients' experience (Kendall et al. 2015, 1957). Also, Skeels and colleagues (2010) discovered that patients wanted an enhanced way of communicating with their care team to better understand their

treatment regimen.

Currently, the most frequently and widely used information delivery material in the patient's room is a whiteboard (Sehgal et al. 2010, 234). Using a whiteboard, care providers update information, such as the name of clinicians, caregivers' information, daily goals, and additional notifications. However, since there is no standardized way to write information among the clinicians, and keeping the information up-to-date is challenging, a whiteboard does not function as an efficient informational source for patients. Also, many inpatient units have information packets, such as information leaflets, brochures, and television channels to help the settlement of newly admitted patients. Those materials contain a vast amount of information and are rarely tailored to each patient. The need for patients to comprehend what to look for often overwhelms and interferes with an effective self-management of their health information (Pratt et al. 2006, 156).

Researchers have paid attention to the value of providing personalized information for each patient given the inefficiencies of existing materials. Prior studies offer a limited view of patient-clinician communication, as they mainly focus on educating patients about medical-related knowledge and treatment instruction (Coulter and Ellins 2007; Fowles et al. 2004). However, some studies investigate the patients' needs for understanding the care delivery procedure. For example, Wilcox and colleagues (2010) proposed a patient-facing, electronic display that allows the patient to refer to their care procedure from their room. The researchers investigated how a patient-centered information display can deliver useful information to a patient during an emergency department (ED) visit and received positive feedback from both patients and providers. The researchers further explored the positive aspects of providing enhanced information to patients from medical records and information related to many of the clinicians' invisible work from the patients' perspective (Wilcox et al. 2011). In a pilot study by Weiland and colleagues (2009), the



Figure 5. Virtual Nurse, Boston, Massachusetts

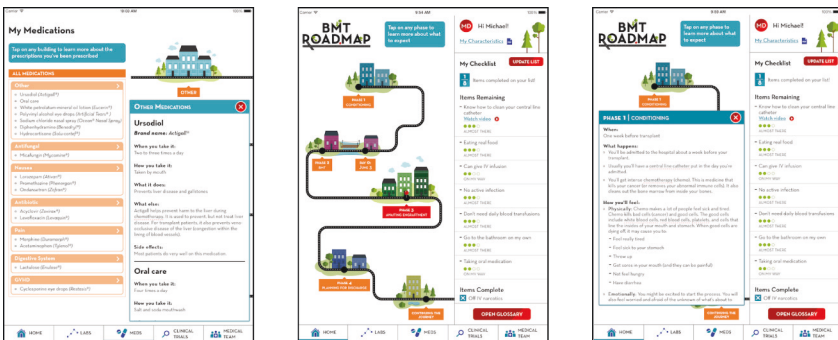


Figure 6. BMT Roadmap, Ann Arbor, Michigan

researchers developed a personalized patient's schedule to provide a care plan and incorporate appropriate treatments with patients' opinions. Other researchers describe an animated, empathic virtual nurse interface used to provide medical information and feedback to patients. Patients showed positive reactions to the information provided by the virtual nurse and felt it provided additional useful medical information for their hospital stay. In the context of pediatric BMT, researchers developed a health information technology (HIT) tool, the BMT Roadmap. The tool is used by inpatients at a BMT care facility, and allows both patients and caregivers to access information related to their treatment process. The study has been continuously conducted to examine its usability and received positive feedback from users (Maher et al. 2016).

As existing interventions mainly focus on educating patients in medical knowledge and providing information rather than providing opportunities for patients to create and organize their information, potential remains for developing ideas to support patients' active participation in their hospital stay.

Potential Impact of Sharing Information

Information technology may make it easier for patients to refer to their medical records. Many studies show that having enhanced information available to patients about their own care improves patient experience (Runaas et al. 2017; Wilcox et al. 2010). However, little research has yet been conducted on the types and levels of information that could be shared, and how it affects both patients and clinicians.

People can become overwhelmed by available information because of its terminology, situational complexity, and the amount (Hutchins 1995; Pratt et al. 2006). In other words, not having information causes stress and anxiety, but having too much information also negatively affects people. When information is exchanged in a particular context, such as healthcare, the types and the amount of information exchanged between people should be considered when designing effective communication. Charles and colleagues (1999) investigated the types of information that physicians might communicate to patients, including natural history of the disease, the benefits and potential side effects of various treatment options, a description of the treatment procedures, and accessible resources. This not only benefits patients but also can aid clinicians because the delivery of care information to patients represents a fundamental change to the traditional workflow particularly for time management (Wilcox et al. 2010, 891). On the clinicians' side, such sharing of information possibly generates frequent opportunities to receive more questions from patients or family caregivers. Since clinicians perceive the lack of time as a challenge

that limits patient input in their care (Anderson and Funnell 2005, 155; Longtin et al. 2010, 56), physician perspectives on medical information sharing should be a critical concern. Wilcox and colleagues (2010) investigated the physicians' attitudes on sharing clinical data with patients during care in urgent care settings, and found physicians felt favorably toward information sharing about medications and the care team. However, they found concerns related to the sharing of diagnostic data types, such as lab results that require accurate interpretation of these data types. Delivering tailored care information to patients is difficult to do well with a lot of non-visual communication tools, such as text, because there are many variations and levels in the treatment procedures, and patients have varying levels of literacy and knowledge (Di Marco et al. 2006, 195). Therefore, there is a large research gap in this context regarding determining appropriate amounts of information and methods of sharing this information with patients under limited time constraints.

By creating a communication platform that helps improve patients' hospital stays by providing clear information, patients will feel more in control of their hospital stay, instead of being forced to be passive communicators. This will reduce patients' stress and anxiety that come from the situational ambiguity they face, leading them to have better healthcare experiences.



PROBLEM STATEMENT

Preliminary research and the literature review led me to generate an initial problem statement:

- How might we help patients have better hospitalization experiences by allowing them to have greater access to relevant information related to their hospital stay and better comprehension of their treatment procedure?

Information Area B





Study Context

I initiated an ethnographic field study in the Internal Medicine Department at Michigan Medicine and St. Joseph Mercy Ann Arbor hospital. I then chose Michigan Medicine as the site of this project for three main reasons. First, because of the wide reach of the hospital, patients' illnesses show various levels of complexity and required lengths of stay. Second, within Michigan Medicine, I focused on



the Internal Medicine Department, which provides care to patients experiencing multiple chronic illnesses and hospitalizations across their adult life span. This allowed me to see problems that were common across illness and patient treatment histories. Third, Michigan Medicine is one of the largest academic medical centers in the United States, and its staff is already accustomed to research projects. A large number of clinicians recognize the necessity of improving patients' comprehension of their treatment procedure and facilitating

information exchange with patients. These three factors provided rich data for ethnographic observations and interviews.

In framing my ethnographic study, I also accounted for differing levels of patients' familiarity with scientific terminology. Patients came from a wide range of socio-economic backgrounds and family structures. Age and educational backgrounds were also varied, with some patients reported no higher education while others are reported several advanced degrees. Because different demographic data produce different patient experiences, I have limited the scope of this project to focus on common issues for patients across various demographics.

Data Collection

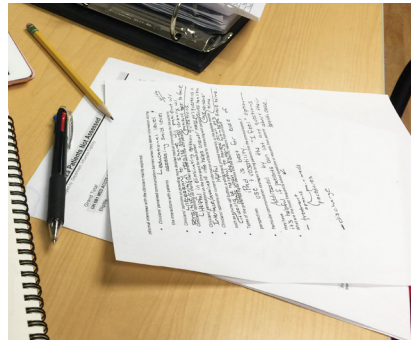
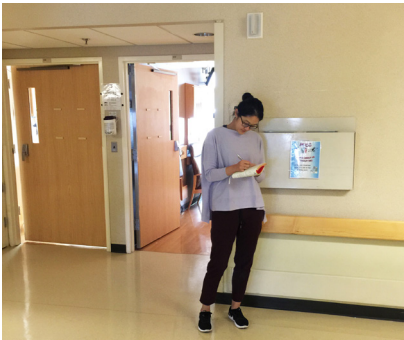
Data was generated mainly through 60 hours of observation in inpatient settings, including observing clinicians during their daily morning rounds, patients' days in their hospital room, and clinicians' daily workflow. During the observations, I also conducted informal interviews with both patients and clinicians whenever the situation allowed. Finally, I conducted seven in-depth interviews with members of the Patient Advisory Board who had multiple experiences of being either a caregiver or patient.

Observation

Observations were conducted from October 2016 to January 2017. Each observation session lasted approximately three to five hours. I observed physicians' and nurses' daily routine to understand the nature of their work. I also stayed with the patients in their hospital room to observe their interactions with caregivers and clinicians. The observations allowed me to gain a basic understanding of an inpatient setting as a non-healthcare professional, and as a designer.



Figure 7. Shadowing a physician in his daily work at Michigan Medicine



Figures 8-9. Taking notes during observations

Once I understood each stakeholder's role, I focused on information exchange between patients and clinicians. I looked for main communication themes that arose during conversations between patients and clinicians, points at which the communication breakdowns occurred, and how communication breakdowns further affected patients' experiences. Also I captured various communication artifacts used to aid information exchange between healthcare providers and patients, such as phones, call buttons, and printed

materials that include medical information or information about the patients' hospital stay. Data was collected through handwritten notes during the fieldwork. I took photographs of the hospital environment, communication artifacts, and each stakeholder's workflow after receiving consent from both clinicians and patients.

Interview

I conducted informal interviews with patients and clinicians in the inpatient settings throughout the observation sessions. Observing patients' behaviors, and conversing with caregivers and clinicians was very helpful in shaping my questions. All patients were in the inpatient settings when the interviews took place. Informal interviews with patients explored the following questions:

- *How do patients record and organize medical information during their hospital stay?*
- *What are the most frequently asked questions from clinicians, and how comfortable do patients feel articulating their physical or mental status, such as their current pain score or feelings?*
- *How well do patients understand their current treatment procedures, their care team members, and their medical information?*
- *Who do patients contact the most frequently during their hospitalization, and why do they contact them? How patients perceive the time spent with physicians or nurses?*
- *How do patients receive information and the knowledge related to their hospital stay when they first hospitalized?*

- *What are patients' opinions on current information artifacts in the patient's room, such as nurse call button, whiteboard, or printed materials? What digital device do patients prefer and why do they prefer them?*
- *What are the positive experiences or aspects of communicating with clinicians especially when patients receive information?*
- *What are the positive experiences with healthcare service that helped alleviate the anxiety or ambiguity of their hospitalizations?*



Figure 11. Observing patients' environment and behavior in inpatient settings



Figure 10. Patient's bedside table which is filled with various items.

