Design and Evaluation of a Context-Aware User-Interface for Patient Rooms

by

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A thesis submitted in conformity with the requirements for the degree of Master of Health Science

Graduate Department of Institute of Biomaterials and Biomedical Engineering
University of Toronto

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Abstract

The process of patient care relies on clinical data spread across specialized hospital departments. Powerful software is being designed to assimilate this disconnected patient data before treatment can be decided. However, these data are often presented to clinicians on interfaces that do not fit clinical workflows, leading to poor operational efficiency and increased patient safety risks. This project relies on ethnographic design methods to create evidence of clinician preferences pertaining to the presentation and collection of information on user interfaces in patient rooms. Using data gathered in clinical observation, a prototype interface was designed to enable doctors to conduct clinical tasks through a usable patient room interface. The prototype evaluation with doctors identified clinical tasks that are relevant in the patient room and provided insight into the perceived usability of such an interface. The evaluation sessions also elucidated on issues of patient-centeredness in technology design, effortless authentication and interface customizability.
A monk told Joshu, “I have just entered the monastery. Please teach me.”

Joshu asked, “Have you eaten your rice porridge?”

The monk replied, “I have eaten.”

Joshu said, “Then you had better wash your bowl.”
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Chapter 1
Introduction

This chapter will introduce the research objectives, project scope, organization of the thesis and provide brief descriptions of some of the design and research methods used.

1.1 Problem statement

In current practice, the process of patient care is reliant on several individuals in specialized roles across hospital departments. Patient data has to be manually assimilated from several disconnected sources (e.g. medical devices, diagnostics tests) before the appropriate treatment can be decided. It goes without saying that in this complex network of care, it is essential that the correct information is effectively communicated in a timely manner. While powerful software products are being developed to assimilate and analyze this data, the presentation of this data to clinicians has not been addressed. This has often led to poorly designed interfaces that do not fit the clinical workflows of clinicians, leading to poor operational efficiency and increased patient safety risks. [1]

This project aims to create evidence of clinician preferences pertaining to the presentation of information on user-interfaces in patient rooms. It will also help identify the various contexts which exist in this environment. This will help establish basic standards of user-interface design for various applications in this environment and provide designers of information systems with an understanding of the functional needs of different contexts identified here.

Furthermore, it can be contended that designing user-interfaces collaboratively with clinicians might result in a higher adoption rate for information (e-health) systems. This is because attitudes of clinicians play a pivotal role in the adoption and use of information technology in healthcare [2]. A higher rate of adoption for e-health tools may equate to a reduction in the rate of adverse events in acute care patient rooms – since the manual data assimilation phase is eliminated and replaced with a usable human-computer interface.
Thus, this research attempts to understand the expectations of clinicians in regards to the presentation and collection of information in the patient room. This research is motivated by the impact of information presentation on clinical effectiveness and patient safety. It can most fittingly be classified as an exploratory Human Computer Interaction (HCI) investigation in the clinical setting. Using the Medical Research Council (UK) framework for design and evaluation of complex interventions to improve health, this research can also be classified as a Phase 1 research, i.e., research using modeling, simulation and qualitative analysis to improve the understanding of the components of an intervention and their relationships. [3]

1.2 Objectives

The objectives of this research are to:

1. Determine the design criteria for a usable patient room information display system, and base these design criteria on the understanding of the context of use (users, tasks, technology, physical environment, organizational practices);
2. Design a user interface prototype for a patient room information display system, based on information from objective one;
3. Evaluate the resulting user interface prototype with a group of doctors to identify usability concerns and measure perceived usability

1.3 Research Question

This research will attempt to answer the following question:

Can a context-aware user interface displaying assimilated medical (or other) data prove to be a useful tool in the treatment of acute care patients?

1.4 Scope of research

The primary focus of this research project is to define design criteria for an adaptive user-interface in acute care patient rooms and to evaluate these design criteria with users to assess perceived usability of such an interface. The only user group included in the design is doctors engaged in acute care; i.e., patients, nurses, allied health professionals and other care team
members have not directly been involved in the research. Neither are practitioners of clinical specialties, which are outside the umbrella of acute care.

1.5 Research Methodology

To design a system for a complex clinical environment with varied user types, it is imperative to develop an understanding of the users, user’s tasks, physical environment, organizational environment and technological environment. In other words, an information display for the patient room exists within a complex socio-technical environment, where users are often not fully aware of the effects of their actions on other parts of this socio-technical environment. Thus to develop holistic solutions, it is essential to use a design methodology that provides a way to bring these social elements into the system development process. A design methodology which satisfies this criterion is known as ‘Ethnographic Design’. An overall representation of the ethnographic design methodology used in this research project is shown in Figure 1-1. Research tasks are shown in grey boxes and the research methods associated with each task are highlighted in a proximal red box.

Figure 1-1: Overall design methodology. Research tasks shown in grey boxes and methods in red boxes.
The design methodology follows a cyclical pattern allowing the design to iterate until a desired level of usability and utility is established. The four major research tasks are to:

1) Understand the context of use - This step builds the researcher’s knowledge of the socio-technical system in which the proposed product operates. This is accomplished through observation sessions (ethnography).

2) Define design criteria - This step further formalizes the researcher’s understanding through use of a tool known as the abstraction hierarchy. It also employs a qualitative analysis technique known as thematic analysis to analyze field notes and images collected in the previous step (observation). Having done so, the researchers are able to define design criteria for the proposed product.

3) Produce design solutions - In this step, user interface prototypes are developed based on the design criteria defined in step two. Good practices from the fields of usability and heuristics are used to guide this stage.

4) Evaluate with users - This step provides the end users with an opportunity to critique and collaboratively improve the proposed design solutions from the previous step. The researchers rely on interviews, usability questionnaires and Wizard of Oz testing to uncover perceived usability of the design.

Brief descriptions of the main research methods (red boxes in Figure 1) used in this research project are included below to further clarify the research methodology used.

1.5.1 Observation (Ethnography)

Ethnography is a research method based on observing people in their natural environment rather than a formal research setting. Ethnography helps researchers formalize their understanding of the end users, how they operate and how they make decisions in a complex environment. When ethnography is made part of a computer systems design process, it helps designers understand the use cases, processes and introduces a social element in the requirements gathering stage. This approach provides designers with a way to place users at the core of system design. [4]
1.5.2 Thematic Analysis

Theme identification is a commonly used method for the qualitative analysis of textual data originating from interviews and observations. Thematic analysis can be divided into four tasks, (i) discovering themes and subthemes, (ii) deciding which themes are important to the project, (iii) building hierarchies of themes or code books, and (iv) linking themes into theoretical models [5]. Thematic analysis identifies recurring patterns, interruptions, assumptions and preferences latent in the qualitative data.

1.5.3 Abstraction Hierarchy

Abstraction Hierarchy is a technique outlined in Work Domain Analysis - the first stage of Cognitive Work Analysis used in the Cognitive Engineering field since 1999 [6]. Abstraction Hierarchy is a five-level functional decomposition used for modeling complex socio-technical systems [7]. It provides designers with a way to formalize and communicate their understanding of workplace functions and interactions in varying level of detail.

1.5.4 Wizard-of-Oz evaluation

‘Wizard-of-Oz’ is an interactive observational evaluation method. In this evaluation method a user interactions with a prototype are closely monitored and system responses are simulated by an unseen human operator. During the evaluation exercise the users perceive that they are controlling the system directly. This provides designers with a method of evaluating software prototypes without full implementation [8].

1.5.5 System Usability Scale (SUS) questionnaire

The System Usability Scale (SUS) was developed to quickly and easily assess the usability of a given product or service. Several attributes make the SUS attractive for use in this project - firstly, it is technology agnostic making it flexible and easy for anyone to understand. It also provides a single score which is widely understood by usability practitioners. Lastly, the survey is quick to complete and non-proprietary [9].

1.5.6 Semi-structured interviews

Semi-structured interviewing is a style of conducting interviews that follows a fluid and flexible structure. A semi-structured interview is usually organized around an interview guide consisting
of topics or areas to be covered during the course of the interview. However the sequencing of these topics and creation of any follow-up questions is at the discretion of the interviewer. This interviewing style allows for a conversational dialogue between the interviewee and the interviewer. [10]

1.5.7 Card sorting

Card sorting is a generative method used to uncover mental models about issues relevant to a design. In this technique end users are presented with cards labeled with a variety of items. The users are then asked to group these cards into various categories which are derived from concepts the designers are attempting to understand [11]. This technique is primarily used to design information architecture for websites, but can be applied to any investigation seeking to uncover user’s tacit mental models.

1.6 Organization of Thesis

Chapter 2 outlines the motivation behind this project and provides insight into the possible impact of such a system implementation. Chapter 3 takes a look at the literature to introduce and discuss e-health systems, context-aware technology and wizard-of-oz evaluations in clinical environments. Chapter 4 describes the observation of doctors in their workplace and the evaluation of this session to define the design criteria for a user interface in the patient room. Chapter 5 describes the proposed system design and introduces mock user-interface designs. Chapter 6 describes the sessions undertaken with doctors to evaluate the proposed system. Chapter 7 ends the thesis document with final conclusions and recommendations for future work.
This chapter will delve into the motivating factors for this research project.

2.1 Adverse Events Studies

Adverse events are events where unintended injury is caused to patients by healthcare management, as opposed to the patient’s disease process. These events contribute to longer hospital stays, disability and even death. A retrospective study of Canadian hospital admissions revealed that 7.5% of all admissions in 2004 suffered adverse events. Of these, 36.9% were judged to be preventable and 20.8% led to death. By extrapolation, these results suggest that in the year 2000 between 9,250 to 23,750 deaths occurred due to preventable adverse events [12]. These figures are roughly three to eight times the number of deaths on Canadian roads due to accidents that same year.

In an effort to curb adverse events, several studies have been carried out to identify error rates in different clinical activities. Some of these studies are summarized in Table 2-1

<table>
<thead>
<tr>
<th>Clinical Activity</th>
<th>Study Description [13]</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication of clinical data over telephone.</td>
<td>Analyzed the reliability of transfer of pathology results to doctors over the telephone. Sample set of 822 calls.</td>
<td>In 3.5% of the calls the doctor had misunderstood or mis-transcribed the data. [14]</td>
</tr>
<tr>
<td>Bedside blood transfusion</td>
<td>1. Freq. and nature of transfusion errors. 808 patients studied.</td>
<td>1. 1.6% ‘serious errors’. 1 in 115 patients receiving wrong blood [15]</td>
</tr>
<tr>
<td></td>
<td>2. Analyzed transfusions with and without bar-coding. 1500 patients.</td>
<td>2. Very poor compliance with checking procedures. [16]</td>
</tr>
<tr>
<td>Accessing test results</td>
<td>Examined clinical awareness of abnormal test results received</td>
<td>Important results were missed in nearly 1% of patient discharges.</td>
</tr>
</tbody>
</table>
These statistics have ensued a lengthy debate over the estimate of harm done by adverse events. In this debate, analogies are often drawn between healthcare and other high-risk industries such as civil aviation and nuclear energy. An article by Amalberti et al explains why the solution for healthcare is not as simple as adopting success stories from these other industries. The article identifies five systemic barriers that currently prevent healthcare from becoming a high reliability industry.

- Barrier 1: Acceptance of limitations on maximum performance
- Barrier 2: Abandonment of professional autonomy
- Barrier 3: Transition from the mindset of craftsman to that of an equivalent actor
- Barrier 4: Need for system-level arbitration to optimize safety strategies
- Barrier 5: The need to simplify professional rules and regulations [20]

In an effort to improve safety by means of addressing to the fifth barrier, i.e. the need to simplify, various information technology solutions are being introduced in healthcare. The process of clinical data assimilation, processing and communication, is being simplified by the use of e-health systems (ex: Electronic Medical Record (EMR), Practice Management software etc). However, while powerful software is being developed to analyze large amounts of data and even predict the onset of diseases, the presentation of this data to clinicians has not been addressed. This has shown itself in the form of growing dissatisfaction amongst clinicians and policy makers regarding EMR usability.
2.2 Clinical Information Systems Usability Studies

A study by Smelcer et al. investigated the usability of EMRs in 2009 and identified two key concerns from a clinician’s point of view – long training times and loss of productivity. They further commented on the fundamental factors contributing to interfaces with poor usability as follows,

“Fundamentally, usability problems arise in EMRs because of the interaction of three very complex components: physicians, their tasks, and the EMR. Physicians are highly trained professionals with very large knowledge bases and deep problem solving skills. In addition, physicians specialize in one of dozens of specialties. The tasks they complete, diagnosing and treating illnesses, are very complex and high risk. Finally, to support physicians as they complete their tasks, they need a very complex but efficient information system. Making complex systems usable is extremely difficult. It is no surprise that most EMRs struggle with usability.” [21]

Another research study by Zhang et al. was presented at the National Institute of Standards and Technology (U.S.A) workshop on creating usable EHR systems (May 2012). It applies the TURF (Tasks, Users, Representation, and Function) model to map critical patient safety risks posed by a paediatric EHR. In this model the researchers describe the relation between poor navigational structure, user interface entities (text, graphs, checkboxes, buttons etc.) and organizational structures (spatial layout, color, shape etc), to adverse events (Figure 2-1) [22].
In 2009, The Healthcare Information and Management Systems Society (HIMSS) also created a taskforce to assess clinician pain-points in regards to electronic health record (EHR) usability. This was part of an effort to identify reasons for poor EHR uptake. They surveyed 94 clinicians and concluded that,

- “Contrary to low adoption of EHR in general, most of the respondents to the survey were satisfied with their EHR

- Although most of the respondents to the survey were satisfied with their EHR, they reported 1,237 usability problems and rated the severity of 80% of them as ‘High’ or ‘Medium’

- Workflow was #1 EHR usability pain point throughout all the 17 EHR modules and components that were surveyed

Other EHR usability pain points include configuration, integration, presentation, content, data integrity, policy, and performance.” [23]
2.3 Implications for Researchers

Several opportunities exist to further define usability concerns in information displays and to develop models to navigate these issues during information systems design phase. A unique and sparsely explored approach to simplifying the complexity of clinical information systems, as experienced by the end user, could be through machine learning. By using context-awareness as an extension of machine learning, intelligent information systems can be created that reduce navigation required in a complex information system environment – thereby improving usability. This idea of context-aware information systems is further explored in the following chapter.
Chapter 3
Literature Review

To simplify the error-prone process of clinical data assimilation and presentation, the use of information technology in hospitals for data processing and communication (termed ‘e-health’), is being viewed as a paradigm shift in healthcare management. In an effort to understand how these e-health systems interact and communicate with clinicians and patients a literature review was carried out. The following are examples of the implementation and/or evaluation of a few information technology systems in hospitals, categorized into three headings relevant to this project; namely, E-health systems, Context-Awareness and Wizard-of-Oz evaluation.

3.1 E-health Systems

E-health system is an umbrella term used to describe a variety of services in healthcare that aim to improve care, efficiency, security and accountability by leveraging information technology. One of the most prevalent e-health systems are Electronic Medical Records (EMR). An EMR stores all the clinical data in a provider’s office or hospital so it can be accessed quickly and thus, creates measures for accountability. E-health systems and particularly EMR systems hold promise of transforming healthcare delivery. Hence their uptake is recommended by healthcare policy makers and governments.

For the purposes of this project, the literature review will examine technologically advanced e-Health systems available for use or under development. This will help comprehend the technological capability currently possible as well develop an appreciation for the degree of possible technology penetration in healthcare institutions.

3.1.1 IBM Stream Computing

The IBM stream computing software can run analytics and discover correlations between several real-time data streams of heterogeneous data types such as alphanumeric, video, EKG, etc. This system was implemented in the neonatal ICU of the SickKids Hospital in Toronto [24]. Here it was implemented to watch 16 streams of data to generate alerts based on collective trends of these streams - unlike monitoring systems which generate alert when only one vital sign is out of
normal range. The system was to predict the onset of disease (nosocomial infection) by assessing real-time streams and making correlations with known clinical data (data-mining). This information system greatly automates information flow between different points-of-interest within the network of care. An information flow diagram of this system is shown in Figure 3-1.

![IBM Stream Computing platform at SickKids Hospital](image)

**Figure 3-1: IBM Stream Computing platform at SickKids Hospital [24]**

### 3.1.2 Integrated Modularized Administrative Technical Information System (IMATIS)

IMATIS is an integration platform that compiles large amounts of data across the hospital and transforms it into one data-repository. This way it is able to distribute any subset of this gathered information to the right people through a web portal that can be accessed from various locations or devices [25]. Using this system architecture (Figure 3-2) as a basis, several applications have been developed. Two of the most relevant ones are,

1. Imatis Ludus: The Imatis Ludus is an application which provides the patient with a range of entertainment options such as radio, movies, e-books, internet access, games etc. It allows the patient to control lighting, temperature, make voice calls from the system, video conference or call a nurse for assistance. To enhance patient education the Ludus allows clinicians to review patient test results, scans etc with their patients at the bed-side. Patients interact with the application through a touch screen display screen mounted close to their bed-side. For ease-of-use, the menu navigation icons are large symbols. The application can
also be personalized for each patient by providing a log-in id to the patient - this provides a uniform user-experience across all the terminals in a hospital.

2. Imatis Visi: Imatis Visi is an electronic whiteboard for emergency departments which supports clinicians in maintaining an overview of the patients at the department. This system has a configurable user-interface, thus attending to the varying workflows in different emergency departments. Rasmussen et al [26] and Hertzum et al [27] describe the implementation of this system in two emergency departments in Denmark. First they detail a survey they used to understand the key expectations that clinicians have towards electronic whiteboards. Using this information they were able to collaborate with clinicians to build custom interfaces for each hospital and go through rapid system development iterations.

![Figure 3-2: The IMATIS System Architecture [25]](image)

**Discussion:** Both these e-health systems provide a powerful framework to securely handle large amounts of data. However, these and other similar e-health tools do not place much emphasis on the presentation of this data to clinicians. The presentation of data is an important avenue of knowledge translation from the e-health tool to the clinician and requires a usable human-
computer interface. The Hertzum et al. [27] study adopts a good method to identify clinician expectations towards electronic whiteboards in emergency departments. They knew that clinicians used whiteboards to maintain an ‘overview’ of the department, however, the meaning of ‘overview’ was fuzzy. Thus, they conducted surveys (7-point Likert scale) at two emergency departments to explore the notion of ‘overview’ and as a result uncovered clinician expectations towards electronic whiteboards. The results from their study were used to develop and test electronic whiteboards in these two hospitals. The information conveyed through computer interfaces in patient rooms is assessed at the point-of-care and quickly translated into a treatment plan for the patient. This makes the information being conveyed very significant and makes it is essential to carry out a design process similar to the Hertzum et al. study for computer interfaces in patient rooms.

A laudable feature of E-health systems is that they enable access to relevant patient data from several devices in different locations. The Imatis Vizi for instance has enabled the emergency department’s staff in a Danish hospital to move their ‘planning time-outs’ from the busy space in front of the electronic whiteboard to a meeting room more convenient for the purpose, while still accessing the same information. Similarly, the Imatis Ludus enables clinicians to share patient test results with them on the bedside display for increased convenience. Although these systems have greatly increased the number of points-of-access to relevant information, they still require explicit input from the user to operate. In essence, one can think of this system as a distributed network of desktop computers with access to central knowledge base. This style of interaction forces the clinicians or patients away from the point-of-care and into the machine’s environment. Furthermore, explicit interactions are usable in a limited set of user and environmental constraints and cannot accommodate the changing needs of either. In a hospital setting, situations can change rapidly and systems which are unable to adapt quickly become a burden to interact with. The missing link to ensuring that these systems remain usable in changing environments is the representation of context.

3.2 Context-Awareness

Lieberman and Selker [28] define ‘context of use’ as comprising of the state of the user, the physical environment, the computational environment and the history of interactions between these three. Context-aware systems are able to utilize these factors as implicit inputs in their
computations, thus becoming more adaptive. By applying context-awareness to interfaces in patient rooms, patients and clinicians will have access to an intelligent system which maintains a basic level of usability across the different contexts of users and associated environments. This will help clinicians and patients move out of the ‘desktop paradigm’ of current e-health systems which rely heavily on explicit inputs.

The international standards organization (ISO) defines ‘context of use’ in the ISO 9241 standard as consisting of “the users, tasks and equipment (hardware, software and materials), and the physical and social environments in which a product is used”. Building on this definition Maguire [29] presents a breakdown of context and recommend key considerations in carrying out a ‘context of use analysis’. Table 3-1 presents the components of context of use.

Table 3-1: Components of Context of Use Analysis [29]

<table>
<thead>
<tr>
<th>Component</th>
<th>Key Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>User role; Experience, knowledge and skills (training, similar experiences);</td>
</tr>
<tr>
<td></td>
<td>Personal attributes (Physical and cognitive capabilities, attitude, age)</td>
</tr>
<tr>
<td>Task</td>
<td>Task output, frequency, duration, risks resulting from error</td>
</tr>
<tr>
<td>Technical Environment</td>
<td>Hardware, software, network, reference materials</td>
</tr>
<tr>
<td>Physical Environment</td>
<td>Workplace conditions (lighting, sounds, temperature); Workplace design</td>
</tr>
<tr>
<td></td>
<td>(Furniture, location, user posture); Workplace Safety (Protective clothing, health</td>
</tr>
<tr>
<td></td>
<td>hazards)</td>
</tr>
<tr>
<td>Organizational Environment</td>
<td>Structure (group work, assistance, interruptions); Attitudes and culture</td>
</tr>
<tr>
<td></td>
<td>(Organizational aims, industrial relations); Job design (hours of work,</td>
</tr>
<tr>
<td></td>
<td>performance monitoring, autonomy)</td>
</tr>
</tbody>
</table>

3.2.1 Context-awareness infrastructure

Bardram et al [30] discuss their various experiences from the deployment of context-aware technologies in a medium-size European hospital. These technologies were supported by a context-awareness infrastructure responsible for the acquisition, distribution and modeling of context information. This infrastructure modeled the following contexts, ‘location’ (sensed),
‘status’ (self-reported) and ‘scheduled activity’ (access to clinician/surgical schedules). The infrastructure comprised of a ‘Context service’ and an ‘Aware service’. The ‘Context service’ stored, managed and grouped context information, while the ‘Aware service’ distributed relevant context information to applications (Figure 3-3).

Figure 3-3: Context-awareness infrastructure used with AwareMedia and AwarePhone [30]

The AwareMedia application supports coordination amongst surgical staff by enabling social awareness of clinicians involved in surgeries. It uses a large interactive display to display each user’s location, self-reported status and scheduled activity. The display can also display status and scheduled activity of each operating room (ex: patient arrived, patient anesthetized etc). This large display was situated in coordination room for surgeries.

The AwarePhone gave this social awareness a mobile form. It also enabled messages to be sent between users. This was a particularly helpful tool for ambulatory members of the surgical staff such as surgical technicians who frequent several ongoing surgeries.

**Discussion:** This study involving AwareMedia and AwarePhone brings the following important and relevant points to light.

1. Through participant interviews at the end of trialing, the researchers revealed that sharing personal context information (ex: location, status and activity) was acceptable to clinicians as the benefits outweighed their privacy concerns.

2. A central context-awareness infrastructure can be used to host a variety of client applications which can be context aware.
3. Designers of context-aware computing systems should consider the following factors,

   a. Accuracy of context information – ex: Self reported status considered more accurate than inferred clinician status

   b. Confidence in action to take – ex: Patients nearly always enter OR for surgery, but a surgeon may enter for a variety of reasons. Thus confidence in action to take is higher in case of patient.

   c. Consequence of the action – ex: Displaying patient record on a shared screen in the OR versus displaying it on a shared screen in a public location. Tradeoff between a passive role or a more active role for technology.

