MD:Notes

Designing an Information System for Public Hospitals

May 8th, 2008
School of Information, University of California Berkeley
Final Project Report

Katherine Ahern, Zachary Gillen and Jill Blue Lin

Acknowledgements:
Thanks to Bob Glushko, our adviser on the project.

Introduction

The health care industry is currently in the process of making the transition from storing patient information in paper format to storing information in electronic medical records (EMRs). There are many initiatives around EMRs, and many software products designed to help hospitals and physicians with the transition. Both Google and Microsoft are working on improving health care by combining improved search with EMRs.[1] In February of 2008, New York City's Mayor Bloomburg announced that the city would underwrite physicians' costs for "software that can track patients' medical records in order to provide better preventive care."[2]

Our primary motivation for the project was to better understand how public hospitals are making the transition from paper to electronic records, and to design a solution that addresses the hospitals' needs. Specifically, we focused on how two public hospitals in the Bay Area work with progress notes.

Progress notes are notes written by a physician to describe the patient's condition during the visit, the physician's assessment and plans for treatment. These notes are an important part of a patient's medical history. Taken as a whole, they tell a rich narrative about a patient's medical past. A progress note is one component of a patient's record consisting of many pieces of clinical documentation.

Our product, MD:Notes, is a prototype for an application that improves the hospitals' processes for creating and retrieving progress notes.

Project Stakeholders

Primary stakeholders: Since physicians create and find progress notes, they are our primary stakeholders and users. Our contextual inquiry was focused on physicians' work processes and their needs.

Secondary stakeholders:
Secondary stakeholders are individuals or departments that exert some influence on the adoption of new systems. These include patients, nurses, finance and billing departments, hospital administration, compliance departments, and the information systems department.

Although all stakeholders exert influence on the adoption of a product, for the purpose of our project, we focused mainly on our primary stakeholders, the physicians.

[1] Lohr, Steve, "Google and Microsoft Look to Change Health Care," New York Times, August 14, 2007.
[2] Santora, Marc, "New York City to Help Doctors Track Patients' Records Electronically," New York Times, February 26, 2008.

Paper Charts vs. Electronic Records

Both hospitals store patient records electronically and in a paper format called a "chart." Both hospitals are transitioning to electronic records, but after approximately 8 years of transition, they still primarily rely on charts for clinical documentation and progress notes.

A chart contains information such as referrals, physicians' orders, and any handwritten notes. Any documentation that cannot be stored in the hospitals' EMR systems is placed in the chart. An EMR contains lab results, reports, and any notes entered electronically.

A chart and an EMR contain overlapping but different sets of information. To review a patient's complete history prior to that patient's visit, a physician must review both the chart and the EMR.

At both hospitals, physicians reported a high rate of missing charts, anywhere from 30% to 80%. When a chart is missing, a physician devotes a great deal of time trying to locate the chart. If the chart cannot be found, the physician must reconstruct a patient's history either by questioning the patient or by ordering new tests. Missing charts result in longer wait-time for patients, additional costs for repeated tests, inefficiencies for physicians and a decrease in the quality of patient care.

According to one of the hospital's Director of Medical Information Systems, the charts are not lost, but may be located in other departments where they are currently needed. Researchers, the accounting department, and other clinics may all be competing for the same chart. In addition, some patients visit multiple clinics in a single day, and their charts may be in transit or waiting to be filed. This theme of charts only being available in one place at any given time is a common argument for a complete electronic medical record.

By its very nature, an EMR is not subject to the physical limitations of a paper chart. Many clinics can access a patient's EMR at once. EMRs are never in transit or waiting to be filed. For these reasons, using all-electronic records would greatly alleviate the problem of missing charts, and result in more efficient patient care.

Methods for Creating Notes

At both hospitals, writing by hand was the main method for creating progress notes. For many physicians, writing notes by hand is the easiest and fastest method, the method with which they are most familiar.

Handwritten notes are included in the paper chart; they are not converted to electronic notes. Handwritten notes are one of the reasons physicians must refer to charts for a patient's history.

Both hospitals have tools for entering notes electronically – dictation, keyboard entry, and speech recognition. However, availability and adoption of these tools varies across clinics and from physician to physician. In addition, some tools allow physicians to enter notes electronically, but this format is not compatible with the hospital's EMR system. These notes

must be printed onto paper and stored in the chart. For the purposes of hospital-wide retrieval, they function much like the handwritten note, with retrieval still tied to the physical presence of the chart.

Issues in the Adoption of technology

Although methods for creating notes are available at both hospitals, writing notes by hand is still the dominant, most preferred method. Below are some of the main factors that affect the switch to entering electronic notes.

Lack of funding to adopt technology for the whole hospital: This leads to clinics using different, sometimes incompatible tools. Neither hospital requires all physicians to enter notes electronically.

Lack of time for physicians to learn new tools: As they should be, physicians are focused on patient care. In the fast-paced setting of a public hospital, they lack the time to learn a new system for entering notes.

Lack of perceived need: Some physicians don't connect their own preference for writing by hand to the difficulties in locating paper charts and the need to have complete electronic records. They believe writing by hand was the fastest method, and did not take into account time lost in searching for charts or reconstructing a patient's medical history.

Existing tools do not support physicians' workflows: Some existing tools require many steps and are time-consuming to use. In addition, human medical transcribers must transcribe dictated notes, so there is a lag time of at least 2-3 hours before these notes become available. This lag time is unacceptable for some types of notes. Lastly, existing tools don't support the mobile workflows of physicians who round in inpatient settings.