I also conducted seven in-depth interviews with Patient Advisory Board members who were recruited by the Integrated Michigan Patient-centered Alliance on Care Transitions (I-MPACT) coordination team. All interviewed members of the Patient Advisory Board had experienced being a patient or a caregiver, and they were willing to share their experiences and insights with the healthcare context to enhance patients' healthcare experiences. Each in-depth interview lasted approximately 45 minutes to an hour. In-depth interviews occurred prior to observation sessions and questions were asked broadly to discover patients' experiences of their hospitalization. In-depth interviews with the Patient Advisory Board members explored the following questions:

- *How did patients feel upon discharge from the hospital?*
- *What self-care did patients expect to have to perform after they discharged?*
- *What would have made leaving the hospital and taking care of themselves easier?*

Informal interviews with clinicians explored the following questions:

- *What do clinicians experience as communication barriers when they deliver information during the interactions with patients?*
- *How do clinicians provide more detailed medical information for their patients?*
- *How do clinicians feel about sharing their general workflow with patients?*
- *How do clinicians perceive the time spent with each patient?*
- *How do clinicians feel about current information artifacts for interacting with patients, such as the nurse call button, whiteboard, printed materials, or the various monitors displaying vitals?*
- *What digital device do clinicians prefer and why do they like it?*
- *What communication strategies do they use to engage patients in the communication?*
- *What types of questions or requests do patients ask or make most frequently?*



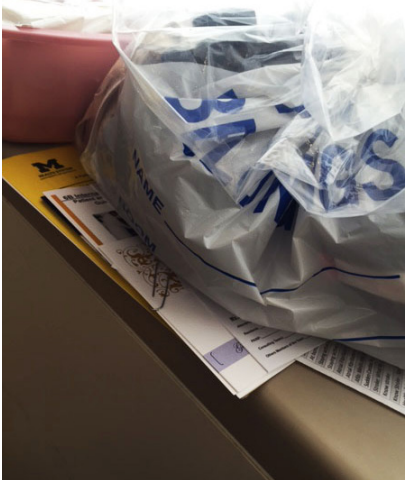
Figure 12. A patient pushing the call button on the bed side remote control

Overall Issues from the Fieldwork

The following is a list of twelve issues I found during my field observations and interviews, which I will later distill into four major problems.

1. Communicating Lab Results

One of the key findings was that many patients asked what the “good numbers” of laboratory results represent. When clinicians reported lab results to the patients verbally, many patients had no idea of how



Figures 13-14. The information packet given out when patients are first admitted to the hospital. This patient placed it far from her bed.

to interpret the numbers. Patients tended to ask follow-up questions when they interacted with clinicians, but five to seven minutes of limited time allotted for each patient made it hard to ask about every detail.

2. Communication Artifacts (Computers vs. Nurse Call Buttons)

Patients pushed the nurse call button whenever they needed help. Patients who stayed with caregivers tended to ask their caregivers to help them, but many patients were alone in their rooms, especially in the early morning. When nurses received call requests from a patient, they would come to the patient's room and check patients' status. Sometimes nurses responded in a minute, but during busy times it took more than a few minutes. On the other hand, clinicians had multiple communication artifacts, including different kinds of phones, pagers, and computers. The artifacts are not for communicating with patients, but for communicating with other clinicians.



Figure 15. Shadowing clinicians in their daily rounds at St. Joseph Mercy Hospital

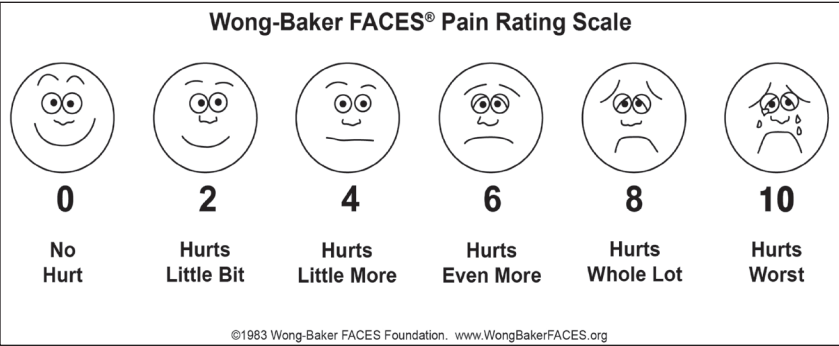


Figure 16. A pain score chart which measuring patients' current degree of pain

3. In-Person Conversations Last Less Than Seven Minutes

The most dominant way for patients to receive information is verbally with clinicians during in-person conversations. Patients met different clinicians during morning rounds or throughout the day and acquired information related to their lab results or upcoming procedures verbally. In addition to verbal conversation, there were files of printed

materials and a whiteboard, but the conversations were obviously the primary means for receiving and exchanging information. However, from my field observations, I witnessed that most of the conversations between patients and clinicians lasted only five to seven minutes. For both patients and clinicians, seven minutes of conversation were not enough to address all information they wanted to exchange.

4. Patients Have Multiple Requests

The other key finding was that patients had multiple requests as their status changed. Their requests varied from having a cup of water to changing their positions. However, the only way to address their needs is to call their nurse by pushing the nurse call button. This caused additional steps in nurses' work because they must physically go to the patient room to check patients' needs. It also generated additional wait time for patients to get what they needed. In inpatient settings at Michigan Medicine, each nurse has four patients to manage. If each patient has multiple requests throughout the day, it will disturb their nurse's workflow.

5. Anticipated Discharge Date

Patients asked clinicians about their anticipated discharge date. Clinicians provided an estimated date based on test results that represented a patient's status. However, patients' status often changes due to multiple factors and hence, clinicians cannot always predict accurate discharge dates. As a result, patients can become frustrated and disappointed by not being able to be discharged on the day they anticipated.

6. Pain and Feelings

Patients' current pain and feelings were obviously the most frequent topic of the conversations between the patients and clinicians. Patients were asked to describe their pain using a number and also notify their current feelings, such as nausea and shortness of breath.

7. Technology Use

While in the hospital, many patients spent time watching TV or using their smartphones, but technology use varied with patients' age. For example, elderly patients did not use smartphones very often, but they watched TV, especially when they stayed without their caregiver.

8. Treatment Option Literacy

Clinicians informed patients about possible treatment options and explained what the causal factors for choosing each option. Some patients understood the clinicians' explanation, but other patients asked clinicians for more details about alternatives. When patients asked for more explanation, their clinicians contacted consultants in the hospital. It took time for patients to get additional information if the issues were beyond their nurse's or attending physician's expertise.

9. Patients' Motivations

Patients addressed their personal motivations and goals. Anticipating activities outside of the hospital, such as taking care of pets, watching football games, or going back to work motivated patients to recover and discharge from the hospital with a healthy status.



Figure 17. A physician making a phone call to his colleague for making a medical decision



Figure 18. Clinicians' communication artifacts

10. Home Environment Post-Discharge

Due to physical changes, some patients had to adjust their home environment to house new medical equipment, such as rehabilitation furniture, an oxygen machine, or a nebulizer, when discharged. If their patients were required to utilize certain equipment, clinicians checked patients' familiarity with the equipment and accommodations of their

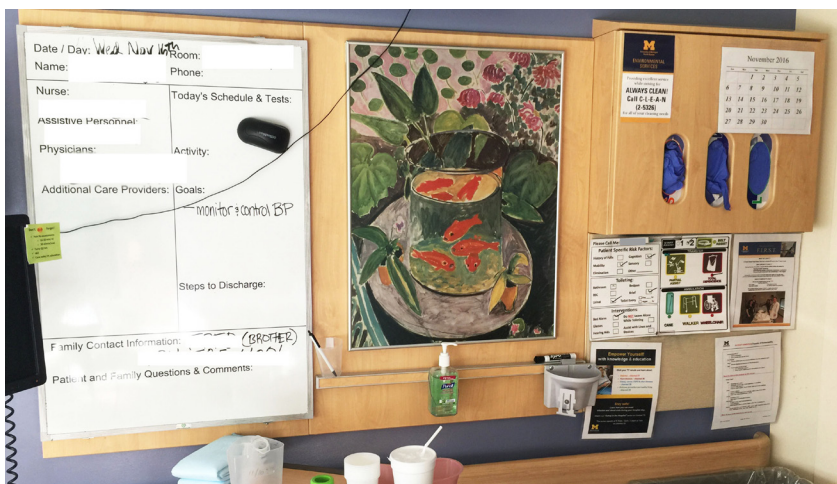


Figure 19. A whiteboard on the wall in a patient room with little information

home environment as part of the preparation for patients' discharge. Also, other consultants, such as occupational therapists, physical therapists, and speech pathologists were involved in the preparation.

11. Whiteboards Have Thin Descriptions

There was a goal of the day written on whiteboards in each patient's room. Physicians often verbally stated what patients had to consider or know for the day. Sometimes the list of goals was too long for patients to memorize. Similarly, some clinicians provided discharge criteria for their patients instead of giving them an anticipated discharge date.

12. Transitions Between Healthcare Institutions

Care transitions between healthcare facilities (i.e. moving from Michigan Medicine to another institution, or moving to Michigan Medicine from another institution) were one of the issues noted during the observation sessions. If the health institution utilized a different EMR system than Michigan Medicine, clinicians had to

receive additional documents from the institutions. Patients were also required to provide information about prior treatment from other medical institutions. Also, clinicians checked each patient's follow-up appointment with their outpatient clinic or Primary Care Physician (PCP).

Along with identifying the issues, I also generated stories to represent what I witnessed during the observation sessions and interviews. The stories show an example of clinician's invisible work from patient's perspective, and time constraints from the clinician's perspective.

Linda's Story

Linda is a 52-year-old female patient living in Ypsilanti, Michigan. She is in poor health condition with multiple medical conditions including obesity, insulin dependent type II diabetes, and high blood pressure. This is her third hospital admission this year. Last night, she suddenly felt short of breath and started feeling dizzy and nausea. She went to St. Joseph Mercy hospital emergency room near her home and was transferred to University of Michigan hospital early this morning. Her son acts as the caregiver, but is currently at work.

a. (7:12am) Linda is waiting until the physician sees her for the first time. Linda was not able to sleep deeply after being transferred to the hospital last night and the bed is different.

b. The nurse told her to read this information when she had time while staying in the hospital. She felt dizzy and did not want to read it, so she put it aside on the table.

c. (7:17am) When the physician knocked and came in, he introduced himself and asked Linda a few questions using unfamiliar terms. But she didn't ask him any questions, thinking she could ask her son later on. The physician left, telling Linda to rest until the consultants come.



Figure 20. Linda's story

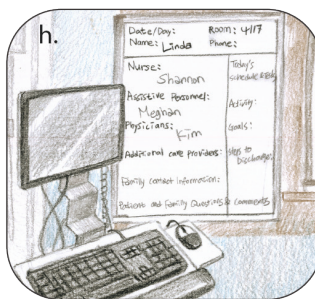
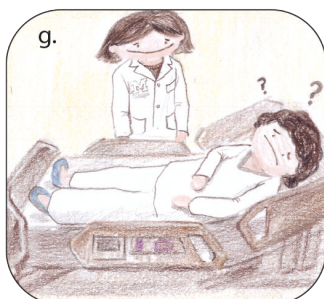
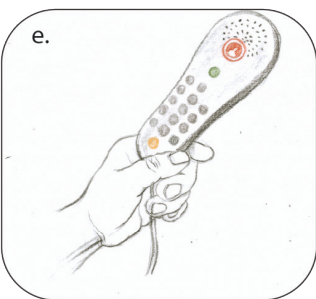
d. “Right, I should’ve asked him whether I could continue taking my medication for high blood pressure..!” More questions arise after the physician had left.

e. Linda pressed the nurse call button on the bedside remote. The nurse seemed to have changed. “But she’s not the one I met early this morning.” In any case, Linda asked the nurse to call the physician she just met, and the nurse said she will page him.

f. It has been more than an hour and the physician has still not showed up. Linda regrets not having asked the doctor her questions earlier and her stress level begins to rise.

g. (4:10pm) After having lunch, she was out like a light from last night’s bad sleep. She woke up after a good while and a woman wearing a white gown, presumed to be a physician, came into the room calling Linda’s name. “Is she my physician as well?”

h. Stealing a glance at the whiteboard, the name of the male doctor who introduced himself earlier was written on the doctor’s column. “Wait, so who is my physician then?” “Why does it always change?”



