pivotal

Designing a Better Way to View Patient Information

Spring Research Report, May 11, 2010 **EXTERNAL VERSION**

GE Healthcare

Carnegie Mellon

HCII

ABOUT THE EXTERNAL VERSION

This version of our research report is intended for interested parties outside of GE Healthcare. As such, many names and photos have been removed from this document for the protection of our participants.

EXECUTIVE SUMMARY

About the Project
Team PIVOTAL is a group of five masters students in the Human-Computer Interaction Institute at Carnegie Mellon University. The unique backgrounds and experiences of each team member provide the advantage of an interdisciplinary approach to understanding the problem space. This capstone project constitutes the culmination of our studies. In association with GE Healthcare, we are in the process of researching, designing and developing a patient information view (PIV) application. This application is meant to serve doctors and other healthcare practitioners who need a quick and easy way to get a complete picture of patient information.

Research
In order to fully understand our problem space, we have performed interviews and observations with a variety of healthcare practitioners from several hospitals in North America. The focus of our visits was to see doctors in their natural work context to get a complete understanding of their workflow. To preserve our data we recorded our interviews, and later transcribed our interactions with the doctors and categorized our findings. We also modeled the flow of information, the workplace culture and the physical layout of the visited facilities.

Findings
As we categorized our research findings, we came to understand the complex context and workflow which PIV will support. Particularly important findings include poor integration of multiple information systems, overly rigid interfaces and communication breakdowns. We also observed the use of mobile technology and other external tools to support information needs. One of the key insights we found was that doctors' needs extend beyond just information. The way in which technology fits into their workflow, and impacts their interaction with patients, was of critical importance to doctors. Patient care always comes first, and technology must support this goal. Many of the systems we saw failed in this regard, causing doctors to

SUMMARY OF DESIGN DIRECTIONS

- Integration
- Present relevant information
- Usability
- Patient Interaction

hesitate to use the systems during patient encounters. This included both doctors lacking confidence in their ability to use the software and also the obtrusiveness of the computers themselves.

Design Directions

From these findings, we arrived at four prominent design directions. First, integrate healthcare systems into a single, unified application. While very large in scope, this would alleviate some of the biggest and most prevalent problems we saw. Second, present relevant information. Doctors only need to see a subset of patient information at any given time, and excess information complicates the clinical decision making process. Third, improve usability throughout the system. This can be accomplished through user testing, better information architecture, and other considerations for how the system will actually be used in context. Finally, the system should enhance the doctor's ability to interact with patients. This could be accomplished through solutions such as new, less invasive computer form factors and patient-facing information within the system.

Conclusion

In the coming months, we will be using our findings and ideas to drive a design for the PIV. We will be meeting with healthcare practitioners who will evaluate our ideas and provide input on the design. This will help ensure that the system is both desired by and tailored to the healthcare practitioners who will use it. Finally, we will create a prototype based on this design and iterate according to the results of user testing.

TABLE OF CONTENTS

INTRODUCTION

Introduction

TEAM PIVOTAL

Youna Yang | Design Lead
Youna is from Philadelphia and is currently in her final undergraduate semester in Industrial Design at Carnegie Mellon. Youna has worked on projects involving families, elders, product brand identity, and interface design. Currently, Youna is pursuing a Masters in Human-Computer Interaction to learn more about user research and to better understand and design for people's needs.

Mike Sparandara | Project Lead
Hailing from New York, Mike attended Tufts University in Boston where he studied Computer Science and Engineering Psychology. After receiving his diploma, Mike transitioned to the West coast where he worked for various Bay Area start-ups doing user interface design work. Mike is now studying at Carnegie Mellon to further his development as a designer.

Anna Ostberg | Research Director
Anna is originally from the San Francisco Bay Area, and studied Cognitive Science with Specialization in Human-Computer Interaction at the University of California, San Diego. Anna has worked on research projects dealing with interaction in public spaces, personal information management, and using cell phones to control public displays.

Nick Leonard | Communications Director
Originally from St. Louis, Nick attended the University of Missouri where he studied journalism as well as information technology. Before coming to Carnegie Mellon, Nick worked for the University of Missouri School of Medicine and a medical technology start-up as a web application developer. Nick is emphasizing design in his graduate education.

Michael Lin | Chief Architect
Michael grew up in Illinois and Connecticut before attending the University of California, Irvine. He studied Information and Computer Science and worked as a software engineer at a major defense company in San Diego. Currently, Michael is pursuing a Masters in Human Computer Interaction at Carnegie Mellon to follow his interests in system usability.


MHCI Project Team: GE Patient Care
Nick Leonard
Mike Lin
Anna Ostberg
Mike Sparandara
Youna Yang
Human-Computer Interaction Institute
227

ABOUT THE HUMAN-COMPUTER INTERACTION INSTITUTE

The mission of the Human-Computer Interaction Institute (HCII) at Carnegie Mellon University includes studying ways to understand the goals of the user through methods that analyze and evaluate human behavior. Interdisciplinary perspectives in design, computer science, and behavioral sciences inform an understanding of user needs. This guides design solutions that best support user tasks while also improving the overall user experience.

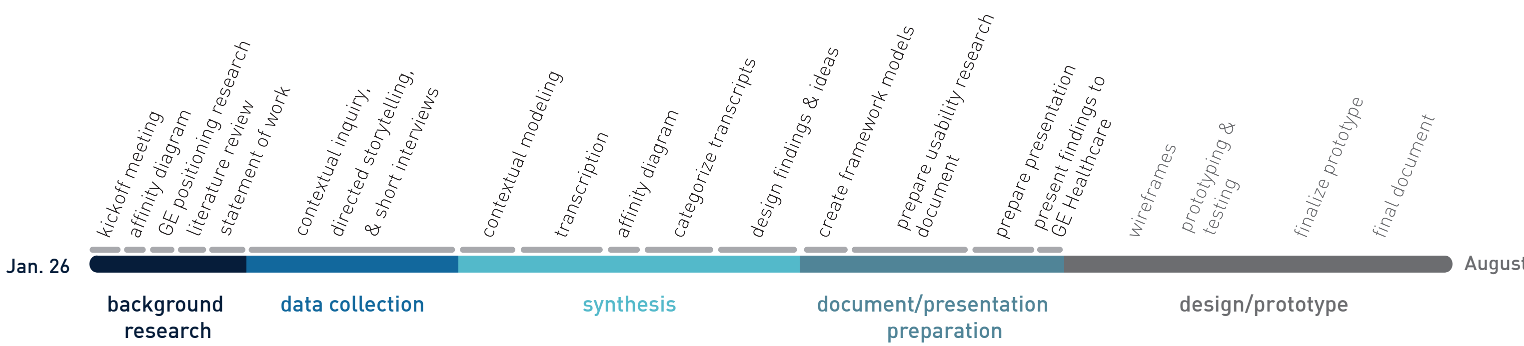
Within the HCII, the Masters of Human-Computer Interaction (MHCI) program is a full-time, twelve-month program that includes an eight-month long capstone project. Students from various academic backgrounds and work experiences collaborate in teams with an industry sponsor to create a working prototype through an end-to-end design and development cycle.

Kickoff meeting with our GE Healthcare client contact.

ABOUT THE PROJECT

Team PIVOTAL is working with GE to design and prototype the interface for a future Patient Information View (PIV) which will allow doctors to more efficiently and effectively understand a patient's medical history. This software is intended to provide healthcare practitioners with a longitudinal view of medical data. Additionally, it will facilitate easy access to artifacts such as radiology images and scanned documents.

The project is split into two phases. The first phase is comprised of research and analysis, with a goal of understanding the needs of doctors and other healthcare workers who interact with patient information. This includes not only how patient information is utilized, but also the general workflow in which patient information is used. This report marks the conclusion of this initial phase. The second phase consists of designing and prototyping possible user interfaces for the system and subsequently testing and iterating the developed prototypes. This second phase will ultimately result in the production of various wireframes, mockups and a completed prototype.



Affinity diagramming to understand the project space. This exercise involves writing out ideas and organizing them into groups to map collective understanding.

PROJECT SCOPE

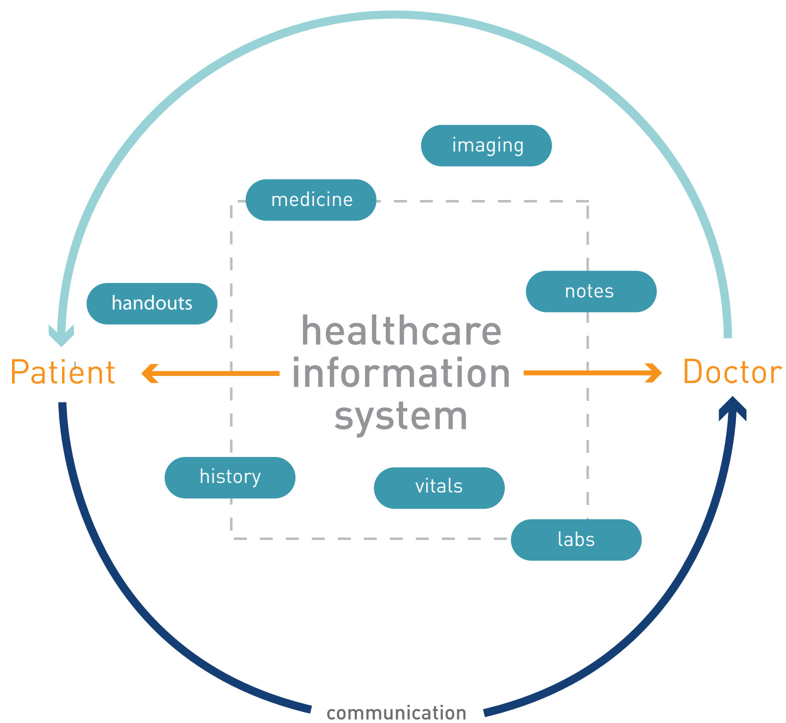
Our client charge was to define and identify the users of the PIV; design a usable interface for the software, with focus on Generation Y users; define workflows for each user type based upon the data they want to view and how they want to interact with the system; and define and design the types of data to be displayed and how it needs to be displayed.

For the purpose of this project, the scope of the PIV has been defined to be just the viewing of patient data and artifacts. The primary user has been defined to be doctors, with an emphasis on referring physicians.

HUNT STATEMENT

To research the workflows, patient information usage, communication and collaboration among healthcare practitioners in order to understand how to efficiently and effectively present a unified view of patient information.

PATIENT INFORMATION FLOW

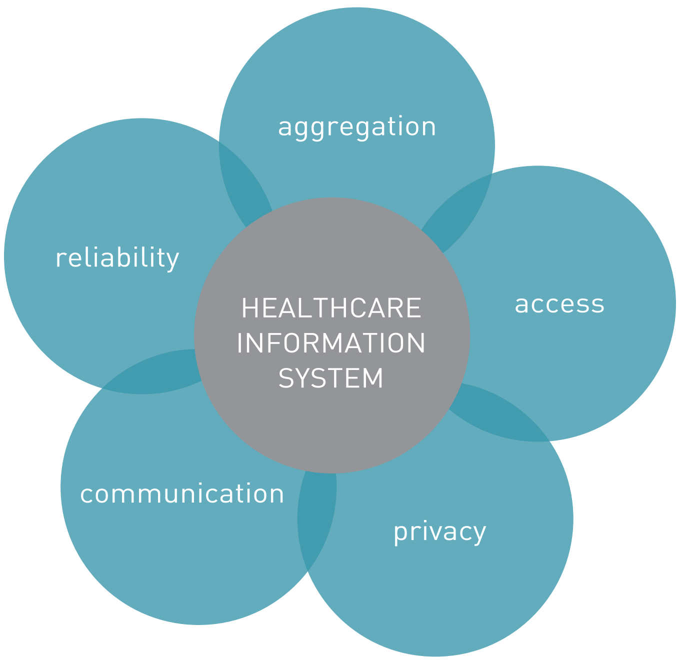


This portrays how an electronic medical record (EMR) system bridges interaction between the patient and physician. It is clear that EMR systems are critical in storing and retrieving patient health information such as medical history, prescription, and vitals. More importantly, the EMR system can support a physician's workflow by providing medical notes, radiology images, and the ability to request lab orders in a cost-effective and streamlined way.