Proposed Solution

Listed below are some of the main features of our proposed solution:

Multiple devices: Our application should work on multiple devices to support the different workflows of inpatient and outpatient physicians

Multiple methods of note entry: Some physicians strongly prefer typing notes, while others have an equal preference for dictating notes. In order to allow physicians to focus on patient care, and to minimize their having to learn a new method, our product should support multiple methods for creating notes.

Speech recognition replaces dictation/transcription: Because human transcription is necessarily time-consuming, we propose using speech recognition instead. For the purposes of our product, we assume that speech recognition engines work at least as well as dictation/transcription for capturing spoken word and converting it to text.

Interaction based on clinicians' census or schedule: Many clinicians work on specific inpatient services, or have appointments with outpatients during clinic visits. Developing any electronic method for note entry should default to the clinicians' schedule. This will reduce the amount of interaction required by the clinician in order to enter notes.

XML document modeling patient data: Because both hospitals use many legacy IT systems, we use XML in our application to model patient data. XML data can be easily transformed to support multiple devices and to ensure interoperability with the hospitals' legacy systems.

What We Accomplished

Overview of the problem, context and methodology
Before beginning our design, we first analyzed the problem of clinical documentation entry and retrieval within the context of a health care organization.

Competitive Analysis
We analyzed the products of five market leaders in the medical transcription arena, and identified opportunities for our product. This includes an analysis of the market, industry leaders and potential for the future.

Contextual Inquiry
We conducted 14 interviews with stakeholders from the two hospitals. We captured the results of our interviews using sequence diagrams and affinity notes. We then consolidated our sequence diagrams and created an affinity map.
Contextual in
Appendix A – Sequence diagrams
Appendix B – Consolidated sequence diagrams
Appendix C – Consolidated affinity notes

Prototype Designs
Based on the results of our contextual inquiry, we created a paper prototype of our application, and then conducted usability tests on our design. We then made revisions to our design and created visual designs for our application.

Patient Privacy Considerations
This section summarizes some patient privacy and public policy considerations in implementation and deployment of a patient information capture tool, with a discussion of how our prototype supports these considerations.

Implementation
We implemented a functional but incomplete prototype of our web application design, using both relational data to drive the website and xml to capture notes in a document modeling the patient. We also developed an xml schema and proof-of-concept translating our modeled patient data into HL7, to show how XML can integrate systems and interact with legacy systems.
Appendix D – Patient Instance
Appendix E – MD:Notes Schema

Technical Architecture
We explored different ideas for types of technical architecture to support both the user requirements identified in our needs assessment and the technical requirements of hospitals running critical legacy systems.

Mapping
This section describes the methodology to map our schema instance to the Health Level 7 standard for healthcare. This will enable MD:Notes to send progress notes to the hospital's electronic medical record, preventing another vertical silo of information.
Appendix F – Consolidated harvest of components

Future Work

Our project was extremely ambitious in scope, and we did not implement the full scope of our proposed solution. Following is a list describing future work for the project:

Support for multiple devices: We implemented a PC/laptop prototype of our product. Although we designed a version for mobile devices, we did not create a working prototype for mobile devices. Because we modeled patient data using XML, the data can be easily transformed for a different user interface for mobile devices.

Speech recognition: We proposed using client-side speech recognition to overcome the time lag required for human transcription of dictated notes. We did not integrate a speech recognition engine in our prototype; this should be included in any future work.

Additional user testing: Although we conducted usability tests on our paper prototype, we did not conduct tests on the working prototype. Future work should include testing with users in real outpatient and inpatient settings, as they enter notes using both speech recognition and keyboard entry. Using speech recognition for voice-to-text display on a mobile device has not yet been implemented, and no prior work exists around user interaction in this area. We anticipate this to be a rich area for exploration.

Conclusion

For our project, we used contextual inquiry to understand how 2 public hospitals work with progress notes. Based on our user studies we designed a prototype with features to support the physicians' workflows. We also did a competitive analysis of similar products, researched patient privacy issues, and explored implementation and technical architecture options. We implemented a functional prototype. We believe our solution can enhance physicians' efficiency, patients' satisfaction with service, and improve patient care.

MD:Notes

Overview of the problem, context and methodology

May 1st, 2008
School of Information, University of California Berkeley
Final Project Report

Zachary Gillen

Abstract:

This section details the problem of clinical documentation entry and retrieval within the context of a healthcare organization. A hospital is a complex service delivery system. Quality of service delivery depends on the point of view from the different actors within the system. The physicians are motivated by administering the best possible care to their patients and contributing to an improved outcome. Hospital administrators expect high level of clinical care, coupled with the appropriate documentation and protocol to insure legal compliance and billing justification. The patient is primarily concerned with the perceived quality of an interaction and their final clinical outcome. This section demonstrates how a successful application design within this service system needs to address the different perspectives of each participant in the system. We discovered that designing to meet these environmental requirements will lead to an increased chance of adoption.

Acknowledgements:
This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team members are Katherine Ahern and Jill Blue Lin. See "MD:Notes – Designing an Information System for Public Hospitals" for a summary of the report.

Thanks to Bob Glushko, our adviser on the project.