   The researchers note that their system was employed by clinicians in a passive manner, i.e. it was used primarily to display context information with the goal of helping surgical staff maintain an overview (social awareness). This is different from the proposed goal of this thesis project, wherein, the context information will be used in the system’s decision making.

3.2.2 Log-in and ubiquitous computing

   In another field study in a Danish hospital, Bardram [31] explores the usability problems existing in current log-in procedures. This is a relevant topic of discussion for this thesis project as we aim to enhance usability of user interfaces while ensuring security of sensitive data. Bardram identifies several usability issues with traditional authentication procedures and proposes a new design which places emphasis on,

   1. Proximity based user-authentication – log-in by simply approaching the display
   2. Silent login – seamlessly alternate between different users
   3. Migrating user sessions – enable personalized access over a distribution of displays
   4. Suspendable user sessions – suspend a session upon interruption in workflow

   Upon conducting design sessions, it was discovered that clinicians preferred to make an active gesture to log-in and did not wish to log-in simply because he/she happened to be standing next to a screen. This led to the creation of a personal pen that each clinician would carry with them.
This pen was used to interact with the displays and was embedded with a Java card which could be read by contactless smart card readers. Upon receiving a log-in request from a pen, the system ensures that the pen is with its assigned owner by ensuring that the pen’s owner is also in the same physical location. This adds another layer of security and is accomplished by using a context-awareness infrastructure similar to the one described earlier. Furthermore, when multiple clinicians are working on a patient’s record on the same screen (ex: clinical conferences), the use of personal pens could enable the system to track individual entries to the corresponding clinician.

**Discussion:** This study presented very innovative solution to a pertinent problem and in doing so it exposes the nature of clinical work. Important lessons from this study are,

1. “The nature of medical work is nomadic, interrupted and cooperative around sharing common material”

2. Features such as silent log-in, suspendable sessions and migrating sessions are designed such that the user does not perceive a visible change in system state. This greatly enhances usability and user satisfaction.

3. There is some discussion about handling variation in roles (ex: doctors can prescribe medicines, but nurses cannot). This is an important social context which needs to be included in designs proposed in this thesis project.

4. The researchers break down ward rounds into three sub-tasks – preparation, visit and closing. Although this thesis project examines the information exchange occurring during the ‘visit’ sub-task, it is important to understand the other sub-tasks as they are deeply interdependent.

### 3.3 Wizard-of-Oz evaluation of displays

‘Wizard-of-Oz’ is an interactive observational evaluation method. In this evaluation method a user interactions with a prototype are closely monitored and system responses are simulated by an unseen human operator. During the evaluation exercise the users perceive that they are controlling the system directly. This provides designers with a method of evaluating software
prototypes without full implementation. Some relevant projects which employed this approach to testing are described below.

### 3.3.1 Clinical Surfaces Project

‘Clinical Surfaces’ is a distributed multi-display environment (dMDE) which aims to help clinicians use public displays for managing large amounts of medical data. In this project Bardram et al [32] used both fixed (wall-mounted) and mobile displays to support the nomadic nature of hospital work. They used a user interface (Figure 3-4) which could be scaled to fit a range of screens from portable tablet computer to large wall based displays.

The researchers utilized ‘activity based computing’ to model and aggregate real-world human activities as a corresponding computational activity. For example, the real-world activity of ‘treating a patient’ can be linked to the corresponding computational activity wherein all medical data related to the patient is collected and displayed. The system was evaluated in a hospital with eight clinicians. In the evaluation fifteen patient cases were modeled and eight clinicians used the system, which was run in a Wizard-of-Oz manner. They employed think-out-loud protocol while the clinicians interacted with the system and also used a questionnaire to examine the perceived usefulness of the system.
Figure 3-4: 'Clinical Surfaces' UI - (A) Context bar; (B) List of activities; (C) resumed activity with associated resources; (D) Two applications running [32]

Discussion: The Clinical Surfaces system was innovative in its approach of using real-world activities as the context for computational processes in the system. Relevant outcomes from this study are,

1. To maximize security of medical data the Clinical Surfaces system was able to operate in three privacy modes- public, personal and private.

2. Result of the post-use questionnaire revealed that clinicians indicated low perceived usefulness for the context-based adaptation of the user interface (3.56 out of 5; 0.84 std.dev). The system used locations of clinicians/patients to determine the most relevant activity was, and adapted its user interface accordingly. However the study shows that the most relevant activity is not correctly identified by location tracking of personnel, rather it is more dependent on clinical issues like the urgency of a case, order of surgeries etc.

3. Another issue with the context-based adaptation of the user interface was that the content and appearance of the display would change based on the people entering and leaving the room. This often caused confusion and hence was undesirable.
4. Only clinicians were the desired users of this system and patients did not play a role in the development and evaluation. Clinicians were not involved in the design of the system from the start. In both these ways the Clinical Surfaces system greatly differs from this proposed thesis project.

5. Since only browsing of patient data was being investigated, a Wizard-of-Oz approach was considered sufficient for system evaluation. Thus instead of using the actual application, the evaluation employed screen-shots of various user interface variations.

6. The evaluation used real patient data (all medical data and events) in an anonymous form.

3.3.2 Patient-centric information display

Wilcox et al [33] identify the need to present patients with information about the course of their treatment as a means of reducing anxiety and negative clinical outcomes. Relying on the experience of physicians, the researchers were able to identify seven items of interest to patients and presented them in the following headings - reason for your visit, your health profile, your vitals, what’s next, we’ve completed, medications/allergies, your care team. Having identified these, the researchers created eighteen paper prototypes of varying sizes and layouts for a Wizard of Oz evaluation (Figure 3-5). These prototypes were placed in patient rooms and information displayed on the prototypes was manually updated as more information became available. The researchers relied on semi-structured interviews with the patients, patient family and hospital staff to draw subjective response and elicit guidelines regarding information displayed, privacy and use cases.
Discussion: Although this project was completely patient-centric it utilized several low-fidelity techniques to develop a design and examine its feasibility. Relevant aspects of this study are,

1. Even low fidelity prototypes can be used for evaluation. These prototypes are able to generate feedback from users by representing a design idea in a tangible and easily modifiable form.

2. Wizard of Oz evaluation followed by semi-structured interviews are a good way to examine the more involved issues of a design. In this study, important guidelines regarding privacy were formed as a result of the interviews.

3. Despite the patient-centered system, no patients were involved in the system design. This may be due to difficulty recruiting patients or due to the fact that physician experiences might better reflect collective patient preferences.

4. There was no interaction with display - it was a pure information display.
This chapter will describe the observational session undertaken at an acute care facility to understand the workflow and information sharing practices currently in use by doctors.

4.1 Research questions

The research questions which were sought to be answered through this observation session are:

1. What types of information exchange takes place in the patient room?
2. What types of information exchange tools exist in the General Internal Medicine ward?
3. What are the key contexts that exist in the General Internal Medicine ward?

4.2 Methods

An observational session was carried out at the General Internal Medicine ward at St. Michael’s Hospital (Toronto, ON, Canada; www.stmichaelshospital.com) between 8AM and 4:15PM on November 20th 2012. During this time a doctor (a fourth year resident in Internal Medicine) was work-shadowed as he provided care to five patients and undertook one discharge and one admission. Notes and sketches were made, recording interactions and information exchange that the doctor engaged in. Before each patient visit, the patient was asked permission to have the researcher observe. Only when permission was granted were the interactions observed.

Thematic analysis was used to analyze the observational notes (as described in Chapter 1). The observation field notes and sketches were divided into 66 smaller expressions or codes. These codes were grouped and re-grouped based on inductive and deductive qualitative analysis practices as outline by Ryan and Bernard [5]. To identify themes in the data, inductive approaches such as looking at repetitions and interruptions were used. Similarly to identify themes around the research interests (an a priori approach), codes pertaining to EMR and patient interaction were grouped to identify themes.
A simplified adaptation of the Abstraction Hierarchy (as described in Chapter 1) was also used to formalize the researcher’s understanding of the function, tasks and tools within the General Internal Medicine ward.

4.3 Results

4.3.1 Thematic Analysis

Using the observational field notes of the researcher created during work-shadowing one doctor (n=1), thematic analysis was carried out (as introduced in section 1.5.2). Thematic analysis results can be summarized in the following visual (Figure 4-1). Each column represents a theme and each silver box in a column is a sub-theme.

Figure 4-1: Key themes identified from observational field notes
First an inductive approach to thematic analysis was taken, i.e. examining repetitions and interruptions in the field notes. The term ‘Nursing Station’ was the most frequently repeated word in the field notes so descriptive conclusions about this space were drawn from the codes. Interruptions to tasks were considered to better provide insight into work practices. Codes that included interruptions were grouped into a theme. Being paged was also considered an interruption to normal workflow as it is an unplanned event. The information exchanged in these interruptions was further grouped into sub-themes.

Then to examine the field notes deductively, codes with the term EMR were grouped together to provide a concise view at the data gathered about EMR. Another topic of interest to this research project was to understand information exchange that takes place in the patient room. Codes that fit this criterion were also grouped to form the final theme from this data. These four themes combined, served as sources of information for the doctors.

**Abstraction Hierarchy**

An abstraction hierarchy was created to display the researcher’s understanding of the overall system in varying detail (Figure 4-2). This tool was preferred over workflow diagrams because workflows in the clinical setting often change and cannot be generalized between clinicians. Smelcer et al. also make this observation in their study on EMR usability carried out in 2009. They note that there is “enormous variability” amongst doctors pace of work, use of nurses, mode and timing of data entry etc [21]. Furthermore, unlike an abstraction hierarchy, workflow diagrams are unable to relay information about the relations of various system components in accomplishing tasks. The abstraction hierarchy created only incorporates three of the five levels described in Cognitive Work Analysis [6], as these three were considered sufficient by the researcher in summarizing the overall system.
4.4 Discussion: Defining Design Requirements

The qualitative analysis of data collected in the observation session provided good insight into the current practices of information management in the acute care hospital setting. The observation session allowed researchers to understand the existing usability concerns with information exchange tools (e.g., navigation challenges in EMR). It also identified the unique features mandated by this environment (e.g., physical form should account for infection risks). Based on this understanding, the following design criteria were formulated to address the shortcomings of currently used technologies and processes. Emphasis was also laid on making a design accessible at the point of care, i.e., in the patient room. The design criteria established are presented in Table 4-1.
Table 4-1: Design Criteria

<table>
<thead>
<tr>
<th>User Interface Criteria</th>
<th>Physical Form Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal Navigation</td>
<td>Ergonomic interactions</td>
</tr>
<tr>
<td>Minimal Confirmation Requests</td>
<td>Mitigate infection risks</td>
</tr>
<tr>
<td>Notification of updates</td>
<td>Facilitate teamwork</td>
</tr>
<tr>
<td>Secure</td>
<td></td>
</tr>
<tr>
<td>Facilitate communication within care team and with patient</td>
<td></td>
</tr>
</tbody>
</table>

These criteria were defined to be broad in nature and technology/systems agnostic so that they could comprehensively represent the needs of clinicians from information systems. Thus, these criteria can be applied to the design of a number of information systems in the clinical setting and in particular to the information systems planned for use in the patient room.

It is important to note that given the broad nature of the design criteria, a large number of possible solutions could satisfy design criteria - in product development terms, this is a large design space. Such design spaces grant designers the flexibility to develop innovative methods of addressing the design criteria and thus are conducive to research. The next chapter will specify one such system to satisfy these design criteria.

4.5 Limitations

This approach to uncovering and defining knowledge of systems and the various contexts therein has the following limitations.

1. Since observership was carried out only in one hospital, the direct exposure to EMR systems was limited to just the one system used in that hospital. Thus some of the problems identified through the thematic analysis, might be biased to reflect the usability and workflow concerns generated by that particular EMR system.
2. Only one medical specialty (General Internal Medicine, GIM hereafter) ward was observed. This was because the researcher’s wished to focus on acute care patients and GIM wards provide care to the lion’s share of acutely ill patients.

3. The only member of the clinical care team shadowed by the researcher was a doctor. This is a certainly a limitation as good design practices recommend involving all stakeholders in the design. However since doctors often lead and direct the patient care teams, shadowing just the doctors was considered a good starting point to exploring issues of sharing and presentation of information.

4. Another limitation is that only one observation session was carried out. During the observation the researcher observed the ongoing care of three patients, one patient admission from the Emergency Department and one patient discharge. This allowed the researcher to collect data on the doctor’s information exchanges with a variety of patients (different ages, acuity of conditions and linguistic capacities). The researcher was also able to note the various locations of information exchange tools (e.g. EMR, charts, paper forms, computer on wheels etc.) within the ward. The amount and variety of data collected during the observership built a general understanding of the functioning of the GIM ward. This general understanding was deemed sufficient to start drawing conclusions from to begin design iterations with doctors.
Chapter 5
Preliminary System Design

Using the design criteria developed in Chapter 4 as guidelines, a preliminary system design was completed. This design draws from context-aware systems reviewed in the literature (Chapter 3) and also on the research team’s experiences in designing intelligent systems. This chapter will elucidate this design.

5.1 System Block Diagram

Figure 5-1 represents the overall system concept showing two categories of input to the system, explicit inputs (e.g., user interactions with mouse clicks) and implicit inputs (e.g., contextual details such as Clinician Specialty, etc). Using explicit inputs, the system performs actions as specified by the user. Using implicit inputs (i.e., contextual information) the system estimates the clinician’s next desired task and presents it in a way that reduces navigation (i.e. explicit input). Information exchange with the system occurs on a point of care user interface when the clinician is in the patient room; and on a mobile user interface when the clinician is in transit.
This thesis project has actively examined the point of care user interface of such a system and the validity of the various implicit inputs in estimating clinician tasks in an acute care environment. Other aspects of the system, such as predictive decision making algorithms, are assumed perfect and not examined in this document. This has been an acceptable approach for projects which can be classified as Phase 1 projects through the Medical Research Council (UK) Framework, as they are exploratory in nature and rely on simulations instead of complete system prototypes [3].

5.2 Patient Room User Interface

Using the design criteria for user interfaces identified in Chapter 4, several user interface designs were sketched. These sketches were guided by the ten usability heuristics for user interface design [34] to maintain good usability at the starting point of design. A list of interface features corresponding to the usability heuristic guideline is shown in Table 5-1. With the exception of a help section in the interface and while working with the designer’s limited clinical knowledge - the sketches were deemed appropriate to build interface mock-ups to elicit feedback from clinicians. Using Microsoft PowerPoint and Adobe Photoshop several clickable PDF files were
created as mock user interfaces for the system. The mock user interfaces were validated by a doctor for clinical accuracy.

<table>
<thead>
<tr>
<th>Heuristic guidelines</th>
<th>Relevant interface features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility of system status</td>
<td>Interface identifies doctor logged in and the patient; Notification of updates to the patient record (e.g. new lab tests available, new consult note added, etc)</td>
</tr>
<tr>
<td>Match between system and the real world</td>
<td>Usage of simple terms and grouping scheme in the main menu; usage of skeuomorphic design (imitates documents laid out on a desk)</td>
</tr>
<tr>
<td>User control and freedom</td>
<td>Minimalistic design allows user access to main menu quickly</td>
</tr>
<tr>
<td>Consistency and standards</td>
<td>Consistent ways to open documents and access menu; However, some non-standard features included in design</td>
</tr>
<tr>
<td>Error prevention</td>
<td>Not fully understood at initial stage of design. Error-prone navigation conditions to be identified in evaluation</td>
</tr>
<tr>
<td>Recognition rather than recall</td>
<td>Use of icons for quick share menu; visual differentiator between documents that have been reviewed and those that have not been.</td>
</tr>
<tr>
<td>Flexibility and efficiency of use</td>
<td>Context-awareness is relied on to provide one-click access to relevant tasks.</td>
</tr>
<tr>
<td>Aesthetic and minimalist design</td>
<td>Minimalistic design - part by choice, part by limited clinical knowledge</td>
</tr>
<tr>
<td>Help users recognize, diagnose, and recover from errors</td>
<td>Not considered at initial stage of design</td>
</tr>
<tr>
<td>Help and documentation</td>
<td>Not considered at initial stage of design</td>
</tr>
</tbody>
</table>

The home page of the mock user interfaces is shown in Figure 5-2 and its various components are explained in the following ‘Main interface elements’ section.
Figure 5-2: Home screen of envisioned user interface
5.2.1 Main Interface Elements

1) Patient and fixed medical information: This section of the user interface is dedicated to displaying fixed information about the patient (Name, gender, date of birth, date of admission) and their fixed medical history (allergies, comorbidities and chief complaint for current admission).

2) Notification area: This region of the careen is dedicated to notifications of new messages from care team members, new imaging results, new lab results and new notes added to the patient record.

3) ‘Pin-board’ region: This region of the interface is populated with the system’s best guess of the tasks that the clinician might want to carry out. For example in the screenshot of the user interface shown above, by assessing implicit inputs, the system is guessing that the doctor would most likely want to see the Medical History of the patient, the Consult Note by Dr.H or an old X-ray of the patient (likelihood decreases left to right). The Pin-board region was envisioned as a secondary workspace, allowing clinicians to view several documents in a limited view - similar to a collapsed window on modern operating systems. This region of the...
screen slides left and right - thereby several guesses of the system can populate the interface (but only three are visible above).

4) Pin-board Index: Since the pin-board region (described above) can slide left-right, it can hold more items than are visible at a time. Thus this small blue bar acts as an index of the items currently on the pin-board and can take the users to these items in a single click.

5) ‘Desk’ region: This region is the primary working space of the interface. Documents from the pin-board can be opened up in full view into the Desk region by a click on the pin-board item or by flicking it down. Any documents that need typing will need to be opened up into the Desk region. Figure 5-4 shows the Medical History summary of the patient (shown on the Pin-Board in Figure 5-3) in expanded view on in the Desk region.

![UI with patient medical history summary open in the 'Desk' region](image)

6) Menu: Figure 5-5 shows the system Menu opened up by clicking on the circular button on the top left corner of the interface. In intended use, it is envisioned that the Menu would only be used by the clinician to complete tasks when the system’s guesses of the clinician’s tasks are incorrect. Thus it is hoped that most tasks can be initiated with only one click by employing system’s guesses from the Pin-Board. When the system’s guesses are incorrect, the correct task can be initiated through this Menu in two to three clicks.
5.3 System Features

5.3.1 Learning from user interaction history

To improve the systems understanding of each doctor’s preferences and workflows in different contexts, it is envisioned that the system will learn from each user’s interaction history. Thus in cases where the doctor uses the Menu to initiate tasks, i.e. tasks which were not populated by the system on the Pin-Board - the system will remember this occurrence and its various clinical contexts (such as time of day, length of patient admission, etc). By including this feedback loop into the systems decision making process, it is envisioned that the system’s estimates of the information that should be displayed will improve over time and will allow the interface to automatically adapt around each doctor’s workflow.

5.3.2 Interaction with Stylus

As part of the system, each doctor on the ward will be assigned a uniquely identifiable stylus to interact with the patient room display. The styluses can be made unique and identifiable using radio frequency identification (RFID) technology commonly seen in many smart-card ID badges. By doing so the system can incorporate proximity based authentication, which bypasses the need
for typing passwords. It is envisioned that a doctor simply walks up to the user interface in a patient room and is automatically logged into the system, without any large changes to the visual state of the interface. A way to make this a secure system is to use two layers of security. First, the system can sense the location of the doctor’s stylus in its vicinity, and second, the system can be made aware of the location of the doctor’s phone. When the doctor’s stylus and phone are sensed in the same location (i.e. close proximity of the user interface) the doctor will be logged-into the system. By extension, when the doctor wishes to end a session, he/she can simply walk away from the display and as soon as the stylus is no longer sensed in proximity of the interface, the doctor is automatically logged-off. By enabling proximity based authentication, two steps are reduced in the clinical workflow.

Traditionally, authentication systems that rely only on hardware devices are classified as single-factor authentication systems. Single-factor authentication systems only rely on something that the users possess, i.e. they do not employ something that the user knows (passwords) and something that the users are (biometrics). The proposed system can be classified as having single-factor authentication. However, the proposed system attempts to improve the security offered by single-factor authentication by requiring the presence of two hardware devices (i.e stylus and phone) for authentication, instead of just one (stylus or phone).

The use of such a stylus and phone location tracking system can also enable multiple users to log in to the system. Since each clinician’s stylus is uniquely identifiable by the user interface, it is envisioned that it will be possible for multiple users to work simultaneously on the interface. For example, a nurse and doctor can work collaboratively or in quick succession to one another without the need to log-in and log-out repeatedly - this is because the system can log-in both of them and can provide them options according to their organizational roles. For instance, organizational rules do not allow nurses to prescribe medication, so this option will not be activated by a stylus assigned to a nurse, however this option can be activated by a stylus that is assigned to a doctor. This is an innate ability of the envisioned technology, however the scenarios in which such interdependent work takes place and the assigning of workflow hierarchies (who has more control on system’s guesses when multiple users are logged in) needs to be further understood.
5.3.3 Patient & Patient family UI

When clinicians are not using the system, the location of the user interface in the patient room makes it ideal for information sharing with patients and their families. Thus when a clinician logs-out of the system (by simply walking away), a patient information display is presented (Figure 5-6). This interface displays events that have taken place during the patient’s visit, what is next in their treatments, pictures of their care team and displays a safety tip (or other relevant information—e.g. weather, etc.). It was envisioned that this display would automatically be populated from the patient’s electronic health record and safety tips could be customized based on pertinent patient information (e.g., for seniors, fall risk safety tips can be displayed). The design of this interface was based on a study discussed in the literature review (section 3.3.2). This study detailed the use of low fidelity paper prototypes to inform patients and their families about their treatment process.

![Patient & Patient family interface](image)

**Figure 5-6:** Patient & patient family interface
5.3.4 Quick share menu

Clinician’s share patient care documents with each other within the care team (those on-call), with consults and with the patient’s family doctor. To enable such sharing from any section of the interface, a quick share menu was designed (circular menu in Figure 5-7). This menu can be initiated through a long press of the user’s stylus on any document that is desired to be shared or printed/faxed. It would present clinicians with an opportunity to quickly send documents within the care team, to the patient’s family doctor, consultants, printer, fax, email etc. It is envisioned that that this menu can be customized by each user.

5.3.5 Physical considerations

The physical size of the user interface and its location within the patient room is not specified. The observation and design criteria do not guide the design enough on this aspect. Due to the heavy amount of text-entry required at times, a keyboard was considered most suited for input. This keyboard will have to be cleanable or be covered by a cleanable sheath to ensure infection control. It is also envisioned that the keyboard could be stowed behind the display when the system is not being used for text entry. (Figure 5-8)

Other options considered for text input were, dictation and templates. However, dictation was not considered a preferred method for input in the patient room, and the effectiveness of using note templates is still an issue of contention in the medical community.
5.4 Discussion

This design combines and presents several ideas in a single system. It addresses, and aims to satisfy, most of the user interface design criteria identified in Chapter 4. It does not address the ‘Minimal Confirmation Requests’ criteria specified in the design criteria. This criterion mainly applied to the ordering of new medication and diagnostic tests. Both these tasks and the issues of accountability associated with these, were not fully understood through the observation and would require more observations or interviews to explore. A preliminary idea to reduce these confirmation requests is to define a new way of sorting, prioritizing and displaying these confirmations to increase usability and clinician satisfaction.

Another design criterion that is not comprehensively addressed is to design a physical form factor that is conducive to teamwork and is ergonomic. This is because neither the observation notes nor literature could conclusively recommend a particular size or location within the patient room for such an interface. This aspect of the design will be explored with users during evaluation.