We created this model based on our understanding of healthcare information and how it fits into doctors' workflows for patient encounters.

PROJECT SCOPE

HEALTHCARE INFORMATION SYSTEM REQUIREMENTS



This diagram identifies the major requirements of healthcare information systems. It is imperative that healthcare information systems address issues such as privacy and reliability of patient medical records. Other requirements include providing communication between healthcare staff, aggregation of medical information, and easy access to information.

This model was built from our observations of the different requirements of the healthcare information systems.

	helpful	harmful
internal	**STRENGTHS** · already an established healthcare presence · strong presence in radiology · familiar with medical imaging	**WEAKNESSES** · new product terrain · some unfamiliar user groups
external	**OPPORTUNITIES** · new and growing product space · high interest in electronic records · government stimulus for healthcare technology · hospitals familiar with GE	**THREATS** · paper-to-electronic is a difficult transition · existing EMR providers have an “in” · existing products in domain (LifeImage, Acuo, etc.) · reliance on 3rd party machines for data

GE'S POSITIONING FOR PIV

While many players exist in the electronic medical information market, no single company holds a dominant position. Increased interest in moving to electronic records, catalyzed by recent government stimulus plans for health care providers moving to electronic records, has brought new players into the fold and broadened the market as a whole.

Direct Competitors
GE seeks to expand beyond their current position as a leader in radiology equipment and software by introducing a Patient Information View (PIV). In direct competition to this product are products such as LifeImage, Philips iSite, and CareStream. Among these products, some common capabilities include workflow support, customizability, patient scheduling, retrieving images, and visualization of data.

Healthcare Technology Industry
Other major competitors in the industry offer similar products, against which this product would be considered. These competitors include EPIC, Cerner, Eclipsys, McKesson, Meditech and Siemens. Some of these companies, such as Cerner and Siemens, once held dominant positions in the industry, but have lost ground due to slow development and a resulting lack in competitive advantage. This lost ground has been claimed by newer companies like EPIC, who boast strong customer satisfaction and a more integrated and easy-to-establish system than many of their competitors.

Target Audience
The initial target customers for GE's PIV are large hospitals, since these are the prominent locations in which DICOM data (which the PIV will specialize in) exists. GE hopes to expand the PIV's customer base to include smaller institutions over time, as electronic data becomes more prevalent in smaller hospitals and clinics. There are no specific types of doctors being targeted, though the nature of specialists' practices may lend itself to a greater need for a PIV system.

A Promising Opportunity
GE's PIV addresses a strong opportunity because there is not currently a dominant company in the information viewing realm, and GE is well positioned because of their existing healthcare relationships. In addition, federal stimulus funding is driving interest in electronic healthcare systems.

LITERATURE REVIEW: MAKING THE CASE FOR USABILITY IN HEALTHCARE

While the push for computerized healthcare solutions has certainly become a prominent force, there are a number of issues which may stand in the way of effective implementation. Of particular importance are the "unintended consequences" [1] of systems with poor usability and unsuccessful integration with existing workflows.

In order to understand and design for healthcare applications, it is particularly important to be aware of the complexity of the work environment. In a report for the U.S. Department of Health and Human Services, researchers describe primary care environments as "cooperative", "highly interruptive" and "time and resource constrained" [4]. All of these factors have significant impacts on usability in healthcare, and help differentiate these types of interfaces from those that would be applicable in other work environments.

In a study at the University of Pittsburgh Children's Hospital, a computerized physician order entry system was implemented. Data was collected during an 18 month period to track changes in patient care and recovery. In a startling finding, researchers found a significant increase in child mortality, increasing from 2.80% before implementation to 6.57% with the new system. Researchers ruled out other factors, and found that the use of the computerized system was the reason for the significant increase in mortality [2].

Initial Problem Areas

While the factors behind the increase are difficult to pinpoint, the research team proposed several potential problem areas. To begin with, staff received very limited training on the new system in 3 hour tutorial and practice sessions [2]. In addition, navigation was difficult because the system required 10 clicks just to enter stabilization orders, which took 1-2 minutes per order. This meant that in some situations a second physician was needed just to enter orders, as the primary physician directly performed medical tasks [2]. This resulted in an effective reduction in staff-to-patient ratios, as staff were now spending increasing amount of time with computers, and away from patients. This is particularly important because "reduced staff-to-patient ratios can have an adverse impact on outcome, particularly in patients with shock" [5].

Problems Resulting from Electronic Communication

Additionally, new technology in a workplace can introduce significant changes to communication between staff [1]. New communication tools can bring with them new types of work (such as sending messages to other physicians) which in turn introduce more opportunities for error [3]. This can be particularly troublesome because these new types of errors are often different from what staff members expect. This means that they may not yet have adequate workarounds or error recovery techniques. Also, electronic medical records can create the "illusion of communication"

[3]. This means that staff members assume that just because something is entered in the system, other people will look at it. However, this is often not the case, even when using inbox and flagging systems. Furthermore, even if there is a way for a staff member to know that someone else has seen a message, there is no guarantee that they will act upon it. This means that the system still requires redundant verbal communication [3].

Information Overload

Another important factor to consider in electronic health records systems is the easy aggregation of data. While this is beneficial for searching and locating information, researchers have found that it quickly leads to problems with cognitive overload. Physicians who are viewing comprehensive and unfiltered patient records may have difficulty extracting the most relevant information for a particular visit [1]. Moreover, with long and overwhelming lists of patient names, it is easy to select the wrong patient and potentially view or enter information for the wrong person. A similar problem also occurs with long medication lists, especially because names are listed close together, in small fonts, and without any visual differentiation [6].

Supporting Clinical Decision Making

In designing a system for viewing patient information, the highest goal is to support clinical decision making. This means that physicians need to have access to relevant information as they diagnose, administer care, or enter new information. Bringing together multiple disparate parts of a patient's record requires not only technical integration, but also consistency with clinical knowledge [6]. Much of the reasoning behind clinical protocols is to decrease variability in patient care. However, if the display of patient information is inconsistent or unreliable, this undermines efforts to reduce variability, and may exacerbate it [6].

1. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. *J Am Med Inform Assoc*. 2004;11:104-112.

2. Han Y, Carcillo J, Venkataraman S, Clark R et al. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics*. 2005;116:1506-1512.

3. Campbell E, Sittig D, Ash J, Guappone K, Dykstra R. Types of unintended consequences related to computerized provider order entry. *J Am Med Inform Assoc*. 2006;13(5):547–56.

4. Armijo D, McDonnell C, Werner K. Electronic Health Record Usability Interface Design Considerations. *AHRQ Publication* 2009;09(10)-0091-2-EF.

5. Arias Y, Taylor DJ, Marcin JP. Association between evening admission and higher mortality rates in the pediatric intensive care unit. *Pediatrics*. 2004;113(6).

6. Koppel R, Metlay JP, Cohen A, et al. Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors. *JAMA*. 2005;293(10):1197-1203.

RESEARCH METHODS

Contextual Inquiry
In order for the team to fully grasp the complexity of a physician's workflow and interaction with technology, we had to observe them in their actual context of work. We primarily observed work practice, pausing occasionally to ask follow-up questions about things that we had observed. By switching between observation and interviewing in the naturally occurring context, we could better understand tacit knowledge and communication. This type of information could not have been gathered in an interview alone. The goal of our contextual inquiries was to gain a broad understanding of the problem space, including workflow and communication as well as the breakdowns and opportunities present.

Short Interview
At several of the facilities that we visited, we had the opportunity to speak with non-physician staff members such as technicians and nurses. Even though these users are beyond the scope of PIV, they play important supporting roles in physician workflows, and we wanted to understand their responsibilities. Short interviews were usually between 15 and 30 minutes in length and focused mostly on how non-physician staff interacted with technology and physicians.

Directed Storytelling
In order to understand situations which we were not allowed to observe directly (due to HIPAA restrictions or physician preferences), we performed directed storytelling with participants. Directed storytelling is a method in which participants are asked to provide a retrospective account of a recent (and highly specific) event as prompted by the interviewer. In our directed storytelling sessions, participants were asked to walk through a recent situation in which they had interacted with patient information. This allowed the team to gain insight into specific types of situations that could not be observed directly.


MSU (5 clinics)
Lansing, MI
London University Hospital
London St. Joseph's Hospital
London, ON
UPMC Presbyterian
UPMC Shadyside Urgent Care
UPMC Sports Medicine
Pittsburgh, PA
Baltimore, MD
Johns Hopkins Hospital
Bayview Medical Center

WHERE WE WENT

UPMC Shadyside Urgent Care
This facility is a new clinic in the UPMC (University of Pittsburgh Medical Center) system intended to serve those with limited access to health insurance or primary physicians. The clinic mostly treats minor injuries and illnesses. At this facility, we spoke with the attending physician, and briefly spoke with other staff including nurses, radiology technicians, and lab technicians.

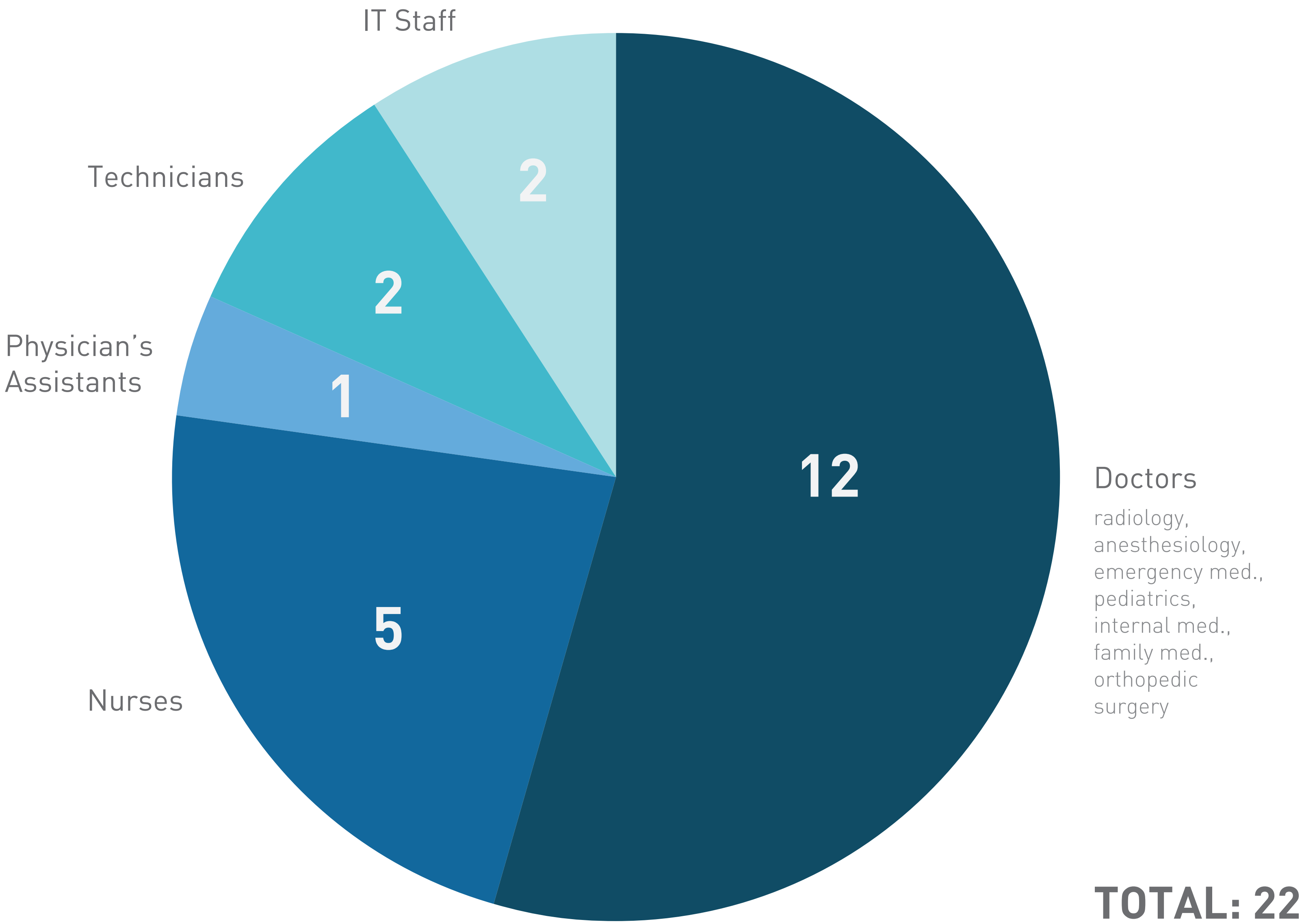
UPMC Presbyterian
Located in the Oakland neighborhood of Pittsburgh, the UPMC Presbyterian Emergency Department sees most of the major acute trauma cases for the Pittsburgh area. Here, we were able to meet with two doctors to understand their interaction with patient data in a hectic, time-sensitive environment.