Defining the context of progress notes

There are a variety of health related service encounters an individual could experience during their lifetime. Each encounter is dependent on age and gender, lifestyle choices, accessibility, genetic predisposition and good old fashioned luck. These factors shape the overall health and wellness of an individual. At some point, even the healthiest person has encountered at least one visit with a primary care physician. These visits are often referred to as check-ups, or they can act as a gateway to other clinical specialists such as a surgeon or physical therapist. Typically, these service encounters are routine examinations and involve some history gathering, basic physiological tests, fluid samples for laboratory work and immunizations. At the conclusion of the visit, the physician will record all the relevant information and complete an assessment and plan. This type of primary documentation is known as a progress note. Specifically, a progress note constitutes the physician's initial recorded experience with a patient during a particular encounter.

While a progress note is a single example of the type of documentation produced by a primary care physician, a typical hospital organization will have many types of outpatient specialty clinics. After an encounter, each physician will produce a progress note. However, other types of notes are commonly generated during outpatient encounters alongside a progress note. Encounter and referral forms are two additional examples of common documents in outpatient clinics. For encounter forms, physicians will mark certain procedures performed during the visit so that appropriate charges can be generated in the billing department. Referral forms provide a mechanism for the primary physician to refer a patient to a specialist for further evaluation. These are additional clinical documents that serve the needs of other hospital departments for completing the various functions of the organization.

The inpatient service gets even more complicated with the variety and quantity of clinical documentation. As an example, the inpatient operative service has a team of physicians working closely with nurses and other clinical staff that record; progress notes, consult notes, pre-operative notes, operative notes, post-operative notes, discharge summaries, orders, etc (See Figure 1 for an overview of the different document types). This list will continue to expand as other inpatient services that require different documents are added. All this documentation is added into folders called the 'patient chart', or digitally into an 'electronic medical record'. For inpatients that require months of treatment, the paper charts might contain several volumes of information.

Introducing this complex framework of health care documentation demonstrates the need to properly address the relevant context for designing an application. Each type of document conveys information for one or more organizational entities. For progress notes, the contents assist the physicians in tracking the pertinent changes to a patient over time. They also justify the level of care for the billing department, and assist in tracking compliance for clinical policy and legislation.

For this project, the goal is to design a system that addresses only progress notes. This type of documentation is entered in both the inpatient and outpatient setting of hospital organizations.

However, physicians are the only clinical providers that enter progress notes for patients. Reducing the context to address only those notes entered by physicians allows a reasonable scope for a rapid user-centered application design. Although this project is not explicitly conducting user-centered design for other clinicians, the goal of our proposed system is to allow the flexibility to continue adding additional types of note templates.