Alex's Story

Alex is an 18-year-old male patient living in Grand Rapids, Michigan. He was diagnosed with Acute leukemia three years ago, and successfully received a third bone marrow transplant 15 months ago. He now must take several medications and regular follow-up visits for severe dryness of his skin and scalp because of side effects of medications. Also due to his immunosuppressive medications, he developed an infection of his respiratory system with a virus and required hospitalization.

a. (7:12am) Alex was not able to sleep well due to the itchiness of his scalp and skin since yesterday. The current steroid cream is not very effective this time.

b. (7:35am) The attending physician came to see him. Alex and his mother wanted to talk to the oncologist in case it is a severe Graft Versus Host Disease (GVHD). The physician tells them to wait as he needs to page consultants and notify them.

c. His mother wants to see the oncologist before going to work as she won't get off work until evening. She asks the nurse when the oncologist would come, but the nurse says the oncologist has another busy day and is not sure when she will come.



Figure 21. Alex's story

d. Alex has questions to ask: should he change the steroid cream or the shampoo?

e. His mother needs to go to work now.

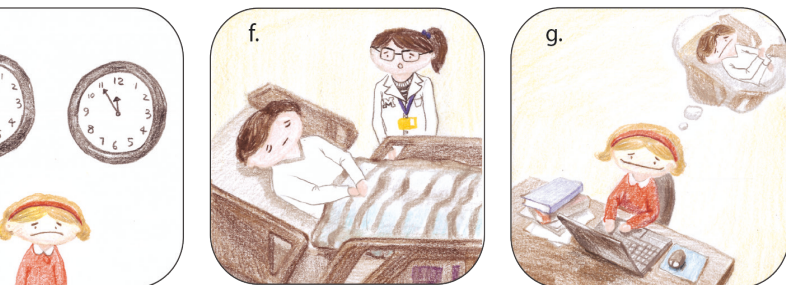
f. (2:49pm) It is afternoon and the oncologist has visited Alex in his room. Alex is taking a nap and there is no one around.

g. His mother is at work but it's hard to focus with Alex on her mind. "When will the physician come?" "Where is the physician?"

Dr. Kim's Story

Dr. Kim is a physician in the internal medicine department. He starts his day at the hospital at approximately seven every morning. Today, he has 11 patients to see by noon. There were 4 newly admitted patients last night. He is in hurry with the thought of having to be more diligent than usual to see everyone in time.

a. (7:00am) Dr. Kim has a meeting with the night shift physician and is informed of the status of each patient and any issue that happened during the night.



b. Dr. Kim first goes to see Linda in room 4117 who was hospitalized at daybreak. The patient has a number of complexities, so clinical consultations must be requested from three consultants. Dr. Kim goes directly to the nursing station to promptly contact the consultants.

c. “I should first contact the neurosurgeon to have him explain to the patient that the MRI cannot be done.” “I better make a call to Nephrology and Endocrinology to confirm the prescription and discuss treatment options.” Dr. Kim pages the consultants. In addition, since the hospital where the patient had formerly stayed uses a different Electronic Medical Record (EMR) system from the hospital, he asks them to send medical information in PDF form.

d. Dr. Kim visits room 6009 to see Alex, his next patient. He finds a symptom of a severe case of Graft Versus Host Disease (GVHD) but the caregiver requests to see the oncologist for an accurate diagnosis. He contacts the oncologist.

e. Dr. Kim still has many of patients to see in the morning, but he returns to the conference room to not be late for the discharge meeting with the care manager and the social worker. At this meeting, he discusses a care plan for every single patient.

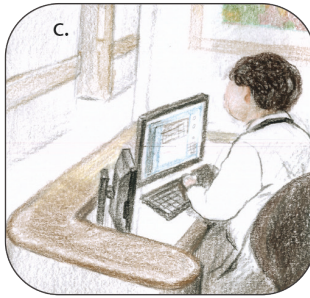
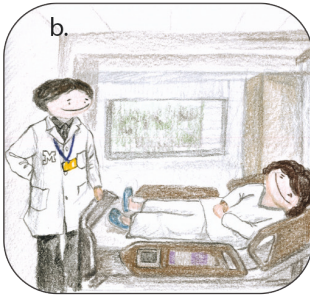


Figure 22. Dr. Kim's story

f. Dr. Kim sees more of his patients. The oncologist calls to let him know that she would go to Alex as soon as she handles her urgent patients because she is short-handed today. Linda's consultant is calling Dr. Kim. The consultant couldn't answer right away since he was in surgery. After delivering the updates to the consultant, he asks the consultant to see the patient.

g. Dr. Kim gets a page from Linda's nurse to go back and see her just as he was about to go to the next patient. He tells the nurse that he will be there right after seeing the rest of his patients. Dr. Kim sees the rest of his patients. He meets with the pharmacist and discusses about current medications and issues.

h. Dr. Kim has a meeting with the care manager who updates him on tomorrow's schedule and they discuss changes to the care plan.

i. (4:10pm) Dr. Kim is giving a lecture in the medical school today. It was a busy day without a break, but he is still running on time. He gives remaining orders, hands them off to a physician who stays until the evening, and leaves for the lecture. He wishes the day is a little longer. "What kind of a physician am I to my patients?"







Although I have previously been both a patient and caregiver, I was unsure what clinicians work look like and other patients' experiences. As the multiple observation sessions were completed, I noticed the repetitive and redundant communications between patients and clinicians. Although the only chance for a patient to be informed about their treatment was five to seven minutes of the interaction time with clinicians, time for in-person communications between patients and clinicians was being wasted by redundant conversations. From each clinician's perspective, they had to check each patient's status

or feelings. However, from the patients' perspectives, they felt that different clinicians showed up briefly, asked the same questions as other clinicians who had already visited their room, and left quickly.

I observed that many clinicians' tasks were invisible to patients and thereby they lacked perspective on the totality of clinicians' work. For example, a patient I met during the observation asked her attending physician to provide treatment options when she met her physician during daily rounds. After the physician had left the patient room, he paged patient's consultants to ask them to come to the patient room and explain details about the treatment options to the patient. The physician waited for more than an hour to get a response from the consultants because they were in an emergency surgery. Meanwhile, he checked the patient's record from her previous medical institutions and had a discussion with a care manager who oversaw the patient's overall hospital stay. The physicians' work was invisible from the patients' perspective because patients stayed in the patient room without being informed. This example illustrates how clinicians' work is hidden in the hospital.

The time constraint with information repetition and invisibility served to interrupt clinicians' workflow and routine, while also increasing



Figure 23. Insight Sorting activity- generating key insights from raw data

before moving onto the design phase. To help redefine the key problems, I utilized Insight Sorting to see the relationship and interconnections between each issue. Insight Sorting is beneficial when designers structure existing findings or knowledge. It reveals patterns of findings and leads discussions (Kumar 2012, 140). I revisited notes from the observations and interviews and rewrote findings in short sentences on sticky notes. I also clustered similar issues by topic and placed them under the 12 issues. After several iterations of this activity, I narrowed down the insights and clustered them into four main problems: (1) Repetition of information, (2) Invisibility of clinicians' work, (3) Limited access to information artifacts, and (4) Patients desire human interaction.

Key Insights

First, repetition of information was one of the most frequently observed problems. Repeatedly answering the same questions and listening to the same explanations frustrates patients. Since patients see multiple clinicians on their care team, the patients are asked to report the same information to each clinician. Based on the overall issues I discovered during the fieldwork, patients had to describe their pain and feelings multiple times. Also, patients were verbally informed about their vitals and lab results by their clinicians. Patients were unable to prepare questions before they met with their clinicians. This also hinders conversations with clinicians and prevents patients from asking questions or gathering new information. This problem led me to consider the necessity of providing a description of the day's activities to avoid redundant questions from clinicians, such as whether patients already met certain clinicians or took particular medical tests. It was also necessary to consider a way to report patients' feeling and requests as a reference for clinicians to avoid asking the same questions.

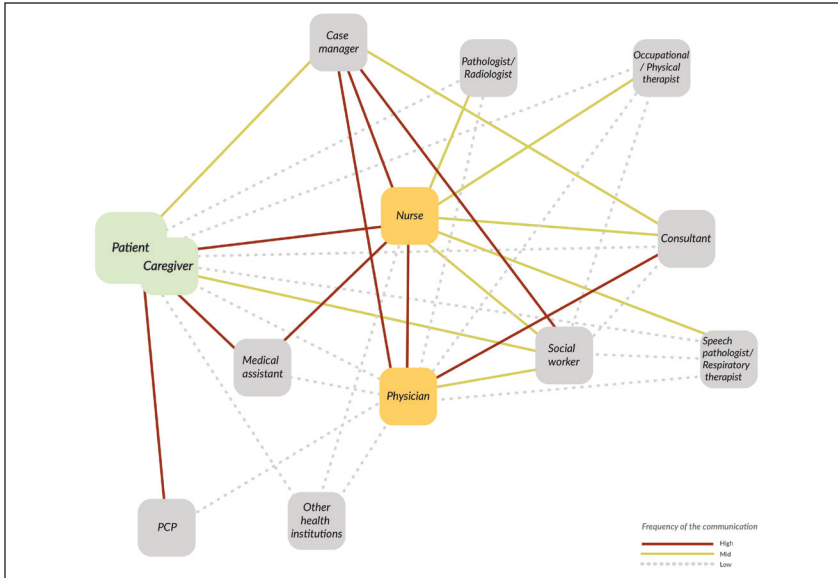
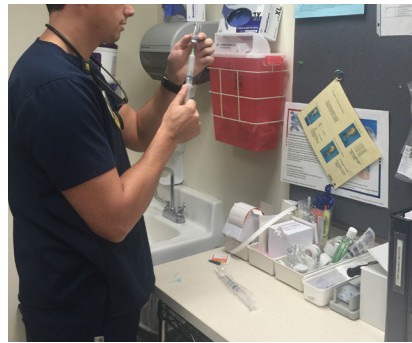
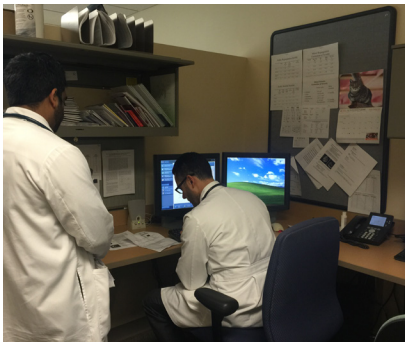


Figure 24. Communication diagram showing informational asymmetry between patients and clinicians