UPMC Sports Medicine
The UPMC Sports Medicine clinic is a small clinic specializing in the treatment and prevention of sports-related injuries, preceding physical training programs. Due to the nature of their work, physicians at this clinic must frequently view radiology images.

Michigan State University (MSU)
At Michigan State University Medical Center, we visited five clinics and a radiology department. We spoke with a nurse, in Sports Medicine, a doctor in Internal Medicine, and a doctor in Family Medicine. In the radiology department, we met with the IT manager in the Radiology Academic and Administration department and one of her staff.

Johns Hopkins Hospital & Bayview Medical Center
At Johns Hopkins, we visited two different hospitals. At the main campus, our visit mostly centered on the anesthesiology department, where we were able to speak with two doctors. At Bayview Medical Center, a smaller hospital in the Johns Hopkins system, we visited the pediatric emergency department. Here we spoke with a pediatrician a nurse.

London University Hospital & St. Joseph's Hospital
At these two hospitals, we met with four radiologists who work in a number of different specialties. This visit provided us with a better understanding of how radiology images are used and notated. We observed radiologists working with x-rays, MRI, and CT scans.


IT Staff
2
Technicians
2
Physician's
Assistants
1
Nurses
5
12
Doctors
radiology,
anesthesiology,
emergency med.,
pediatrics,
internal med.,
family med.,
orthopedic
surgery
TOTAL: 22

WHO WE TALKED TO

The goal of our research was to gain a thorough understanding of workflows and information needs within healthcare. While our focus was on doctors, we also sought out other roles that support the work of doctors or otherwise interact with patient information.

In the course of our research we spoke with 12 physicians. These physicians represented a broad range of specializations–including, but not limited to, emergency medicine, internal medicine, sports medicine, anesthesiology and radiology. Our observations of workflows and technology use in these different settings helped us understand the need for PIV.

In addition to these 12 physicians, we also met with a number of people who work in supporting roles. This included five nurses, one physician's assistant, two technicians and two radiology IT staff members.

FINDINGS

PIVOTAL team members model data from field work.

PREFACE

We have come to a number of findings based on user research across various hospitals and clinics. While our research emphasis was focused on things within the scope of PIV, the nature of our contextual research meant that we came away with many findings both in and outside of this scope. All findings are included here with the hope that they may aid in the understanding of the overall environment in which electronic patient information is used. This section contains a total of 29 findings grouped into four categories: integration, presenting relevant information, usability, and patient interaction.

All findings are accompanied by recommendations for possible improvements. While some of these recommendations may be beyond the scope of PIV, they are intended as guiding ideas and starting points for future development.

INTEGRATION

INTEGRATION

POORLY INTEGRATED SYSTEMS WASTE VALUABLE TIME

Hospitals use many different systems for entering and accessing patient information. Often, these individual systems operate independently and data cannot be shared between them. It is not uncommon for hospitals to employ four to five different systems, including systems for scheduling, radiology, EMRs and more. For doctors, this adds not only the need to be familiar with multiple systems but also additional time required to access all relevant information.

Furthermore, carving out the most possible time to spend with patients is always a priority. Forcing a user to open separate applications to view different types of information adds additional time costs and is thus a notable burden on doctors. Lacking, or poor, integration was a problem at every site we visited and a frequent cause for concern among doctors.

"Clearly a single point system is the way to go, I think. That's three systems: I get my x-rays from one; I get my lab and graphical displays from another; patient history from another... This could be done much better."

- Doctor, anesthesiology

RECOMMENDATIONS

- Consolidate systems into a single application
- Increase continuity (behavior, appearance, etc.) across applications

INTEGRATION

POOR INTEGRATION AND ORGANIZATION IMPEDE IMAGE FINDING

While most doctors were happy with the features offered for interacting with radiology images, many had issues actually finding the image they wanted. In some cases, doctors had to search for the patient's name in a separate radiology viewing system, without any quick way to pull up images from the EMR. In other situations, a list of images for a patient could be opened by clicking a link from the EMR. Even then, slow loading times discouraged image browsing and disrupted workflow.

At one site, the doctor had to know where the image was taken in order to search for the patient, which was rarely known off-hand. Once a patient was found, the doctor then had to find the desired image, which often introduced additional trouble due to a lack of labeling and the inability to preview an image before opening it.

"I asked it to pull up the hip x-ray. It takes me to the PACS viewer, it takes me to the patient but it doesn't take me to that x-ray. I have to go find it."

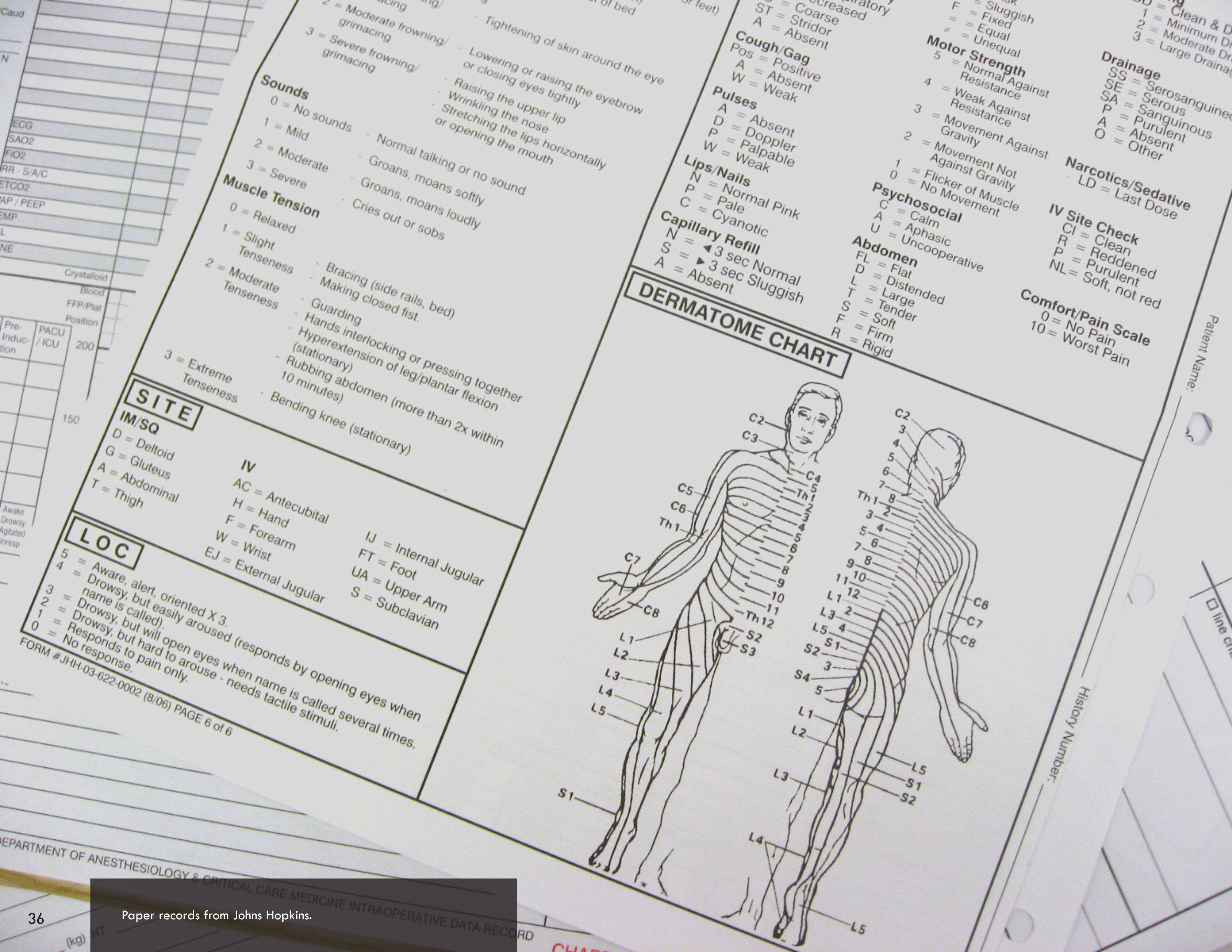
- Doctor, internal medicine

"There's a whole separate system for x-rays so if I send a kid to x-rays I have to open up a whole other file to pull those up."

- Doctor, pediatrics

RECOMMENDATIONS

- Integrate image viewing with patient information



Paper records from Johns Hopkins.

INTEGRATION

PAPER RECORDS LACK ACCOUNTABILITY

While some doctors feel that it is currently easier to use paper records, many believe that paper records are less accurate and easier to falsify. Inaccuracies in paper records usually occur because there are no data constraints and forms can be filled out after the fact (when doctors have potentially forgotten the relevant information). Also, there is no logging of paper records, so physicians are less accountable for mistakes in the record. Electronic records, on the other hand, make it easy to trace a dubious entry back to the physician responsible for the error.

The presence of paper records also introduces yet another system with which doctors need to interact. Entering and accessing information from paper records cannot be easily integrated with other systems. Some facilities scan paper forms, but this means that the data is only available as a scanned image, not as indexable text.

"I think a lot of the old-timers pencil whip the hell out of the chart, so I don't think they care about (paper charts) to tell you the truth. And that could probably be studied as well. There's a lot of little things off here."

- Doctor, anesthesiology

RECOMMENDATIONS

- Ensure consistency and accountability in data entry

PROLONGED TRANSITION TO DIGITAL RECORDS INCREASES WORK

Many hospitals that employ electronic health systems still rely on paper charts. Often, data will exist both in electronic and paper form, though some data may exist only in one or the other. Hospitals that double chart have acknowledged this as being inefficient, and almost all are moving towards remedying the situation.

A nurse in the emergency department complained about wasting time having to enter information twice—on paper and in the EMR. She acknowledged that the transition to digital records was generally positive, but said that the transition period was painful and led to inconsistent patient data.

"Once I've safely induced anesthesia and we've got the surgery underway, I usually then direct my attention towards documentation. And that's also sort of split between half paper and half electronic. That varies on the venue in this hospital... Most of it's on paper. Some of it is duplicated between paper and electronic."

- Doctor, anesthesiology

"So, I think in some ways, you can't completely get rid of your paper system. At least, we haven't really found that we can completely absolve it."

- Physician's assistant

RECOMMENDATIONS

- Work with clients to fully integrate systems and eliminate redundancies

SECURITY VULNERABILITIES INTRODUCE PRIVACY RISKS

Often, when physicians want to view radiology images, the EMR will open these images in a browser such as Internet Explorer. This presents a problem because these windows do not close when the EMR is closed, meaning that they can be left open on a workstation. In addition, some systems allow users to be logged in at multiple locations, which means that at least one of the workstations is vulnerable to unauthorized use.

Several doctors said that it was not uncommon for a patient's information to be left open on a shared workstation. When they returned to the workstation hours later they could mistakenly reference data for the wrong patient.

"And the one danger... is that these documents are just opening in an (Internet) Explorer window outside of the EMR, outside of the secure atmosphere. So I can close down Centricity but these scanned documents remain on the desktop. If you close them you can't reopen them but a lot of people walk away with Explorer open."