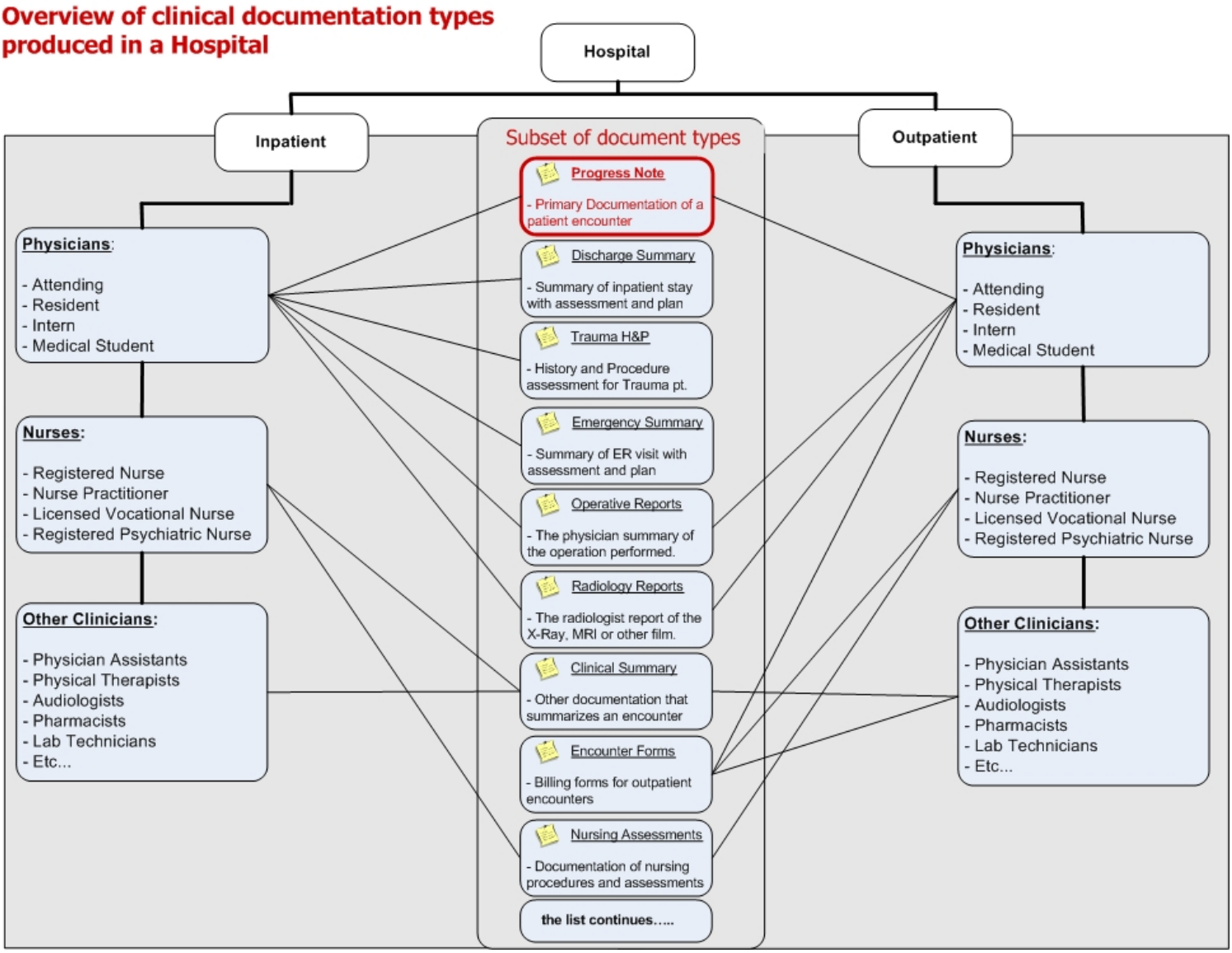


***Figure 1**: Demonstrates the breadth of possible document types produced in a hospital setting. This project is only dealing with the modeling of the progress note.*

The MD:Notes project is using the rapid contextual design process for defining a new web-based application for progress note entry within the complex hospital service system. Contextual design is an approach to defining software and hardware systems that collects multiple customer-

centered techniques into an integrated design process.[1] This process keeps the data and information collected by observing the customer the central focus of application design. First, determining the scope, constraints, and stakeholders of this complex service system are critical to defining the customer's 'point-of-view' and their needs. For the context of building this new prototype, the physicians are the primary stakeholders and the focus of contextual design. The secondary stakeholders are responsible for the implementation and deployment challenges that arise when developing a new prototype application within a constrained legacy environment. Designing to meet the requirement of these secondary stakeholders is critical to eventual acceptance and adoption.

Synthesizing the methods of design

Scoping the System

A service system can be defined as "service providers and service clients working together to co-produce value in complex value chains or networks. The key is that providers and clients work together to produce value."[2] Within the context of the health care organizations, these value chains can have many nodes depending on the level of granularity within the system. In order to scope to the appropriate level for design, the 'point of view' and the 'service chain' must define the critical service touch-points to improve value to the customer.[3] The critical component in designing a new application is identifying the 'actual' customer and those additional customers along the service chain where value is created.

In the traditional health care service value chain, the patient is often regarded as the central customer. For any patient encounter, the quality of the service is not judged on the quality of the progress note generated by the physician. In fact, unless the individual requests a copy of their medical record, they would never view the contents of a progress note. Instead, the perceived service quality is determined by the physical interaction with the providers or delivery organizations for themselves or loved ones.[4] In addition, the patient is concerned with the overall outcome in improving their health. Should the health of a patient not improve over the course of a visit, this could have a negative impact on the service encounter, independent of the actual quality of medical attention delivered by the clinician.

While there are many variables that can impact perceived quality, there are two that relate to progress note entry. The first is the amount of time spent waiting; whether before the appointment, once placed in the examination room, or post-appointment when waiting for follow-up orders. The second is the amount of repeated information gathering from the various services within an organization. This could be repeating health history to a new physician on a follow-up visit to the same clinic. These customer inconveniences are not singularly tied to progress notes. However, our contextual interviews consistently demonstrate how progress note

[1] Beyer, H. and K. Holtzblatt (1997). Contextual Design: Defining Customer-Centered Systems, Morgan Kaufmann. Pg 3
[2] Spohrer, J., P. P. Maglio, et al. (2007). "Steps Toward a Science of Service Systems." Computer **40**(1): 72.
[3] Tabas, L. (2007). "Designing for Service Systems."
[4] Kenagy, J. W., D. M. Berwick, et al. (1999). Service Quality in Health Care, Am Med Assoc. **281:** 661.

entry and retrieval contribute to process breakdowns that lead to poor service quality for the patient.

This perceived quality is generated by those service providers in direct contact with the patient (See Figure 2). Physicians, nurses and the billing departments are often directly responsible for service quality because of the front-stage nature of the encounter. In truth, many functions that drive poor service quality happen in the back-stage of the service encounter and are not apparent to the patient. Progress notes are an example of a back-stage job function necessary for the physicians, but leads to poor service quality from the perception of the patient. The MD:Notes application attempts to improve the quality for the patient by improving the overall progress note entry process for the physician.