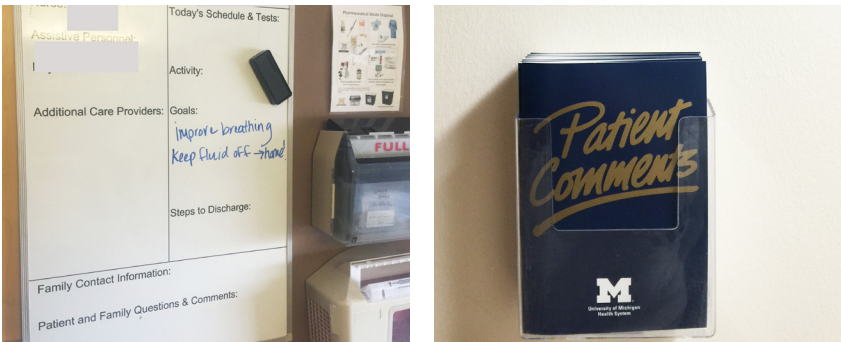
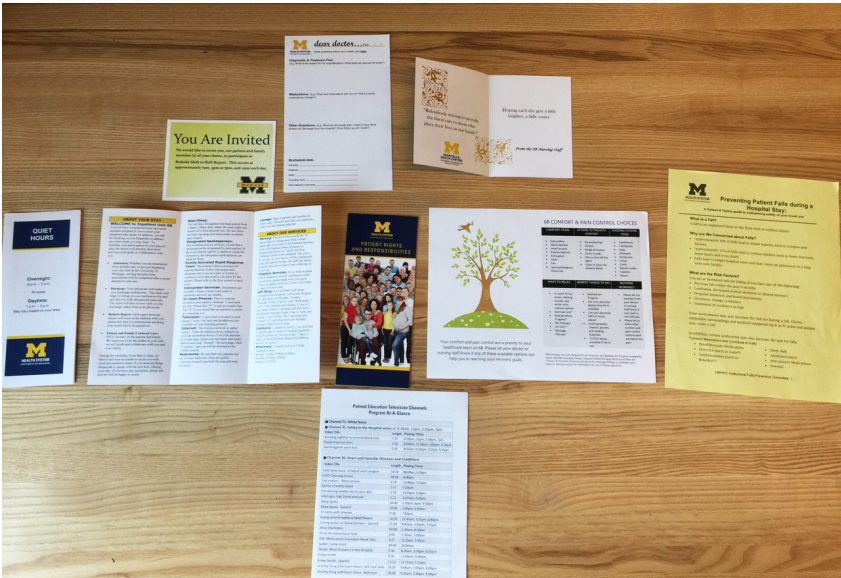
Figures 25-26. Clinicians' work is invisible to patients

Second, clinicians' work is invisible to patients and patients are not aware that their care team is working for them when they are not in the room. Due to this invisibility, benefits or successful outcomes of invisible work is difficult to recognize (Nardi and Engeström 1999). Patients usually stay in their room in bed during their hospital stay. Therefore, their only contact with clinicians is when clinicians visit the patient's room. Otherwise, they don't have access to their clinicians nor

do they feel empowered to seek them out. Based on the discoveries made during my fieldwork, patients were unable to see their clinicians' work, such as discussion with consultants about patients' treatment options or discharge paperwork, which takes a considerable amount of time from physicians. This problem led me to consider providing profiles of their care team and general workflow to make invisible clinicians' work more visible to patients.

Third, patients have limited access to information artifacts. While clinicians have multiple communication platforms, such as EMR, phones, or pagers, patients don't have access to any information artifact other than a nurse call button or whiteboard in the patient's room. Verbal interactions are the primary communication medium and information can be quickly forgotten if it is not recorded. There are also no existing tools that address patients' needs for sufficient information. From my fieldwork, it was apparent that patients had only several ways to access to information, including a whiteboard with thin descriptions of their care team or day's goal. Also, patients had to make multiple requests, such as repositioning their bed or having more blankets. These issues led me to consider providing more detailed options to address patients' need and more rich information related to their hospital stays, such as ongoing treatment procedures and lab results.

Fourth, patients desire human interaction during their hospital stay. Patients are not in their best condition, either mentally and physically during their hospitalization, which causes them anxiety and creates a desire to interact frequently with their care team. In my fieldwork, I saw many patients who wanted to obtain reliable information from human beings, not from a piece of paper or static digital device, such as a monitor. However, it was impossible for them to interact frequently with clinicians under the limited human and time resources. For example, patients had only a few minutes of interaction time with their physician during daily rounds. Sometimes patients addressed



Figures 27-29. Many information materials designed to facilitate the communication between patients and clinicians are not frequently used

their need for social interaction with clinicians, such as discussing their personal matters or motivations for their treatment. I found the benefits of having a more valuable conversation between patients and clinicians and this led me to consider an overall concept of my design prototype. If the time constraint is hard to change, it is important to utilize in-person interaction in meaningful ways with valuable conversations.



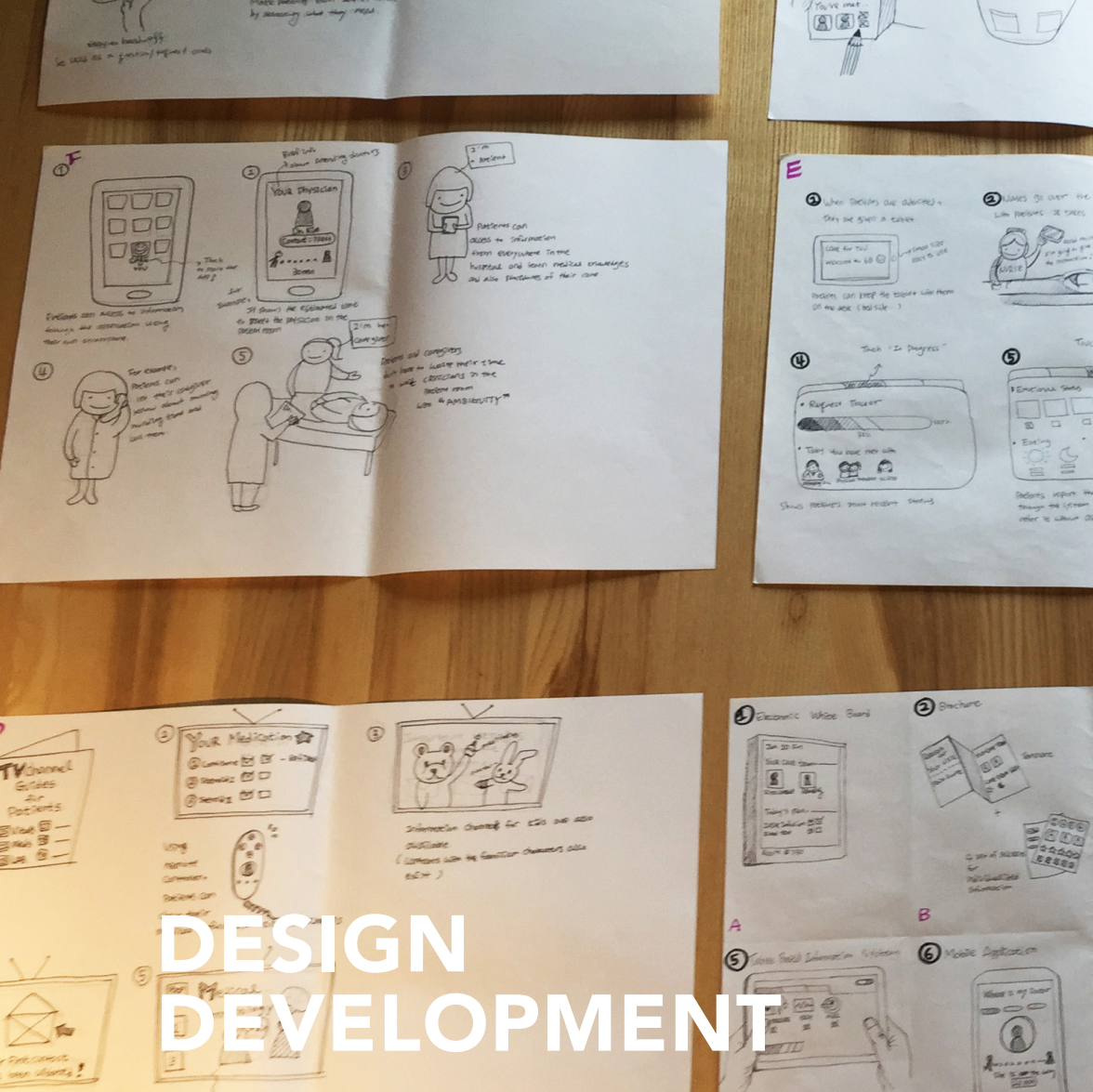
PROBLEM REDEFINITION

As I narrowed down the insights and clustered them into four main problems, I came up with two additional concrete problem statements in addition to the initial problem statement:

- How might we help patients have better hospitalization experiences by allowing them to have greater access to relevant information related to their hospital stay and better comprehension of their treatment procedure?