- Doctor, family medicine

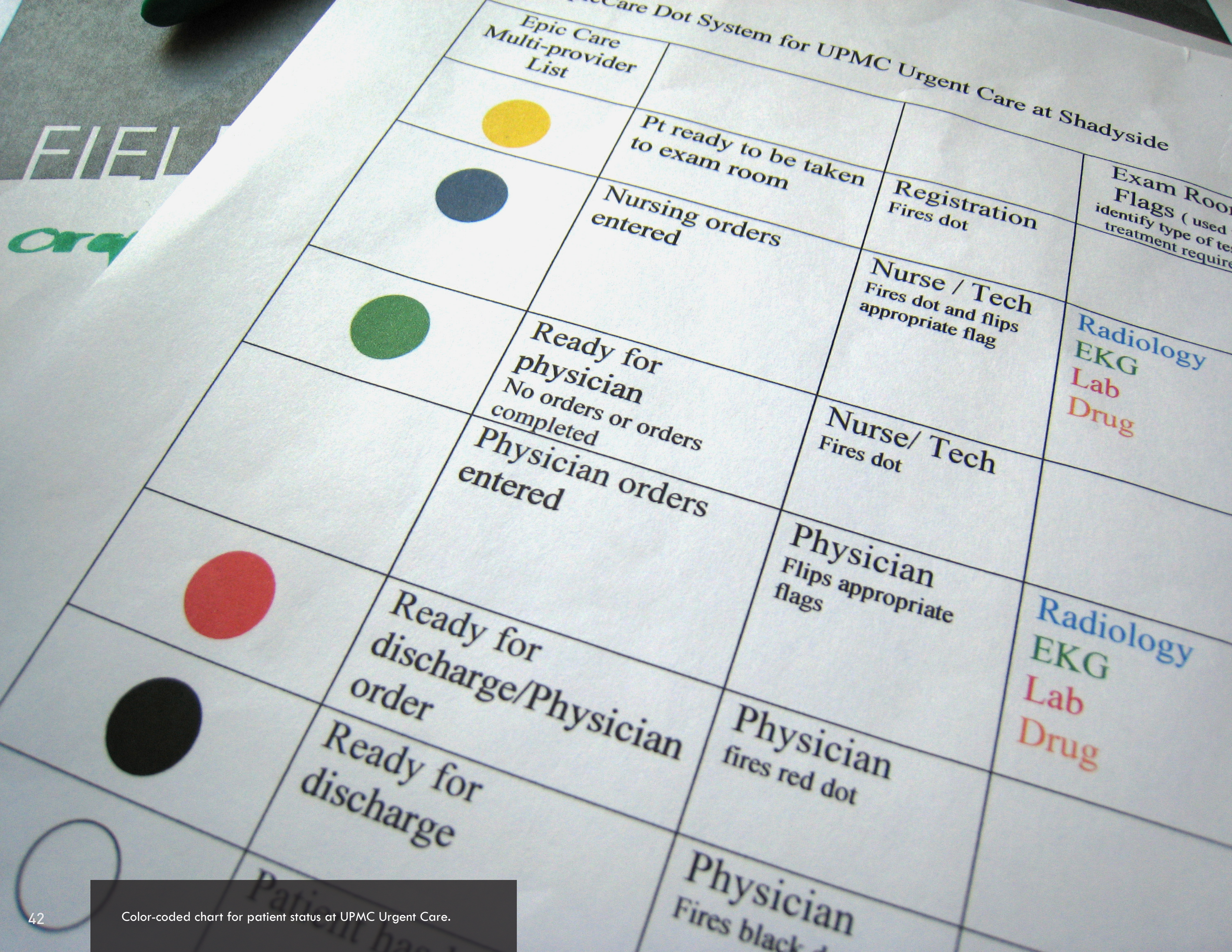
RECOMMENDATIONS

- Ensure that automatic timeouts apply to anything that contains sensitive information

"This will tell me this user is currently logged in multiple times which you're not supposed to be. But, if I'm in my triage room or at my workstation, so when I get this I go 'oh yeah, no kidding'."

- Nurse

PRESENTING RELEVANT INFORMATION



Color-coded chart for patient status at UPMC Urgent Care.

PHYSICIANS PREFER GLANCE-ABLE PATIENT INFORMATION

Physicians need quick background information about patients in order to get a general sense of patient health. Physicians prefer to see this information in a glance-able, holistic view. They liked having access to extensive background information in the medical record because it made them look prepared in front of the patient. In addition, the use of symbols and colors allows physicians to quickly interpret relevant patient information. Finally, different providers and physicians may want to see information at varying levels of granularity, according to their role and specialization.

In an emergency room we observed large displays which were used as status boards for patients. The use of large, clear symbols made it easy for hospital staff to track various pieces of information at a quick glance. For example, they could see icon indicators for severity, medication orders, radiology orders, and the type of patient complaint.

RECOMMENDATIONS

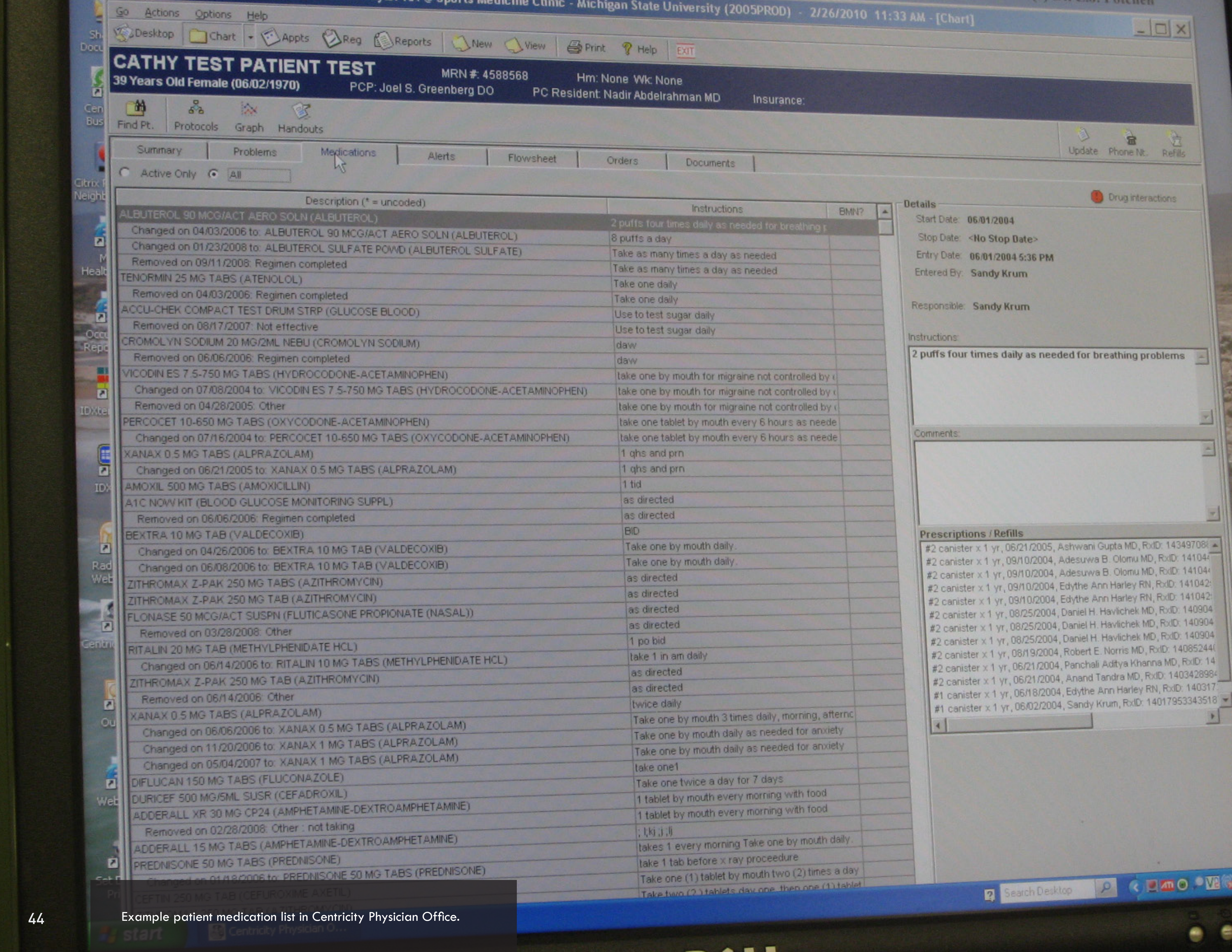
- Use symbols and color-coding to make information glance-able
- Allow for customizable granularity

"He can easily figure out by the symbols, like these two are being admitted and have beds, this person is being admitted and is being transported by ambulance, this one has labs that are pending."

- Doctor, emergency medicine

"I'm only caring for one patient at a time. So I have to have a very holistic view of that patient's health status, and also what's happening in the operating room at any given time."

- Doctor, anesthesiology



Example patient medication list in Centricity Physician Office.

PRESENTING RELEVANT INFORMATION

EXCESS DATA COMPLICATES INFORMATION FINDING

In electronic medical records, information is easily recorded, which can result in an overwhelming amount of data. Physicians frequently struggle with information overload, in which they are presented with unnecessary details about every encounter that a patient has had. While some of this information may be relevant, the most pertinent information is not organized or highlighted in a meaningful way.

"If we list everything that's ever happened to somebody over 10 years, in the middle of it may be metastatic cancer, coronary heart disease, but it's mixed in there with colds, and ear infections, and sprained toes."

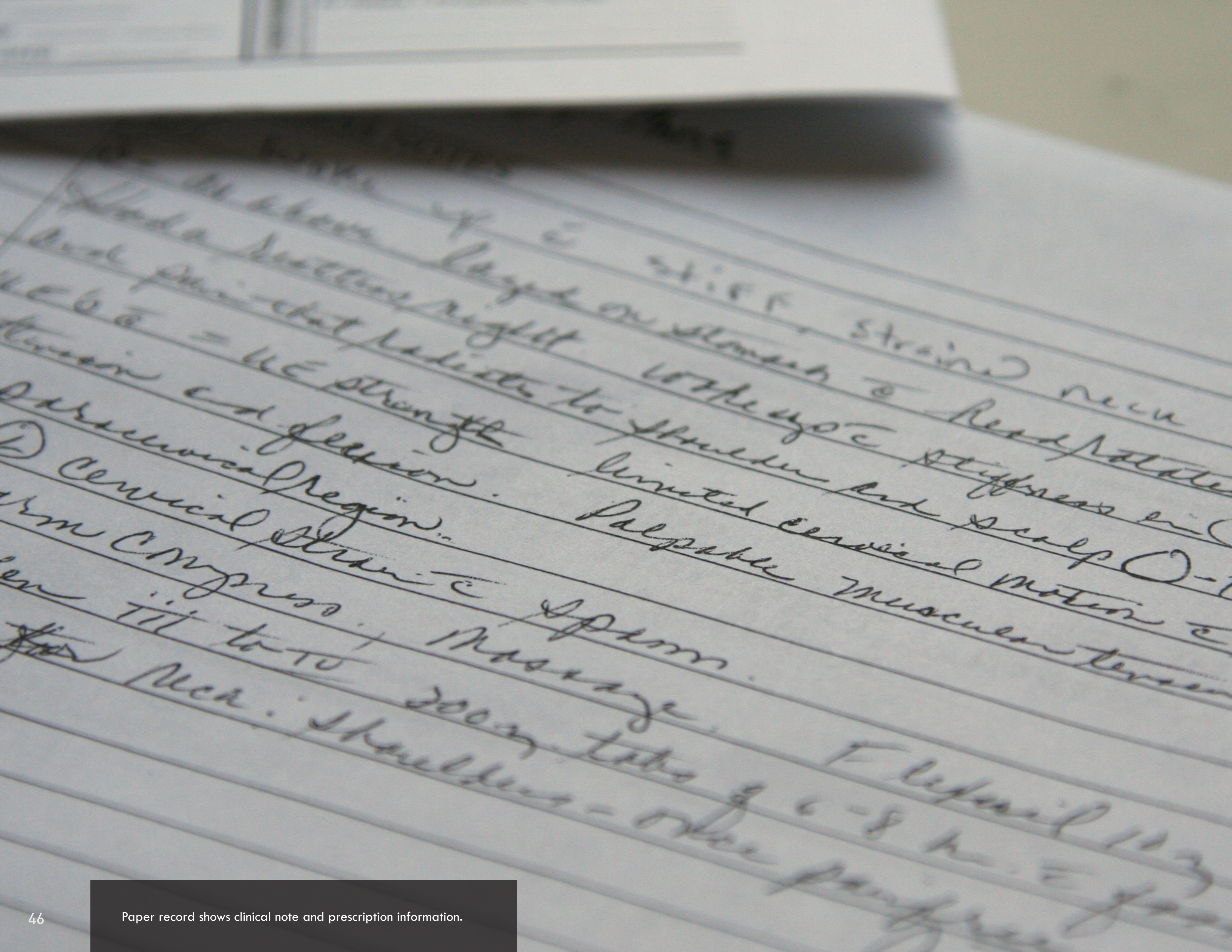
- Doctor, family medicine

"They don't need to see all the old histories that they're a smoker, necessarily, or a diabetic. They want to know they're coming in for a foot exam. Unless it's relevant to the procedure we're doing, they don't care."