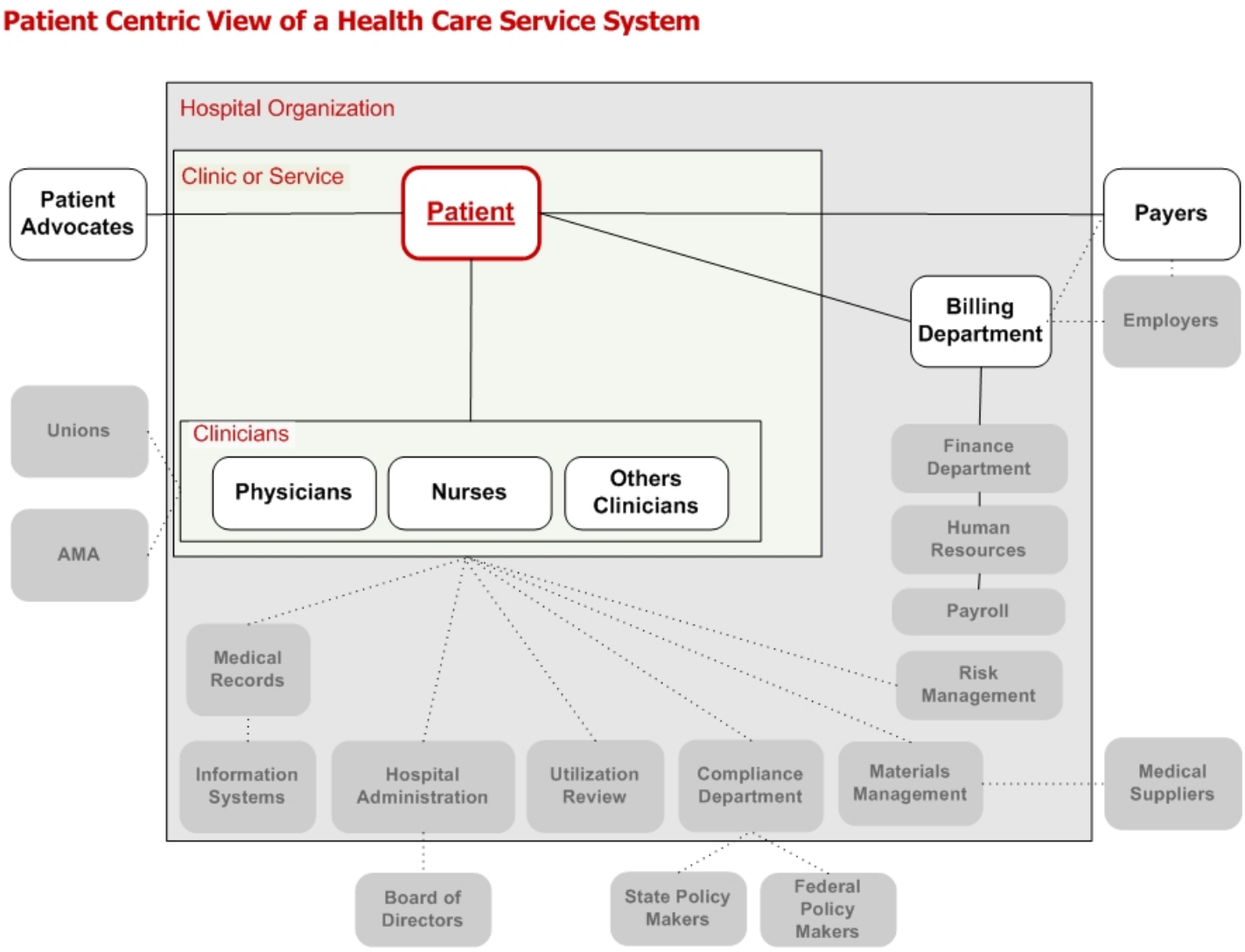


Figure 2*: Illustrates the direct contacts of a service encounter where a patient perceives service quality within a health care system. Each layer shows the level of context from outside the organization, to the hospital, to the service or clinic where the encounter occurs.*

Primary Stakeholder

The stakeholders of a system are "individuals or organizations who stand to gain or lose from the success or failure of implementing new technology or process design; including customers or clients (who pay for the system), developers (who maintain the system), and users (who interact with the system)."[5] For the MD:Notes application, the primary users are the physicians. Because they are the only clinicians entering progress notes, modeling the patient from the perspective of the physician seems the logical choice for design. The user-centered contextual research is targeted on this group of stakeholders because they would be the primary users of the application. This process for observing the physicians work and identifying their needs is discussed in the following chapter, "Contextual Inquiry."

Importance of Secondary Stakeholders

The secondary stakeholders are those individuals or departments within the organization that exert some influence on the adoption of new systems. For the MD:Notes application, designing for the needs of physicians is acceptable. However, for adoption to occur, additional design features must be considered to fit within the context of the entire organization (See Figure 3.)

Hospital Administration and Compliance: These two departments work closely to define internal policies and procedures, while abiding by the legislation enacted at the state and federal levels. The administrator's are primarily concerned with adhering to the mission statement of the healthcare organization and the future viability of the business or non-profit. When building a progress notes system, MD:Notes needs to address security issues addressed by the Health Insurance Portability and Accountability Act (HIPPA) and reporting capabilities outlined by state legislation (California State Law title 22, sections 51003 and 51327). Particularly, these two sections mention the ability to report on all those people viewing and making changes to documentation over the course of the process. Essentially, this is the same as an 'audit trail', or ability to verify the dates and times of all people viewing and changing the clinical documentation.

Finance and Billing: The administrators holding these positions ultimately make the decision to fund a new application or adopt technology. While the physicians can exert a certain amount of influence, the decision is generally decided by overall cost and future return on investment. The design of MD:Notes needs to improve the workflow process to improve physician efficiency with retrieving and recording progress notes. As discussed in the contextual design section, there are more process breakdowns with the retrieval of clinical information. Demonstrating an increase in productivity can generate additional revenue, or save time to other clinical staff attempting to retrieve documentation.

The administrators within billing are concerned with retrieving progress notes to justify the level of service for audits. Should they have an easy reporting mechanism, this could save that department precious time and money.

[5] Nuseibeh, B. and S. Easterbrook (2000). "Requirements engineering: a roadmap." Proceedings of the Conference on The Future of Software Engineering: 37.

Information Systems: This department is concerned with how the application will fit within the context of the existing technical infrastructure. This includes scalability within the organization, network traffic loads, ability to communicate with other systems, etc. The design of the application needs to have the ability to communicate with the other hospital systems to obtain the necessary information for displaying patient information associated with the progress note, and be able to effectively translate this note back to the Hospital's electronic record. A system meeting these environmental requirements will more likely be given a good recommendation by this department.