In the case where the interface is not being used by clinicians, a patient information screen shows patients details of their visit. Confidentiality issues with displaying patient visit details on such a screen were identified early on, but these could not be resolved without first clarifying the physical size and location of the interface. Furthermore, the designed patient information screen was deemed worthy enough to act as a prompt to elicit feedback from doctors as proxy users and to understand their preferences in regards to sharing information passively with patients.
Chapter 6
System evaluation with doctors

This chapter describes the sessions undertaken with doctors to evaluate the system described in Chapter 5.

6.1 Evaluation goals

These evaluation sessions aimed to satisfy the following research goals.

1. To understand the perceived usability of such a system by means of a subjective assessment of system effectiveness (the ability of users to complete tasks), efficiency (how difficult it was to perform tasks) and satisfaction (how the users felt while performing tasks)
2. To identify confusing terms and design in the prototype UI by means of a scenario driven interface exploration exercise
3. To learn about doctor’s preferences regarding the physical size and layout of such a display in the patient room
4. To receive feedback on Patient UI from doctors as proxy users
5. To explore additional functionality for such a patient room display

6.2 Methods

Individual evaluation sessions were hosted with five doctors at the CareLab at the Toronto Rehabilitation Institute (Toronto, ON, Canada; www.uhn.ca/TorontoRehab). The CareLab offers a simulated hospital room setting which adds realism to the evaluation. The evaluation sessions were carried out from July 29, 2013 to August 19, 2013 and each took nearly 70 minutes to complete. The protocol followed was approved by the research ethics board at the University Health Network (REB submission # 12-0544-DE). The sessions were video/audio recorded.

Inclusion criteria to participate in these sessions were:

1. A doctor who provides at least 10 hours per week of care to inpatients in an acute care setting (attending physicians who supervise residents also included), and
2. has at least 1 year of experience in acute care.
The evaluation session guide is included for reference in Appendix C. In each session the doctor was introduced to the research using a brief standard script. Then the following Wizard-of-Oz scenario (as described in Chapter 1, 3) was conveyed to them and they were asked to interact with the user interface while thinking out loud.

“Scenario 1: This is your first visit to patient John Cow who has been transferred from the Emergency Department. He had come to the ER after coughing-up some blood and temporarily losing consciousness.”

This allowed the participant to explore the interface in the context of the scenario and voice their initial thoughts about the system. Then in a semi-structured interview (as described in Chapter 1), various features of the system and UI elements were introduced to the participant and their feedback was gathered. The participant then engaged in a card sorting exercise (as described in Chapter 1) to examine how the various contexts that exist in the patient room environment affect the likelihood of doctors doing certain clinical tasks. The participant completed four card sorts with 14 clinical tasks (written on cards). Each card sort examined the likelihood of clinical task execution in a certain context introduced by the researcher. This activity aimed at generating knowledge of the participant’s tacit mental models of this environment and how it affects their tasks (See section 6.3.4 for further detail). To end the evaluation session, the participant was asked to fill out the Systems Usability Scale (SUS) questionnaire to help create a quantitative measure of the perceived usability of the system as presented to them.

The SUS questionnaires from all five participants were scored and a SUS score was generated from each one. Pictures of the various card sorts were taken and translated onto a Microsoft Excel spread sheet available freely for card sort analysis. This excel sheet created a visual method of showing correlation for the five participant’s card sorts. The video recordings of the Wizard-of-Oz scenario were examined and areas of the UI that were confusing or misunderstood were identified. The semi-structured interview transcript was examined using a deductive thematic analysis (as described in chapter 1, and section 4.2) to reveal participant feedback pertinent to UI elements and system features.
6.3 Results

This section describes the results of the evaluation session. The results are divided into the following sub-sections: SUS questionnaire results, feedback on UI elements, feedback on system features and card sorting results. The sections ‘feedback on UI elements’ and ‘feedback on system features’ describe composite results of the Wizard of Oz session and the semi structured interview. They have been relayed in this manner to match the description of the proposed system in Chapter 5 for easy comparison and reference.

6.3.1 System Usability Scale (SUS) questionnaire

All five participants completed the SUS questionnaire to reflect on the perceived usefulness of the system as presented to them during the evaluation session. The mean SUS score for the system was 78 (on a range of 0 to 100).

A study by Bangor et.al that looked at a distribution of 3,463 SUS scores, places a SUS score of 78 in the top 25% of scores. The 3,463 SUS scores in the study were taken from usability evaluations across the six following interface modalities, web (41%), cell phones (17%), interactive voice response (17%), graphical user interface (17%), hardware (7%) and television (5%). [35] Researchers at the Human Factors International Inc., used this study to develop a grading scale for raw SUS scores (Figure 6-1). [36]

![Figure 6-1: Grading scale for SUS scores by HFI Inc [36]](image)

Another web researcher examined 500 SUS scores to develop the chart in Figure 6-2 to convert a SUS core into a percentile rank (of perceived usability). Using this chart, a SUS score of 78 corresponds to nearly 82% percentile rank, and a “letter grade” of a B+. [37]
The mean score for each of the questionnaire items is summarized in Table 6-1.

**Table 6-1: Mean of raw responses to individual items on the SUS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Raw Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>I think that I would like to use this system frequently.</td>
</tr>
<tr>
<td>Q2</td>
<td>I found this system unnecessarily complex.</td>
</tr>
<tr>
<td>Q3</td>
<td>I thought this system was easy to use.</td>
</tr>
<tr>
<td>Q4</td>
<td>I think that I would need the support of a technical person to be able to use this system.</td>
</tr>
<tr>
<td>Q5</td>
<td>I found the various functions in this system were well integrated.</td>
</tr>
<tr>
<td>Q6</td>
<td>I thought there was too much inconsistency in this system.</td>
</tr>
<tr>
<td>Q7</td>
<td>I would imagine that most people would learn to use this system very quickly.</td>
</tr>
<tr>
<td>Q8</td>
<td>I found this system very cumbersome to use.</td>
</tr>
<tr>
<td>Q9</td>
<td>I felt very confident using this system.</td>
</tr>
<tr>
<td>Q10</td>
<td>I needed to learn a lot of things before I could get going with this system</td>
</tr>
</tbody>
</table>
6.3.2 Feedback on UI elements

The Wizard of Oz scenario identified some usability problems with the prototype user interface. These were elements of the interface whose purpose was misunderstood by several participants or elements which were assumed to be clickable while not being designed so. The semi-structured interview further aimed to touch upon all interface elements with the participants and gather their feedback on them. The following feedback was gathered on the UI elements (refer Chapter 4 from Page 32 to 37 to see the UI)

1) Patient and fixed medical information: Several participants assumed that the list of comorbidities was clickable - either to see if there are more items than listed, or to add conditions to the list. Participants also recommended the addition of current medications taken by the patient to this area. Some feedback was obtained on how dates and durations are observed - it was noted that for treatment, the patient’s age is more useful than knowing their date of birth. Similarly, for most temporal information duration was considered more useful than the date. For cases where a date was required, it was preferred that the month be expressed alphabetically instead of numerically.

2) Notification Area: Several participants were unsure about the notification ‘1 Unread Message’. It was not apparent from just the notification who the message is from, who it’s for and how urgent it is.

3) ‘Pin-board’ region: This region of the interface is populated with the system’s best guess of the tasks that the clinician might want to carry out. Several participants misunderstood a ‘Physical Exam’ card on the pin-board as a physical exam for their review (i.e., already filled out by another doctor). However, the intended purpose of this card was that it would open up a blank physical exam chart for the participant to fill out. Thus it was observed that it was not intuitive design to present documents that warranted review and those meant for documentation in the same visual manner. Two participants expressed that documentation should be a completely separate activity, not included in this section of the UI.

This region was also envisioned to be a secondary workspace, where multiple documents could be viewed in a limited view. This would allow the doctors to complete documentation tasks (in the ‘Desk’ region of the screen) while having review documents in sight on the
same screen. However, participant feedback regarding documents displayed in the pin-board region primarily stated that the text was too small to read comfortably.

The design also included red dots on certain cards to notify doctors that they had not yet reviewed certain information. This idea of making a visual distinction between documents that have been reviewed and those that have not been reviewed was welcomed by the participants. However, using a red dot to draw this distinction was not considered intuitive. Suggestions from participants to improve this aspect of design were to use check marks instead of red dots and also to display age of the documents where appropriate (e.g. “Consult Note from Dr.H - 14 days ago”)

4) Pin-board index: This UI element was largely disregarded as not being helpful. The participants felt they had an understanding of what was on the ‘Pin-board’ region and thus they did not require an index for it. Furthermore, the iconography of such an indexing bar was considered to be complex as no standards iconography currently exists for the various kinds of medical documents.

5) Desk: Most participants correctly identified that this was the primary workspace of the UI as it was the largest pane. Two participants expressed the desire to have a consistent means to open the documents from the desk in a full screen mode.

6) Menu: The organization of menu items by action (‘Review prior’, ‘Order’, ‘Create new’ and ‘Share’) was welcomed by the participants as simple way to group tasks. Some participants were confused about which exact documents the terms ‘Full note’, ‘Medical History’, ‘Consult Note’ referred to. This confusion could be fueled by the fact that different healthcare institutions/department use different terms to describe documents that accomplish similar tasks (i.e. lack of standardized documents). One participant was inadvertently confused between the ‘Order’ and ‘Create new’ headings. Another participant suggested that ‘Create new’ be relabeled as ‘Document’. Several participants expressed their liking of the ‘Share’ options and the inclusion of an UpToDate.com search bar in the menu.

At the end of the session, the participants were also asked to list the most positive and most negative aspects of the design. A summary of their responses is shown in Table 6-2.
Table 6-2: Participant responses to Most negative and Most positive aspects of design

<table>
<thead>
<tr>
<th>Most negative</th>
<th>Most positive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P1</strong></td>
<td></td>
</tr>
<tr>
<td>Unclear navigation</td>
<td>Not overwhelmed by info</td>
</tr>
<tr>
<td>Inconsistency at times</td>
<td>Most commonly used over addressed</td>
</tr>
<tr>
<td>Valuable real estate for infrequent conditions</td>
<td>Good use of color &amp; space</td>
</tr>
<tr>
<td><strong>P2</strong></td>
<td></td>
</tr>
<tr>
<td>Too much info on main interface</td>
<td>Patient interface great idea</td>
</tr>
<tr>
<td>Medical jargon on patient interface</td>
<td>Ability to send results or messages</td>
</tr>
<tr>
<td></td>
<td>Choices appropriate</td>
</tr>
<tr>
<td><strong>P3</strong></td>
<td></td>
</tr>
<tr>
<td>Concern re: security (lost/stolen stylus)</td>
<td>Visually simple to follow</td>
</tr>
<tr>
<td>&amp; confidentiality (info/data visible to all in patient room)</td>
<td></td>
</tr>
<tr>
<td><strong>P4</strong></td>
<td></td>
</tr>
<tr>
<td>Likely need multiple set up with variable display &amp; functionality. E.g. In patient room &amp; viewable by patient; outside patient room for rounds; in office for detailed review and documentation</td>
<td>Nice to look at</td>
</tr>
<tr>
<td>Wouldn't exhaustively show patient all details &amp; creates irrelevant distraction</td>
<td>Easy navigation</td>
</tr>
<tr>
<td>Need to better allow for emergency triaging &amp; highlight elements that are critical to know right now</td>
<td>Easy to read</td>
</tr>
<tr>
<td></td>
<td>Intuitive layout</td>
</tr>
<tr>
<td><strong>P5</strong></td>
<td></td>
</tr>
<tr>
<td>Inability to achieve &quot;full screen view of documents&quot;</td>
<td>Very intuitive design</td>
</tr>
<tr>
<td>Navigation - fwd/back</td>
<td>Excellent readability, colors, fonts etc.</td>
</tr>
<tr>
<td>Inability to dive directly into left column areas for modification</td>
<td>Very good content</td>
</tr>
</tbody>
</table>

6.3.3 Feedback on system features

The semi-structured interview provided the participants to express their views on the key system features. Interview guide can be found in appendix C.

6.3.3.1 Learning from user interaction history

Most participants felt that this feature would save time and reduce effort by providing them with a list of their most accessed tasks. Although there was agreement with the general concept, one important caveat was expressed by two of the participants - The use of interaction history to predict and suggest tasks might be detrimental in the event of the clinician following sub-optimal
workflows. In other words, a prediction system relying (i.e., using as input) only on one user’s workflow could potentially reinforce poor workflows if the original workflows do not adhere to good practice guidelines. In colloquial computer science terms this is referred to as ‘garbage in, garbage out’ or GIGO. In such cases the participants expressed the desire for the system to interject and draw the user’s attention to items they have been missing in their usual workflow, but might be important for treatment.

A recommendation made by two other participants was to include user-initiated customization (explicit input) into the system. They envisioned such user-initiated customization to take place as a onetime activity where they can set their preferences of what information to display and arrange the various information panes to their liking. They were of the opinion that this would bring satisfaction to the users faster than the predictive customization learnt from the interaction history and that it would provide a steady base to begin predictive customization on.

### 6.3.3.2 Interaction with Stylus

The use of the stylus was a point of contention for all participants. While they lauded the idea of effortless proximity based authentication, they were convinced that the styluses used to achieve this will be repeatedly misplaced and that it will not be practical to replace them. This issue was further aggravated by the fact that the second authentication factor, the clinician’s phone, also faces similar challenges albeit less often. Thus two participants expressed the need to have a traditional alternate log-in method for cases when they lose their hardware authentication devices.

The sensing of stylus proximity also designed to support multiple user log-in. This feature could enable clinicians to work collaboratively (or in quick succession) on a particular patient record without the need to log-in and log-out repeatedly. However, the participant response to this feature was lukewarm at best. They felt that situations where they are taking turns working on an interface would seldom arise and even when they do it is best left up to the clinicians to sort out.

### 6.3.3.3 Patient and Patient family UI

When clinicians are not using the system, the interface was envisioned to display information for the patient and patient family. The participants unanimously agreed that showing patients pictures and names of their care team was beneficial to the patients. They also immediately
identified the confidentiality concerns with presenting treatment related information on a screen in the patient room. In slightly different ways, they also agreed that some of the information presented on the screen could cause the patients anxiety. For instance, the use of medical terminology on the patient screen (e.g. you were admitted for Hemoptysis) would likely confuse them and make them nervous. Also, sharing details like their vital signs was considered a source of unnecessary distraction from the treatment of their chief complaint. Furthermore, notifying patients of when their imaging or lab results have been reviewed by the clinicians was considered to be a source of nervousness for the patients. Generally, the participants felt that the information to be provided to the patients through this passive display should be high level (e.g. diagnosis, tests to be completed) and any granular details of their treatment (e.g. vitals, notification that a clinician has reviewed their lab results, etc) can be delivered to their screen when clinician chooses to do so on a case-by-case basis. There was also general agreement on the notion that there is a risk-benefit consideration to be made while passively providing details of treatment details as this may induce anxiety in patients or further increase the care team’s work load in explaining things to the patients that are not critical to the treatment.

One participant also expressed the view that providing any information regarding the treatment to the patient through an interface felt rather impersonal. Furthermore, this participant felt that any information of consequence should be personally delivered by the clinician to the patient.

Several suggestions on what information to include on the patient UI were made. These are listed in Table 6-3.

<table>
<thead>
<tr>
<th>Names and pictures of care team members and consultants who visit</th>
<th>Patient satisfaction survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targeted, customized safety tips</td>
<td>Next of kin, substitute decision maker contact</td>
</tr>
<tr>
<td>If able to type, questions for the care team</td>
<td>Tests completed</td>
</tr>
<tr>
<td>Upcoming tests (if possible with estimated time or day, currently not possible)</td>
<td>Dietary selection and feedback on meals</td>
</tr>
<tr>
<td>Patient education materials (e.g. checking blood sugar, physical therapy exercises)</td>
<td>What’s happening in the hospital today</td>
</tr>
<tr>
<td>Translation (e.g. MediBabble)</td>
<td>Games and other entertainment</td>
</tr>
</tbody>
</table>
6.3.3.4 Quick share menu

Participants felt that this would be a useful feature to share documents with physicians external to their organization (e.g. family doctors, referring physician), with team members who are on call and with consultants on select cases. It was expressed that this feature would be most useful for imaging studies which required some degree of interpretation (e.g. Electrocardiograms), as other textual data could be conveyed and discussed easily over the phone.

For messaging within the care team, there seems to be a need for a more unstructured form of communication like handover notes (written at shift change). Internal communication suggested by the participants can be described as ‘flagging’ some aspect of the patient record for another care team member or alerting a care team member of patient information.

6.3.3.5 Physical considerations

Most participants felt that the system, with its totality of features, was not ideal for the patient room. Two participants suggested this mildly and mentioned that they are fine with having this depth of information available in the patient room as long as they have access to this information before they see the patient as well. Two other participants felt strongly that doing clinical tasks that require some degree of concentration (e.g. reviewing a consult note, creating a note) distracts from a relationship with the patient that is more personal. Doing these involved clinical tasks in the patient room was considered to be potentially conflicting with patient-centeredness of the treatment and not conducive to building an amicable patient rapport.

The participants felt that a subset of the system’s features would be useful to them in the patient room. They expressed the desire to see imaging studies, lab studies, information useful in emergency situations and patient education materials in the patient room. Desire was expressed to have this limited functionality built into the patient’s media centre screen (or on similar display mounted on an arm) so they could easily share patient education materials and the confidentiality issues concerning the patient UI are mitigated.

Participants had mixed opinions about the use of tablets for this system. Instead a desire was expressed to have a multi-display environment:
1. A patient room display for quick review documents (e.g. imaging, labs), information useful in emergency (e.g. medications, next of kin), patient education materials (general and case related) and functionality of the Patient UI

2. A display outside the patient room to capture a snapshot of the patient and their condition, message the care team, complete some orders and hold educational rounds.

3. A workstation in an office-like, secluded setting for review of long notes and creation of documentation. This setting would allow them to sit and complete these tasks with minimal interruptions.

6.3.4 Card sorting results

Card sorting was used to examine how the various contexts that exist in the patient room environment affect the likelihood of doctors doing certain clinical tasks. Prior to these evaluation sessions the concept of ‘context’ had not been explored with doctors. Thus card sorting was used as an exploratory and generative tool to examine the doctors’ tacit mental models regarding contexts. The participants were presented with cards with 14 cards with clinical tasks written on them. Then they were asked to arrange these cards based on how the likelihood of doing a clinical task (written on card) is affected by change in a certain context.

1. Context considered is ‘Clinical Specialty’. Thus the participants grouped cards based on how the likelihood of doing certain task changes with a change in Clinical Specialty. Number of participants who responded to this context is five. The Table 6-4 presents the correlation in the participants grouping of tasks.

<table>
<thead>
<tr>
<th>Card no</th>
<th>Clinical Task/Card name</th>
<th>Most Affected by Clinical Specialty</th>
<th>Least Affected by Clinical Specialty</th>
<th>Moderately Affected by Clinical Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Review Prior Admissions</td>
<td>40%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review Medical notes</td>
<td></td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>3</td>
<td>Review Trends</td>
<td></td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>Review Medical History</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Review Imaging Results</td>
<td>20%</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Review Lab Test Results</td>
<td></td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>7</td>
<td>Order Medication</td>
<td>40%</td>
<td>40%</td>
<td>20%</td>
</tr>
<tr>
<td>8</td>
<td>Order Labs and Procedure</td>
<td>20%</td>
<td>40%</td>
<td>40%</td>
</tr>
</tbody>
</table>
2. Context considered is ‘Time of Day’. Thus the participants grouped cards based on when they are more likely to do certain tasks. Number of participants who responded to this context is four. One participant abstained from this sort exercise as he felt that this did not affect the treatment process much and it was difficult to say. This participant expressed that a better way to examine this would be ‘during regular hours vs. on call’. The Table 6-5 presents the correlation in the participants grouping of tasks.

Table 6-5: Card sorting correlation for Time of Day as context

<table>
<thead>
<tr>
<th>Card no</th>
<th>Card name</th>
<th>Earlier in the day</th>
<th>Later in the day</th>
<th>Anytime</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Review Prior Admissions</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review Medical notes</td>
<td>75%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Review Trends</td>
<td>25%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review Medical History</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Review Imaging Results</td>
<td>75%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Review Lab Test Results</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>7</td>
<td>Order Medication</td>
<td>25%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Order Labs and Procedure</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>9</td>
<td>Order Imaging</td>
<td>25%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>10</td>
<td>Create Full note</td>
<td>75%</td>
<td></td>
<td>25%</td>
</tr>
<tr>
<td>11</td>
<td>Create Progress Note/SOAP</td>
<td>25%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>12</td>
<td>Create Consult Note/H&amp;P</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>13</td>
<td>Create Consent Form</td>
<td>25%</td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>14</td>
<td>Create Discharge Summary</td>
<td>25%</td>
<td>50%</td>
<td>25%</td>
</tr>
</tbody>
</table>

3. Context considered is ‘Length of Admission’. Thus the participants grouped cards based on how the likelihood of doing certain task changes with variation in the Length of Admission. Number of participants who responded to this context is four. One participant abstained from this sort exercise as he felt this was not a relevant context. The Table 6-6 presents the correlation in the participants grouping of tasks.
Table 6-6: Card sorting correlation for Length of Admission as context

<table>
<thead>
<tr>
<th>Card no</th>
<th>Card name</th>
<th>Most Affected by length of admission</th>
<th>Least Affected by length of admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Review Prior Admissions</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review Medical notes</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Review Trends</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>Review Medical History</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Review Imaging Results</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Review Lab Test Results</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Order Medication</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>8</td>
<td>Order Labs and Procedure</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>9</td>
<td>Order Imaging</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>10</td>
<td>Create Full note</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>11</td>
<td>Create Progress Note/SOAP</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>12</td>
<td>Create Consult Note/H&amp;P</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>13</td>
<td>Create Consent Form</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>14</td>
<td>Create Discharge Summary</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

4. Context considered is ‘Patient condition severity’. This category was introduced by the participants. Thus the participants grouped cards based on how the likelihood of doing certain task changes with variation in the severity of the patient’s condition. Number of participants who responded to this context is two. A participant who abstained from sorting, felt that this context did not affect the general overall treatment process. Another participant who abstained felt that it was too difficult to sort generally on this context. The Table 6-7 presents the correlation in the participants grouping of tasks.

Table 6-7: Card sorting correlation for Patient Condition Severity as context

<table>
<thead>
<tr>
<th>Card no</th>
<th>Card name</th>
<th>Stable</th>
<th>Sick</th>
<th>Very Sick</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Review Prior Admissions</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review Medical notes</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Review Trends</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review Medical History</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Review Imaging Results</td>
<td>50%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Review Lab Test Results</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Order Medication</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Order Labs and Procedure</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Order Imaging</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Create Full note</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Create Progress Note/SOAP</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Create Consult Note/H&amp;P</td>
<td></td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>13</td>
<td>Create Consent Form</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>14</td>
<td>Create Discharge Summary</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
5. Another context considered was ‘Patient Specifics (e.g. age, gender)’ but all participants felt that it did not affect the likelihood of clinical tasks in any way that warrants generalization.

6.4 Discussion

The evaluation sessions provided a lot of very useful feedback on nearly all design aspects. The SUS score provides a quantitative method of comparing usability and the semi-structured interview provides a qualitative insight into this score. The Wizard-of-Oz scenario made it simpler to identify usability concerns that were confusing or often misunderstood. The card sorting activity generated a knowledge base which provides an insight into how context-awareness could be built into a predictive, prompting system. Some important ideas that emerged from these results are:

1. Technology and Patient-centeredness of care

In the patient rooms, technology that increases the frequency or duration of events where the doctor is focused on another object rather than the patient was considered to be undesirable and not conducive to a good doctor-patient relationship. However this distinction does not exist outside the patient room. This is indicative of one design flaw of the preliminary system design which is that the context of physical location within the ward was not considered.