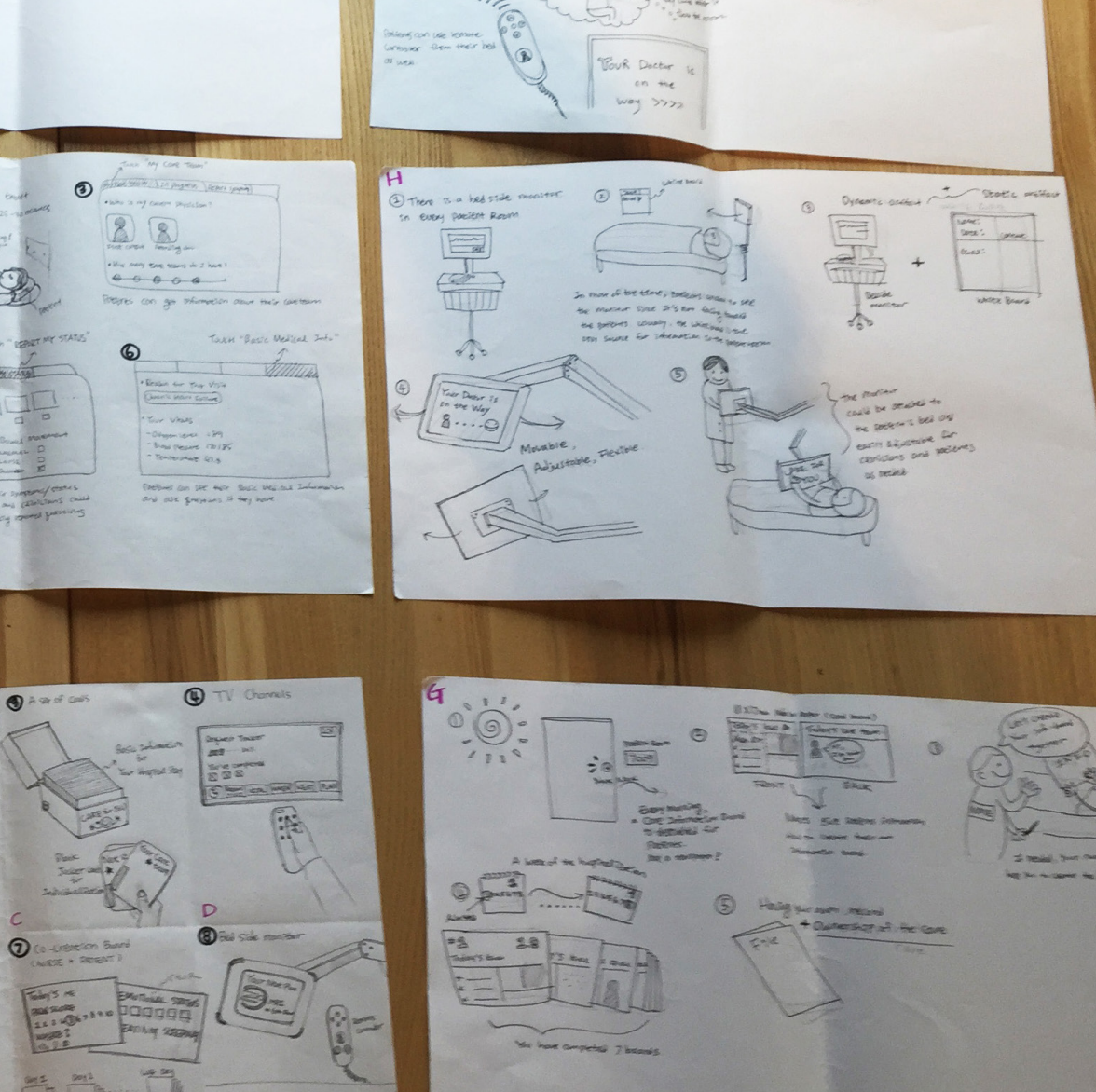


- How might we rebalance communication between clinicians and patients by allowing them to more efficiently use their in-person time together and reduce repetition?
- How might we empower patients to participate more actively and be more prepared for conversations with their clinicians?



Ideation

After gaining insights from the observations and interviews, I planned to design an interactive care information tool for patients. Although I have a design background, including environmental and service design, I expected to develop skills and knowledge related to user experience design. Developing an interactive tool is a new experience for me, so I decided to take an Interaction Design course in the School of



Information. The benefits of the course were that every student could work on a project which is driven by their interests and all the students were assigned to a peer critique group, which allowed me to acquire useful feedback from other designers. I acknowledge a limitation that many students in the class were technology-driven, so they were already familiar with technological aspects of product or service design. I expected to compensate for this limitation by also receiving feedback from an actual user group, such as patients, nurses, and



Figure 30. Cartoons for design interventions

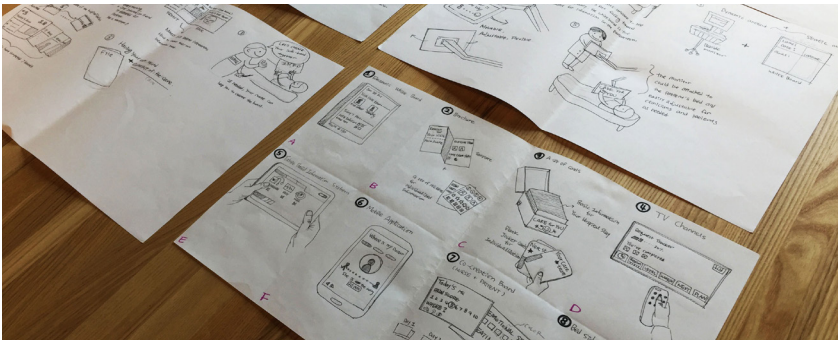


Figure 31. Storyboards of eight possible directions for design interventions

physicians.

During the course, I began with discovering eight possible technology directions for my design interventions, including digital forms and analog forms. These eight possible ideas originated from the findings from my ethnographic observations and interviews. I then sketched out storyboards for eight suggested design interventions to compare features. By generating user stories based on the patients' day in

their room, I could visualize patients using each design intervention throughout the day. Some of the possible interventions had a mixture of positive and negative aspects. Before I made a decision, I brought the eight storyboards to my peer design critique group and received useful feedback from four other designers as they all had experiences being either a caregiver or a patient. They provided me with details of design considerations related to patients' conditions, such as a necessity of using a larger text size, voice instructions, and a patient-friendly interface. Besides, my group also provided suggestions on the user interface, including the places of each component and use of icons. These critiques allowed me to focus my idea and come up with the most appropriate idea before I moved onto the prototyping phase.

When I made a final decision to create the platform, one of the key considerations was simplicity and visibility for patients. It was evident that patients were not in their best conditions during their hospital stay. Many of them had physical limitations due to their medical conditions, and it would be hard to navigate information freely using sophisticated devices, such as complex applications on a smartphones or lab tops that require additional space. Considering the limitations I observed during the fieldwork; I decided to adopt tablet-based platform as my design intervention. Using a tablet, patients could adjust the size of images or text themselves. Also, if needed, they could share their tablet and receive assistance from their clinicians or caregiver, and look at the content together.

Concepts Generation

The generated design concept is a tablet-based platform that could be used by patients in inpatient settings with a purpose of communicating clearly with their clinicians. The design concept has six key features: My care team, Requests, Feelings, Today's activities, In progress, and Medications & Lab results. Each feature is designed to solve main

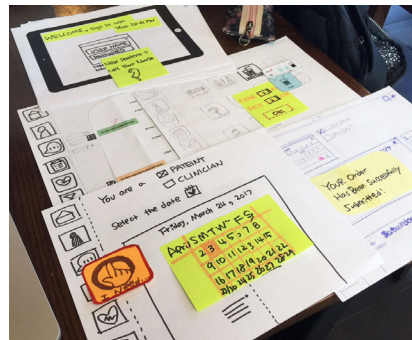
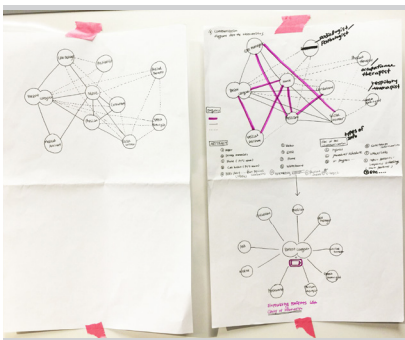
problems that were identified in my fieldwork. The details of the design concept will be discussed in the next section, *Design Prototype*.

Initial Prototype

The goal of the initial prototype was to examine the usability and capacity of the idea from the users' perspectives in the early stages of design. I used paper and sticky notes to create a paper prototype of my design idea. A paper prototype is a common form of a low-fidelity prototype, which allows designers to test its usability and observe how potential and future users interact with design components (Kumar 2012, 234).

Concepts Validation

Before I generated an advanced prototype, I brought my initial prototype to the hospital and shared it with target users to further develop my ideas. I also introduced my key fieldwork findings to the users: patients, nurses, and physicians. This introduction was followed by questions that attempted to determine whether this design prototype would serve the intended functions, and whether it would meet the patients' and clinicians' needs. Users' responses suggested that the prototype is an appropriate response to the four key findings from the field observations and would be a potentially successful approach to solving the identified problems. The users offered some specific suggestions about the prototype development that I took into consideration. For example, users thought that patients' needs could be specified more than the current prototype allowed. They also suggested I consider patients' physical limitations during their hospitalization and that it would be better to provide more visual components than providing more text. According to the physicians, shared medical information should also be carefully determined.



Figures 32-34. Lo-fi paper prototypes and early digital prototypes to have concept validations with users and other designers

On the other hand, there were more fundamental considerations, such as patients' technology literacy or safety issues while patients use a tablet in their bed. Users' opinions led me to iterate upon my current prototype and design with a more calibrated digital prototype. I discussed the details of the design in the next chapter, *Design Prototype*. Further details on the suggestions offered by users are listed below.



Figure 35. Having conversations with a nurse to receive feedback on early digital prototypes

- **Patients’ needs could be more calibrated**

Nurses responded favorably to receiving detailed patient’ requests through the proposed platform. They suggested calibrating the tool to further meet patients’ needs by including additional options to the ones I had developed. They noted that pain report, medications request, and noise adjustment are the most commonly addressed issues when patients push a nurse call button. Patients shared that currently there is no way to check if the room is clean other than talking to the person who is in charge of managing the patients’ environment. When patients require room cleaning, they need to call their nurse, which causes additional work for both patients and nurses which other nurses also recognized was inconvenient and ineffective.

- **Patients’ conditions might affect the usability**

One of the most commonly addressed opinions was that many

patients are not in their best condition during their hospital stay, and it would be hard for patients to utilize a digital tool that requires further physical movements. According to some patients and caregivers, holding a digital device, adjusting the angles, or clicking buttons to navigate information might be challenging for their health status. However, they also said the tablet could be held by caregivers or medical assistants to mitigate patients' physical limitations.

- **Technology literacy could cause limitations**

According to patients and clinicians, patients' technology literacy could limit the use of a digital platform similar to patients' conditions. Specifically, it might not be the best solution for elderly patients who are unfamiliar with the digital device. Also, some of the nurses pointed out that patients with vision or memory challenges may not be able to read or understand text displayed on the device. Possible solutions, such as having medical assistants or nurses assist with tablet use, involving caregivers, or having multiple comprehension levels of information were also suggested.

- **Shared medical information should be carefully determined**

One of the caregivers noted that they do not want to know all the lab results or vital signs. He said that they want to hear from their physician, not from paper or computer monitors. This is because they are not able to understand the meaning of the numbers and sometimes knowing the numbers makes him more anxious. On the other hand, many clinicians said that they are comfortable enough to share patients' vitals since those are shared in any case, but they are not sure whether lab results should be shared with patients. Clinicians believed that lab results should be interpreted with medical expertise. Therefore, when medical information, such as vitals, blood work, or

other lab results are shared through design interventions, it should be determined very carefully.

- **Safety issues should be considered**

Few clinicians had concerns about safety issues. They said that patients are mostly in bed when they are in inpatient settings, and they have limited physical movement. Without any safety protection, it is possible patients may drop the device, which could cause safety problems.

- **Visual elements could be provided along with text**

Patients responded favorably to having visual elements, such as icons, images or photographs along with the text.



DESIGN PROTOTYPE

Design Overview

I created a portable, tablet-based platform to use the limited resource of time in the healthcare service by fostering valuable communication between clinicians and patients. This platform would provide access to medical treatment procedures, care team's general workflow, information related to the patient's hospital stay, and provide a way to address patients' needs. Using the platform, patients could not only simply receive information, but also prepare for their conversations

with clinicians with better access relevant information. Based on the patients' needs that arose from ethnographic field observations and interviews, I prototyped the interactive care tool Boim. The tool visualizes six main themes, such as Care team profiles, Laboratory results and medications, Ongoing treatment procedures, Summary of the day's activities, Means to report patients' current symptoms and feelings, and Options to address patients' needs. The name of the platform, Boim, originates from a Korean word meaning visibility. It is designed to draw related information from EPIC which is the EMR system used at Michigan Medicine. When patients make a request based on their needs, it will automatically generate a message for their nurse, who will receive the message on his/her pager.