Primary and Secondary Stakeholders for MD:Notes

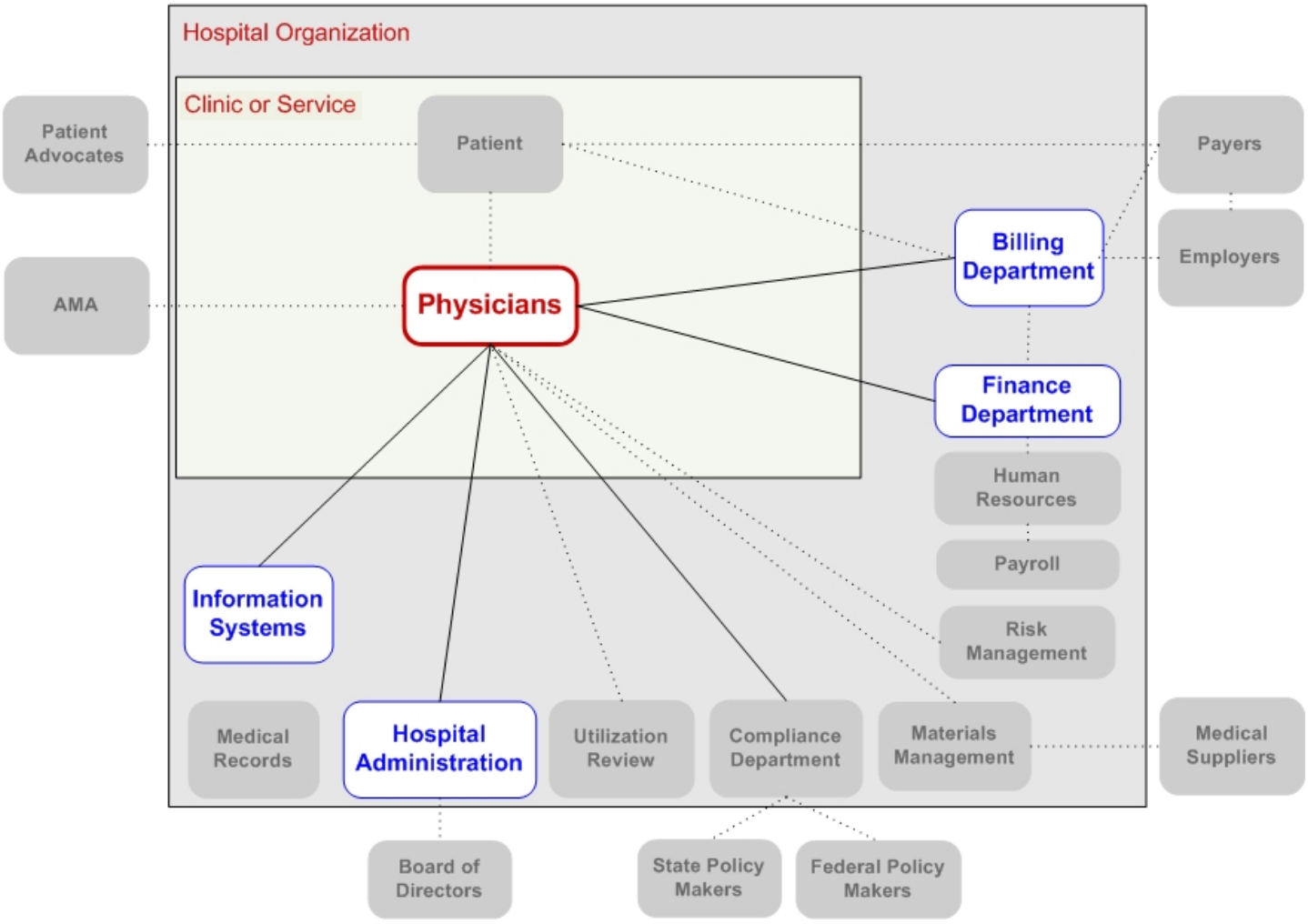


Figure 3*: The primary stakeholders are the physicians. The concerns of the secondary stakeholders (represented in blue) need to be addressed for a proposed solution to be adopted.*

References:

1. Beyer, H. and K. Holtzblatt (1997). Contextual Design: Defining Customer-Centered Systems, Morgan Kaufmann.

2. Kenagy, J. W., D. M. Berwick, et al. (1999). Service Quality in Health Care, Am Med Assoc. **281:** 661-665.

3. Nuseibeh, B. and S. Easterbrook (2000). "Requirements engineering: a roadmap." Proceedings of the Conference on The Future of Software Engineering: 35-46.

4. Spohrer, J., P. P. Maglio, et al. (2007). "Steps Toward a Science of Service Systems." Computer **40**(1): 71-77.

5. Tabas, L. (2007). "Designing for Service Systems."

MD:Notes | Competitive Analysis

May 1st, 2008
School of Information, University of California Berkeley
Final Project Report

Zachary Gillen

Abstract:

This section analyzes five of the leading companies in the medical transcription (MT) market. There are currently three different types of transcription methodologies used by these companies to automate the transcription process and provide clinical documentation solutions to their customers. While each vendor excels in different core competencies that streamline the clinical documentation process, there are gaps and opportunities that can be leveraged in present and future versions of the MD:Notes application.

Acknowledgements:
This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team members are Katherine Ahern and Jill Blue Lin. See "MD:Notes – Designing an Information System for Public Hospitals" for a summary of the report.