2. Predictive customization as a possible reinforcer of poor workflows

This was an important caveat to the otherwise affable acceptance of an intelligent system that enables predictive customization for a portion of the UI, based on the context. This is an important consideration for predictive algorithm design as it can be a serious patient safety concern. Flaws like these point towards the fallibility of technology and highlight the need to scrutinize technological systems to adhere to the limits of human error.

3. Pragmatism of effortless authentication

The concept of effortless logging-in and logging-out of information systems is highly desirable. However, developing a practical way to achieve effortless authentication is challenging. De facto authentication means rely on something users know (e.g. password) to log them in or to rely on something the users have (e.g. RSA key generator). While it is cumbersome to enter passwords,
it seems that this method is more preferred than the carrying an additional physical device for purposes of authentication. The other authentication modality that has not been considered in this thesis is to sense something that that users are, i.e. biometrics.

4. Patient UI has great utility and promise

The idea of the patient UI was generally well received by the participants and lots of additional functionality was suggested enthusiastically. This display might play an important role in improving patient satisfaction in hospital and provide patients with a dedicated means of communicating with the care team. It has the potential to serve as a key patient education tool, which might positively affect treatment outcomes. The physical form factor and interface design of such a display needs to mitigate any confidentiality risks.

6.5 Limitations

This approach to evaluation of a system and generating knowledge of the various contexts in the design environment has the following limitations.

1. The number of participants in the SUS and card sorting activity is small. For early usability studies such as this one, SUS responses from five users are generally acceptable. Evidence suggests that the average SUS score from five users is within six points of the true (very large sample size) SUS score 50% of the time. Seventy five percent of the time the scores differed by 10 points and 95% percent of the time, by about 17 points. [38] Card sorting with five users has 0.75 correlation with the actual results (with larger sample size). The recommended number of participants for card sorting is fifteen, which provides a correlation of 0.90. [39]

2. Exploring the notion of contexts affecting clinical tasks was a tough one to communicate to participants due to its abstract nature. The card sorting was helpful in simplifying this difficulty by having the participants focus only on one context at a time. However, this task seemed to be challenging for the participants and did not give them ample opportunities to suggest other contexts that may affect clinical tasks.
3. Although the Patient UI functionality was welcomed by the doctors, it is important to note that input from patients and their families has not been considered in its design. As patients are the primary users of the Patient UI, they must be included in its design before this feature can be considered fully examined. Doctors can serve as good proxy users as they reflect the cumulative and generalized experiences of patients, however they cannot replace actual design examination with patients.
Chapter 7
Conclusion

7.1 Conclusion

This thesis presented an exploratory human computer interaction (HCI) study in an acute care patient room setting to answer the following research question, stated in Section 1.3:

*Can a context-aware user-interface displaying assimilated medical (or other) data prove to be a useful tool in the treatment of acute care patients?*

Based on the evaluation of a preliminary system by five doctors, a context-aware patient room display would be a useful tool in the treatment of acute care patients. The doctors interviewed in the system evaluation (Chapter 6) desired a patient room display which would enable them to review pertinent imaging or lab results quickly, engage in patient education and access emergency information of the patient quickly. The doctors also emphasized the need for any patient room technology to be patient-centric, i.e. it should mitigate the frequency or duration of events where the doctor is focused on another object rather than the patient.

Furthermore, the addition of a patient UI (Section 5.3.3, 6.3.3) was generally well received by the doctors and lots of additional functionality was suggested enthusiastically. Amongst several things, this user-interface was expected to engage the patient in patient education and even promote compliance to exercises from allied health professionals such as physiotherapists, occupational therapists and respiratory therapists.

The desired patient room display is significantly less complex than the preliminary system design (Chapter 5) presented to the doctors. This is primarily due to the doctors expressing the desire to limit the clinical tasks they wish to perform in the patient room. This reduction in clinical tasks also reduces the need for predictive customization of the user interface and hence the amount of context awareness required. Further evaluation is required to define and understand the need for predictive customization of the UI with this limited functionality. Thus context awareness in the patient room could potentially be limited to sensing clinician and patient presence to enable effortless authentication.
Further design and evaluation is required to define what physical form would be most useful as such a patient room display. Related to physical form factor is also the idea of shared hardware for the doctor and patient, which also needs to be further examined.

The patient room is also frequented by nurses and healthcare aides which makes them key stakeholders in the design of patient room technology. Future design cycles should include representatives of these groups in system evaluation sessions.

### 7.2 Future directions

For the next cycle of iterative design, it is recommended that the following changes be made to the design:

1. Divide the functionality of the system prototype presented in Chapter 5 into three separate displays, one for the patient room, one just outside the patient room and one in an office-like space (as described in section 6.3.3)

2. Change effortless authentication methods to reduce the dependence on hardware. Thus explore possible inclusion of biometrics (e.g. facial recognition) as one factor in authentication with an existing hardware device (e.g. RFID chip on existing ID cards) as the other. Gesture based authentication and interface control relying on computer vision can also be explored.

3. Patient UI confidentiality concerns need to be addressed by inclusion of an effortless authentication process for the patients. One unique patient identifier that could be used to do so is the patient’s armband which generally has barcode or other identifier on them.

4. On the pin-board cards, a visual differentiator (e.g. background color) needs to be added to clearly differentiate between documents that need to be filled out and completed documents that need review.

5. For clinical documentation tasks, a usable secondary workspace needs to be created so that while creating notes, the doctors can refer to older documents in the patient’s health record without switching between windows. The pin-board was envisioned to do this, but the text in the cards was too small to be functional as a secondary workspace.
6. Further explore the idea of user set-customization and how it can be used to develop a firm base for the predictive customization to build on.

The following lessons regarding evaluation methods can be used to advise evaluation in the next phase of iterative design.

1. Wizard of Oz scenarios are useful when the goal of evaluation is to receive feedback on a certain function of the design. These are more time consuming exercises that help uncover confusing terms and interface design, but do not contribute as much to the conversation about overall system design.

2. Semi-structured interviews were very useful in allowing participants to provide their feedback on system features, and also in encouraging them to provide their insights on alternative methods of implementation and additional functionality. This exercise nearly had a participatory design element to it and generated lots of data (when compared to wizard of oz exercise or card sorting). The prototype user interface and the scenario for the wizard of oz were used as props to visually explain system features and to have common language in discussion.

3. Card sorting was an easy way to present the idea of contexts and elicit comments on how they affect clinical tasks. However, card sorting did not provide participants many opportunities to suggest new contexts. Perhaps storyboards would be an easier way to explore contexts that the participants tacitly consider in their daily work.

4. It was also observed that participants who were comfortable with technology (by virtue of their academic background or through involvement in their organization’s EMR implementation) provided feedback that was centered on usability, technology and system implementation. On the other hand participants with purely clinical backgrounds, and little involvement with EMR initiatives, provided feedback on how such a technology would affect their workflow and how its inclusion would affect clinician-patient relationships. This culminated in a good mix of the types of qualitative data received as feedback for the preliminary system design. In future evaluations, clinician experience (or inexperience) with EMR/clinical information technology could be a consideration while recruiting participants.
If such a system was to proceed to deployment, it would require heavy customization for each hospital and possibly for each department that it is implemented in. This is primarily due to the fact that there is no standard clinical process for patient care (admission to discharge) and furthermore because different hospitals might have slightly varied terms for their documentation and review tools which should be adhered to in the system implementation to maintain real-world consistency. This also affects system development as the design has to be able to accommodate such customization for each implementation.

An ideal system should require minimal user training after deployment. The intuitiveness of the interface can be enhanced by basing the interface elements on facets of web design that users are already familiar with. The unfamiliar aspects of the design (e.g. estimates on the pin board, quick share menu) should be introduced with the help of short, visual, pop-up style training guides within the system. Such visual training guides are becoming a mainstream means to explain new features and layouts to users, and have most recently been used by Google in its various products.
References


Appendices

8.1 Appendix A: Recruitment Email

Hello,

We are researchers from the Toronto Rehabilitation Institute and the University of Toronto who create adaptive and intelligent technology that helps users participate fully in their daily lives. We are looking for doctors in acute care to share their experiences with us in a device evaluation session. Information from this session will be used to create guidelines to help build new ways to present electronic medical record (EMR) information in a usable format.

If you are a doctor who:

• provides at least **10 hours per week** of care to inpatients in an acute care setting (attending physicians who supervise residents also included), and

• has **at least 1 year** of experience in acute care,

we invite you to participate in our device evaluation session. **You will be compensated $150 for your time and participation.**

Please contact the study’s research coordinator, Manas Bhatnagar, at m.bhatnagar@mail.utoronto.ca or by telephone at **(416) 946-8573** for more information.

The device evaluation session will take place at Toronto Rehabilitation Institute (University Centre) and should take between 60 to 70 minutes to complete.

If you are interested in learning more about our research please visit our website at [www.iatsl.org](http://www.iatsl.org) or contact Manas Bhatnagar.

We look forward to hearing your thoughts!

Dr. Alex Mihailidis and Manas Bhatnagar, Investigators
Appendix B: Information and Consent Form for evaluation session with doctors

Design of a context-aware user-interface for patient rooms

INFORMATION AND CONSENT FORM

Principal Investigator: Dr. Alex Mihalidis, Department of Occupational Science and Occupational Therapy
University of Toronto
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email: alex.mihalidis@utoronto.ca

Co-investigator: Manas Bhatnagar, MHSC candidate
University of Toronto
Ph: (416) 946-8573
email: m.bhatnagar@mail.utoronto.ca

Background
Patient care relies on health care professionals sharing information about the people they are caring for, sometimes across departments and even hospitals. Currently, patient data is manually gathered from several sources (e.g. medical devices, diagnostics tests, observation, etc.) and manually recorded on charts. It is essential that the correct information is recorded and communicated in a timely manner in a way that clinical professionals can understand, regardless of their background. This process of clinical data collection and presentation should be simple and intuitive to reduce or eliminate possible mistakes.

We are looking for participants to provide their opinions in a device evaluation session to understand clinician expectations from a patient room display system. The findings from this study will be used to create guidelines for the design of user-interfaces for a computer-based system that can be used in a patient room to collect and review data.

This study is part of a research being conducted by Manas Bhatnagar at Masters level research under the supervision of Dr. Alex Mihalidis at the University of Toronto. Please contact the student investigator, Manas Bhatnagar, at m.bhatnagar@mail.utoronto.ca or (416) 946-8573 to answer any questions you may have about the study.

Purpose
The purpose of this study is to identify factors that will be used to create a computerized user interface for capturing and displaying medical (or other) data that could be useful in the treatment of acute care patients.
Procedure

If you agree to participate, you will be asked to participate in an evaluation session to provide your opinions on mock-ups of user interfaces. These mock-ups will be sketches on paper or on a laptop computer. It is expected that the evaluation session will run for between 60 – 90 minutes. The general structure of the session will be as follows:

1. Welcome and introduction to the study
2. Discuss current practices and possible areas of improvement
3. Opinions on various user interface layouts presented by researcher
4. Opinions on various ways to interact with user interface, presented by researcher
5. Discuss the benefits and drawbacks of automatic adjustments to the user interface
6. Fill out a short usability questionnaire
7. Closing and Thanks

Some other details to consider are:

- The evaluation session will be moderated by up to two members of the research team.
- The evaluation session will take place in the Care Lab facility of the Toronto Rehabilitation Institute, University Center.
- The evaluation session will be videotaped to ensure no details are missed. All videotaped data will remain strictly confidential and will only be viewed by the researchers for the purpose of this study. After a period of five years all video data will be destroyed.

Confidentiality

The information collected during this study will remain strictly confidential. The research team, principal investigator and focus group analysts will be the only people who have access to the recorded video, which will be securely stored in a locked cabinet and treated as confidential material. Video data will only be used for the purposes of this study. Any electronic data collected will be stored on password protected secure servers at the Toronto Rehabilitation Institute. The servers are protected by video surveillance, have controlled access through access cards and are fireproof. Consent forms will be the only items that contain participant’s names, and will be kept in the secured cabinet along with the recorded video. This information will be stored for five years following the completion of this study, at which time it will be destroyed. Confidentiality can only be guaranteed to the extent permitted by law.

Risks / Benefits

There is a time commitment if you participate in this study. We will try to schedule the evaluation session at a time that is most convenient to you and the session moderators. There is also a risk of loss of reputation or embarrassment if the confidentiality of your participation and responses is breached. The research team will treat your responses respectfully and confidentially.

You may or may not benefit directly from participating in this study. However, possible benefits include contributing to researcher’s understanding of the unique challenges you face in providing clinical care and your needs and preferences related to technology.
Your responses will be used to develop a device to help improve the experience of other clinicians and patients. You will not benefit financially from the development of such a device.

Costs and Compensation
There are no direct costs associated with participation in this study. Participants are being compensated $150 (cash) to minimize any indirect costs of participating in this evaluation session.

Your responsibilities as a participant
If you decide to participate in this study you will be asked to do the following:
- Carefully read all the information in this package;
- Ask any questions you might have about the study, either in person if you are completing this with a researcher, or via email or phone;
- Sign the consent form;
- Participate in the study session to the best of your abilities;
- Communicate openly and honestly during the sessions, demonstrating respect of the unique opinions, values and experiences of other participants;
- Respond to any emails or telephone calls related to this study;
- Remember that we want your opinion, so there aren’t any wrong answers!

Legal Rights of a Participant
All participants in a research study have the following rights:

1. You have the right to have this form and all information concerning this study explained to you and if you wish translated into your preferred language.

2. Participating in this study is your choice (voluntary). You have the right to refuse to participate, or to stop participating in this study at any time without having to provide a reason. If you choose to withdraw, it will not have any effect on your future medical treatment or health care or employment. Should you choose to withdraw from the study, please immediately contact Manas Bhatnagar (Student Researcher) at (416) 946-8573 or m.bhatnagar@utoronto.ca, or Dr. Alex Mihailidis (Principal Investigator) at (416) 946-8565 or alex.mihailidis@utoronto.ca.

3. You have the right to receive all significant information that could help you make a decision about participating in this study. You also have the right to ask questions about this study and your rights as a research participant, and to have them answered to your satisfaction, before you make any decision. You also have the right to ask questions and to receive answers throughout this study. If you have any questions about this study you may contact the person in charge of this study Principal Investigator, Alex Mihailidis, Occupational Science and Occupational Therapy (University of Toronto), at (416) 946-8565 or alex.mihailidis@utoronto.ca. If you have questions about your rights as a research participant
or any ethical issues related to this study that you wish to discuss with someone not directly involved with the study, you may call the Toronto Rehabilitation Institute ethics review board at 416 597-3422, ext. 7611.

4. By signing this consent form, you do not give up any of your legal rights.

5. You have the right to receive a copy of this signed and dated informed consent package before participating in this study.

6. You have the right to be told about any new information that might reasonably affect your willingness to continue to participate in this study as soon as the information becomes available to the study staff. This may include new information about the risks and benefits of being a participant in this study.

7. If you become sick or injured as a direct result of your participation in this study, your medical care will be provided.

8. Any of your personal information (information about you and your health that identifies you as an individual) collected or obtained, whether you choose to participate or not, will be kept confidential and protected to the fullest extent of the law. All personal information collected will be kept in a secure location. The study staff and the University of Toronto Research Ethics Board will have access to your personal information for purposes associated with the study, but will only be allowed to access your records under the supervision of the Principal Investigator and will be obligated to protect your privacy and not disclose your personal information. None of your personal information will be given to anyone without your permission unless required by law. When the results of this study are published, your identity will not be disclosed. The data for this study will be retained for five years.

9. If, as a result of your participation in this study, any new clinically important medical information about your health is obtained, you will be given the opportunity to decide whether you wish to be made aware of that information.

10. You have the right to access, review and request changes to your personal information (i.e. address, date of birth).

11. You have the right to be informed of the results of this study once the entire study is complete.
Consent to Participate

I have read the entire consent form and my questions about the study have been answered by the researchers. I understand I will receive a signed copy of this consent form. I understand that I am free to ask questions about the study at any time. My participation in this study is voluntary and I am free to withdraw or discontinue participation at any time.

I consent to participate in this study.

Printed name of Participant  Signature of Participant  Date

Consent to Videotaping

I consent to have my participation videotaped, and I understand captured video data will be treated as confidential. I understand that these videos will only be viewed by the research team for the purpose of this study. I also acknowledge that these videos may be used for educational purposes (e.g., academic presentations, conferences), but that identifiable features (e.g., faces, spoken names) will not be used. Any videos where the individual’s face/name is recognisable will not be shown without my express permission.

Printed name Participant  Signature of Participant  Date

Person obtaining consent

I certify that I obtained the consent of the substitute decision maker of participant above. I understand that I must give a signed copy of the informed consent form to the substitute decision maker of participant, and keep the original copy on file in the repository location designated on my REB application files for 3 years after the completion of the research project.

Print name of Research Assistant  Signature of Research Assistant  Date
8.3 Appendix C: Evaluation Session Guide

Evaluation Session Guide

Complete Informed consent

Complete Demographics form

Explain Research: “We are attempting to reduce navigation (i.e. the number of clicks) required to complete a desired task in an EMR. We want to develop a system which is able to predict what task a doctor requires at a given time and present it to the doctor up-front, accessible by just one click. For example, the first time that a doctor goes to visit a patient, the system expects the doctor to want to look at medical history summary and presents it upfront. I completed an observership in the St.Michael’s Hospital’s GIM ward, based on which we have designed some mock UI. While we have had one doctor review these UI, we wish to expand to receiving input from several doctors. Input on the UI and the entire idea of a system predicting a doctor’s task.”

Wizard-of-Oz scenario: “This is your first visit to patient John Cow who has been transferred from the Emergency Department. He had come to the ER after coughing-up some blood and temporarily losing consciousness.”

Think out loud; Ask questions as they will help identify confusing design; Mock UI developed quickly on powerpoint so feel free to criticize; Not fully functional, some filler text.

Semi-structured Interview - Introduce the following system features and UI elements to the participant

1. Tracking using mobile phone & stylus (effortless, silent authentication)
2. Input using stylus and keyboard
3. ‘Pin-board’ - can slide; notification red dot
4. ‘Desk’
5. Fixed medical information pane
6. Notification area
7. Menu - how is grouping? Is it missing anything?
8. Multiple users can sign-in
9. Sharing documents with a long press
10. Patient UI
11. System learning from the user/Predictive customization

Q) Any initial thoughts or first impressions on the UI?
   Probing Q - Anything confusing or surprising?

Q) Do you think the patient room is an appropriate place for this display?
   Probing Q - What should be its layout & size in the room?

Q) What are your impressions of the menu?
   Probing Q - Any features to add or remove?

Card Sorting activity
- Clinician Specialty
- Time of day
- Length of admission
- Patient Specifics (e.g. age, gender)

System Usability Scale (SUS) questionnaire

Compensation and receipt

Provide Consent form copy
8.4 Appendix D: Evaluation session transcripts

8.4.1 Participant 1 (P1)

(START OF TRANSCRIPT)

I: I’ll give you five minutes to roam about – Feel free to criticize; created on PowerPoint; incomplete; think out loud;

WIZARD OF OZ SCENARIO START: TIME 4:34 UI SCENARIO START.

I: That’s not built in yet

P1: Not sure how I’m supposed to go back [from xray blow up screen]

I: Ok. Is there a reason you clicked on comorbidities?

P1: It’s not clear to me if that’s a complete list or not – most people have a longer list, so I wanted to see if there is a longer list.

P1: This doesn’t scroll? [desk region]

I: No, not yet

…

P1: Not sure who that could be from [Unread message notification]

P1: Doesn’t work yet huh [Menu options]

I: yea, some of them do – like Imaging, but we didn’t go too far

I: This is a screen for the patients

P1: Oh oh, this is for the patients. And again I’m not sure how to go back from here. Just because you need a consistent bar for navigation purposes for going back or for whatever. You want to be as intuitive as possible.

I: So have like a ‘Back’ bar?
P1: Yea, there should be like a website where you have a constant manner – or anything like a list of sub folders at the top to see where you are.

P1: But these are three of the same thing [icons for logged in users at the top right corner], so I’m not sure…

FEATURES LIST STARTS: AROUND 7:30 MARK

I: Ok, let me walk through a features list of what we thought the system would do – now that you had some time with it. We wanted to enable silent log-ins, so go past the idea of …

P1: People lose pens all the time. Smartphones though – most people have their smart phones on them.

I: Right

P1: So maybe send a message or have it send an id code..

I: We wanted to put two layers of security so [interrupted]

P1: But you can’t have one where you don’t have a pen and you can’t do anything. Coz right now its one password for EPR and another password for [inaudible]. So two areas are good, but if you have this [phone] you might have to put in a code to use it. So you would put in a code to activate the app or something. Or you could have the pen and the other too, so if you lose the pen, you still [have a way to log in]. I always have stuff here [pocket], but a lot of people lose stuff.

I: it’s good to hear that feedback

P1: Uh, we also have people flying in to assist us and so how do they get in [log-in]

I: Our idea was with RFID, so almost like workbadges [interrupted]

P1: Ya, you could have a part of your badge

I: ..but the functionality of the badge in a stylus. So it can be reassigned if you loose one.
P1: Right, right. But if it’s the weekend, you can’t get one till Monday. Unless you have multiple styluses - so if you still have a log-in option. [inaudible]. You have to have a few alternate options because pens will go missing, phones will get left at home – its usual. Good thing about the log-in now is you can’t forget your password – for a certain amount of time. So, uhm, so ya, it’s a good idea to think about extra ways to access the system, but there are issues [inaudible].

I: Ok and another things I wanted to say was that the input is using the stylus and keyboard.

P1: Um Hmm.

I: So the way I was thinking about the interface … [pinboard] – was that obvious in your roam about?

P1: Ya, I mean its hard to say. It looks like it has scrolling options – which are not working yet – but I know that, but some people might not know that. So it depends, if it’s the first time looking at the record in emergency – so it depends – issues for me are to have a common bar to have a bar up there interns of – well there are a few options, a few common ways I want information presented. We talk to the EMR people about customization that right now we can’t customize – like when I click something a list of 40 things comes up but things I commonly used are at the bottom so I have to scroll and a bunch of stuff I never use is there. So an issue is to have some sort of – its not customization – but its some sort of thing that can be remembered; so when I log in again it knows how I like information presented.

I: Right, that was sort of what [interrupted]

P1: Well this could be a starting point, but then you can have an option like ‘how would you like [inaudible]’. [Something about drop down menus]

I: That was the idea – although its not functional- but the idea was that if this is a sliding screen [pinboard] then you might have things that are this would be an index

P1: Its also very hard to read like that [pin board small window]. You could get rid of that and have a smaller bar [just the words] and click on it and it opens up onto the bigger screen. I mean I can read it, but its not the easiest.
I: Ok, so the red-dots, just mean that these are things that have recently been added or just been made available.

P1: Ya well that’s that other thing that’s unclear what the red dots mean. I also don’t know how old these are[ no dates]. If you know the dates these were don’t [note and xray] and the current date – which is’nt posted here – then you could tell the relative time period. 8 weeks ago, saturday – So instead of the red dot, which could be a day or a week or month. So you should have some sort of relative time index. Same thing, I have to look at this [date on xray] and do some math in my head as to how old this is. I can do it, but it’s just friendlier if it’s just there. It’s not just about extra clicks, but also extra mental steps.

I: So this are is where things blow up [desk] [interrupted]

P1: They don’t just blow up – this[ the xray] it opens in a new screen, which is ..