- IT staff

RECOMMENDATIONS

- Highlight the most relevant information to the current visit
- Minimize the amount of excess information on each page



Paper record shows clinical note and prescription information.

INACCURATE MEDICATION HISTORY POSES CRITICAL RISKS

Physicians rely on other staff, and each other, to enter accurate information. However, some information is entered based on a patient's own observation and may not be verified for accuracy. In addition, medication lists are not always up to date, which can lead to confusion regarding a current treatment plan and the possibility of adverse drug interactions. Generally, the burden was on the doctors to ensure that the data was up-to-date.

One doctor relayed a story of how a patient record indicated no allergies in big bold letters, but then listed several allergies directly below it. He laughed this off as another example of how patient data contained in the EMR is not always trustworthy.

"The computer is only as good as the people who are entering the information."

- Physician's assistant

"We're supposed to know what every patient is on coming into the hospital. I got to tell you, often times we don't and then their blood pressure the next couple of days goes through the roof, as an example, because we have no clue as to what the heck they're on."

- Doctor, anesthesiology

RECOMMENDATIONS

- Put patient prescription and allergy information front-and-center
- Grey-out/de-emphasize out-of-date information

DOCTORS NEED EXTERNAL TOOLS TO SUPPORT THEIR WORK

Beyond the systems used for entering and viewing patient information, doctors may utilize various other tools in their day-to-day work. These tools include things like calculators for determining various measures, reference guides for prescription doses, and other medical references. Some tools are electronic, like looking up what a particular condition looks like on Google, while others are paper-based, such as referencing a medical reference book.

A doctor we spoke with relies on medical calculators and reference guides that are loaded on his Android phone. He uses these frequently when interacting with patients. He expressed surprise that something that was so quick and convenient on his phone did not currently exist in his medical software.

RECOMMENDATIONS

- Include built-in calculators and dosage information
- Provide quick access to reference information

> *"Wouldn't it be nice if there was more like an ABG calculator or an Apache score calculator? Some of this is in Eclipsys but these are the things you need."*
>
> *- Doctor, anesthesiology*

> *"I'll just do a simple Google search for an image of whatever it is I'm trying to explain to them... And I'll look up some meds and dosing and other things on my iPhone.""*
>
> *- Doctor, family medicine*

POOR LABELING CAUSES CONFUSION FOR DOCTORS

When searching for documents or images, doctors frequently encounter problems as a result of poor labeling. Ambiguous or generalized labels often force doctors to open multiple files in order to find the correct information. Also, it is not uncommon for there to be many similar or related images for the same patient, thus requiring greater detail to distinguish among them.

"It's a titling problem. And we'll see different titles. Sometimes it'll say it's a chest x-ray, and sometimes the titles here are of what the patient's complaint is. It will say 'Image report: cough and fever for three days' and that's the title of the image report."

- Doctor, family medicine

RECOMMENDATIONS

- Enforce consistency in document and image labeling (e.g. drop-down menus, auto-complete)

CLINICAL NOTES NEED TO BE CLEAR AND CONCISE

Clinical notes are a key attribute of many systems. These notes capture information from a patient visit, such as the complaint, diagnosis, treatment plan, and follow-up information. Often, notes are simply free text, which may be misused as a catch-all repository in lieu of filling out structured forms. Notes may also come in the form of dictations which are often transcribed. Generally, doctors want clinical notes to be clear and concise, without extraneous information.

"There's a lot of controversy about cluttering up notes and making them too long and too crazy."

- Doctor, internal medicine

"I always leave what I call breadcrumbs of the important findings (in the note), and then fill it in from there. What will always be there are: what labs I ordered, what x-rays I ordered, what the diagnosis was... I fill in the problem list, what I've decided it finally was."

- Doctor, family medicine

RECOMMENDATIONS

- Provide a way to create streamlined notes (e.g. templates)

VERIFYING PATIENT INFORMATION IS CRITICAL AND ARDUOUS

Knowing patient history and current medications is critical for doctors. Often, they have to rely on patients to provide this information as it may not exist in their computer systems. One clinic employed a patient portal, which allowed patients to log in and update their own information prior to a visit as well as make prescription renewal requests. Doctors, however, still had to review this information and interpret it based on their own analysis. Furthermore, doctors frequently ask the same questions over and over to ensure the most thorough reporting from patients.

"I mean you sort of have to trust in your conversation with the patient and the family and the surgeon preoperatively that you have all of the information."

- Doctor, anesthesiology

"That's just the way we structure our medical system, is to make sure we verify, re-verify. It's good because it's a quality control."

- Doctor, emergency medicine

RECOMMENDATIONS

- Highlight patient-provided information for easier reviewing and verification

NUMERICAL DATA CAN BE DIFFICULT TO INTERPRET

Physicians find that strictly numerical data, especially from labs, is difficult to process and analyze without using some form of visualization. Applications that allow for graphing values over time are useful for forming a diagnosis and showing patients their progress. Visualizations that include indicators for baseline and mean values also help doctors interpret data more quickly.

An anesthesiologist we spoke with emphasized the criticality of tracking patient health over time. He felt that graphs and visualizations greatly facilitate this. Unfortunately, some medical software outputs patient data strictly as numbers, making it difficult to see trending information.

"I can look at their labs that were performed today... and then if I'm interested I can trend it over time... I can graph these and see how well over time these labs did. So I know that today, this is the highest the potassium has ever been, because normally it's in this area."

- Doctor, emergency medicine

RECOMMENDATIONS

- Offer graphs and other visualizations for numerical data
- Show baseline values and other thresholds to make data glance-able

USABILITY

USABILITY

COMPLEXITY OF EMR SYSTEMS INTERRUPTS WORKFLOW

Doctors recognize the need to move toward electronic records. However, many find that the current systems actually take longer or are simply harder to use than their paper counterparts. Reasons for this include that electronic records sometimes require far more interaction than a paper record. For instance, in electronic records, fields can be required, whereas in a paper form a doctor has more freedom in what is recorded. Further, some healthcare professionals expressed concern over the rigidity of many forms present in their EMR systems, stating that they often prefer free-text entry so they can be more precise.

One doctor we spoke to, a former Air Force doctor and current reservist, voiced extensive frustration with the EMR system he used. He compared the EMR interface to the controls of an F-16 fighter jet, but noted that the jet was far easier to manage.

RECOMMENDATIONS

- Allow for more flexible data entry (reduce unnecessary required fields, add free-text fields, etc.)
- Perform usability testing to minimize required clicks and save time

"Vital signs and drugs that I gave and things like that I find the paper is much easier... The experiences I've had with our new system are that doing the things that I used to do are now difficult... Things I like to do in my medical record that I now have to click 40 times to do."

- Doctor, anesthesiology

"When you sit in an aircraft like the F-16, it does look like a different world. But after a couple, just a couple brief sims even... You'd have that down in literally an hour, like playing a video game. Yet, here look at this, does this look like anything that's a reasonable dashboard? I would argue not."

- Doctor, anesthesiology

USABILITY

ILLOGICAL NAVIGATION CREATES CONFUSION

Patient record systems often contain many different types of information. This information is not always organized in a way that makes sense to doctors. This causes problems with finding information or forgetting to input data when the field is outside of the logical workflow.

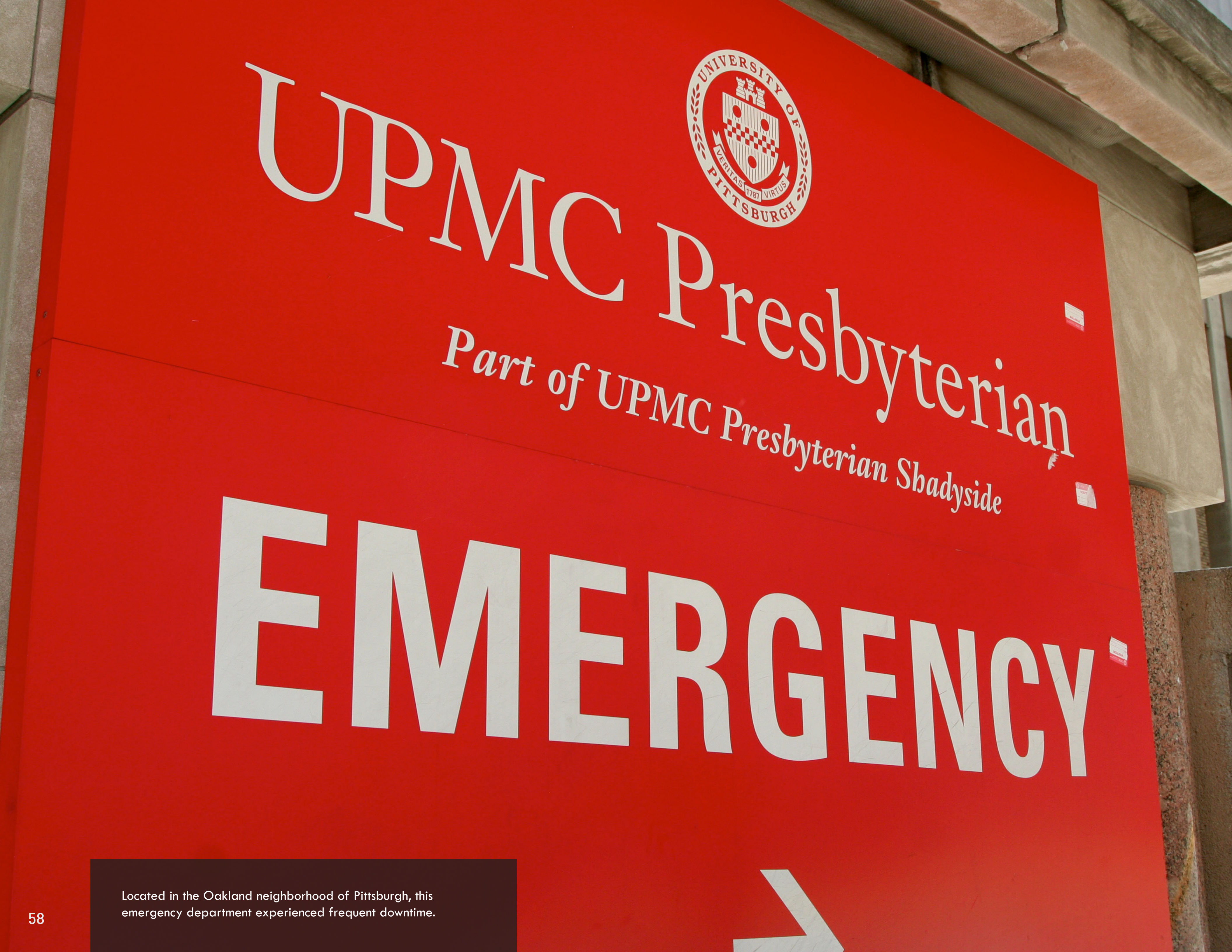
A pediatrician we spoke with bemoaned the illogical process of entering a patient's weight. In her pediatrics department, the patient's weight was required for saving the patient's information in the EMR. The placement for entering the patient's weight was in such an unexpected location that doctors frequently forgot to enter it, meaning that patient information was not updated to the record.

"There's just not an 'enter the weight.' You have to go to allergies, patient data, and then weight. Especially for (pediatrics) where you have to put that in for every patient, it would be nice if it were more up front."