Thanks to Bob Glushko, our adviser on the project.

Competitive Analysis

Introduction to medical transcription services

For the purposes of scoping the final project, the MD:Notes application was developed from a physician centered contextual analysis of entering progress notes. However, the proof-of-concept application allows for the extension of various other types of clinical documentation that could be added in future work. All clinical documentation and various methods of entry are traditionally considered part of 'transcription services' within the medical records department. This field is rapidly changing with the introduction of personal computers, mobile devices and speech-to-text processing. A discussion of this market and the potential that exists is essential to identify the opportunities for a new MT entrant, such as the MD:Notes service.

The current market for Medical Transcription (MT) services is estimated at $6 billion annually.[1] While relatively small compared to the entire health care sector, the market size is still substantial and is comparable to the internet gaming industry. With HIPAA regulations expanding on the rules, completeness, and measures for clinical documentation, the number and frequency of dictations should continue to grow. In fact, a 2004 International Data Corporation (IDC) report forecasts that outsourced transcription services alone will account for $4.3 billion dollars in 2008, with a five-year compound annual growth rate (CAGR) of 16.1%.[2]

The outsourcing of these services is continuing, and we directly observed the decline of the traditional internal transcription services during our contextual inquiry due to the outsourcing of these services. The reason stems from business process optimizations that outsourcing MT companies can make by contracting transcription services from many health organizations. Instead of Hospital B employing MT professionals and maintaining the necessary infrastructure required for internal transcription, they can outsource these services for a cost savings. This structure is mutually beneficial, saving the hospital money, while providing a profitable business for MT vendors.

However, the advancement of the electronic medical record requires MT companies to make the next evolutionary step. First, as identified by the IDC report, is the integration of transcribed records into the electronic medical record systems.[3] Second, the trend toward innovations in automated speech-to-text engines that further reduce cost and report turnaround time by eliminating human actors.

There are several types of methodologies that MT companies employ to integrate automated speech-to-text into their current manual transcription offerings. They can be divided into the following three categories.

[1] 10Q Detective, "Transcend Services: Transcribing Profits." July 10th, 2007.
[2] International Data Corporation, "U.S. Medical Transcription Outsourcing 2004-2008 Forecast and Analysis." December, 2004. Report #32609
[3] Id.

- **Server Side Speech-To-Text**: Currently, this is the most common methodology for processing speech. The clinician can use any device that supports the application of the MT vendor. The device records sound files which are then sent to the speech-to-text server through web (HTTP) or other application specific protocols if internet connectivity is not supported by the device. Once received by the server, the audio file is processed into text and delivered back to the clinician for editing in textual form (see Figure 1). The primary difference from client-side speech processing is the minimal hardware requirements necessary to only capture audio (simple microphone and recording application). However, quality microphones and large storage requirements are still required for handheld devices in order to increase the accuracy of speech transcription.

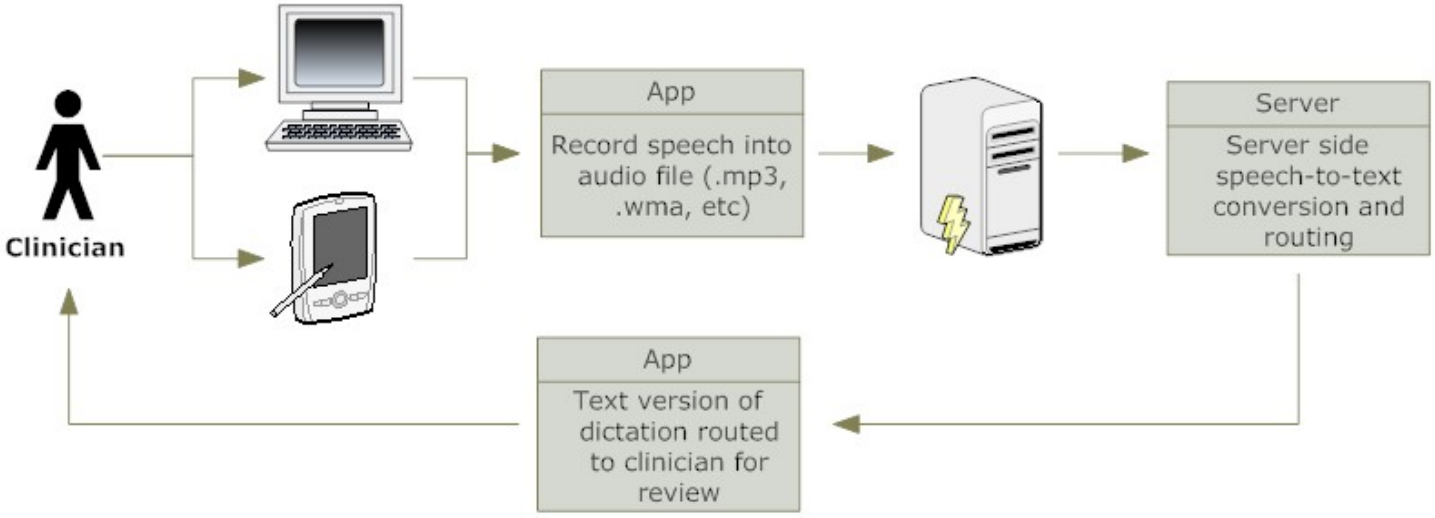


Figure 1: *Server side processing workflow*

- **Hybrid approach using human transcription**:
  This approach involves server side speech processing coupled with human MT professionals to fix obvious errors in the transcription process. Employing this strategy eliminates the amount of editing required for clinicians, as many errors are corrected by transcription professionals (see Figure 2). For organizations that are switching from internal or outsourced solutions that have 100% human transcription, this method will greatly reduce costs. However, this solution does not eliminate the need for human intervention completely (as seen in the two previous solutions). The benefit of this solution is reducing the amount of editing required by the clinicians when speech-to-text software produces errors in the processing of the audio files.