I: what are your thoughts about that? Should that be a standard thing

P1: Umm. I like consistency so I would have it[xray] open up here [desk] and then click on it again to open it in big screen view. So it becomes a consistency issue – so anything I click here [pinboard] opens up here [desk] and if I want the whole screen, then I would just click on it again.

I: Ok, so the fixed medical information is there

P1: You could have the meds that people are on currently – a lot of people like that. Um I would’nt put it as one because then you’d take up all the space, but that’s one of the ones you could use – click on it and it opens up here.

I: This is the notification area …

P1: Ya, Imaging is there, but you’d want lab results too. So you’d probably want uh, those options. New note, is this for creation? So this is confusing. If you have to create information there should be a different way – cause I saw an option here [inaudible]. So interms of what you have, these are your two big areas across navigation [pinboard and fixed info pane] and there are fewthings which if you clicked on it could drop down. Unread message I’m not sure if that’s specific to me – so I’m not sure who that’s for.
I: Menu

P1: So a little non intuitive that that’s there because usually ther’s some sort of commonly what is done is – lot of apps have arrows that indicates there is something minimized.

I: So say that [interrupted]

P1: Um ya it’s a menu, but it’s really [inaudible] to know it’s there. So you probably want to have a little more – it’s interesting. You want a system that is intuitive and people don’t have to take an information session about – because people don’t want to. Its nice to have education, but if your interface is really good, then. … that could include anything from something like a site map if you need, so you can find something you don’t see an option for. Or basically go through lot s usability iteration to try to get the kinks out. And as you go through it, it should get easier.

I: So one thing I wanted to mention was – these three here – Multiple user log-in

P1: Well the issue that goes into our current EMR is that you have a physician desktop and a student desktop which are actually different. [inaudible – but something about organizational difference]

I: This was one of reasons we wanted to go with the stylus because we can track organizational rules.

P1: I mean it’s a login so it would recognize that. [inaudible] Students don’t see the other desktop, so its confusing for them when they have that option. So I’m not sure if that’s ging to continue but right now three physician desktops & then some for allied health.

I:[Menu][interrupted]

P1: I’m not sure what trends is – its very vague, usually, we trend lab results [inaudible] Right now this [all three order functions] is all done on our site by the same function – you just type what you want.

I: How do you feel about how it is split up?

P1: I don’t know what happens when I click on things
I: No, I mean overall, in terms of how these are grouped, coz these are things that you review, there are things you order and these are things you add to the patient record. So I don’t know if these are currently grouped like that – I grouped it by task [interrupted]

P1: So right now out notes are still written – discharge summaries are typed- consent is printed, there is a sheet to fill out on the computer and right now these are [inaudible] for us.

I: So in terms of the grouping is it intuitive?

P1: Ya I mean, full note, consult note I’m not sure what that means – is this an admission [note]? or [inaudible]. You only have one admission note and one discharge summary. So in terms of what is left there you might just want to have progress note & ‘other’. That just saves you time because more option – the more they need to think about it before making a choice. So you just have to consider what is the most – I mean these [order] are done commonly right. Note creation is less common.

I: So one other feature I just wanted to talk about was this – ability to share …

P1: I’m not sure how you got to it either – so very non-intuitive. Anything that you have to tell someone to do obviously need training sessions and if they have the session and use the system 4 months later, they’re going to forget. That’s not a common function to hold [long press] – just using the iPad – it’s not a common gesture. Then there is also confidentiality issues here. This would only matter to people/providers outside the organization, because then – its an organization and they have access to it. [inaudible]. Usually we just that when we do the discharge summary, we indicate something. So there is not a lot of sharing necessary, plus you get into all sorts of confidentiality issue.

I: Right, that is not something we have considered in depth.

P1: Oh ya, but confidentiality is a big issue and even now we have issues where you don’t want the patients family doctor to know about something, because they have expressed so to us. Blah blah blah. So I think anything with regards to sharing – privacy has become a very very sensitive issue, so you have to be careful. So you can do it, but you have to be really careful of a bunch of privacy issues. … [talk about the index]…
I: So the last thing I wanted to touch upon was this idea of the system learning from how the user uses the system – user history [interrupted]

P1: I’m saying you might want to take a – that takes a whole bunch of programming – but if you just make a customization option so the user controls – It would be interesting to do a study and compare the two.

I: At this point, we just want to get your opinion on what if there was this system – that is able to do this [interrupted]

P1: So these would populate by whatever the computer, it would use some intelligence obviously – but the problem is that with different patients you want to see different information and there is no way for the computer to know what type of patient. So this patient, I want these three [items on the pin board] but another patient I want another three. So I’m just saying, there are problems with generalizability to what those options are.

I: Ok let me grab this sheet [contexts sheet]. I wasn’t planning on showing this, but you touched on it really well. So we are calling those things contexts – patient, how long they have been admitted for … [interrupted]

P1: Another option here is to have something for first-time [hand motion]

I: Sorry?, first-time?

P1: Like a screen for a first time visit accessible by a click

I: Like a dashboard

P1: ya, ya, ya – I’m saying because it’s very hard to predict. Sorry. But you’re gonna be guessing wrong, even and there’s no time for it.

I: I understand. Our idea was that even when the systems guess is wrong – the desired task is available from the menu, which is not too many clicks away.
P1: Right you don’t want to have too many [items on the pinboard] – if you have 3 there and the 12 items on the menu, that would get to the most commonly done tasks. I mean you could do – right now when I go to labs, I get this big list of 40 things of which I only use [a few].

I: That would be part of customization, because as your workflow [interrupted]

P1: Well there is set-customization, like I’m saying, you actually go and you have options to tell [the system] what you want. Versus, predictable customization where you’d have to program and do probabilities to figure it out. [inaudible] for different patient s you want different things, but in general, you have a certain way you like to get information – that you can customize – I think its easier, requires so much less background programming.

I: At this point [interrupted]

P1: Or you could use your first thirty to say, “look this is our suggestion” and then they change it to their taste. So there is different way you go about it – you could do it upfront, you could do it after a certain amount of time – it’s like websites like kobo right or Netflix – suggestions based on previous stuff. So there’s different ways to do it but a lot of people will be happy with just the – regardless of the – I guess its reduced clicks also - I guess everyone has different ways of seeing things, so that would‘nt change too much, cause I mean the options are still there right. But most people have certain common things they want – there are going to be times we’re going to want to go outside of that – a less common thing. … I’m just saying because in general internal medicine we have patients with lots of different problems – in surgery it will be pretty straight forwards. [inaudible].

I: That’s why we wanted to chose GlM [interrupted]

P1: Yea, if you make it there, you can make it anywhere. Anything will be simpler. There is nothing more complicated – we are the most complex. …

I: On a realted note, I wanted to show you the patient UI

P1: They’re not going to be able to read that at the foot of the bed.
I: Ok, sure. But let’s say this was on a display like that [bedside arm mounted] – Is the information displayed here, worth sharing? …

P1: Right now we have a board that we write on. The issue is like saying I reviewed a Xray with a cardiologist is going to cause some anxiety [inaudible] plus you have confidentiality issues. Neighbors can read this etc. So you have to decide on the patient portal options, because they are working on that in UHN – so I don’t know if this is too much. Right now that would cause a lot of anxiety. We give them information at the end of the day.

I: What about ‘what’s next’ – ok you’re awaiting a CT scan at such and such time. Would you want to give them an expected time?

P1: We don’t give them an expected time because that’s not under our control. So you’d have to decide – it’s a risk-benefit of [providing patient with information and it being wrong] – CT scan happens several days later than predicted.

I: So you’d want someone on the clinical team to be able to moderate this?

P1: Yes. I mean we tell patients we put in a CT scan, but we don’t tell them when. So there’s a few things – if nothing is pending then they’ll [patients] will be like why am I here, what’s going on. So there’s a few [inaudible]. You have to do a risk-benefit. But it might be better to do it separately.

Or there could be an option to show the other things there can be an option to show.

I: Which other things?

P1: Oh the hospital is already working on a patient portal like that – so you don’t have to do anything because they will design. … Confidentiality issues with family members of other patients coming in.

OPEN ENDED Q

Q ON PHYSICAL SIZE AND LAYOUT

I: Do you think such a display would work in the patient room? And if so where is a good place
P1: Usually we are at the foot of the bed – that’s where the team is. There is not a lot of room on either side of the bed. I don’t think it’s for the patient. . . . So I think there [foot of the bed or on the wall] would be fine. Then you have issues of confidentiality – two people rooms. That’s why I said – for the patients, I don’t know – but this is more for the doctors. Patients would need something towards the head of the bed. In terms of size, one screen how much can a person see – but then you have issues of cost. It would be nice to walk around with a tablet instead of going back and forth between the nursing station.

I: You think that this display would be better suited on a tablet – because we are completely open to physical form.

P1: Depends, this [current display] provides a teaching opportunity to the team – where everyone can see everything. But on a tablet, 4-7 people are not going to see things – it’s not practical. So it really depends on feasibility. This obviously allows – if its this [current size] size and at the foot of the bed then the whole team could see this [xray] together [inaudible]. So you’d have to chose what the focus is – but right beside is not practical. . . .

So right now I think this [current size] is good because there is no way someone from the other corner of the room can read what’s on it. [inaudible]

So you’d have to decide who it’s for.

Q ON FUNCTIONALITY

CARD SORTING ACTIVITY
8.4.2 Participant 2 (P2)

(START OF TRANSCRIPT)

I: I’ll let you roam freely & request you to think out loud when you are clicking things – why?; if something seems surprising or confusing, just point it out. If you have any questions, ask them too. The mock interfaces we have made are made in powerpoint so feel free to criticize them as things can easily be changed.

P: Do you want me to pretend i’m coming into the room to see a patient and this is what i’m presented with?

I: Ya, and just take your time to get comfortable with the system for a few minutes and then I can come and go over a features list of all things that we have thought. But I’ll give you a chance to explore before I start. Also, its not fully functional, so there is some filler material – so some things when you click them, nothing will happen. I’ll come-in and let you know when that happens.

P: Ok Can I make one comment? If I was walking into a room and I had a user interface, I would not want to be next to the pt [patient] because I typically review the chart of the pt before seeing the pt but coming into a room if I haven’t met the patient before or if I have, I want that first interaction – is so important. So I would’nt want to – it would be very rude for me to go straight to the computer. So what I’d prefer to do is to have a computer, fist of all so I’m standing [participant was seated in front of the mock interface at this point], either outside the room or I would have it just, not next to the patient – so I could look at it, see what the story is and then go in.

I: Ya, ya.

P: Ok, so you want me to through it? [Reads the Scenario text aloud].

WIZARD OF OZ SCENARIO START : TIME 2:26 UI SCENARIO START.

P: First of all, the text is really small. [Points cursor to ‘Pin-board’ section of interface]. Umm and the layout of everything is very different than the way i’m used to looking at things, when they are on a computer – so certain institutions like Sunnybrook Hospital already have the
history and some of the information included on the computer that you can [inaudible]. And so my mind is used to seeing it a certain way, umm so I would want to see the history first. Ok, so I’ll click on this [Medical History window on pin-board region]. That’s good. And then, ok. [Clicking through other links].

Ok. Umm, its missing a lot of [clinical] information, but I assume it’s not the point. Whoever did the admission did not do a very good job [sarcasm], did’nt put too much information, as to what’s going on [with the patient]. But that’s ok.

Umm. I like the colors. I mean, I like the black on white – very useful. And, ok, so I have a bit of the history..and I guess here it reminds me what the [clinical] issues are. Ok. Then i’m going to go to the physical exam.

I: We don’t have that [physical exam] built in yet.

P: Oh, you don’t have that yet. Ok. And that would be someone else’s physical exam, I guess [exam filled by another doctor] or the last one that was entered. And then there would be a Note..

I: So this is a Note that somebody had completed.

P: Consult Note, so someone came to see this patient. Umm.

...

I: So not so much about the case, but in terms of how things are laid out is there something that strikes you as odd? Off the bat.

P: Ya, I think there is too much on the screen – so, umm, I think, its ok to have; we are all very familiar with using media where we can have – like i’d rather have all my information on one page and click on what else I want. Like to have imaging results, physical exams, I would put them all in one side here [cursor at left hand edge of interface]. We always start with history first so that would come up first. And then everything else I could click on, rather than it being there. There is no reason to take up space here with this, cause I’m just going to click on it and want to look at it. And with imaging results same thing – i’m going to click on it and look at it eventually, but it doesn’t need to be so big, doesnt’ need to be – it’s not good enough for me to
see it just so small, you know [cursor on pin-board region X-ray image]. So I will have to click on it and open it, so don’t waste your page.

Quality is pretty good [looking at expanded X-ray]. How do we go back?

I: Its the cancel icon on the top right.

P: Oh. Ok. Ya , I guess that would be my biggest comment – is that there is just too much on the page and so i’m not really sure where to go because of that. But I like the information you provide, like you’ve given me kind of what I would want, the history, a note from someone who has seen the pt – you might want to put a date incase you have more than one. If you put it on the left, you could have medical history pop-up right away and then you could have on the side, notes or consults and then say consult note 1 with the date, consult note 2 with the date. So i’d be like, “Oh look someone saw him [pt] four days ago and I can click on it and then the information would come up.

That’s my gut feeling, kinda.

FEATURES LIST STARTS: AROUND 7:30 MARK

I: Ok. So I’ll go over what we had in mind as we designed this system.

P: Sure.

I: The Idea was to incorporate - You can comment and add your thoughts as we go along. One of the things we wanted to bring-in was this idea of effortless log-in. The idea is that a unique stylus is assigned to every doctor – so almost like your ID badge functionality is in the stylus. So the stylus with your phone being in the same location, is sensed by the system and it logs you in automatically.

P: Oh

I: So that was an idea to reduce the log-in step required. To reduce complication

P: Ya, no, that’s great. Timing is really important, so that’s very good.
I: Right. Same idea when the doctor walks away [from the display], you don’t have to log out, you just walk away and it senses that you are no longer in that certain range and logs you out.

P: And so, considering that there are a lot of different doctors that can potentially come in, like if I ask a consultant to come see my patient. That consultant may never have seen the patient before – so how would you…?

I: So, they would not have the stylus, is that the idea you are getting at?

P: They, oh, I ..So you would..How would they…You’d have to give a stylus to every single physician in the hospital – like that would be really hard. You know you could have a stylus by the room. …. So they walk-in, they grab the stylus, or something like that – so it goes by the room, so when a patient leaves or if it’s a different physician..So it’s based on the actual physical location rather than the doctor, because doctors change all the time. It’s not the same ones, especially in University center with all the residents, all the medical students – I mean these are all people who’d want to access the information. Even the nurse, you can put the nursing information in here as well.

And so, yeah, like if you had a per patient, you just have to be careful not to – just in terms of patient confidentiality you know. But I like that idea.

I: Ok. So. Umm another thing is that the input will be using the keyboard and the stylus. … It seemed that the most ideal thing for use in patient rooms for input was still the keyboard

P: yeah. And there are things I would say about the patient, that I don’t want the patient to necessarily hear [in reference to use of Dictation technology for input]. You know, or even Medical jargon, in the patient chart there is medical jargon that ther patient is not going to understand – so for me to say, “Oh, he has [medical term] suggestive of this”, he’ll be like “what? What do I have?”

And it’s just going to cause stress. So, ya.

I: One more thing was that, this are of the screen, is what I call the ‘Pin board’. This is where the system’s next guess of what you want is populated. For example, … [explaining scenario]. So this area of the screen was dedicated to the idea of, lets populate what they [doctors] might need,
so that its accessible by one click. And then this was your main work space [pointing to the ‘Desk’ region of the UI] – where you’d do any typing etc.

P: Then in that case, I’d probably put this [‘Pin board’ region] at the bottom. I actually just noticed that it was a billboard – like I didn’t even notice it until now. And the reason was that I went straight to this [Desk region] – this was the biggest.

If you put this thing [pin board region] at the bottom, then I would go straight to it [desk] and then I would gravitate towards what else was there.

I: Cause in the start it [desk region of UI] was all blank, right?

P: Ya, no it was. Yeah its true, when I clicked it, it opened up.

I: So our idea was that anything that is not here [pin board], should be accessible on this menu. So just wanted to get your overall thoughts on the Menu also. I’ve grouped it in terms of reviewing things, ordering things, creating new information in the medical record and sharing information. I don’t know if that is currently how things are grouped…

P: Its fine, like I think the ‘Trends’ is good. Lab results is fine. Ya, I would see them that way too. The History, the notes – review prior, so it could be any notes?

I: Right. The idea was that [interrupted]

P: This should say the admission history, not the medical history, because there is the first history and then there is histories every day. So the admission history will be the first one and then the notes can be done every day. So you’d have a lot of different notes and the results, which would be the most recent results. Trends to look backwards and medication, labs, imaging – no I like that, I think that’s good. Create new, and do what you want to do, discharge summary, - you’d want to put in ‘Medication’ there, in the ‘Create New’ section. It depends on if you want to do it just for history or if you want be able to order things such as medication. Do you want to integrate it into EPRs, like into the current systems at UHN. We can order medications and all that on the computer. Yea that would actually be really useful, cause then I would’nt have to – cause we have computers outside the patient rooms; if I had a – if I could come into a room, see what the history was, talk to the patient, look at the notes, the most recent labs, look at anything
that’s recent, open up a new note – and then speak to the patient, do my physical exam and then put it in, order my labs, like everything I want, all investigation – all on the same computer, all at the same time, without being logged in logged out all that and then leave the room and everything is done for that patient – that’d be fantastic. Or like write a note, or even send a message to the nurse; or flag something and say “please don’t forget this” or whatever. And then when she walks in, maybe you’d have a pen for allied health professionals, and then a message would come up for her saying, “Oh BTW the doctor came in and ordered this”.

I: Right. Because one of things I noticed in my observation, was that there is a lot of ad-hoc communication that was happening and that information was in the record, but there was a preference to just tell each other about it.

P: Ya, ya. And I don’t think you are going to avoid all of that, because then we’re just not going to trust the system as much as seeing someones eyes and telling them “I’d like you to do this please” or “What do you think about this”

I: Yes. Our idea was to incorporate that ability into the EMR also. So not try to replace it, definitely not. But somehow, provide a way to do it [on the computer]

P: Yea, that’s great. I like it – I like this part [menu]. And I like ‘uptodate’ there on the bottom, that’s fantastic. And translation – fantastic. Can I try that? Does it work?

I: Sorry, it doesn’t yet. We didn’t have enough background [interrupted]

P: This is good too, Patient education materials and then you could – see the advantage of having the screen – you could even put the screen somewhere where it’s not next to the patient bed, but lets say its here [pointing to the wall closest to the foot of the pt bed] and that way I can walk in do my things “Hello, you know, blah blah blah blah” and then if I have information and I want to share with the patient then the patient could see it, potentially. Something like that in terms of design.

I: Ok, ya. [Coming back to the features list] The patients fixed medical information is there [pointing left side of UI]

P: Ya.
I: and this is a notification area that we came up with, so if you have a message from a nurse, it shows up there.

P: There would just have to be some addition of how urgent the notes or the messages are, because we get so many messages and if its – there would have to be some kind of criteria or maybe it would say it was urgent or..Because we get paged when its urgent and I may come in really quickly and may not have time to look at the message, so I want to know how urgent it was.

I: So could urgent messages pop-up here [pointing to pinboard area]?

P: I think if it was an urgent message, I would just have it pop-up right away. Kind of like, you walk in and the message is there and you see the message. That’s how I would do it, so it gets your attention right away. It could even beep or something.

I: So the idea with the red-dot there [on the pinboard cards], was that those are things that have been newly added – or that have not been reviewed yet. I don’t know if that was [obvious]

P: I wouldn’t have noticed the dot. Ya, I don’t think that’s implied – no. If it says ‘new notes’ there [notification area] its better over there and disappears once you’ve read it – than putting a dot.

I: Ok. Ok. So the idea with showing three people here [top right corner] is that we wanted to enable multiple people logging in, since you can log-in silently. Hence the question in the demographics form as to how large the rounds teams are … so we could have multiple people sign into the system

P: Umm Hmm. But you’d never have more than – the staff physician, the person who is assigned to the patient that day and then the senior person in-charge of the team, the nurse and then you could count all the allied health – the physiotherapist, occupational therapist, consultant. But in terms of the medical team that takes care of the patient every day, you could have one person. You know, wouldn’t be that many people.

I: The idea with the stylus was also that we could abide by organizational rules – if nurses are assigned a pen and doctors another, they could actually be working on the interface, ideally , at
the same time and we would now [can track] nurses cannot prescribe some medications and doctors can.

P: Umm Hmm. Umm Hmm.

I: There was another idea we had on doing a long press and then this sort of a menu comes up which enables you to do tasks of sharing quickly – so if you want to print something or fax something or send it to the patients family doctor - this was to reduce the steps required to do that. Or email things.

P: Hmm. I like that idea. It’s be nice to – if it was – you could chose an item or you could chose the whole chart and all the information and send it through secure ways.

I: So in terms of sharing, would you be sharing things more with the family doctor or with your own care team members?

P: Well, my care team members would have access to – I would assume, would be able to access this information not only at the patient bedside but also outside, and so, because often they – for example when they are on call in the middle of the night they don’t need to see the patient, they might be able to do a lot of things from their own call rooms where they sleep. So I would assume that this could be available to them outside. And so, the information I would want to send would not be to them, because they are going to see the information, I just have to alert them to it – or they have to be alerted to it. But the information I want to send is to people that are not in the hospital, so family doctors, other consultants even patients themselves if they want certain information, you know about their discharge summary – they would’nt have to bring it home. You give them discgarge summaries at the end of the day, when they leave and in this day and age people lose them, it’s a piece of paper, you could email it to them.

I like the printing option. What’s this supposed to be? Is this for sharing?

I: Yes, that was my representation of the family doctor.

P: Oh, Ok.

I: The idea was that you could configure this menu as you wish, so if some people use printing more often than others – you could change things like that. That brings me to my next feature,
about individual adaptation. We noticed that some doctors like to come talk to the patient first and then go look at the charts – whereas some doctors like to read the chart and then see the patient. So there is a lot of variance in how doctors operate, so we wanted to build in this capacity into the system, where it starts to learn how a certain doctor prefers things and based on that these suggestions [pointing to pinboard] would change. A really simple way to try and understand this is like on amazon or kobo – ‘Other people with your interests have read books like this’ – that sort of idea, where it starts to guess, over time, given what time of day it is, who the patient is, how long the patient has been admitted for – things like these, the system can start to take a guess, maybe the doctor wants to do a physical exam at this point or maybe the doctor would want to order medication because the test results have just come out.

P: I think that’s ok, I’m just questioning what the ultimate goal of that is – is it trying to save time for the individual?

I: Ya, the goal for us by doing this would be to bring up the right things in the suggestions panel [pinboard].

P: I guess my concern would be, just because you do something doesn’t mean it’s the best way to do it or the right way to do it. And you know, for example if I had a – I have my way that I think is right and I prefer to do it. But sometimes you do things differently on a certain day and for example, if I had a trainee, a medical student let’s say, who is still learning the method and who comes in, uses the same interface and doesn’t enjoy doing the physical exam or doesn’t feel good at it. And then the next thing you know, the physical exam never pops up anymore because they haven’t been doing it – but they should be doing it; and they need to be reminded to do it, but they haven’t been doing it and so I would just fear that similarly, you could have a physician who does things a certain way, but the reminder that something hasn’t been done is important in itself. So I just worry that by doing it based on your trends, that you’re not necessarily encapsulating good practice. It might help you forget that you have something you’ve been forgetting a lot. You know it just makes it easier for you to forget. Just like for example, a similar analogy is when I’m on facebook, Facebook picks up all your different things that you like and then gives you all these advertisements now. These are things that I would not look at usually, but now that it’s been happening so often I’m looking at it – it’s because I’m looking at it I’m not
looking at something else. You know, it’s kind of distracting and so I would worry that the new interface could be distracting for other things that you may have looked at if it was not there.