- Doctor, pediatrics

RECOMMENDATIONS

- Perform user research to determine optimal navigation flows



Located in the Oakland neighborhood of Pittsburgh, this emergency department experienced frequent downtime.

SYSTEM DOWNTIME CAUSES MAJOR DISRUPTIONS

Hospitals must frequently update their systems and workstations. This usually requires the system to go offline and become unusable by staff. Staff must work around this scheduled downtime, resulting in disrupted workflow, wasted time, and inferior patient care. Often, paper is still used as a back-up system when computer systems go down unexpectedly or for maintenance, forcing physicians and staff to revert to an old and increasingly unfamiliar system.

At one emergency department, doctors complained that IT staff took the system down on Saturday nights around 1 a.m. While convenient for most of the hospital, it was one of the busiest times for the emergency department. Staff had to resort to using paper orders, whiteboards on wheels, and running down the halls to relay information. In the already hectic environment of an emergency room, this disruption brought efficient patient care to a halt and was a major source of frustration for staff.

"It just becomes a big pain in the butt from that perspective. That's probably the worst thing is when the system goes down."

- Doctor, emergency medicine

RECOMMENDATIONS

- Provide a seamless update process (no downtime, no workflow changes)
- Create scannable paper versions of electronic forms (for use during downtime)

USABILITY

TEMPLATES CAN BE OVERLY RIGID

Physicians often use clinical protocols and templates to build their post-visit reports. Using these templates is helpful to physicians and provides an easy way to enter information after a visit. However, using them can be time-consuming and some physicians have mixed feelings about how these templates compare to dictations.

At many facilities, physicians completed post-visit reports using template systems. While these reports existed primarily for billing purposes, one physician noted that they were also useful for reviewing patient history. Templates were well suited to this particular facility because it primarily dealt with simple complaints. However, this same physician also worked in an emergency room, and said that the complexity of cases encountered there would not lend themselves well to templates, and that dictations were a much better choice.

"I'd much rather (use a template) for a simple complaint than having to dictate things over and over again about wherever. So, (using a template) is nice because of the level of complaint, but once you get a person that has a really complex medical condition you just end up typing for a long time."

- Doctor, emergency medicine

RECOMMENDATIONS

- Allow for custom template creation

USABILITY

AUTHENTICATION WASTES VALUABLE TIME

To protect sensitive patient information, systems have automated, timed logouts. This logout feature forces doctors to login dozens of times throughout a shift, and can result in substantial wasted time especially if the state of the system is not restored upon re-login. Another problem is that different systems have different password requirements, meaning that physicians must keep track of multiple passwords. Solutions to these login problems involve fingerprint readers and RFID, which make the process of logging in somewhat easier.

We observed one doctor switching systems to access patient images. Before logging in, he had to pause and think about what his username and password were for this particular system. After several failed attempts (and wasted minutes), he was able to remember his login credentials.

"If an average triage time is, what, five to six minutes, the system will automatically, not shut down, but lock you out if you're away from it for more than two minutes. So if you're out of it, you have to go back into it again."

- Nurse

RECOMMENDATIONS

- Use a universal login for any system component
- Save UI state across sessions to reduce wasted time
- Allow for a fast and secure login solution (e.g. biometric, RFID)

SYSTEM IMPLEMENTATION ADVERSELY AFFECTS USABILITY

Most systems are deployed over many machines, making the experience inconsistent for users. To make this more manageable, systems are often deployed through virtualization (such as Citrix). Implementing systems in this way introduces speed and image quality issues.

One problem we saw directly was doctors outside of radiology trying to view radiology images. The resolution and color depth are usually not up to par for proper viewing, meaning that these images are not useful for diagnostics. Reasons for lower image quality include old or low-resolution monitors and intentional image degradation in the system (for speed reasons).

> *"So the real issue, at least in my opinion, is that thick, thick client from Centricity. Because with that thick client, it makes you use a system to deploy that isn't necessarily the best solution for imaging."*
>
> *- IT staff*

RECOMMENDATIONS

- Run software directly from the web to reduce end-user issues

SYSTEMS DO NOT MATCH DIVERSE WORKFLOWS

Not only do different hospitals operate very differently, departments and individual doctors within the same hospital may have vastly different workflows. These differences include using different computer systems, having different roles and responsibilities, having different patient procedures and more. These differences often result in frustration with systems, which are not tailored to how that particular person works. Even in locations with customized systems, the systems were only customizable by a few people. The rest of the system's users then had to conform to the systems made by these people, regardless of how well it fit their own workflow or personal preferences.

"By department? Who cares by department, they're in the ICU. Some of this is relevant when they're on the floor, but it's just not a well-designed interface."

- Doctor, anesthesiology

RECOMMENDATIONS

- Make the interface customizable (modular layout, workflow)

SOFTWARE TRAINING IS LARGELY INEFFECTIVE

While staff members do receive training on new systems, it is usually not presented in the context of real workflow. Classroom training sessions often do not provide staff with adequate preparation and they find themselves relying on the few features they understand. Because many staff members have irregular schedules, they may go long periods between shifts and forget how to use the systems, meaning they must re-learn them for almost every shift.

We visited a facility that had recently implemented a new software system, and staff had just undergone software training. One nurse remarked that the training was a waste of her time because the training occurred in a classroom setting without any context. The actual context of her work entailed faster use and more complicated situations.

> *"Well, sitting in a classroom for four hours saying this is what this does, this is what this does, but, until you actually use it... I didn't need those four hours wasted."*
>
> *- Nurse*

RECOMMENDATIONS

- Usability test software to reduce required training
- Make features easily discoverable

LOCATING PATIENT RECORDS CAN BE DIFFICULT

Finding patient information in the system falls mainly into two different tasks. First, physicians need to look up historical information about a patient. This is done within an EMR system, where searches are usually done by patient name. The other situation arises when physicians are doing rounds and refer to their patients by looking at the room number, patient complaint or schedule listing.

At some hospitals, patients have unique identification numbers, which can be useful in looking up data. At other facilities, however, such IDs have not been successfully implemented. Finally, at some hospitals, doctors were forced to select a department within which to search for a patient, which was found to be inconvenient.

"If I put in his medical record number his surgery won't come up. I have to put in his name and then look for his birthdate, and then his surgery will come up. You kind of have to look around and find things because they don't have the medical record numbers consistent just yet."

- Physician's assistant

"I don't necessarily know everybody's name off the top of my head. So when the nurses talk to me, they're like 'that guy with the heart problem in room 15' so then it's quicker to see."

- Doctor, emergency medicine

RECOMMENDATIONS

- Allow for global, non-filtered searches

SYSTEM INTERFACES DO NOT MATCH DOCTORS' DESIRES

Many of the doctors we talked to had very strong opinions regarding the systems they currently use, and often had suggestions for how they could be improved. These doctors had specific ideas for what their ideal future system entailed and how technology could improve workflow within the hospital.

One physician we spoke with woke up hours early every day to load up his netbook with patient data. He did this so that he could be at the bedside with all of the relevant information at hand. He chose his netbook over a COW (computer on wheels) because it was unobtrusive and portable. He imagined a future where mobile technology permeated the hospital workplace and better supported his workflow.

"It'd be nice if I could design it myself, but instead it's people who don't work here."

- Nurse

"When we do our bedside evaluation, what would be helpful and what I think is already a problem is again, it's hand-written stuff. I'd love to be able to go to the bedside and have a tablet."

- Doctor, anesthesiology

RECOMMENDATIONS

- Provide a feedback mechanism for users
- Involve doctors in the design process

PATIENT INTERACTION

DOCTORS WANT TO INTERACT DIRECTLY WITH THEIR PATIENTS

Hospitals usually have many computer stations located throughout their buildings, including those at desks, in patient rooms, and on mobile carts. Many of these systems go unused—particularly those in the patient rooms. Staff dislike using in-room computers because they are often bulky and/or located such that they interfere with the doctor's ability to interact with the patient. Doctors do not want to seem as though they are distracted or otherwise not engaged with the patient.

Since physicians prefer to interact with patients face-to-face, they do not have the opportunity to enter information in real-time. As a result, doctors often wait until after the patient visit to input information, which may result in information being forgotten or misremembered. As a workaround, physicians make notes to themselves or try to memorize the information so they can enter it at a later time. This has the potential to introduce errors and inaccurate information.

"If you disengage from the patient, you can see it, they can't. They don't know what you're doing. You're doing your thing. It disengages them. They don't like it."

- Doctor, internal medicine

RECOMMENDATIONS

- Provide patient-facing content
- Experiment with new computing form factors (e.g. tablet computers)

PRIVACY CONCERNS HINDER COMMUNICATION BETWEEN DOCTORS

Electronic communication between physicians can take the form of emails, documents with comments, and short electronic messages. Some pitfalls of electronic communication include lag, overlooked information, and privacy concerns. Several doctors expressed concerns about putting sensitive information into the patient record. Doctors want other healthcare practitioners to be aware of a patient's possible depression or drug addiction without the patient having access. One system we saw handled this situation gracefully by enabling doctors to send each other quick messages which were not saved to the patient's record.

"I still don't trust it completely, that it's not stored. So I still don't put anything in there that I wouldn't want the world to see someday. There might be something where you send somebody a flag that you just saw their patient and you'd say 'kind of a difficult encounter' not 'this was a very ill-tempered and rude woman who I never want to see again.'"

- Doctor, family medicine

RECOMMENDATIONS

- Create a secure messaging channel outside of the patient record

A doctor explains why doctors should feel confident using technology in front of patients.

DOCTORS WANT TO APPEAR CONFIDENT WITH TECHNOLOGY

When using technology in front of the patient, doctors are often sensitive to the patient's perception of their technical expertise. Doctors want to appear confident in front of the patient at all times to maintain trust. If they appear unsure of themselves using medical software, patients may begin to doubt the quality of care. An unintuitive or confusing system will more likely cause fumbling or uncertainty. According to a doctor we spoke to this was a primary concern for healthcare practitioners when considering the use of technology in their practice.

"It affects your confidence level, your trust level. Docs don't like it, so that's part of why the two paths are 'learn to use it well and take it into the room,' or 'not deal with it, and leave it out there,' in which case, what is the price you pay for quality, efficiency, safety?"

- Doctor, internal medicine

RECOMMENDATIONS

- Usability test software to minimize doctor confusion and embarrassment

DOCTORS PERCEIVE E-MAILING PATIENTS AS WASTING TIME

E-mail communication with patients varies among doctors, however most doctors prefer not to communicate electronically. Doctors prefer face-to-face communication but will resort to phone communication if necessary. Reasons for disliking electronic communication include that it requires too great of a time commitment, is not billable, and may not be secure. While some hospitals currently employ systems for securely messaging patients, use of those systems is not widespread.

A physician's assistant we spoke with said that the time required to e-mail patients was too great to be practical. She feared that such easy opportunities for communication would prompt too many patient inquiries.

"Some practitoners choose to correspond with their patients via e-mail. I don't like to do it. I know it seems convenient, but for me it's not convenient because then I feel like I would get bogged down with e-mails from patients."

- Physician's assistant

"We're not paid to communicate by e-mail, and if it's going to be four paragraphs, and they're going to need more explanation, and they're going to ask more questions, that's free. And we can't run a business that way."

- Doctor, family medicine

RECOMMENDATIONS

- Avoid technology that introduces new responsibilities into doctors' workflow

DOCTORS WANT TO PROVIDE CUSTOMIZED PATIENT HANDOUTS

At the end of many patient visits, doctors and nurses discuss the visit with their patients. In doing so, they often provide a printout which includes information such as exam results, discharge papers, patient education handouts, medication lists, and instructions. These forms are frequently auto-generated and not customized to a particular doctor.

One of the nurses we spoke with said that she liked to give patients take-home information, such as how to care for a cast, but often would not have much time to come up with the information. She was forced to rely on handouts provided by the system, which did not always convey the information that she wanted.

"It's just under handouts here... I don't have much customized here, but like bronchitis, acute bronchitis. I can pick it off the list and all I do is hit print so I have it to hand to them, so they know about that."