Each of six main themes designed to solve four major problems: Repetition of information, Invisibility of clinicians' work, Limited access to information artifacts, and Patients desire human interaction. Some of the themes were addressed to solve multiple problems because the four main problems I identified were not isolated from each other. Also, adding to the initial design ideas that I generated from four main problems through Insight Sorting, I accommodated users' suggestions, such as providing more calibrated needs for patients, utilizing visual elements with text, and considering the ease of use in a digital prototype.

I presented the details of design descriptions and relationships between four main problems and design solutions below.

Design Description

Provide care team profiles

This particular feature was designed to address the following problems: (2) Invisibility of clinicians' work and (3) Limited access to information artifacts.

<p>12 General issues</p> <ol style="list-style-type: none"> 1. Communicating lab results 2. Computers vs. Nurse call button 3. 5-7 minutes contact 4. Patients have multiple requests 5. Anticipated discharge date 6. Pain & feelings 7. Technology use 8. Treatment option literacy 9. Patients' motivations 10. Home environment post-discharge 11. Whiteboards have thin descriptions 12. Transitions from/ to other healthcare institutions 	<p>4 Key insights</p> <ol style="list-style-type: none"> 1. Repetition of information 2. Invisibility of clinicians' work 3. limited access to information artifacts 4. Patients desire human interaction 	<p>6 Features</p> <ol style="list-style-type: none"> 1. Requests 2. Careteam 3. Inprogress 4. Day's activities 5. Labs & Meds 6. Feelings
---	--	--

Figure 36. Findings and design considerations

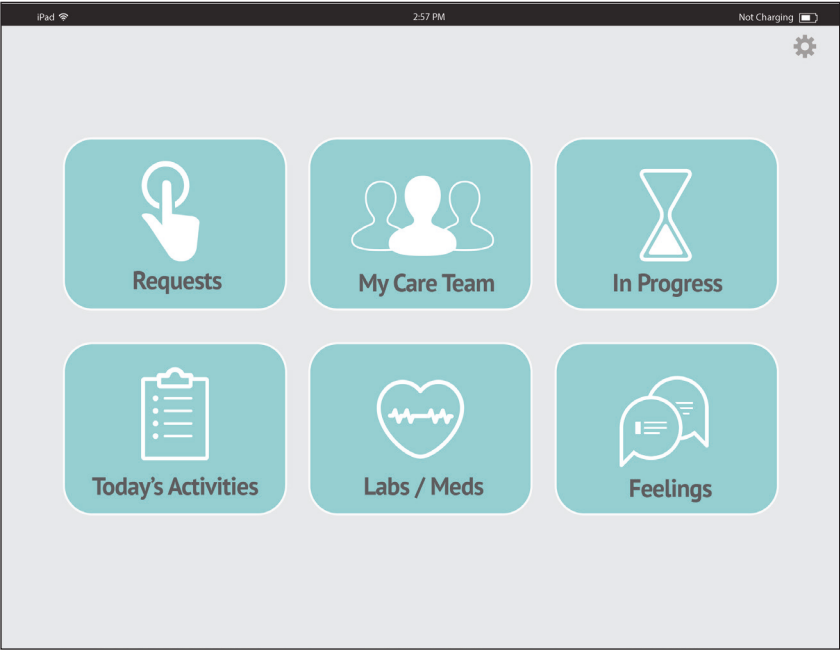


Figure 37. Six main features

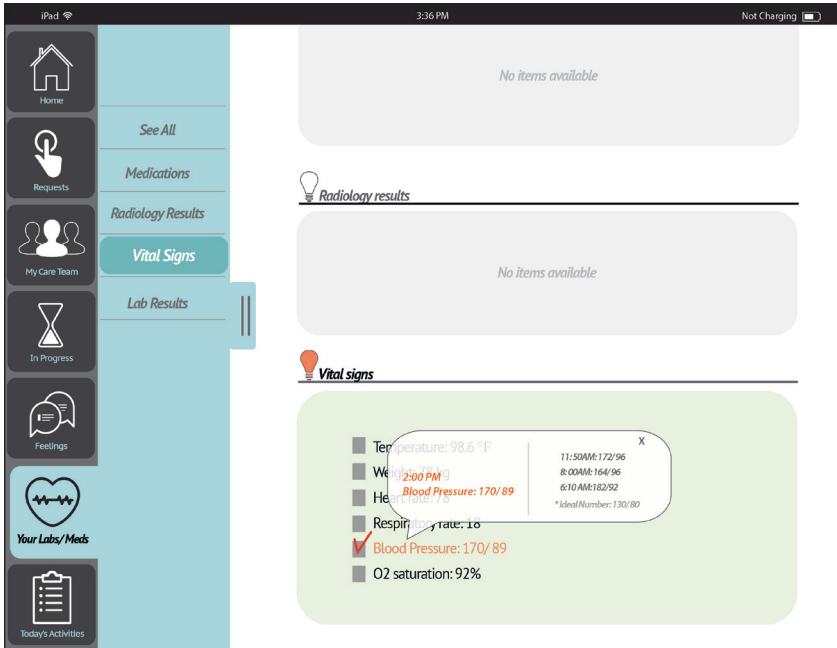


Figure 38. Laboratory results and a list of medications with brief descriptions

Patients often complain that they have difficulty identifying their clinicians during their hospitalization. Because their clinicians rotate on multiple schedules, it is challenging to keep track of each clinician and to understand their roles and tasks clearly. However, based on my field observations and interviews, I found that having information on all the members of each patient's current and subsequent care team is challenging with the current EMR system. Real-time clinicians' on-service information is difficult to track and even for the clinicians themselves, and it is often difficult to know their patient allocation until the last minute. Based on input from clinicians, highlighting each patient's attending physician, first contact, bedside nurse, and care manager is possible with the current EMR system. I included information that allows caregivers and patients to refer to photographs, names, roles of the clinicians, and their general workflow.

Provide Laboratory results and a list of medications with brief descriptions

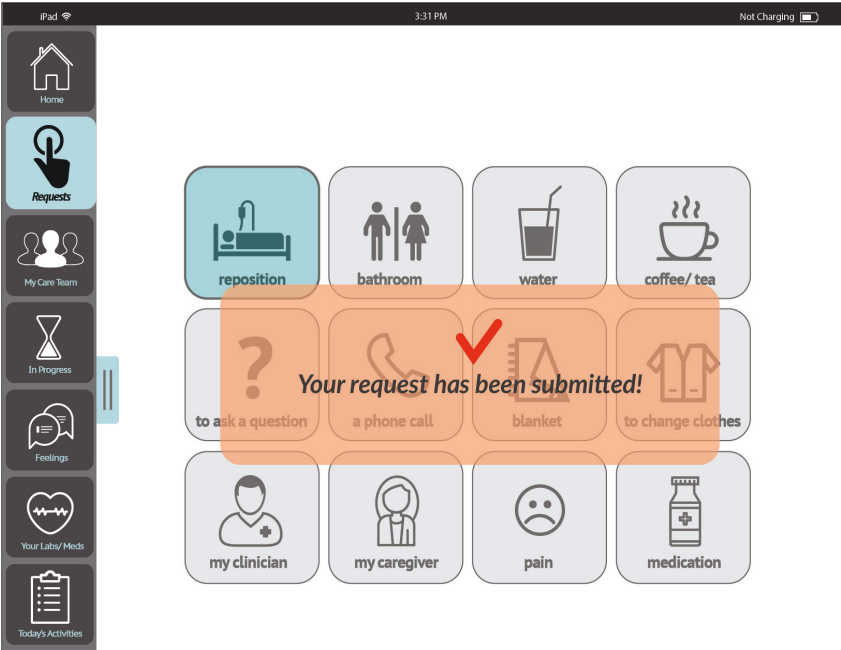
I designed this function to address the following problems: (3) Limited access to information artifacts and (4) Patients desire human interaction.

Having patients' laboratory results with brief interpretations, such as the most recent results and ideal status might provide patients more time to understand their information and prepare questions before daily rounds. Needs might vary from patient to patient and providing ways to individualize the level of sharing information could alleviate this issue. For example, using the platform, patients can freely navigate information they want to know and prepare for conversations with clinicians by developing questions or issues to discuss. Patients with more detailed needs would be able to have more detailed questions for their clinicians, such as their full medication list or details of laboratory results. Patients with fewer information needs could view basic vitals with a brief interpretation from the tablet without asking further questions. In this way, patients and clinicians would be able to avoid random conversation and meaningfully use in-person interaction time.

Provide information on ongoing treatment procedures

This function will address the following problems: (2) Invisibility of clinicians' work, and (3) Limited access to information artifacts.

If a patient could avoid repetitive conversations, it will be possible to also alleviate the problem of (4) Patients desire human interaction. In most of the cases, patients in inpatient settings are involved in multiple treatment processes. However, until each care team member physically enters the patient room and verbally informs them, patients are unaware of the treatment processes in which they are currently enrolled, due to the amount of information in this complicated



Figures 39-40. Multiple options of communicating patient's needs

situation. To help patients be better informed about their treatment process, my design intervention provides real-time access to detailed information about the patients' ongoing treatment process. Patients who need more detail can explore information by themselves instead of calling a nurse to ask questions on their current status at every turn.

Provide the multiple options of communicating patient's needs

This feature was designed to address the following problems: (1) Repetition of information, (2) Limited access to information artifacts.

Currently, when patients need help, they are asked to call a nurse by pushing a button on the bedside remote control. Although having a single button to address patients' need is the easiest way, the limited options for communication give rise to multiple situations in which the needs of patients are not appropriately met. Providing more calibrated options for expressing patients' needs could provide an opportunity to communicate clearly. Also, instead of physically coming to see the patient and check their request, clinicians can be aware of more details of patients' needs through the system, such as a pager or EMR. It would reduce clinicians' workload as well as wait time for patients. When I received feedback from nurses, I found that this function is the most desirable feature from nurses' perspective.

Provide a way to inform patient's current feelings

This function was designed to address the following issues: (1) Repetition of information and (4) Patients desire human interaction.