I: So it might reinforce poor workflows, cause they won’t break.

P: Ya, just because you do things all the time it doesn’t mean it’s an efficient way or a good way or a way that – I for example on my computer a list of emails that I have to go through because I haven’t had a chance to do that and I put them all in a box. And if that box wasn’t there to remind me that I had to go there, I wouldn’t know that I had to go there – like I’d forget. Just a thought.

I: Thanks. Last thing is, when the doctor walk away, this information screen comes up for the patient and patient family. We haven’t gotten much into patient preferences, so at this time it is a purely informational screen and so we were wondering from the doctors as proxy users – what are your thoughts about this? Is this something that the patient will find useful? Or their families?

P: Ya, I think this is great. This is my favorite part I have to say because there is so much – you could have it; if the screen was not near the patient, you could even have it on their TV – it could somehow be linked. They could just click on it as an option. First of all the pictures of the people taking care of them is fantastic there are studies at UHN that are looking at being able to physically see who is taking care of you improves quality of care, so I think that’s a great idea. ‘What’s next’ is their biggest question – we never have [estimated] time, but if there was the ability to have a time or an idea of time or just the day – you know, now you are waiting for this, these are the things that are needed to be done – that’s fantastic and its going to appease. They might then have questions and they are ready for questions. You might even put, if they were able to use the computer, for questions for the doctor, questions for the nurse and they could just type in their questions. That might be something that is pretty useful for them. I love the fact that you could do education - I mean this is great – you could everyday they screens could have a different tip like, ‘Did you know that..blah blah blah ..Pneumonia or whatever’.

I: You could personalize it also. For example older people could be given tips for fall prevention.

P: Ya, fantastic right! I love this idea. And your visit so far, you would just have to make sure that this is modified for the patient because some patients are going to be super stressed out to
find out that this has been reviewed and they don’t know about it yet. Or then you’re just going to give more work to the care team. But I think generally the fact that you have what’s next, you have some safety stuff, you have the care team taking care, you might have the time, you could have games – you could really incorporate something kinda – I think it’s fantastic.

I: This is one of the things we want to get a feel from doctors on – how much information is ok to share? For example, the idea here was that this is not something we want to burden the doctors with. The idea was that the system would automatically, as things are being added to their [pt] record, whatever is appropriate we’ll bring in. But is it really worth it to share their vital details with them? How much detail is good? Or where’s the line?

P: Ya, where’s the line? I think things that have happened with pertinence – so ‘we’ve reviewed your medical history’ is something they’d want. Who visited the patient, I think they always ask, “What’s your name?” and they want to write it down – that’s useful information. I don’t think vitals are important for them; I mean they can’t interpret those, they have no idea – so I don’t think that. Anything that has a medical jargon to it, I don’t think is useful. Anything that should be for the patient to know, ‘these are the things we have reviewed’ so that they can ask a question, if they have a question about what we’ve reviewed. Or to allow the physician to review certain things – but some things are just not pertinent, like the vitals is for us [care providers] but it’s in the grand scheme of things. For the patient, I mean, that’s going to scare them if they look at that. So yea, I wouldn’t even, ‘We’ve noted the reason for your visit: Hemoptysis, unexplained syncope’ – you [Investigator] put it in quotations because it’s a medical word. So to put that on the screen for the patient, like there is no point. So I personally would put things like doctors visited you, this is his name, the nurse has visited you, this is what is due, - because they’ll know, we tell them “You’re going for a scan” “You’re going for a chest X-ray” - we might not say CT scan, they won’t know what that is but those would be the things I would put. I wouldn’t put half the stuff, like when things are done that’s fine. If they see that we’ve reviewed it outside and we haven’t told them about the results, it could be – you know I review CXR all day, but I don’t go see a patient and tell them what their Xray showed. So I almost wonder if it would be better if there be information for the patient like who saw you, what tests are needed to be done what has just been done and you were visited today by these people. But in terms of the what’s been done and what’s been reviewed I think should be the physician – and if the physician wants the patient to know, there could be an option where the physician can sy ‘ I want the patient to
know that I have just reviewed their Xray so they know to expect me’. But it would be my choice, but some patients I will – I told them “you’re going for a scan and I’m going to look at the results around this time and I’ll come back and we’ll review them with your family” Let’s say if I’m expecting something bad or something good or whatever. But I do that for a very few amount, so I would want – that would be nice to know that then the patient could know when I’ve reviewed it - right cause, things happen during the day. But for them to expect me to come and to review every single test, I mean that would just ruin my whole day – cause you don’t do that, you review it, you only review what is pertinent.

I: Specially if things look OK.

P: Ya, half the Xrays are – more than half the x-rays are normal. You could add things like – blood’s been drawn, you could have diet – your diet selected is this. That would be useful information. Even there is not just clinical physicians, there is also physiotherapists who can give them exercises to do in bed sometimes, so you [system] could say ‘your physiotherapist has just come by and left you with these exercises to do’, then they [physiotherapist] could input whatever they wanted them [pt]to do and it would pop up on the screen and it would be like “Oh look at that! That’s going to remind me”. Or respiratory technologist has told me that I have to breathe in this tube 10 times a day. I think that would be fun for them. Those are the kinds of things I would give them [pt] – I would give them educational stuff that the healthcare team could decide on, so that it was patient centered.

I: Ok.

P: I think it’s great, overall.

OPEN ENDED Q

I: Going back to the clinician display – we covered it briefly before, but just want to bring it up again – anything that was confusing or surprising ?

P: Ya, no. Like I said, there was just too much on the screen – I don’t – you could put this [pinboard region] down here or here [bottom and left side of UI] and then just have one thing per page with something on the side that you can click on and get more information.
Q ON PHYSICAL SIZE AND LAYOUT

I: Ok. We also covered this briefly before – how appropriate this sort of screen would be in the patient room? If so, where could we place it and what size, maybe? Because we have’t really considered if it should be on a tablet and what’s a good size? That would also depend on how far it is? Or if it is better to have a separate screen for the patient display? Things like that.

P: Ya, so I think a lot of it going to come down to costs. But in terms of efficiency, it would be efficient for us [clinical team], similar to how the Blood pressure and all the vitals are written on a patients room – not all hospitals have that, but a lot do and I personally prefer that. I like to go into the room and have access to the information in the room – as long as I have the choice to access the information before I see the patient. SO I personally prefer- where I did my training at McGill – we have computers with information, they are all outside the room – but then I wouldn’t be able to use it to do teaching with the patient. So something like having it so that I can look at it without - so maybe like an iPad would be good because then I could look at it and then bring it in, if I wanted. And then you could share with multiple patients. But then there is the whole infection control issue, what, are you going to clean the tablet everytime? So you would have separate ones for the rooms where there is isolation so then you wouldn’t have to visit – so you could have an iPad for patients that are in isolation and they could be cleaned.

I: What about rooms with multiple patients – would you require just one display? This is cost and technology no barred

P: you know, I think one for several patients is fine if you can move it. Similar to we have in UHN interpreters on the pole. So its basically a phone on a pole and if we need an interpreter and there is no one we can call to come face to face then we can just grab the pole – the speaker phone. And then it’s just a speakerphone and you can wheel it into a patient’s room. So I could have four patients in the same room and I could be seeing every patient and they might all need interpreters, and so they don’t have to actually touch it – there is no issue of contact or anything.

Q ON FUNCTIONALITY

I: Going back to the Menu, is there anything that you think can be added or removed?

P: No, the menu’s great.
I: Ok

P: Very user friendly

SECOND DEMO SCENARIO

CARD SORTING ACTIVITY
8.4.3 Participant 3 (P3)

(START OF TRANSCRIPT)

I: I’ll let you roam freely and click around in the interface. Thin out loud. Any questions/confusing/PowerPoint. Not fully functional. Give you five minutes

WIZARD OF OZ SCENARIO START: TIME 2:15 UI SCENARIO START.

P3: First thing that I really like to know about is past medical history of the patient of the patient. I like the fact that it is readily available in front of me and I can access it quickly. I’m about to press on this [medical history link on pinboard], I would want to click on that and learn more about the past medical history that gives me an indication of how serious presenting compliant might be that the patient now has. And its useful to have that at my fingertips. I like that facet that the allergies are readily visible and I don’t have to click on anything additionally to find that. Its find of interesting that the physical exam is already up – I don’t know where this physical exam is coming from or who it specifically refers to. This is the last physical exam that was done by somebody who did a consultation, so I’m just wondering where that might actually fit into things – might need a little bit of tweaking. I like the fact that the imaging results are quite readily visible as well. Maybe more interesting than the physical exam right here would be any lab results; so next to the imaging results maybe it would be very helpful for me to have the basic lab results that were already reported or most recently done on this patient because that’s the first thing that we do once we’re done seeing our patient – is we want to know what are the routine blood tests telling us about other things we should be aware of, concerned of, regarding etc. But I certainly like the visual layout. Kind of interesting that the visual layout is appealing – its pretty easy to follow and there’s a good amount of information without it being too busy.

Wondering what the option 2 is here [Menu>Order Imaging]. New lab results doesn’t take me anywhere and unread message doesn’t take me anywhere – so I don’t know how much left to go through here. So presumably ‘Create New’ is where I’m going to be adding things, which is nice. I like this ‘Share’ option here, which is to send a message or page – I like the fact that that’s part of the same template and screen, because often you want to cross reference something with maybe another physician or somebody else who might have some useful information to impart about what you’re reading. So far I like this. Again my biggest, won’t say criticism, but my
biggest piece of advice would be that this physical exam, I'm not sure it's quite as relevant – right off the bat I think it would be better served to replace this with lab results.

FEATURES LIST STARTS: AROUND 5:50 MARK

I: Ok. I'll quickly go over some of the features that we envisioned. And as I'm bringing these up, whatever your thoughts are just feel free to voice them.

P3: Sure yeah.

I: Silent log-in.

P3: So it would be authenticated somehow.

I: Yes, kind of like ID badges – that functionality built in to the stylus that you work with.

P3: Wow! That's very cool. It's interesting – I guess my only concern is if you lose this stylus-you know, is it going to be functional through another mechanism. There are people who are going to lose it and get locked out of the system. Apart from that I like that idea. The less intrusive the less palpably visibly to a patient if you are in the same room, the better.

I: And part of the idea was that as you walk away… logs you out.

P3: Ya, that’s nice.

I: Also we wanted to use the stylus and the keyboard as inputs. Because we realized that you guys still do a lot of typing.

P3: So where would the stylus actually go – would it go right on the screen?

I: Yes, instead of the mouse you’d just click trough with the stylus.

P3: Ah, ok I see. Gotcha. Ok.

I: So no mouse. You just have your stylus.

P3: I definitely like that more than a mouse. For sure.
I: So any typing that needs to be done can be done through the keyboard and you can click through things using your stylus.

P3: ya. Ok great.

I: So this are of the screen [Pin board] … I think we need to clarify that it is for the doctor to DO a physical exam

P3: Ya I think that would be more useful to have that in the area next to where you are creating new report. To me when I’m looking at this, conceptually I’m trying to envision things that have already been done – that are going to help me than embark on my assessment of the patient. So putting information that I’m going to be inputting and mixing that in with the other information to be becomes a bit confusing. Does that make sense to you? For me it is awkwardly placed – sorry for being that.

I: ya. That does make sense. This is the main working area [desk]; [fixed medical infor][notification area]

[Menu] Divided the menu. Any opinions on how the menu is divided? I don’t know if this is how things are grouped normally.

P3: No they’re not – I mean they are, but in a much more clunkier fashion. I like the fact the there is headings and then there is subheadings so that you can think quickly as to what the action is. As opposed to having twenty different tabs that you might have to sort of visually process and then decide what you are doing. So I think this is an improvement for sure.

I: And it terms of what it cover, from a broad level, do you think this is missing something

P3: No. I mean you want to look at what’s been done previously and then the only things you order are tests and medications and the only things you really create are documents of some kind. I like the fact that there is the share addition there because that’s certainly a benefit that is not available on most interfaces as far as they know. So that stands to sort help be an extra layer of support and a reference [inaudible]. Its kind of nice to have that UpToDate.com there as well – ya I like that a lot.
I: Ok. Another feature we had in mind because we are signing in people with just their styluses being around [multiuser login]

P3: So how would the system differentiate between one person as opposed to five people logging in. How would that work. Would there be more than one stylus or?

I: Yes, our vision was that every doctor would have their own stylus. So if you started writing something, it would know that that was you writing as opposed to somebody else with their stylus.

P3: Interesting.

I: That being said, we don’t know at this point, how feasible it is to write things on there or multitasking. But any thoughts on that generally or is that too out there?

P3: It’s a little bit out there, but I like it. I like the concept – I like the theory and it’s just one less layer of things to go through. The only other concern I have is, if somebody steals your stylus then there is confidentiality issues that you need to be aware of. It’s a lot easier to just steal a stylus than to actually know what somebody’s password is type of thing. So from a security standpoint, I wonder about that being the bug.

I: Definitely. A lot of people have brought up that concern. So your phone and the stylus, both have to be there. …

P3: I think enough people carry their phone with then, pretty much all the time now that that’s probably not a big deal. Ok interesting.

I: [quick share]

P3: So that would be to share this X-Ray for example? That I’d be able to email this image to someone by just clicking on it.

I: Ya.

P3: Oh I love that. That’s a great idea. One particularly useful tool of that I can think of in particular is EKGs for example and specially from a teaching standpoint, if there is somebody on
call for example and if they can very quickly email the image of the EKG to the cardiologist who is at home and then can review it. Normally gets done by a fax or something else right now, which is obviously more cumbersome. So that’s a great idea. I like that a lot.

I: Ok and so in your opinion, where is this sharing happening – mostly with who?

P3: Probably with imaging studies more than anything else, because you are really going to be sharing things that need some degree of interpretation; that are still amenable to some degree of interpretation. You could always send other documents but you can just as easily speak to somebody over the phone, I suppose if you just want to tell them out loud “This is what the CT report said” for example. But actually being able to share an image or EKG with someone and then being able to in real time review it as well – I think is a nice advantage, its useful.

I: Ok. Another idea [learning from doctor]

P3: Tendencies?

I: Yes. …

P3: So it prioritizes things. Your favorites and that kind of thing. Ya, great idea. Absolutely. You spend half your time just again spending those extra few seconds every time you log-in to get to that spot that you know is what you want. With the computer automatically identifies that – and does it for you, I think that increases the efficiency of the encounter.

I: Right. So just that fact that it brings it in your vicinity so you can access it in one click, rather than having to go through menus. Ok last thing [patient UI]. Gather your opinion on things that we have listed – how useful they are- …

P3: So this is after the visit? So Ok. This is for the patient to see. And is any of the information that goes into your visit so far meant to be inputted by the visiting clinician or is this information going to somehow automatically already be processed.

I: So that’s one thing we wanted to ask you guys. Would you want it to have some sort of moderating ability on this.
P3: I don’t think from an efficiency standpoint you’re going to want the visiting doctor to start inputting more information now. So whatever can be done automatically that’s already integrated into the visit – to me would be better. I don’t want to have to enter anything else when I’m on rounds or when I’m seeing somebody. I want to tell the patient directly what I think is going on and I want to leave. I don’t want to have to spend any more time on a computer.

I: Our idea was that it would be pulled out from the patient record. That being said, its difficult to say how much information is healthy to give them and how much is overkill and how much can cause anxiety.

P3: I’m almost of the opinion that I’m not so sure it’s helpful at all – because to be honest its rather impersonal to have information on a screen, that it’s going to be of any major significance. Furthermore there’s going to be confidentiality issues, so if there is somebody else who walks in to the room, from housekeeping –do we want them to know for example, what the chest Xray has reviewed. I’m not so sure that we would. I think that any information of consequence should be personally delivered by the physician prior to leaving, if it merits enough attention. So I think this is to a certain extent superfluous, from what I think about it. I don’t think a patient really cares enough to know about their individual vital signs. Again unless there is a specific implication to elaborate reading of some kind, in which case, again, its sort of behooves the treating clinician to convey some of that to the patient themselves. So I’m not sure if this screen is as useful overall to anyone.

This might be useful [care team members photos] – I don’t mind this, ‘Your Care Team’, the nurse the resident the attending physician, that’s useful because again particularly if you have a patient that may not be English speaking or they are concerned that a family member or acquaintance or a friend or somebody wants to relay to someone and the patient is not in a position to be able to do that on their own – it’s probably not a bad idea for that information to be readily available to them. That’s about the only thing I think is useful on this screen.

I: So what about the ‘What’s next’ – is it helpful to tell them what’s coming up next and give them specificity of some sort.

P3: I’m not sure that that’s useful either. Again, expected time for a procedure is going to be fraught with a lot of difficulty, because the expected time can change dramatically depending on
a lot of things that are out of your control as a physician. And again it come down to confidentiality too - I don’t think you want any level of detailed information that has to do with the patient themselves being left on a screen that somebody else might be able to access. I mean knowing the attending physician and the resident physician or the nurse to me is fine, I don’t think that’s a big deal if somebody walking knows who the attending physician of that particular patient is. Might not be anybody else’s business about CT scans etc.

OPEN ENDED Q

I: Any other thoughts? I can give you another chance.

P3: None that I can think of

Q ON PHYSICAL SIZE AND LAYOUT

I: Ok, so how appropriate do you think this display is for the patient room? Physical location, size.

P3: I think it’s intriguing. I almost think it’s – we don’t spend a lot of time on a computer in a patient room & I don’t know if it facilitates much of a rapport by having a computer screen in the patients room with too much information – if anything, I think its detracts from a relationship that is a bit more personal, that you can have with a patient. Particularly if you’re going to get into details about prior consults etc. I mean if you’re going to take the time to look through prior consults, I don’t think you want to be directing your attention away from a patient long enough to read through an entire consult report, just feels awkward. On the other hand, imaging studies or lab results you can probably look at fairly quickly and get a quick sense of things – that might be useful to have in the patient’s room. The other tabs are I think probably more useful to be outside the patient room. Specially when you’re going to get into creating your own notes etc – I think it would be very awkward and not conducive to a very nice patient rapport to be dictating a note in the middle of the room or even to be typing it in the middle of the room next to the bed. I think that’s awkward.

I: Ok. Would it be more useful if it was tablet sized?
P3: Oh tablet size would be great. Absolutely. It still doesn’t change the concept – the idea that when you’re in the patient room, you’re trying to balance two potentially conflicting aims, one is efficiency and the other is patient-centeredness of your care. The more you engage in one, the more you may have to suffer the consequences of the other not being met. Particularly the idea being, if you are looking at something, if your gaze is fixed on something other than the patient while you are still in the physical proximity of said patient – it is going to unintentionally make the feel the patient feel as though they are less important; that they are being less valued; that you are not giving them your due attention. And you do not want that as a physician – with the exception being, if you can have an X-ray that many doctors can quickly assess in a matter of few seconds; you can get a gestalt appreciation for what you think is going on – that’s not going to make the patient feel offended in any way about you ignoring them, being too distracted. Patients recognize already now-a-days that phones go off because pagers tend to go off less, because we tend to rely on text messaging and emails etc. And we maybe transiently distracted for one of two seconds at a time - patients are cognizant of that, they are conscious of that. And they will feel offended or to a certain extent ignored if the frequency of those interruptions exceeds X numbers per visits and the amount of time that you appear distracted starts to become an issue. So we don’t want to layer on top of that more distractability. So I think from the point of view of what’s going to be in the patient room, personally, I would not want anything else, but imaging results – actually imaging studies, so I can actually look at them. If the results are already available reported then great. And lab results then you could refer to them quickly. But I don’t want any more detail – not in the patient’s room. And it wouldn’t matter whether it’s on a tablet or on a screen, because I’m still going to be distracted enough to direct my attention.

Q ON FUNCTIONALITY

I: Are there any features that you can think of adding or removing from the system? You did mention, but anything that can be added?

P3: You know one thing that might be helpful in the patient room is contact information, so certain demographic profile information for a specific patient, I think that might be useful to have readily available; particularly for patients that have communication deficits of some kind, whether language based or other kinds. Instead of having to go out of the room or instead of having to go to another source to find the next of kin, to find spouse emergency contact – that
may be helpful to have more easily accessible. I think I would like that to be accessible in the room.

SECOND DEMO SCENARIO

P3: So looks like the abnormal lab results are highlighted in red – and I like the fact that there is a trend that is next to it. I guess my question would be is this going to be the totality of the results? My next thought is going to be how many of these results are there, I’d want a slightly bigger menu of results already available to me. Now there is probably, on average about 10 different lab values that clinicians would want to have readily visible right away and those generally include the complete blood chemistry, hemoglobin, WBC and platelet count in addition to these electrolytes, plus kidney function and liver function tests as well. Probably run you closer to maybe twelve tests, but it would be nice to see all of those right away rather than having to scroll down to see more. And it might be interesting to have alternatively, maybe a different panel that’s available, an emergency panel, a cardiology panel, other panels so that you can click on and you can know that these are the types of results that you would be most interested in having right away. For cardiology for example, an EKG plus a test which is known as a troponin and a CK might be useful to have those sort of integrated to somehow to come up together.

I: So you can order them or review them?

P3: So you can review them. It wouldn’t be unhelpful to have them together, so you can order as well – but to review would be nice as well. So that might take some extra work, because you have to basically get into the mind of the particular consultant to say, “when I’m doing a consult on somebody for chest pain, these are the absolute musts that I want to see” and if you could somehow group them for me; right waya I’d know what’s going to come up. I’d have a panel for nephrology, for cardiology, for respirology for neurology – to have that information all – that would be great. That would take work, but I think that would be ideal.

I: Its great to hear because then we have more direction …

CARD SORTING ACTIVITY AT 35:00 MIN MARK
8.4.4 Participant 4 (P4)

(START OF TRANSCRIPT)

I: I’ll let you roam freely and click around in the interface. Thin out loud. Any questions/confusing/ PowerPoint. Not fully functional. Give you five minutes

WIZARD OF OZ SCENARIO START: TIME 2:15 UI SCENARIO START.

P4: Even before I see anything. I tend to find I go see patients with and agenda, in a situation like this my #1 agenda is actually a triaging agenda. So this is a potentially life threatening presentation - he could be very well or he could be extremely sick, so my first consideration is does this guy need to go to an ICU or operating room? And is my time better spent at the bedside or at the computer. So that would be the first thing I would want to get a quick handle on is do I need to make a decision right now, even within the next 2 or 3 minutes.

So if I’m coming here, I’m assuming the guy is reasonably stable, if he’s not stable I probably would be doing a lot of things while standing at the bedside trying to coordinate things on the phone or do whatever. I’ve never used this EMR before so the first thing I’m doing is just getting a lay of the land to see what even is here, because they all look different. So right now this information is not so important, because I’m more concerned about what’s happening with him, but I’ll come back to that later. Actually, I think this [chief complaint] I’d almost make it more visible, because I want to be able to sit down and know exactly what I;m dealing with and then I kinda use this context later. Ok, so. I don’t know who Dr.H is..So this is background information on the patient. This is helpful but I’m not going to read it right now, because I want to know what’s happening to him right now. So ok, this is actually what I’d want to read [consult note]. Alright, umm then this is a lot of latin. I guess one thing in this scenario is, I’m not exactly sure what my role is as compared to Dr.H’s role. So why I’m actually showing up here. So that’s got less to do with the system and more to do with [inaudible]. So I’m going to assume Dr.H is someone who saw this guy in the emergency department and this guy needs to be admitted to the hospital – which is what I do and I take care of them once they are up on the floor. So I’m going to assume this guy [Dr.H] saw him in the emergency department and said that he needs to be admitted and I’m coming down to figure out kinda who this guy is and bring him up to the floor. Alright so this guy is probably a respirologist, he’s going to do a bronchoscopy on Tuesday and
he is on Coumadin. This is something [Coumadin] which was highlighted at first glance. This guys suddenly got sick and I had to leave the computer – just glancing at this I don’t know if I would have necessarily noticed that this guy was on Coumadin. And being a blood thinner, I’d want that to stand out – I mean that’s far more important than if he’s got a peanut allergy at this moment of time. So it just doesn’t grab me – you know what I mean. Ok so, I glance at this, he’s on Coumadin and that’s a problem – like right then I’d want to know what his coagulation status is, like is his blood is super thin. So in some way what I’d want here is the labs more than Dr. H’s physical exam. To kind of put this into context with the bleeding. The imaging results here, just to confirm, but this story didn’t suggest that there was going to be pretty much a find, but glance at it. But that is not as important to me at the moment.