- Doctor, family medicine

RECOMMENDATIONS

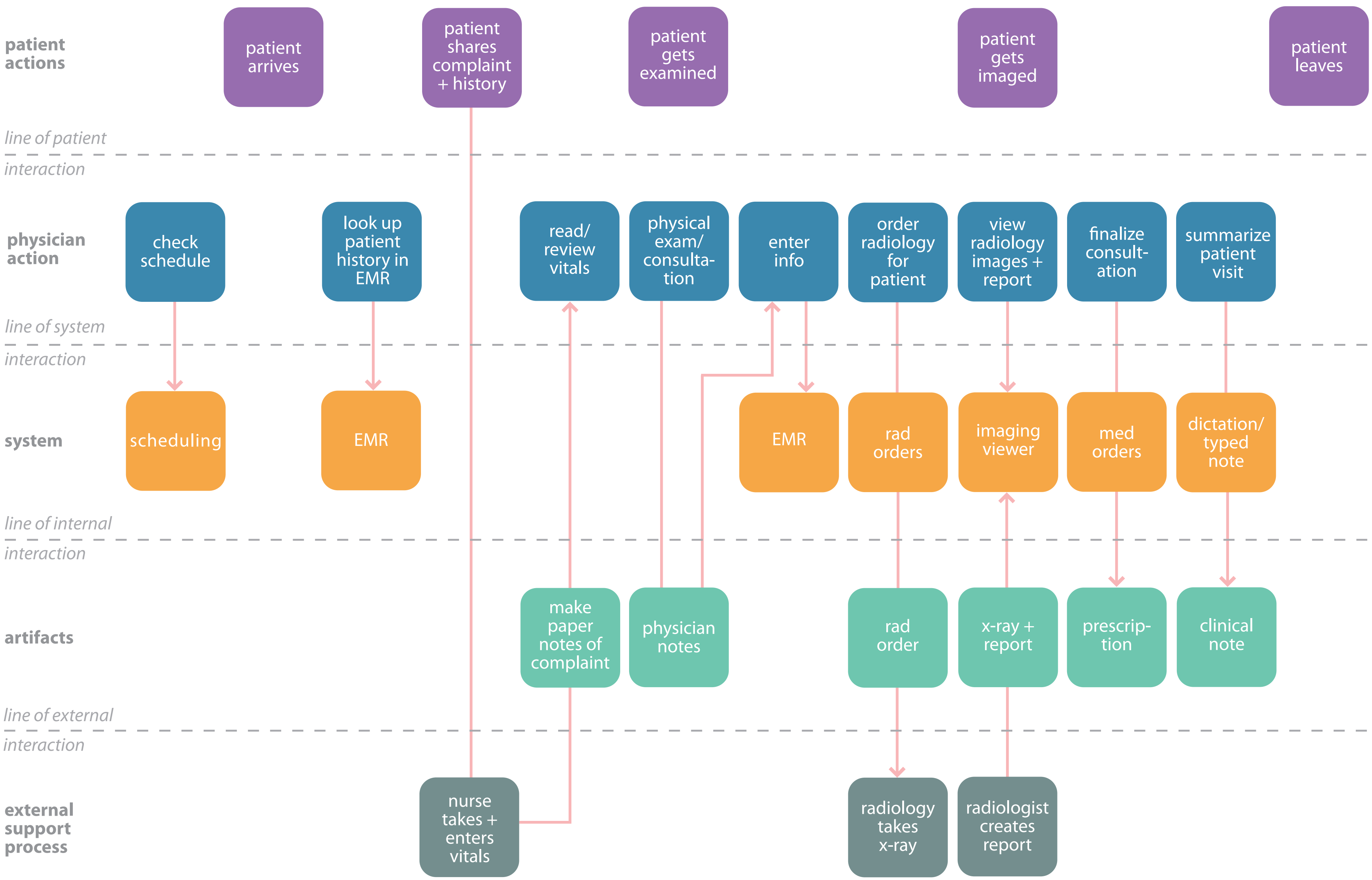
- Provide an automated method for generating customized patient handouts

SUMMARY

SUMMARY OF FINDINGS

Our findings summarize data from 22 different healthcare practitioners at eight different locations. Through transcribing, modeling and categorizing our data we came to myriad insights about the work practice of doctors and other healthcare practitioners as well as how patient information plays into this practice. From these insights we derived four overarching themes: integration, presenting relevant information, usability, and patient interaction. Our insights were categorized based on these design directions, and for each we have made recommendations for how future products can better address the observed needs.

DESIGN DIRECTIONS


patient actions
patient arrives
patient shares complaint + history
patient gets examined
patient gets imaged
patient leaves
line of patient interaction
physician action
check schedule
look up patient history in EMR
read/ review vitals
physical exam/ consulta-tion
enter info
order radiology for patient
view radiology images + report
finalize consult-ation
summarize patient visit
line of system interaction
system
scheduling
EMR
EMR
rad orders
imaging viewer
med orders
dictation/ typed note
line of internal interaction
artifacts
make paper notes of complaint
physician notes
rad order
x-ray + report
prescrip-tion
clinical note
line of external interaction
external support process
nurse takes + enters vitals
radiology takes x-ray
radiologist creates report

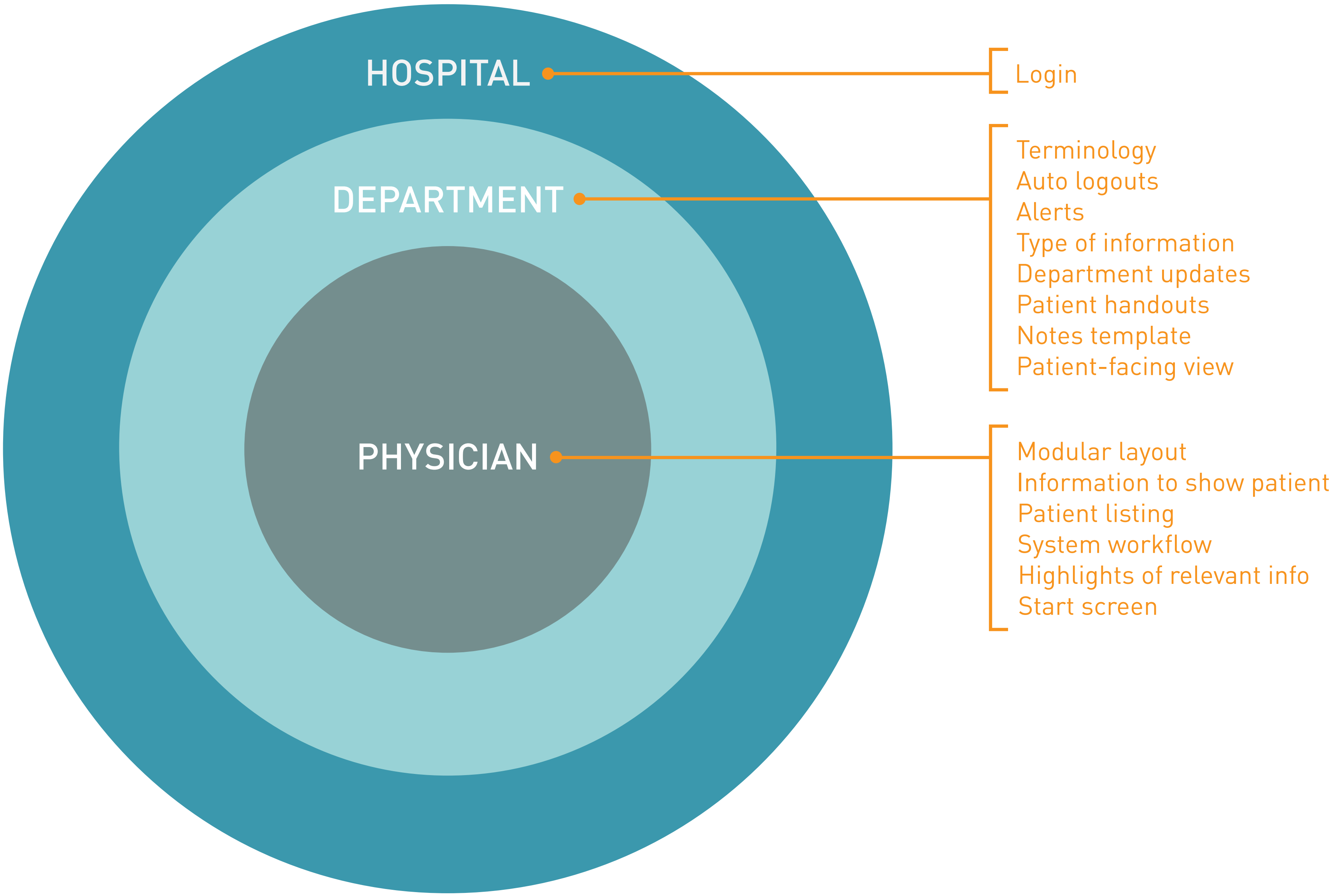
INTEGRATION

At all of the facilities we visited, we observed widespread problems with software integration. Physicians and staff that we spoke with complained of having to open several different programs in order to view all of the information that they needed for a patient encounter. This was problematic because it wasted valuable time, made it difficult to get a comprehensive view of a patient's health record, and forced physicians to look around for relevant patient information.

The ideal future state of healthcare information systems sees all of these systems merged into one, unified application where related data can easily be referenced. At the very least, the existing systems should increase continuity by linking to data in other applications and ensuring consistency in interfaces. This would involve changes to the appearance, behavior, terminology, and workflow of different systems. This would mean that even if they do not directly integrate, users will still experience a more continuous workflow. The aim of this is to alleviate the strain and frustration of poor system integration.

WORKFLOW DIAGRAM

This model describes actions that may be performed during a physician's encounter with a patient. Representing the various levels of interaction helps explain the complex process that a physician goes through when providing care to a patient. From the line of system interaction, it is apparent that the majority of interaction is between the physician and multiple healthcare information systems.


HOSPITAL
DEPARTMENT
PHYSICIAN
Login
Terminology
Auto logouts
Alerts
Type of information
Department updates
Patient handouts
Notes template
Patient-facing view
Modular layout
Information to show patient
Patient listing
System workflow
Highlights of relevant info
Start screen