During their hospital stay, patients are asked to describe their core symptoms, such as pain score, nausea, shortness of breath, eating, or

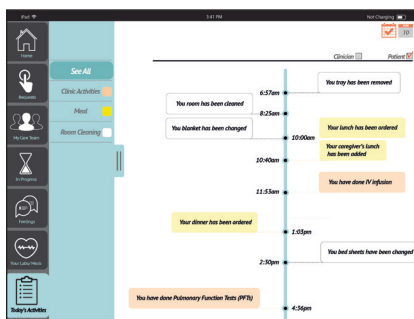
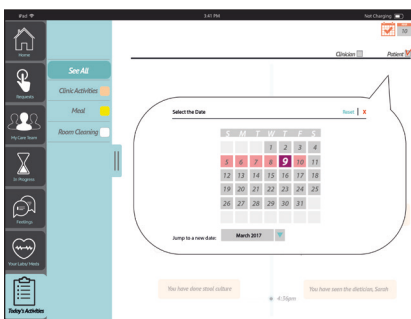
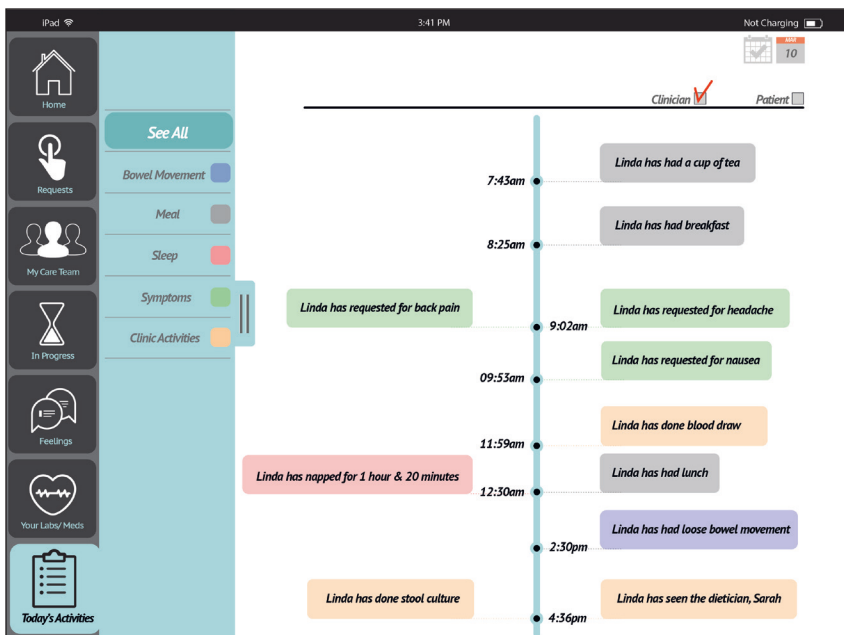
opportunities to address details about their status. Also, patients often have to repeat the same answer for many clinicians. This function provides a way to report detailed information about their current feelings, allowing patients to store and review daily, and share this information with clinicians.

Provide a way to keep daily basis record of clinical activities

This function was designed to address all of four problems: (1) Repetition of information, (2) Invisibility of clinicians' work, (3) Limited access to information artifacts, and (4) Patients desire human interaction.

Considering the importance and potential impact, this function is the most developed feature of the application. It is apparent that a whiteboard and a file of the printed materials have been the primary resource for capturing information for patients in their room. However, existing information, such as information on whiteboards are written without details and not actively used by patients on a regular basis. After clinicians leave patient's room, it is almost impossible to recall all the details of information because most of the information exchange happens verbally.

This platform provides access to a summary of the clinical treatment, symptoms, patients' requests, and patients' records so patients are better informed when they communicate with clinicians. If patients want to view previous days' history, they could click the dates to see the records from previous days on a timeline.



Figures 41-43. Daily basis record of clinic activities

User Scenario

To put my design intervention, Boim, into an inpatient user context, I generated an example of a final scenario that will help explain when patients will utilize it and how it works.

This is a story of a patient (Linda) who I introduced in the *Insight Generation* section as a patient story.

Linda is a 52-year-old female patient from Ypsilanti, Michigan. She is in poor health condition with multiple medical conditions including obesity, insulin dependent type II diabetes, and high blood pressure. This is her third hospital admission this year. Last night, she suddenly felt short of breath and started feeling dizzy and nausea. She went to St. Joseph Mercy hospital emergency room near her home and was transferred to University of Michigan hospital early this morning. Her son acts as the caregiver but is currently at work. During the daytime, Linda has been seen by multiple clinicians, but she has a hard time figuring out each clinician's role. Clinicians ask multiple times about the reason for her hospital admission, how she is feeling, and her pain degree. She is wondering how many physicians she has and also how many times she has to state her feelings and describe previous treatment procedures. Not only does this situation irritate Linda but it also makes her feel that she is wasting time spent with clinicians because they all seem busy but ask the same questions and leave quickly. She is frustrated, and her stress level increases.

How does Boim help Linda deal with this frustrating situation?

When Linda was first hospitalized in this inpatient setting, she was given a tablet to use a platform, Boim, which was designed to navigate information related to her hospitalization. A medical assistant gave her a brief introduction on each of the six tabs after she created a username and password for Linda. The medical assistant told Linda that this platform could only be used in this hospital, but she could use



Figure 44. A medical assistant giving a patient a brief introduction on each of the six tabs

it whenever she wants to gain information related to her hospital stay. Over the course of Linda's hospitalization, clinicians visit her room and ask to describe her previous medical activity during the day, such as a blood draw or a visit from a speech pathologist. Now, using Boim, Linda could draw on related information for each clinician with a few simple clicks instead of describing information verbally. When she has time during the day, Linda can consider ahead of time whether she wants to ask particular questions relevant to her status. To get more detailed information, such as details about side effects of medications and treatment options, she could prepare to ask her physician based on her information in Boim by making a note. At the end of each consultation, Linda and her clinicians could use the time to discuss more detailed information based on Linda's questions. Also, the time saved because she didn't need to repeat the same information allows her and her clinicians to get to know each other through social conversation.

Boim is designed to draw related information from EPIC, the EMR system used at Michigan Medicine. When patients make a request based on their needs, it would automatically generate a message for their nurse, and they could get a message from their pager.



Figure 45. Testing my design prototype with a patient in Michigan Medicine

User Feedback

I tested my design prototype within the healthcare context with actual users: patients and healthcare professionals. I met with four nurses, two physicians, and four hospitalized patients at Michigan Medicine in March and April 2017. Each conversation lasted for 30 minutes, and I provided a brief introduction to users about my design prototype. This activity provided evidence that the tool I prototyped could be effective within the healthcare context once it is fully developed and that it could help alleviate existing problems identified from the fieldwork. The users provided further considerations to improve the prototype and develop it into an actual application. These points could be useful factors in a follow-up study.

Mainly discussed ideas for further development from users are listed below.

Technological literacy

Many patients claim that technology literacy might affect the accessibility of the platform. One of the patients said that he doesn't have any knowledge of using a smartphone or tablet, and it might be hard for him to use the tablet. He said if his caregiver (wife) or a nurse could help him use the tool, he would like to use it. His suggestion led me to consider expanding the scope of the user group to include caregivers and nurses. Another patient argued that the platform seems very easy to use, like an ATM at the bank. Even though the ATM is an advanced technology, it is very pervasive across the world.

Time spent exchanging medical information versus social interaction

One of the physicians expressed his frustration with time constraints. He said that for physicians, understanding each patient during a short in-person interaction is challenging. Until patients are admitted to the hospital, they don't know each other and have never met before, but physicians are only allowed a few minutes of conversation due to limited time. However, sometimes patients complain about physicians' apathy. He believes that the platform would make the same amount of time spent for in-person interactions more useful for social interactions with patients rather than just reducing time spent for each patient from the physician's perspective. Social interactions would foster patients' trust in their clinicians. In the healthcare context, trust between patients and clinicians often positively impacts medication adherence and engagement in clinical procedures (Skirbekk et al. 2011, 1182).

Medical information security

Clinicians said that connecting the design prototype with the current EMR system is desirable. But at the same time, they expressed



Figure 46. Testing my design prototype with a nurse in Michigan Medicine

concerns about medical information security. Even though the platform will only be available in the hospital, there is a chance to take a photograph of the screen or share protected health information with people outside the hospital.

Information hierarchy - Indicators for updated information

Many participants suggested having notifications for new information on the main page of the prototype, such as updated medication list or most recent laboratory results. When I designed the prototype, I didn't consider indications for each theme and users had to click and check when they wanted to view information. Clinicians noted that in the current EMR, there is a substantial amount information and it is almost impossible to track all the changes or updates for each patient. They suggested having indicators, such as a notification of how many new lab results or how many new medications patients have, might be helpful for both patients and clinicians so that patients can track their



Figure 47. Testing my design prototype with a patient in Michigan Medicine

important notifications and clinicians also can recognize it when they visit their room.

Educational level of the provided contents

As I mentioned briefly in section 6, *Fieldwork*, patients' education levels are variable. It is almost impossible to cover every patient in inpatient settings with information, but it is critical to cover as many patients as possible with an appropriate level of information. One physician suggested meeting with a patient education specialist in the hospital, who consults on the levels of information materials at Michigan Medicine.



DISCUSSION & FUTURE WORK



Discussion

In this study, I examined the communication factors between patients and clinicians in inpatient settings that lead patients to become passive communicators. I noted the most frequently addressed needs of patients during their hospitalization using ethnographic observation and qualitative interviews. I also noted the factors causing communication challenges between patients and clinicians, and reported insights led to the creation of a design prototype in the form

of a tablet-based platform. This design prototype aims to provide patients with a better understanding of their hospital stay and foster valuable communication with clinicians during patients' hospitalization. I concluded the study with feedback from patients and clinicians.

I believe my work benefits the field of design research in two ways.

First, my work not only uncovers currently emerging problems, but also suggests a design solution to alleviate those issues. Although there are multiple ongoing trials to investigate informational needs in the healthcare context, gaps still exist regarding solutions that aid patients' comprehension in inpatient settings. Since most work indicates what the problems are, but don't suggest how to address them, the current challenges are not so different from those that existed a decade ago. The efforts on examining current gaps, along with the investigation of possible design solutions, would make a small, but meaningful, step forward to fill the existing gap.

Second, it includes potential users from the very first stage of the study and thus allows me to accommodate actual users' needs and primary barriers over the course of the study. I used a qualitative design approach to capture unaddressed issues from data-driven methods that are pervasive in the healthcare context. I frequently interacted with people face-to-face. My design prototype was generated from the insights of patients, caregivers, clinicians, and multi-faceted discussions from my design colleagues and faculty advisors. Throughout the study, I examined the possibility of designers' collaborations with healthcare professionals and the healthcare system's capacity for further development. At the same time, I learned about the work culture of the healthcare system, medical language, and the context of inpatient settings during the study. These two levels of efforts lead to meaningful work.

The feedback from the patients and clinicians shows an important trend towards interventions to lessen patients' anxiety and fear.

Furthermore, it also demonstrates clinicians' desire to understand patients' needs more fully and patients' desire to communicate more efficiently with clinicians.

Limitations

My approach demonstrates how design research could inform the creation of new communication tools to empower patients and prepare them for valuable conversations with clinicians. However, I also acknowledge the limitations of this study.

First, the study was done in an inpatient setting in Ann Arbor, Michigan. The limitation of the location and the participants may affect the results. Ann Arbor is one of the most highly educated college towns located in the Midwestern United States. The population in Ann Arbor might not be representative of Michigan and similarly the population of Michigan might not be representative across the country. Since socioeconomic background and family structure influence healthcare experiences, people with different backgrounds might not have and report the same thoughts.

Second, the patients who granted ethnographic observation and the interviews were in relatively good physical condition. They were able to sit, talk, and listen to others. Patients who had more complex issues might not be able to share their insights due to the physical limitations, and their experiences in the hospital would be different from those patients who are more stable.

Third, this study only covered commonly revealed issues across the various diseases. The study doesn't include the specialty of particular diseases, such as special treatment, medications, or other supports that may be required by patients with particular diseases. Deeper investigation could reveal that different procedures would lead to various limitations, such as patients' movement, eating, drinking, or

restrictions, and it would also significantly affect patients' responses. For example, patients who are admitted to the hospital for their high blood pressure versus patients who are admitted for cancer might not go through an identical course of treatment procedures, which may differently affect their physical health and emotional state.