I guess when I get a patient like this, I’m going to sit down and the first thing I’m going to try to decide is what do I have to do right now. So right now is – how stable is this guy – and I guess that’s something that’s not really jumping out at me from this. He came in emerg he was seen by some people prior to me, like there is the EMS – I don’t know if he came in by ambulance or he came in with his wife. But EMS would have taken vitals, perhaps done things, given him fluids, done some similar stuff like that. I don’t know if he’s like coughing up so much blood, he ended up up on a ventilator – I mean is he intubated, is his oxygen status and then other things would be very pertinent like the fact that he’s on Coumadin –that doesn’t really stand out relative to everything else. Because this guys propranollol is – if he’s got BP problems because of the bleeding he’s going to have issues. His insulin I need to know, but its more of a side issue right now, relative to the fact that he’s bleeding and he’s on a blood thinner. So I’d want to sit down and say – what do he look like when he came in, how sick is he right now, he’s bleeding so what’s up with the Coumadin, do I need to reverse it right now, does this guy need to have a surgery right now, is this guy good enough to a normal ward bed or does he need to go to a highly monitored ward bed. Actually in the workflow we do, because we generally do a quick triage and then we have to choose where someone gets admitted to before we really do a full consultation, because of the way the timing works. That’s important to be obvious right away. Because we have to make that decision right now. So if I came in and that information was more visible, like what’s his stability, then I’d feel more comfortable reading through some of this stuff, kinda at my leisure. So then, my next goal is going to be “ok, I think this guy is stable”, to be honest the first thing I would likely do is, go and just kind of walk by where he is in the ED
and look at the monitors – just do a quick check that way. Go make sure he’s conscious and is talking and all that. Then comeback and take a look at some of these things – maybe talk to his nurse find out what they’ve been saying. Then my goal is, “ok what I’m I going to do about the chief problem”, so this note is really helpful [consult], because this guy is a respirologist and the fact that they are already involved is important. The X-ray is fine, but he’s going to need a CAT scan I’m sure.

Oh, I was’nt sure how to get back, once I click this note and go back to the prior note. So then I’m going to be primarily .. want to find out what all of his issues are, so I go upto the floor, and then “I need to have his medications for diabetes, I need.. because of bronciactisis, he might need a few other medication, such as a puffer, steroids and he’s got atrial afibrillation, so I also need to determine how high his risk of stroke is.” So because this is here and he in on the Coumadin and he’s bleeding, the other consideration is how long can I keep him off the Coumadin, obviously he has to stay off of it right now, because he’s bleeding. But if he’s got a really really really high stroke risk, I don’t want to leave him off forever. So other things that would help if they jumped out, would be things like that. And that’s obviously like pretty advanced decision support, but you know, anyway. So then I’m going to be basically doing my own note.

I don’t know what this is [notification area].

I: Unread …

P4: Oh ok, so that’s the note and this unread message would be?

I: I don’t have that inbuilt yet.

P4: Ok, so what’s the difference?

I: I had in mind that messages would be things like communication. So..

P4: Like from Dr.H to me?

I: Uh, yea. Or anyone from the care team to you.
I: Ok. I’ll quickly go over some of the features that we envisioned. And as I’m bringing these up, whatever your thoughts are just feel free to voice them.

I: [Silent authentication]

P4: I’ve a few questions. So would the plan be that this is on my personal phone or would I have a separate device? And if it was my personal phone, what would have to happen to my phone, in terms of the hospital saying you need to do all this with your phone in terms of the whole privacy security thing? Like are they going to decide they have the right to remotely wipe my phone and do all these things to my phone. So those are things that concern me whenever my personal devices are involved, but at the same time, I don’t want to carry a separate device. So its got nothing to do with your system, when it comes to your system, I love the idea, but in the broader context where – its one of those things, where I don’t really want to give the hospital control of my personal devices, but I also don’t want to carry an extra device. So for me its about finding that balance so that my phone is still my phone but I understand there have to be a few things from a security point of view, but sometimes if they are overzealous, I just find I prefer not to do it with my personal device.

So with the stylus, one consideration for sure is that I leave pens all over the hospital perpetually. So this is’nt something that is very easily to leave somewhere. Maybe if my phone and the pen were too far apart from each other my phone would ring and say like you’ve abandoned your pen or something … But as a general concept I like it. Why do you need both?

I: Its two layers of security …

P4: Oh ok, that’s cool. It’s a hardware two factor authentication in a way.

P4: So who do you envision having the devices? Just doctors or a lot of other healthcare people?

I: I would think, maybe in the grand scale of things, maybe everyone. My idea of the stylus was more like your id cards, that ability built in the form factor of a stylus.

P4: Ya, so I actually really like it. Just from a design consideration point of view – what if multiple of us walk into the room at the same time.

I: Right, so that’s another feature we had was this ability to [teamwork]
P4: I can see, if obviously 10 people are trying to touch the screen with the pen at the same time, its going to be quite obvious to both people that they are doing that – so that’s something they can just sort out between themselves. One thing though that would be, I don’t know where this is going to be in the room, but assuming I’m in an actual patient room and there is some sort of display somewhere up on a wall or something that can detect who I am – sometimes, I might not be in the immediate proximity of the machine, but I might still want to benefit from the types of things this display is showing, so I’m not sure how exactly I could, show my information without necessarily physically walking up to the screen. Like if I walk into the room, it would be nice if it just recognized I was in the room and then showed me the stuff I need to know. But then if you have multiple people in the room, it becomes a bit more challenging. But I think that overall I really like the idea, because by far by far by far, the log-in process is one of the most annoying processes in the universe – specially if you have to log-in on a phone or something. Those kind of things, they keyboards suck and you have to go through multiple passwords sometimes, sometimes you need an RSA key as well. The whole thing just drives you nuts. So I actually really like that idea – its good. And then the logging-out when you go away – I mean obviously I don’t want it open after I’ve left right.

I: [multiple users]

P4: I think it could be very confusing if you don’t know immediately who the display is actually responding to and I can see very clearly that that is me and not my senior resident who is standing right next to me. … So in someways it has to be kind of slick.

So where would it be, so I guess it would actually really depend on the context of where you are. It would be very different in different situations. So like in this situation, the guy I presume – he’s still physically in the ED – then its in multiple places, because I don’t really go and stand at the patient bedside read all this patient history with the patient right there and completely ignore them. You can’t physically do it – they’re going to ask you questions, you’re going to get interrupted 10 trillion times, you’re not going to read through this stuff and process it in any useful capacity. So patient bedside, the stuff that I want to see if more, immediately actionable information. Like I came to see you and now I’m seeing information that’s saying you need to do something right now; but not the hey lets read for the next 10 minutes. But in the reading I prefer to be in a place where I can be as non-interrupted as possible. So I don’t want the patient room, I
want a place that is somewhat secluded where I can just read and process this information and decide on a gameplan. It’s almost impossible not to be interrupted but doing it next to a patient just guarantees you’re going to be interrupted constantly. At the same time, next to the patient, I don’t see much value to bringing up Dr.H’s consult note next to a patient. All it does is engender a lot of – you’re going to end up clarifying information in these notes ad nauseum. Some aspects though, like imaging that actually i’d like to be able to bring these things up. Like lab trends, imaging – not necessarily because

I need to know them but because in that context I want the patient to know them, so i’m kinda using it almost as a patient education tool. But I don’t find reading and inevitably you get into some debate where some Dr.H wrote something, where [patient says] “that’s not exactly..” – but we can’t; it’s not really about that right; we’re trying to sort out what’s wrong with you. But on rounds, it really depends on how people do rounds, but let’s assume you are actually doing rounds with a group or team, so your rounds probably have multiple purposes – education for the team and actual patient care. So if I go around with a number of people, like I said, we all might have styluses, so it needs to be immediately clear who’s controlling what. It would be good if there is some way to almost click through – if it’s a really advanced stylus – and click through things from really far away. If you were like the active person, so a group of you could be standing by the bedside, talking to the patient and you kind of do this [hand gesture] and pull up your X-ray or whatever. A lot of this information I almost envision, being outside the patient room in many senses. Because I’m going to go, we’re going to sit down, we’re going to talk a lot of times outside the patient room and just do more educational stuff with the [inaudible] and review what happened today, what consultant saw them today, what did they say, what did the labs show, what are the vitals – then you kind of go looking for all this information that happened and then you kind of educationally throw it to them and say what’s your plan and they come up with a plan, and you discuss the pros and cons of it. There’s no point doing that in front of the patient, because it’s more of a educational exercise in many ways. Seeing them go through that exercise, I don’t know if that engenders a lot of confidence in the care team, if you’re in a situation, you are constantly correcting somebody – then I find it best to say, this is our plan we’ve sorted it out and then we go into the patient room and explain what’s happening and that sort of thing. So I think in the room and out of the room, we’d want to see very different information. This [gesture towards consult note] is the kind of stuff I’d like to see outside of the
room. Inside of the room it’s be emergency stuff, things that could help me educate the patient, I’d say will be the most helpful things in the room.

I: keyboard and stylus for input; pinboard; desk; fixed medical info; notification; Menu

P4: I think one thing from a design point of view is actually I would prefer - so the system’s going to guess what I want, fantastic; but there’s something I don’t want, what I’m immediately going to want to do specially with those dots there [white dots on pinboard] is just swipe to get to the next stuff. That would be my immediate inclination. But I’d also prefer if the stuff that I can’t see here [pinboard] is also accessible here [center region of the screen]. Let’s say I wanted to find a note that is’nt in the guesses, I almost want to be able to hit something here to pull it out. An that’s not me creating notes, because this is – I think there is a big difference here – the stuff that’s here, I would actually view primarily as informational for me and not necessarily places where I would be creating documentation mixed with informational stuff. Almost like two separate tasks. So if I see physical exam here, I’m expecting this to be someone else’s physical exam that I can review and so if, for example if Dr.R saw somebody I know that Dr.R saw somebody, but the computer did not anticipate that I want to see that – it’s almost like I want a place here [around the pinboard] where I can easily find that note from Dr.R – I know it exists and maybe a little dropdown here which will help me find something; but something kind of in this context here. The documentation, I’d actually consider a totally separate activity that’s makes more sense over here [menu]. I’m going to create XYZ and that sort of stuff and it would be nice if my review panes were still active, so that while creating the documentation, I can still physically see the review things. So I wouldn’t necessarily want the documentation I’m creating to fill up this spot[desk], because I may actually want to look at the stuff in this spot and be able to kind of flip back and forth between stuff while I’m creating the document youknowwhatimean. So almost like two separate things like I’m typing here [left hand side of screen and I’m reading here and now I’m going to pop up the xray and keep typing, and now I’m goig to pop up this guy’s note and now the labs – but hove this sort of thing and if it’s a touch screen its nice, because then I can move through stuff and create my documentation this way. So I wouldnt want my documentation to suddenly replace my viewing – because I find that one of the things you do when you are documenting is in part you are recalling what you saw and in part you are basing a lot on other notes you have seen and labs and other things like this. So one of the most difficult things with it is the switching. In a conventional EMR you’re kind of
always, you have an old school kind of thing, without a touchscreen its got a mouse and a keyboard – and the EMR has all these different tabs and stuff like that, that are really annoying to move through and then you have wither a piece of paper or in the worst case you actually have a separate Microsoft word note or something like that, so you have these windows that you keep trying to flip back and forth and it just drives you crazy. So having a layout where you could actually simultaneously do those things, would be really key I’d say.

I think the master menu – I think I would assume that my review and my creation of documentation would be so separate that might not even see them here. Although the ordering and creating new stuff and messaging makes a whole lot of sense – but whether I need the review to be there as well as there, I don’t really know. Like right now, from a space point of view it might become a problem but, if I was looking at this I’d almost say, I want to make my consult note *pop* [stylus click noise imitation] and then I can place my note here and then simultaneously I can click all this review information so while I’m creating my new note, I have access to everything from my review over here. If it was actually touchscreen, that would be amazing, especially I’m right handed and I can type type type and do this *pop* [finger tap sound] and type type type. A leftie might have a problem, but. It should be great.

If I’m in an emergency situation, I’m probably not going to be typing a lot of notes while I’m taking care of the patient. If I’m in the patient room, I really don’t know how I feel about computer systems that have people typing notes on them when they are doing a patient assessment – I find that it’s really hard. One thing I have noticed that when I work in those rooms is that the computer itself is so distracting that it almost becomes the focus of all discussion from both the patient and the doctor’s point of view – if you’re using it too much. So I think, like I said, emergency stuff and educational stuff at the patient bedside is what I’m going to see, but I’m not going to type notes at the bedside, I think its rude. I think it’s just, I don’t know, it’s weird. But I do would like a place where I can review things and create my notes in kind of a secluded place and I don’t want that to be standing in a COW outside the patients room right – like outside of the patients room, I’d like to be able to catch a snapshot of the patient that I could mostly look at it with a touch screen, maybe do some orders with the stylus or send messages- fine. That’s helpful right, because maybe the nurse is’nt there right now and I want to leave a message for the nurse. So if this was on no the wall I walk up and it recognizes it’s me and I go *tip tip tiptiptip* - fine. But I was actually going to create documentation, i’d want a
place with a chair where I could sit – sometimes it takes a long time to create documentation – I’m not going to stand outside the patient room and do that, it’s going to kill my back and my shoulders. You know what I mean.

I: That’s great. [quick share menu]

P4: So does this apply to almost anything? Like if I was to do this on the notes and stuff.

I: Yes.

P4: Ok perfect. If it worked everywhere it would be great. Would I as a user, basically you have 6 things here, be able to customize what these options are?

I: Yes.

P4: Because, I almost never fax stuff. Some people do. And I may send messages to certain people predominantly. It would be nice in some ways if there was certain people by default – it would be hard to know but, the people I’m going to most likely send a message to are people who are directly part of the patient’s care team. It would be nice if the computer knew that, so if I wanted to send a message to somebody here, that I could send it somehow know this is the nurse, this is the physio or occupational therapist, speech therapist, case manager, these are the other doctors – that sort of thing. So I can easily pick these people, or even choose multiple or all.

I: Oh that’s true. Ya, ya.

P4: Because I find one of the biggest challenges is even knowing who these people are sometimes. A lot of times I could walk around for 5 – 10 minutes going around like who is this patient’s nurse, where are they? I just want to find this patient’s nurse. It would be so much easier, if I could just send a message to them. And maybe the nurses tends to be more of a local assigned – umm, nurses are assigned more on a physical location that exists where as other people like doctors are assigned based on the actual patient. So the nurse is assigned to room 62 and whatever patients are in that room – so maybe with nurses there is something more local. If the monitors are there anyway, there’s a better local way of messaging people who are physically at a physical location. But the doctors they could be anywhere, same thing with the physios and that sort of stuff. I like that though, that’s good.
I: [Individual adaptation]

P4: I think that’s good in a sense. In part, I think there’s two [inaudible] and I think it depends on to what extent you are building in a lot of clinical decision support. I think there is my personal workflow, that it will kind of tailor itself to – I think that’s fantastic, but at the same time, I think it needs to know when to override my workflow because, if I do my conventional workflow a very important piece of information maybe left until too late. In some ways, it’s going to figure out who I am and its going to figure out that I go through the record in this particular way when I’m seeing a new patient and I kind of do this – that would be fantastic because I think everyone kind of has their own routines and I think that works out really well. But if there is a really really really key piece of information in there somewhere, I think that has to come up to the front in some way so that it draws my attention. Like “hey!” like the Coumadin, for example. Its something that captures me even if my personal workflow would’nt have gone their first. Yousnowwhatimean.

I: Ye yeyeye. [patient UI]

P4: So from the patient point of view – like I was saying you could have these in multiple places and depending on where they are itmay be totally irrelevant, but in the patient room it is relevant. I like this [what’s next] actually and the other things actually be there like, like random things like this is going on in the hospital tody, the hospital is going to want to do things like how to donate to the hospital or there’s going to be various things. In some ways you could almost call that an ad. Someone will be deciding what the ads are. And maybe the ads are targeted to the persons demographics like google, although that may creep people out.

I: But like for an older person, you could give them fall safety tips as opposed to hand hygiene

P4: Oh I think it’s a fantastic idea. You probably want to be general enough that it does’nt creep people out with this “wow this computer knows a lot about me”. So if you’re older and its fall safety, that’s somethingpeople probably would’nt notice. But if it’s like, ‘oh okay, you have these 10 problems you should be doing this’ that would be creepy. So I think, we talked about this before, but some of these things, you probably don’t need. What does the patient actually want – they kinda want to know what the gameplan is. They are in the hospital and a lot of the times they are not told moment to moment what’s happening, they are not told what tests are
happening, they don’t know when the tests are going to happen, they don’t know why the test is being done; but they do know things like you were visited by your nurse and so whether or not using screen space to tell them things that they obviously know helps anything. Some information like your vitals and stuff, I don’t know – I think sometimes there is this almost like a policy of openness though that doesn’t really add any benefit – “Oh you had blood work drawn, hence you should see the blood work”. The problem with that is that there is a lot of normal variation and there is a lot of interpretation of things on the part of the physician that goes into things. Something is going to get flagged as high, but it might not matter. And in some ways it almost distracts from the discussion if they’re like, what about this what about this what about this what about it, I saw my blood work and that was H. And then you end up spending this time dealing with this and not dealing with the actual primary issue. So I don’t know if by default seeing all that stuff is actually a good thing. I think in some ways its best if either the nurses or the clinicians can come in and access that stuff – like in an educational manner

I: Like if they do want to share

P4: yea exactly and they’d go like what’s happening with my sodium – you could actually go like, lets show you and then you can show them a trend. But them seeing just the number everyday; same thing with blood pressure, because individual numbers don’t mean much its actually the average so I find that one of the most common things I get is someone who is with it enough on a monitor, they almost always focus on all these numbers on the monitor – staring at it and anytime there is a minor variation, you’ll hear “Oh 9:45 my BP was this and what are we..” And sometimes that doesn’t really help things. And the nurses know that information anyway. So for some of these things they probably – you know “we’ve reviewed your medical history” things like this are probably not as important as diagnosis, tests to be completed or upcoming tests and why, when those tests might happen, and the care team – more so than the chronicle of everything that happened. Now the care team, one of the things that I think of from a patient point of view – when I look at the screen and a doctor is interacting with it using a stylus, I’m going to assume as a patient that this somehow allows me to get in contact with this physical individual. So maybe in some way that can happen in an indirect way, maybe that’s not a bad thing right. Like if they have a question for the attending physician, maybe that’s a good thing if they can actually hit this and type it in. Like “Oh I’m concerned about my headaches. Can we talk about my headaches”, that sort of thing.
The thing with patients is that there is a whole variety of patients, in terms of their motivation, their education, their ability to understand medical information. And I thin kone of the problems when you actually interview them is that you’d likely find that there is a lot of things they’d want to know, but I don’t know if its necessarily. You know it seems very paternalistic, but it really does’nt matter if your sodium was 134 yesterday and now its 133 – it really doesn’t matter. And its these things that just almost create unnecessary distraction – youknowwhatimean. So its hard to do that, but ya.

OPEN ENDED Q

I: Any other thoughts? I can give you another chance. Confusing or surprising

P4: In terms of the overall layout, I find that this bar [medical history bar on the desk region] makes me believe that there is something below. Because usually I’m used to seeing title bars on top of windows, I think that that’s just Microsoft windows trained me that that’s the case. This to me almost makes it sem like there is something below and if I click this something new is going to open up.

I don’t really know what these three things here are [users logged in]

I: Who is signed in …

P4: Ok. Ok. I think the active person signed in needs to be more clearly labeled and perhaps even the color in some way needs to be something that is readily identifiable.

This here [pinboard] does it move left and right.

I: [index][slide]

P4: that’s good I like that [index]. These three dots I find confusing and I would assume that there are pages and I would assume that there are atleast 7 items open. …

I: [explain]

P4: Oh ok the icons on the index were’nt really congruent, so I thought…gotcha gotcha. That makes sense. I thought this [three white dots] was working different than it was.
This might be a little more prominent [chief complaint, I think]. One of the things I find irritates me about EMRs is when they present the D.O.B, which doesn’t really have a whole lot of relevance to me instead of the age. I find that this just forces me to make a mental calculation. But I really don’t care if he was born on Feb 17 1972. Maybe the system can give me a pop-up to say its his birthday or something, but this is just forcing a mental calculation. Similarly the admitted on date, it’s the same way – you want to know how long a person has been there. Like in hospital for 17 days. Which is more useful than – admitted on date is almost an administrative thing doesn’t mean a whole lot to me. I need it for billing but that’s about it. I like to know how long people have been in the hospital and how old they are.

Q ON PHYSICAL SIZE AND LAYOUT

I: Concluding thoughts is it more useful on a atablet?

P4: I think there would be a real temptation to use tablets, because they are this on vogue thing. But I would find that then I’m stuck carrying around a tablet and I don’t know if it actually provides me a whole lot of – I mean if these things are present, I don’t know if I need the tablet. So if I was to pick three places these things were I would say, in the patient’s room – maybe on something like this [arm] so I can easily bring it to a patient who in bed and immobile so we can show them, these are the tests you’re going to have, this is what’s happening, this is your blood work, this is how your chest x-ray looks - so I can do educational things with them. And then the hallway is tough because of the whole privacy issue, because of the fact that you are opening patient records. But if you have a room which has a little bit of an alcove or something then on the wall immediately inside or something, and that’s where you could pull up stuff if you’re doing team rounds before you go in and talk to the patient you can pull some of the stuff. You’re not in the patient room yet, but kind of close; and it would be nicer than wheeling around a COW which are gigantic things that are really annoying to move around and then you also have to worry about having them plugged in and I find that they are not as nice for something like rounds, atleast from my opinion. So if I had something on the patient room, like maybe on an arm so I can easily show it to them, if in they are in a neck brace or something and they can’t turn their head. If there is one just outside the patient room, that allows me to get quick snapshots when I’m doing rounds of what’s happened to the patient recently … ok let’s go in and talk to them, allows me to do some orders immediately. And then in some sort of private place where I
have a chair, I have computer and I can take time to read and create notes. I think in all situations I would say the bigger the better. So if you move to a tablet, you’re going to have size issues. If I take a tablet into the patient room, so there is cleaning problems with the tablet, from patients on isolation and isolation gowns don’t really have places to put it, so you have to put it down so you can put on the stethoscope and examine them – its just you’re at a lot more risk of losing it, leaving it somewhere and if these things are present ni enough places, I don’t know to what extent it adds value. So in the private rooms – if you go and there is more like the office style room, where I have aproper keyboard and a chair and I’m mostly going to do documentation, I’m not going to want to do that on a tablet anyway. If all the computers are taken, I’m more likely to wait than to try to do it on a tablet. Or at least that’s me personally. …

Q ON FUNCTIONALITY

I: Gather thoughts on Menu. Added or removed or if something is duplicated

P4: I would say this [review] things from here [pinboard region], like trends would be the most useful thing to have there [pin board extra information access]. To be able to create trends on labs and stuff from here too, but it would be fine if it would be here too. But there are certain things like when you’re looking at the episodic things, like labs on Tuesday, labs on Thursday – you kind of miss out because you can’t do the trends and so some of the higher level analytics and stuff like this would be good if you add this. The ‘ordering’ I like. The ‘create new’ I think I’d name that something different like ‘order document’ – because order is kind of creating new as well. I like the ‘share’.