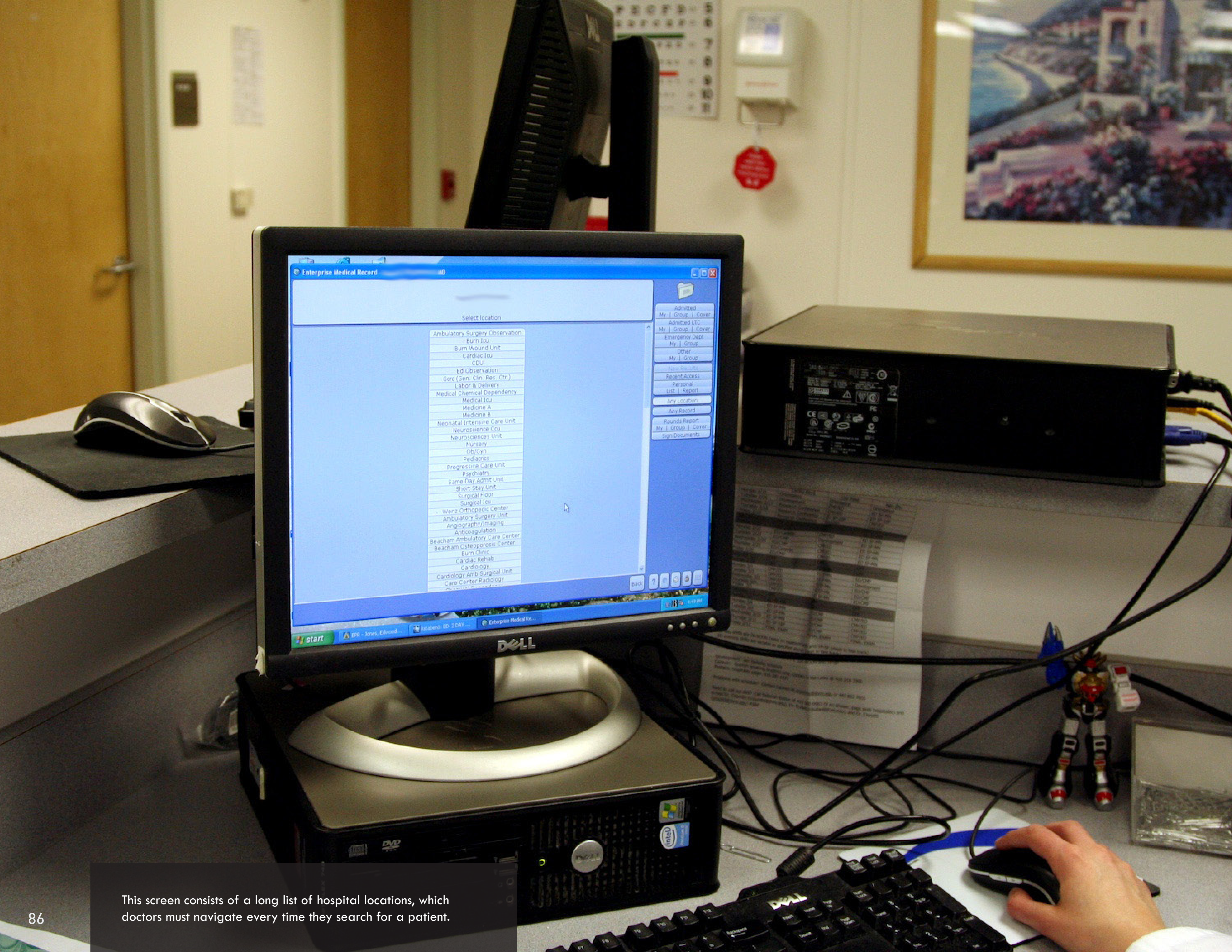
PRESENTING RELEVANT INFORMATION

Electronic medical records make entering information and storing documents incredibly easy compared to their analog counterparts. While this wealth of information is valuable for the sake of having a complete medical history for a patient, it can be overwhelming for a physician to view records from every medical encounter that a patient has had. In the context of a particular patient complaint, a physician may need to view very specific information, while the rest of the patient's medical record is less important. Relevance, recency, and severity are crucial to finding the most salient information in a patient's medical history.

Providing mechanisms for customizing the granularity of data shown, as well as highlighting the most relevant information can help achieve this goal. Color coding and information placement can further aid in ensuring the most important data is easily seen. Finally, the system should ensure that all of the information needed by doctors is available and readily accessible.

LEVELS OF CUSTOMIZATION

Customization can be broken into three levels of granularity—hospital, department, and physician. Customization on the departmental and hospital levels help maintain a standard protocol for sharing information between physicians as well as provide a consistent look-and-feel of the PIV system.



This screen consists of a long list of hospital locations, which doctors must navigate every time they search for a patient.

USABILITY

Many of the problems that we observed in our field studies could be tied directly to issues with usability. Doctors were often confused by convoluted or illogical navigation and organizational hierarchies in the software. Other non-intuitive aspects of both the system implementation and design of the user interface wasted time or detracted from quality of patient care.

In order to implement software with greater usability, it is important to understand real work practices and to design systems that will support those. Supporting information needs and clinical decision making processes are both particularly important. User testing and participatory design can help illuminate the most prevalent user needs as well as the actual workflows the system should support. By addressing the real-world needs and workflows of healthcare practitioners, the system is sure to be both usable and desirable.

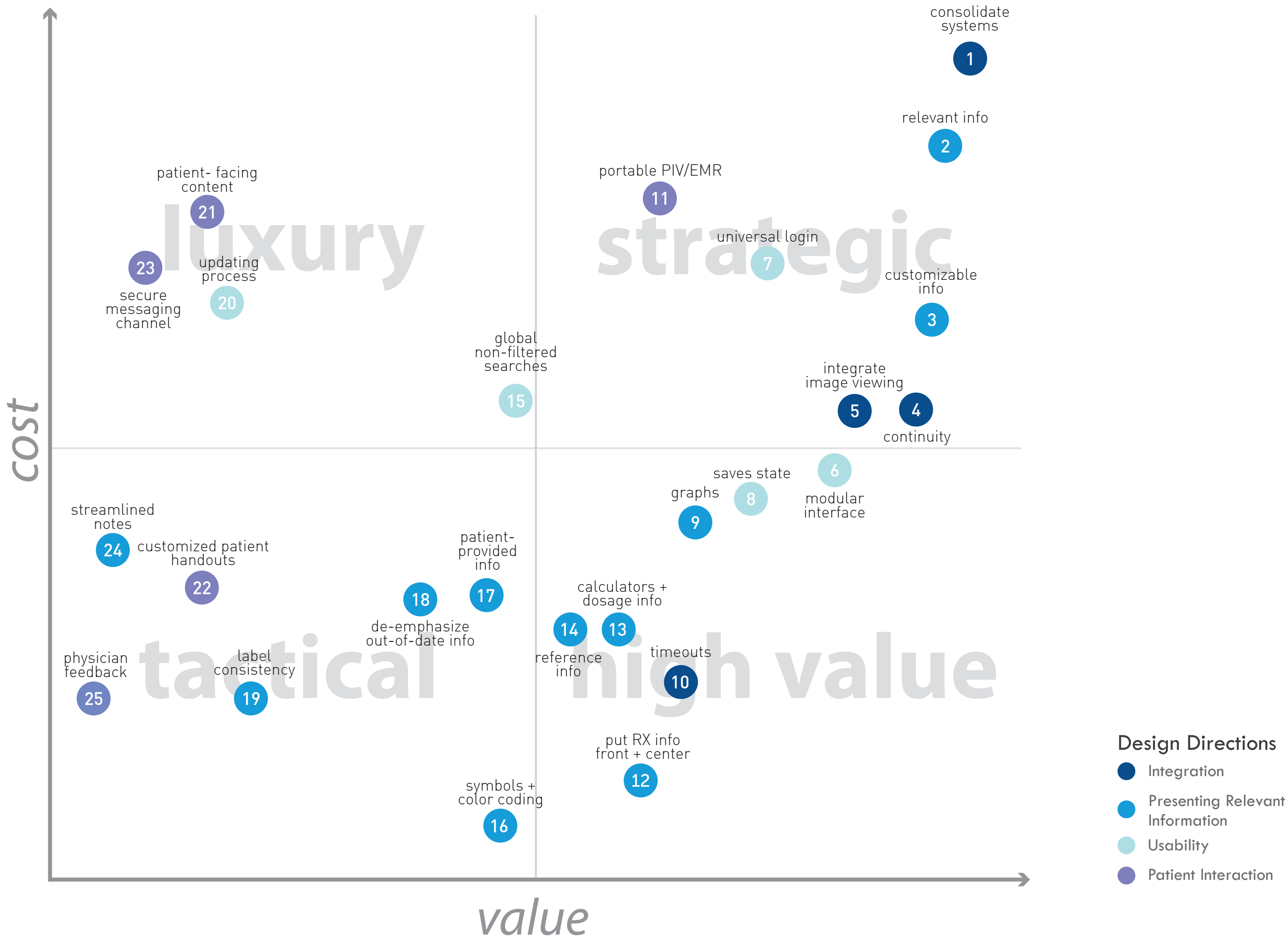
An additional benefit to improved usability is the reduced need for training. Several healthcare practitioners complained that existing software training takes too long and is out of context, and thus may not be effective. By making the software interface intuitive and discoverable we aim to remove the necessity of training.

Two doctors demonstrate a routine physical therapy visit.

PATIENT INTERACTION

The highest priority of every doctor we spoke with was ensuring the highest quality care for their patients. This meant meeting with patients face-to-face with complete knowledge of any relevant information regarding the patient's visit. Doctors said that the current technology solutions, such as computers-on-wheels or wall-mounted workstations, did not adequately support this goal because they were too obtrusive and impeded communication with the patient. They also felt that patients viewed the use of technology during visits negatively, thinking the doctor was distracted. Doctors also worried about their ability with technology, fearing that small slip-ups during a patient encounter might adversely affect patient trust.

To address these issues, new form factors such as tablets and other small handheld devices should be considered. Such devices allow for more seamless use of technology during a patient visit while being minimally obtrusive. Many doctors explicitly stated a desire for such systems. Further, patient-facing information can also help alleviate fears of seeming distracted as the doctor could then include the patient in the interaction. By improving technology's role in doctor-patient interaction, systems can effectively improve the overall experience of both patients and doctors.


cost
value
luxury
strategic
tactical
high value
consolidate systems
1
relevant info
2
customizable info
3
4
continuity
integrate image viewing
5
6
modular interface
universal login
7
saves state
8
graphs
9
timeouts
10
portable PIV/EMR
11
put RX info front + center
12
calculators + dosage info
13
14
reference info
global non-filtered searches
15
symbols + color coding
16
patient-provided info
17
18
de-emphasize out-of-date info
label consistency
19
updating process
20
patient- facing content
21
customized patient handouts
22
23
secure messaging channel
streamlined notes
24
physician feedback
25
Design Directions
Integration
Presenting Relevant Information
Usability
Patient Interaction

COST-VALUE ANALYSIS

1. Consolidate systems into a single application p.35
2. Highlight the most relevant information to the current visit p.47
3. Allow for customizable granularity p.45
4. Increase continuity across applications p.35
5. Integrate image viewing with patient information p.39
6. Make the interface customizable (modular layout, workflow) p.67
7. Use a universal login for any system component p.65
8. Save UI state across sessions to reduce wasted time p.65
9. Offer graphs and other visualizations for numerical data p.51
10. Ensure automatic timeouts apply to anything that contains sensitive information p.41
11. Experiment with new computing form factors (e.g. tablet computers) p.75
12. Put patient prescription information front and center p.49
13. Include built-in calculators and dosage information p.52
14. Provide quick access to reference information p.52
15. Allow for global, non-filtered searches p.69
16. Use symbols and color-coding to make information glance-able p.45
17. Highlight patient-provided information for easier reviewing and verification p.55
18. Grey out/de-emphasize out-of-date information p.49
19. Enforce consistency in document and image labeling p.53
20. Provide a seamless update process (no downtime, no workflow changes) p.63
21. Provide patient-facing content p.75
22. Provide an automated method for generating customized patient handouts p.81
23. Create a secure messaging channel outside of the patient record p.77
24. Provide a way to create streamlined notes (e.g. templates) p.54
25. Provide a feedback mechanism for users p.70

Note: Recommendations are prioritized by value

COST VS. VALUE

From our findings, we extracted the design recommendations we felt were most relevant to the scope of PIV. We evaluated the cost and value of each finding and placed them on the axes accordingly. The value of each recommendation was based on findings from our field research. We considered cost to be the time and effort required to implement the recommendation, in addition to its monetary cost. To assist in our evaluation of cost, we surveyed our client contacts to get their insight on the cost of our recommendations.

CONCLUSION


PRIVACY ISSUES
Viewing Labs
Hospital Work flo
+
processes
Prescriptions
Viewing Radiology
SCHEDULING
NOT ENOUGH TIME

SUMMARY

At this point we have concluded our initial research phase, including our research synthesis. We have lived in our data, turning our project room into a "war room" wallpapered with user research. In our travels across North America visiting hospitals and clinics of various types, we have interviewed and observed dozens of doctors, nurses and other health care staff. As part of our research process, we have transcribed thousands of minutes of interview audio and have categorized data points into multi-axis tables. We have also read the latest research papers on the topic and have attended conference sessions on the topic of medical software.

We are pleased with our research findings and synthesized results. We have a full and balanced understanding of the landscape for which we will be designing, and are prepared for and excited to take on our next steps.

NEXT STEPS

Now that the initial research phase has completed, we will move on to the design phase. In the design phase we will take our learned insights and apply them to a new design. We will start by using our major ideas proposed in this document, and build off of those. We will continue to iterate on the design, creating storyboards, wireframes and mockups along the way.

At various points throughout the design phase we will meet with target users to validate our ideas. Additionally, we plan to have several "make sessions" over the coming months. These sessions are a form of participatory design in which we work with our target users to help prototype and provide input into the design. This is a great method for getting user buy-in, while also leveraging our users' vast experience.

Finally, after we have iterated and tested our design, we will prototype it and work out more of the interaction details. We will continue to meet weekly with GE to ensure that we share a common goal. We will continue to polish and usability test our software until our project deadline.

We look forward to continuing this process with you.