Finally, the study was conducted over seven months of the academic calendar, with approximately 60 hours of field observations and interviews. These limitations closely interrelate with the three limitations above, including participant recruitment, site selection, and the deeper understanding of particular illnesses.

Future Work

I received positive feedback from patients and clinicians. The feedback shows possibilities for further development of this study. Next steps would include refining the design prototype and creating a more developed tablet-based application. Seeking a partnership with institutions or integration with current EMR systems might be one possibility. To compensate for the limitations of this study, such as limited number of the participants, it would be ideal to recruit a larger number of participants and conduct more ethnographic interviews to provide richer data with a more complete application.

Furthermore, this research topic, patient-clinician communication, has great potential in the field of design research because of its potential impact on patient satisfaction. As I noted in the *Preliminary Research* section, my other projects are also broadly focused on improving patient satisfaction. Furthering my interests in my post-graduate studies, I will work as a researcher at C.S. Mott Children's Hospital in Michigan Medicine to enhance children's communication experiences over the course of their hospital stay and quality of care in the context of BMT treatment. Working at the hospital will provide an opportunity to interact with patients and healthcare professionals more closely.

This will enable me to explore the healthcare context through a patient-centered perspective as well as deepen my understanding of clinicians' work.

“

*I know they are busy
and everything,
but there ought to be
some way
that they could...*

*...make a patient
feel like, I'm not just
a set of symptoms.
I'm a real person.”*

CONCLUSION

I identified that the main problem with communication between patients and clinicians is the combination of limited access to information related to patients' hospital stay and clinicians' time constraints. This interferes with clear communication between patients and clinicians. I believe that high-quality in-person conversation will result in patients' better understanding of their care.

Based on my experiences with fieldwork, advanced technology cannot fully substitute human interaction.

“

I don't remember that well. I don't recall getting anything but more paperwork. The nurses were very good about explaining, you know. But again, it's more difficult than it seems when they say it.”

“

So I look at the medication list, and it's seven at night. I realize — oh my goodness — they did not tell me which ones he took today. I don't know the impact of giving double doses...”

Even with access to advanced technologies, patients will still desire human interaction with their clinicians. My approach to introducing a tablet-based platform would allow patients to be prepared to have effective in-person conversations with clinicians. It would also help avoid repetition and foster greater understanding between patients and clinicians. Having enhanced and high-quality patient-clinician conversations will result in better healthcare experiences, better healthcare outcomes, and improved patient satisfaction.





Figures 48-50. The design prototype was presented at 2017 MDers Graduation Exhibition

Works Cited

Anderson, Robert M., and Martha M. Funnell. 2005. "Patient Empowerment: Reflections on the Challenge of Fostering the Adoption of a New Paradigm." *Patient Education and Counseling* 57 (2): 153–157.

Ash, Joan S., Marc Berg, and Enrico Coiera. 2004. "Some Unintended Consequences of Information Technology in Health Care: The Nature of Patient Care Information System-Related Errors." *Journal of the American Medical Informatics Association* 11 (2): 104–112.

Baker, Alastair. 2001. "Crossing the Quality Chasm: A New Health System for the 21st Century." *BMJ: British Medical Journal* 323 (7322): 1192.

Bickmore, Timothy W., Laura M. Pfeifer, and Brian W. Jack. 2009. "Taking the Time to Care: Empowering Low Health Literacy Hospital Patients with Virtual Nurse Agents." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1265–1274. ACM.

Charles, Cathy, Amiram Gafni, and Tim Whelan. 1999. "Decision-Making in the Physician–patient Encounter: Revisiting the Shared Treatment Decision-Making Model." *Social Science & Medicine* 49 (5): 651–661.

Coulter, Angela, and Jo Ellins. 2007. "Effectiveness of Strategies for Informing, Educating, and Involving Patients." *Bmj* 335 (7609): 24–27.

Council, Design. 2007. "A Study of the Design Process." *UK Des. Counc* 44: 1–144.

Di Marco, Chrysanne, Peter Bray, H. Dominic Covvey, Donald D. Cowan, Vic Di Ciccio, Eduard Hovy, Joan Lipa, and Cathy Yang. 2006. "Authoring and Generation of Individualized Patient Education

Materials.” In *AMIA Annual Symposium Proceedings*, 2006:195. American Medical Informatics Association.

Fowles, Jinnet B., Allan C. Kind, Cheryl Craft, Elizabeth A. Kind, Jeffrey L. Mandel, and Susan Adlis. 2004. “Patients’ Interest in Reading Their Medical Record: Relation with Clinical and Sociodemographic Characteristics and Patients’ Approach to Health Care.” *Archives of Internal Medicine* 164 (7): 793–800.

Giordano, Laura A., Marc N. Elliott, Elizabeth Goldstein, William G. Lehrman, and Patrice A. Spencer. 2010. “Development, Implementation, and Public Reporting of the HCAHPS Survey.” *Medical Care Research and Review* 67 (1): 27–37.

Hersh, William R. 1995. “The Electronic Medical Record: Promises and Problems.” *Journal of the American Society for Information Science* (1986–1998) 46 (10): 772.

Hutchins, Edwin. 1995. *Cognition in the Wild*. MIT press.

Kaziunas, Elizabeth, Ayse G. Buyuktur, Jasmine Jones, Sung W. Choi, David A. Hanauer, and Mark S. Ackerman. 2015. “Transition and Reflection in the Use of Health Information: The Case of Pediatric Bone Marrow Transplant Caregivers.” In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 1763–1774. ACM.

Kendall, Logan, Sonali R. Mishra, Ari Pollack, Barry Aaronson, and Wanda Pratt. 2015. “Making Background Work Visible: Opportunities to Address Patient Information Needs in the Hospital.” In *AMIA Annual Symposium Proceedings*, 2015:1957. American Medical Informatics Association.

Kumar, Vijay. 2012. *101 Design Methods: A Structured Approach for Driving Innovation in Your Organization*. John Wiley & Sons.

Longtin, Yves, Hugo Sax, Lucian L. Leape, Susan E. Sheridan, Liam Donaldson, and Didier Pittet. 2010. "Patient Participation: Current Knowledge and Applicability to Patient Safety." In *Mayo Clinic Proceedings*, 85:53–62. Elsevier.

Maher, Molly, Elizabeth Kaziunas, Mark Ackerman, Holly Derry, Rachel Forringer, Kristen Miller, Dennis O'Reilly, et al. 2016. "User-Centered Design Groups to Engage Patients and Caregivers with a Personalized Health Information Technology Tool." *Biology of Blood and Marrow Transplantation* 22 (2): 349–358.

McCarthy, Danielle M., Barbara A. Buckley, Kirsten G. Engel, Victoria E. Forth, James G. Adams, and Kenzie A. Cameron. 2013. "Understanding Patient–Provider Conversations: What Are We Talking About?" *Academic Emergency Medicine* 20 (5): 441–448.

Nardi, Bonnie A., and Yrjö Engeström. 1999. "A Web on the Wind: The Structure of Invisible Work." *Computer Supported Cooperative Work (CSCW)* 8 (1): 1–8.

Ozkaynak, Mustafa, Patricia Flatley Brennan, David A. Hanauer, Sharon Johnson, Jos Aarts, Kai Zheng, and Saira N. Haque. 2013. "Patient-Centered Care Requires a Patient-Oriented Workflow Model." *Journal of the American Medical Informatics Association* 20 (e1): e14–e16.

Park, Sun Young, Yunan Chen, and Shriti Raj. 2017. "Beyond Health Literacy: Supporting Patient-Provider Communication during an Emergency Visit." In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*,

2179–2192. ACM.

Patel, Rupa A., Andrea Hartzler, Wanda Pratt, Anthony Back, Mary Czerwinski, and Asta Roseway. 2013. “Visual Feedback on Nonverbal Communication: A Design Exploration with Healthcare Professionals.” *2013 7th International Conference on Pervasive Computing Technologies for Healthcare and Workshops*, 105–112.

Prakash, Bhanu. 2010. “Patient Satisfaction.” *Journal of Cutaneous and Aesthetic Surgery* 3 (3): 151.

Pratt, Wanda, Kenton Unruh, Andrea Civan, and Meredith M. Skeels. 2006. “Personal Health Information Management.” *Communications of the ACM* 49 (1): 51–55.

Prey, Jennifer E., Janet Woollen, Lauren Wilcox, Alexander D. Sackeim, George Hripcsak, Suzanne Bakken, Susan Restaino, Steven Feiner, and David K. Vawdrey. 2014. “Patient Engagement in the Inpatient Setting: A Systematic Review.” *Journal of the American Medical Informatics Association* 21 (4): 742–750.

Runaas, Lyndsey, David Hanauer, Molly Maher, Evan Bischoff, Alex Fauer, Tiffany Hoang, Anna Munaco, et al. 2017. “BMT Roadmap: A User-Centered Design Health Information Technology Tool to Promote Patient-Centered Care in Pediatric Hematopoietic Cell Transplantation.” *Biology of Blood and Marrow Transplantation* 23 (5): 813–819.

Schillinger, Dean, John Piette, Kevin Grumbach, Frances Wang, Clifford Wilson, Carolyn Daher, Krishelle Leong-Grotz, Cesar Castro, and Andrew B. Bindman. 2003. “Closing the Loop: Physician Communication with Diabetic Patients Who Have Low Health Literacy.” *Archives of Internal Medicine* 163 (1): 83–90.

Sehgal, Niraj L., Adrienne Green, Arpana R. Vidyarthi, Mary A. Blegen, and Robert M. Wachter. 2010. "Patient Whiteboards as a Communication Tool in the Hospital Setting: A Survey of Practices and Recommendations." *Journal of Hospital Medicine* 5 (4): 234–239.

Skeels, Meredith, and Desney S. Tan. 2010. "Identifying Opportunities for Inpatient-Centric Technology." In *Proceedings of the 1st ACM International Health Informatics Symposium*, 580–589. ACM.

Skirbekk, Helge, Anne-Lise Middelthon, Per Hjortdahl, and Arnstein Finset. 2011. "Mandates of Trust in the Doctor–patient Relationship." *Qualitative Health Research* 21 (9): 1182–1190.

Star, Susan Leigh, and Anselm Strauss. 1999. "Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work." *Computer Supported Cooperative Work (CSCW)* 8 (1–2): 9–30.

Stewart, Moira A. 1995. "Effective Physician–Patient Communication and Health Outcomes: A Review." *CMAJ: Canadian Medical Association Journal* 152 (9): 1423.

Wilcox, Lauren G., Justin Gatewood, Dan Morris, Desney S. Tan, Steven Feiner, and Eric Horvitz. 2010. "Physician Attitudes about Patient-Facing Information Displays at an Urban Emergency Department." In *AMIA Annual Symposium Proceedings*, 2010:887. American Medical Informatics Association.

Wilcox, Lauren, Dan Morris, Desney Tan, and Justin Gatewood. 2010. "Designing Patient-Centric Information Displays for Hospitals." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2123–2132. ACM.

Wilcox, Lauren, Dan Morris, Desney Tan, Justin Gatewood, and Eric

Horvitz. 2011. "Characterizing Patient-Friendly Micro-Explanations of Medical Events." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 29–32. ACM.