Consent might be interesting because the patient will have to sign it – I don’t know if there is a local thing where you can have them sign it.

I think a lot of these things are ultimately going to come down to the local workflow, not only in the hospital but even the department, because they may have different ways of doing documentation even within their own groups. I’d be hard for me to say as an internist to say what everyone’s going to want there. Like ok you create a lot of documents, but the emergency guys never create discharge summaries.

What do you envision here? [sharing section]
I: Translation I was thinking almost a translator will come up and you could type and it would help you communicate with the patient. . . .

P4: If you shared with the patient, then it would be interesting if I could share patient education materials from there and when I was gone away that patient education material was accessible to them from here. So if they’re in a bed and they have this thing there like their TV- it’s almost like I’m sharing it to their TV for when I’m not there and they can actually look at it on the TV.

The translation if you have it set up like that, it is really great. Specially if it’s a translator is like MediBabble – ita an app that these guys who had gone to Haiti after the earthquake. So it’s very limited in terms of its language, but what they did is they created a pre anticipated list of questions that could be answered by yes, no and gestures rather than whole speech. That was actually really good – they cover 5 languages, but if it covers one of those languages – because it is really hard to ask open ended questions through a translator. So their idea was to pre anticipate list of questions and the doctor can just click on the questions which are short enough to then display in huge text on the screen and they will also read out audio and then their answer is always yes/no/gesture. And so you can get a lot of useful information that way.

So say you had it set up like this at the bed, I mean, that would be amazing, if you could pull up the translator and then hen the translator is up – I don’t know how the doctor would necessarily enter – whether it would be speech to text or whether it would be typing – I should’nt be just audio, because I have a lot of patients with hearing impairments and the speakers on those things are terrible and the headphone too. So it should display visually, really big. And then it’d be almost, by design be one way, because it is very difficult for them to then give you a very complicated paragraph of information in say Cantonese back –especially as you’re unlikely to have international keyboards mappings. But it’d be good from a relaying of information point of view and it would be really good if they could see it while you’re doing the translation. That’d be very cool. I like that.

And the patient materials would be good, you could pick it and be like this person is diabetic so I’d like him to have the option to watch some videos about checking your blood sugar and I can pop it on the screen, so when the screen is idle, maybe he does have a few things to click. I could be like “Hey watch these videos”. That would be very cool.
CARD SORTING ACTIVITY AT 1:02:00 MIN MARK

8.4.5 Participant 5 (P5)

(START OF TRANSCRIPT)

WIZARD OF OZ SCENARIO START: TIME 2:15 UI SCENARIO START.

I: I’ll let you roam freely and click around in the interface. Thin out loud. Any questions/confusing/PowerPoint. Not fully functional. Give you five minutes

P5: I see there’s a picture of the patients, highlighted the admission date, some of the data around allergies which is important. There is a problem list here indicating the comorbidities that the person has which is a lot for a fairly young person. I can see that his chief complaint is that he presented with coughing up blood or hemoptysis and then I see that there is messaging and some other things. I haven’t used this before, but I’m assume that when I click on here [pin-board] it’ll present a larger view, which is what it does. And I guess to see,…

I: the scrollbar isn’t active yet, but our idea was that this would be scrollable.

P5: Yes. Now what might actually help me here is if I could, just like a standard webpage I can actually bring this [content loaded in the Desk] to full view. Like a full screen view might be helpful rather than just scrolling. So in other words, if I was to click on the consult note — and now that disappeared [the earlier consult note card on the Pin-board]. Ok, so obviously some issues around the navigation in those windows. So here’s my imaging and here I can pick different images — that’s kinda nice. And then to close that, I close there. I’m still not exactly sure what happened to the original note that was there, the series of notes. I like the idea but the ability to go to a full screen view right off kind of helps. Just a little icon, either you go windows or mac for the ability to do that. [Clicking on physical exam card on pin-board] I guess this is not an active pane, but I get the idea, but it’s nice to be able to put in imaging. Now physical exam is separate from the consult note, but most of us might think of the physical exam as part of a consultation note. But having the physical findings as separate is fine too.

So this expands the side menus I guess. And then I’ve got history, lab results, I can order, I can create new documentation, I can send messaging so that’s quite helpful and I assume that if I
click on this that will collapse that side pane. Ok, so that’s reasonably intuitive and kinda nice. Sometimes its nice to have hovering functionality over these things ‘expand’ or ‘contract’ – it kind of reminds me of the Adobe type applications like acrobat where you can open and close various panes. So that’s good. So in here not exactly sure what these [X ray side menu] functions do.

I: They are not active yet

P5: And these are the care team members is that right? [Three user icon on top right corner] Opens patient UI

I: Ya. So this was something that we envisioned for the patient, an information screen

P5: Looks good. Now again with the navigation, I’m not sure how to – what’s nice is to use standard browser – arrows going forward and back.

P5: So why are there three [user] icons?

I: So I think you’ve pretty much explored everything that was active.

P5: I did…. Ok good excellent

FEATURES LIST STARTS: AROUND 5:50 MARK

I: Ok. I’ll quickly go over some of the features that we envisioned. And as I’m bringing these up, whatever your thoughts have please voice them. I will get to your question about the three people in a minute.

[silent authentication]

P5: My only concern – definitely the proximity type of sensor is a great idea – my only idea with having something like a pen or whatever is they invariably get forgotten and so there you have to look at, if it’s hardware specific, - I’ve personally been involved with some of this to a limited degree – is whether use something like the id tag and use some kind of a chip technology rather than assigning another device. Whether use RFID or some other proximity thing associated with
a tag and the reason I bring that up is because, if you forget your tag, presumably they can give you one in security or do something for you, whereas if you lose the proximity pen it’s a bit of a problem. So I’m just looking at that – the cell phone is a good idea, but again what happens if you forget it. Do you need dual hardware for this?

I: that was the idea.

P5: One of the other things I’ve seen, more in development would be something like the proximity being the tag and then some biometric like maybe a finger print scan or something. I don’t know if you’ve thought about that.

I: We have, one of the tricky things with those was that fingerprint scanning is difficult because something you have gloves on and there are infection risks.

P5: Or retinal, but then you get into privacy issues.

I: Ya, you can really only use retinal or face recognition.

P5: Face would be great, if you could do that.

I: What kind of privacy issues would that run into?

P5: With the face I don’t think there is – because you have your face on the ID tag. SO I think once again if you are sort of trying to harmonize with the existing, I think it’s fair to say that most healthcare providers within their healthcare organization – its actually mandated that you shouldn’t go into a patient care area without a suitable ID. By virtue of the fact if you have your face on the ID and your using that as one of your biometrics, I would say from a policy perspective that would seem to make sense to me.

I: Ok that’s good to know.

P5: Ya, so some kind of chip and then the facial. But I think if you’re doing the facial recognition, then do you really need two factors? Wouldn’t a face be strong enough? What do you think? It’s a pretty strong biometric.

I: Umm. It is.
P5: Just a thought for you, if you bring it to the level of facial, maybe that’s good enough.

I: Yes, I need to think about that.

P5: If you are looking at procedure suits – like endoscopy or surgeons the same kind of thing. I may login look at the patient data and then I may have a documentation tool or order entry or whatever. I may leave the monitor, do the procedure and then want to come back. If the system if quick enough where I just put my face in front and it brings my back to right that point in the record and it does’nt require any uptime, then the logoff logon makes a lot of sense. If it’s one of those scenarios where you have to wait for the system to boot up and go back, then one of the solutions might be to try to adjust the timeout in certain areas if you understand where I’m going. But in an ideal world, in this kind of patient room – let’s say I’m up here and I’m chatting with the patient and I’m reviewing somethings then I go back and I examine the patient, I will be away, and then I go back and I want to document or do orders – you would’nt want there to be a significant lag in the login in that context. So it depends on how you’re doing it.

I: Maybe that’s where we could sense the proximity tag on a card or something to keep them logged in.

P5: That’s a great idea. And you can set the proximity at 3 meters or what you think is an appropriate. So that’s actually a very good way of combining the proximity sensor with the recognition. I like that idea.

I: That’s a great idea, but I’ll have to continue the rest of the interview more with the stylus, as that is the system [to evaluate]

P5: Sure, sure. The stylus thing reminds me of, I don’t know if you’ve ever had the older generation tablets, where you needed a dedicated pen – how many times did you lose it?

I: [laughter] I didn’t personally have it, so it’s not a pain I know personally

P5: But you can know it’s a real problem, right. That’s one of the real success stories of the iPad, you use your finger not a dedicated piece of hardware.

I: [keyboard & stylus]
P5: Moving forward we might have templates that are structured on some areas and then free text or free voice recognition coming in.

I: [multiple users login]

P5: So your pen is a data entry point as well, is that what you are saying? Like handwriting recognition? Is that it?

I: Ya.

P5: Ok, so I take that back, if it’s actually handwriting recognition input tool, then that’s a little different than you know.

I: …. [technology capable of having multiple users although we do not fully understand where such collaboration could take place..]

P5: Again, I think, good ideas and solutions, as you probably know there have been on the market devices – these electronic pens for some time. I think the biggest challenge with adoption is the cost, proprietary nature and the fact that people will lose them. Just, this is my own sort of bias. I think it could be great technology, but those are the problems that we run into.

I: [pin-board]

P5: you could just slide right

I: yes, but that functionality is not built into the PDF. [red dot notification]

P5: Oh no, that was not very intuitive for me. You know what I would have thought the red dot is? That it was the active frame underneath [open on the Desk]. See I would have associated – that the red dot is what you’re looking at below.

I: Oh.

P5: Now having said that I kind of like the layout and the usability and I think it’s a nice kind of display of the information and the fonts and all that. Umm yes, I wonder if a more intuitive way – because what you want to do with these interfaces is make them as familiar as possible, so when I look at these things sliding across, I’m looking at a lot of news portals. For example, the
globe and mail online now, if you read it on an iPad, that’s the way it looks. They structure their stories and you just scroll through and then you zoom in and then it launches the story. So I think that’s good. You don’t want to be unique in this kind of business. I think the idea of differentiating what has been reviewed from what has not been reviewed is important – I think it might be more intuitive to put a little checkbox on pages that have been reviewed. You understand what I mean – because if I hit that page, and I’ve opened it and reviewed it and then I’m scrolling through, if I saw tick boxes on the pages I’ve looked at – like to me it would be pretty obvious that I’ve seen them. Once again if I wanted to highlight to go back, it might be nice to be able to tag, just as you would – I know you are using adobe software here- but the nice thing about using let’s say acrobat is you could highlight sections or pages and then you can go back and take a look at them. So that function may be useful. So just think about it as, if this was a paper chart and you wanted to put in some sticky notes – that might be helpful.

I: oh ok, so an equivalent of that.

P5: Ya, that kind of an equivalent right. So I like you idea of being able to tag what you’ve seen and what you’ve not seen, but I would may be take it a next step and that is – if you wanted to tag certain areas that might be useful for you too. So if I was the cardiologist, and I went through the imaging results and I saw the echo study I may want to flag that – so when I go back the next time, I know where it was right.

I: ya, ya. That’s good. So this area was the main workspace – I call it the ‘desk’. So any typing that needs to be done or anything that needs to be seen in full view opens up here.

P5: I like that, my only other comment though would be to be able to just expand so that you could see that full screen if you wanted to. So it’ll reduce your scrolling.

I: Right, right. Got it. And so this area is fixed medical information – allergies, comorbidities, chief complaint – do you think something else might be useful to have right up front OR if some of this is less relevant than other things and so should require some restructuring.

P5: Ya, no. Good, good question. So I guess what we’re seeing as useful information in addition to these kind of – for example in some patients their resuscitation status, whether the
patient desires full resuscitation or no resuscitation, if they are palliative or whatever. That maybe something you want right up in there.

I: Oh, ok. So like a DNR?

P5: Exactly, yeah. So we don’t call it – there is a more politically correct term

I: Oh, sorry!

P5: No, no don’t apologize to me. I think it’s called their code status or resuscitation status. So we don’t necessarily say – it is the DNR, but there is a more politically correct. Look up the right terminology, but that may be there. The other one might be any other key things- for example, if the person has a designated power of attorney or something. That might be useful to know, right. So let’s say you are looking at John Cow, but for whatever reason he’s delegated to someother caregiver then that might be interesting or of relevance. So you know that if you are inquiring as to consent or notification or if he is sick, when you expect a major change that there is somebody you have to contact right away. So that might be useful. The other question I would have is that lets say you are one of his caregivers and you want to add something else to his comorbidities – so lets say he’s got diabetes, bronchiactisis, atrial fibrillation and you just diagnosed him with a urinary infection, should you add that – like do you add that in from this [fixed medical info] panel or is this just a static kind of thing.

I: We had envisioned it to be more of a static thing so [interrupted]

P5: So, but lets say I want to add a new allergy – how do I go about doing that, right?

I: I would think that would happen through the menu and then going through either a note or something. But I see your point – it could be much more [interrupted]

P5: Interactive. So the question is do you want it to be much more interactive or not and that depends, because sometimes these things are pretty useful – like if you want to edit it could take you – like see right there it has the allergies and it’s a summary right?

I: Yeah.
P5: But, umm, where would that be – [reading off menu] Medical history, Notes - so its kind of buried in here if I want to document an allergy. None of the useful things might be, some little hotkey or something [interrupted]

I: when you hover over it

P5: Ya when you hover. If I want to add an allergy or edit or whatever the case is, so it takes in right into that area ther.

I: Umm Hmm. Got it, yeah.

P5: Ok.

I: So, this we had envisioned as a notification area. We found that notification was something that was important – so as you said, similar to your idea of tagging – sometimes it was difficult to say when new test results were available or when doctors had to manually go in and check. So this was a notification area, ‘New Note’ …

P5: Now is this in the patient context or across all patients? Here the unread messages and all the rest.

I: So I would think it would be in the patient context.

P5: Ok.

I: I had envisioned that may be care teams members can communicate to each other regarding [interrupted]

P5: So that’s a bit of a learning, what you’re talking about. This isn’t across all the patients, this is very specific to this patient, correct?

I: Yeah, to this patient.

P5: Now is it related to the patient and the visit or patient across the board.

I: Patient across the board.
P5: I think that’s good. I’ll tell you why – because a lot of these patients that get admitted, they may have outpatient results also. And so the reason that’s important is some of these medical record systems are structured around the visit- so lets say John was short of breath a week prior and he was seen in an outpatient clinic and they ordered a CAT scan of his chest. And maybe that result is actually available, but it wasn’t done on that visit. But that could be material to his management here. So I think its great that you’ve clustered, its all patient-centric right. Ok, so its very good.

I: Ok, and so I also wanted to get your opinion on the Menu. The way I’ve structured it is things that the doctor might want to review, things that the doctor might want to order and things that the doctor might want to create as addendums to the patient record and then also share. So any views or thoughts around that?

P5: Ya, so if we go here, you’re reviewing prior history. Now again, I don’t know exactly what the difference between the medical history and the medical notes are. Do you see what I mean? That’s more of a semantic result, pretty intuitive. Now gain, trends, I don’t know the difference between trends and results, because normally trending would be a function of your lab review – if you follow what I’m getting at, right. So you know there maybe common trends or whatever or a whole different thing or there maybe trend profile, but again, I think those would be under the results. So I think Review, you have history, umm, you might break these down more into lab results, pathology, diagnostic imaging, those kind of categories, right. And then they could cascade – because I’m not exactly sure what the difference between history and medical notes – or the maybe progress notes. So you want to order here and again you have medications, labs, procedures, imaging. Now in some organizations you may actually be putting in consult requests to have other consultants see the patients or whatever the case is. Dietary orders. So you could take a look at any sort of medical record on the CPOE side and just try to line them up with the various orders that go through there, right. And then when you’re talking about create new. Umm. Instead of a full note, I think what you’re talking about here is a consultation note. Is that what you were talking about here primarily?

I: Umm.

P5: Because I don’t know – oh here you have a consult note/H&P. I don’t know what a full note is.
I: Ok.

P5: So these are primarily documentation tools here right. So what you are doing here is, these are primarily review – a review cue right. This is an order entry. This is really documentation tools, that you’re providing here right. And then I’m not sure what a full note is versus a consult note.

I: ok.

P5: I mean you know, there may be a thing. And then this is consent for procedure, Its nice to have it there. Discharge summary is good. And then, instead of share may be a nice way to rephrase that might be around communication. Communication information or you may want to split them, here’s what I’m thinking – because in terms of communication tools you can send a message, umm, and what are you doing here requesting translation?

I: Yes, or we have thought that if it’s in the patient room there would be some sort of translation ability built into the system.

P5: Ok, so may be that fits better under communication, just cluster communication including messaging, right, translation and then maybe I would say, split off the education bit and just put educational materials and then you could list like resources. Education and resources, or something might be helpful. I don’t know if that kind of helps you at all.

I: No, that does.

P5: Now what kind of missing to me – and this may be buried in there – is there are sometimes sign-over tools that we use. So for example, lets say you want to leave notes for the on call team.

I: Right. So sign-over is when one team finishes and the next person takes over right?

P5: Exactly. Right. So this is an area where its not a full note it may or may not be a progress note – what it is you’ve got your documentation there but it maybe just sort of points for the team that are on-call. So I would say, if MR.Cow, spikes another fever, repeat his blood cultures.

I: ok
P5: Do you see what I mean? So that’s not a real documentation point, its more of a handover to the people that are on-call. Umm. If he develops recurrent chest pain Dr.Smith the cardiologist wants to be notified. Right, like those are specific instructions related to the patient.

I: Ok, so would that fit somewhere in the communications bit, instead of the documentation?

P5: Ya that may be. Absolutely. I think you could put it – it depends on how you’re doing- it could be either send a message or it could be almost like a bulletin board functionality right around the patient or a sign over note. I don’t know if that helps you.

I: Right, right.

P5: So that’s why may be putting a communications part there makes sense. Right?

I: Right. So I don’t know if – does this work in terms of how it is grouped? I don’t know if this is how EMRs currently group.

P5: Ya, so they are kinda broken into – so you have the, the – One way to look at EMRs specially in the in-patient setting is, have you heard of the HIMSS analytics scale.

I: Yes.

P5: So if you look at HIMSS level 1, its basically just reviewing information and then, you’re kinda layering it in here –you have labs, you have diagnostic imaging here etc. etc. Then when you get to the next levels you’re doing order entry and then you get higher up yo’re doing communication, intraopreability, you know, positive patient identification. Then links – one of the things here, and we’re moving in this direction would be links to regional electronic systems or others, right. For example now we have a initiative that’ll hopefully go live within the next year or so, and its connecting GTA, so it’ll be pulling data from electronic health records across half of Ontario’s population. So what would be wonderful is if you had a link in here maybe you could pull in data, if you’re at, lets say, St.Michael’s you’re pulling in Sunnybrook data, or whatever the case is, right.

I: Ok, for that particular patient?

P5: Now that may be the ideal, would be if you could pull it in the context of that patient.
I: and, so our idea with this blue bar here – we thought was, this is not very intuitive, it was kind of the index for what’s on the pin-board. So say this is a document, and then an image and then a document. Because if there are several things open and someone wants to get to what they want quickly, this could act like an index. Although, we have’nt differentiated between – we’re not sure how to say this is a consult note vs. this is a physical exam – the iconography we can use that regard.

P5: So you’re using this as a.. filter? So in other words if I want to see a certain type of document, I click there and would that just present me with all those types of notes or if I just wanted to look at the images?

I: So I think it would present you with – like it would center- because this is a sliding part of the user interface, it would center to what you are clicking on. But I see what you’re saying, that you could use that as a filter also?

P5: Ya, I’d find a filter may be even a little more useful, because lets say I only wanted to see consult notes. If this was a filter where I knew if I click here I just get consult notes. That might be useful. If I filter here and all I want to look at the medical images, then I would look at the images. I don’t know, there’s different ways of – I think the bar idea I think if you’re just using it as a middle as your reference point and what you’re seeing is what’s on either side, Its kinda nice, but I can see what’s on either side right.

I: Ok, got it, got it. That’s good to know. And the idea when a clinician walks away and the screen logs off from this interface to a purely information display for the patient and their family. So this was one of the ideas where you know, we tell them what has happened in their visit so far, what’s next and also give them a visual of who their care team is for that time.

P5: ya, and this could be viewed by the patient through a PHR type of interface? Is that the idea?

I: Yes..or we were thinking that whatever the interface is that the doctors are going to access, this is basically its logoff mode. For that patient it would pull out and display this information.

P5: Oh so once the doctor logs off this is sitting on the patient’s screen?

I: Ya,
P5: Ya the only issue you have to be careful is the privacy part about having this. So you’d want the patient to kind of log-in somehow.

I: Ok, so have the patient [interrupted]

P5: Ya so once again that’s where positive identification through their armband, think about that. That might be a way to think about it. Because presumably patient’s in the very near future, already most organizations have some sort of identifier on their – most of them have atleast a bar code, some of them have RFID. So one way to may be access this is if you had a simple bar code reader the patient could do it or whatever, right.

I: Ok, that’s really useful. I’ve never considered that.

P5: Because my only concern about having this is kind of the desktop – because remember, patients are getting sent to different procedures, they’re coming and they are going for a walk. You wouldn’t want this all open to anybody that walks into the room, right. Because its telling you – it has your vitals signs – in other words it has PHI there. Identifiable information, right.

I: Ya, ok.

P5: So I think it’s a great idea, but I think just as on the provider side you want to create some sort of a authentication on the patient side. And what’s kinda cool about that is if you had that, maybe that’s a way where you know the patients have access to online resources and everything else, but you know they have to scan their id tags so they get in there and - just a thought.

I: No, no. Its really useful. Because once again, weve designed thi [patient UI] using clinicians as our proxy users, because we have’nt directly interviewed or observed with patients, right.

P5: because one of the areas that we’d like to build on is kind of a patient kiosk experience. Where maybe part of it is you customize the hospital gives them their patient satisfaction survey, they log in and they go well how did people treat you, how was the status of your room, did you get your food delivered on time – like you never know right.

I: This is a more impersonal way for them [patients] to be honest about it.
P5: Ya, think about it, you can layer in all their information, they subscribe to TV or whatever, they scan themselves and enter all the stuff. Maybe they can order their diet through this thing. Instead now we push all the paper in front of them – may be this is a good interface both for the patient and the clinician.

I: ya. And so [interrupted]

P5: Remember if you guys make a lot of money off this, you gotta cut me in if..

I: [laughter] A lot of this is [interrupted]

P5: Its all for the common good – this is going out in the public domain, I know. [laughter]

I: So one of the ideas we had is around enabling quick sharing of documents, so suppose you wanted to share an X-Ray with someone- you’d just do a long press and this sort of a menu would come up. Again we had the stylus in mind, so you could click or drag one of these. So you could print it or fax it or email it or send it to other care team members relatively easily instead of – almost like the right click functionality, but because we designed with the stylus, we had the long-press option.

I: [system learning from user]

P5: end –user customization and then predictive modeling

OPEN ENDED Q

I:

Q ON PHYSICAL SIZE AND LAYOUT

I:

Q ON FUNCTIONALITY

I:

CARD SORTING ACTIVITY