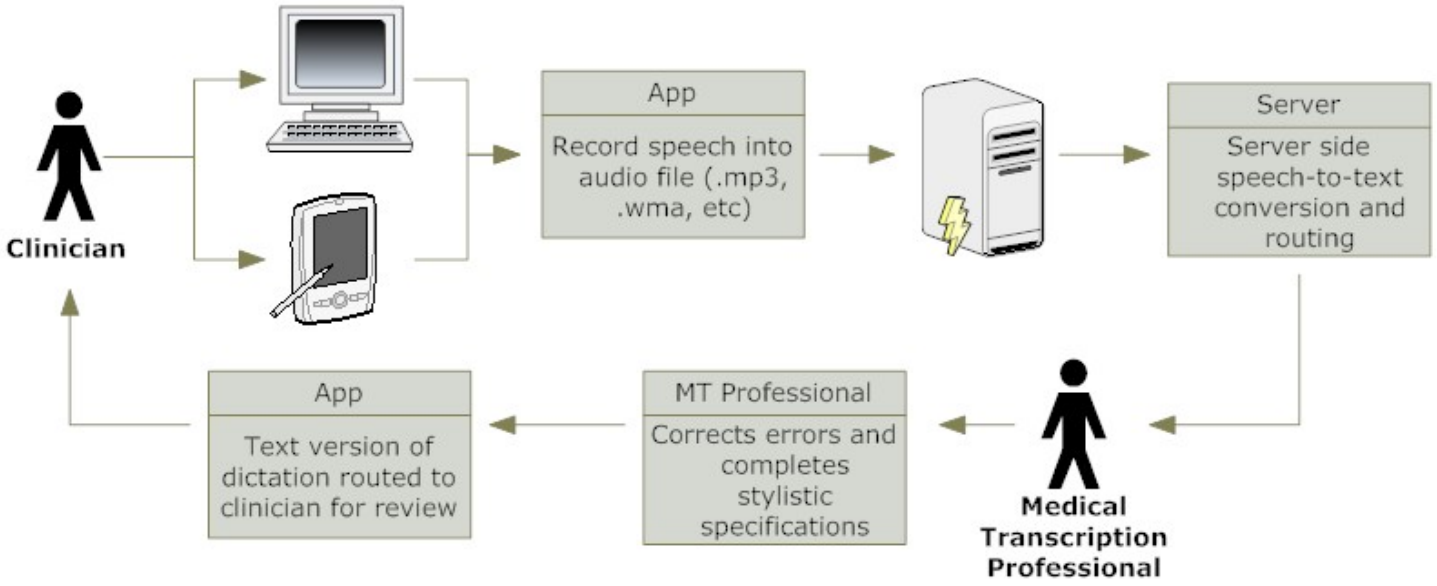


Figure 2: *Hybrid information workflow*

- **Client Side Speech-To-Text**:
  The industry leaders are beginning to incorporate speech recognition directly into desktop devices in the clinical setting. This can come in the form of a desktop computer requiring specific hardware components, or a specialized desktop optimized for speech recognition capture and processing. A clinician will open an application on this device and use an external microphone for voice capture. The client desktop will process the speech and output real-time text for the clinician to edit while dictating. Once the clinician is finished with their dictation, the text is submitted to a 'Document Management Server' that stores and routes the information to the electronic medical record or other dependent clinical applications (see Figure 3). Real-time client side speech engines require fast processors, large amounts of memory and high-quality audio capture equipment. As this technology continues to improve, this will become the future of clinical documentation.

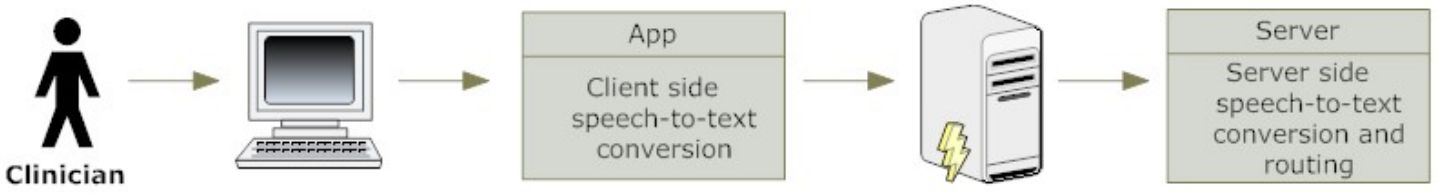


Figure 3*: Client side processing workflow*

The Medical Transcription Market Leaders:

The current MT market leaders employ various configurations of the above three models to address the organizational needs of clinical documentation. Some focus on specific applications, such as Radiology or the PACU (Post Anesthesia Care Unit). These applications address the specific workflow and reporting requirements of these complex services. Others try to address the needs of more general clinical documentation that include discharge summaries, operative reports and progress notes. Our MD:Notes design takes advantage of some gaps and opportunities that still exist in this market. The next section will analyze the strategies of the current market leaders, their current product offerings and areas where potential still remains for the future development of the MD:Notes product.

Companies analyzed:

- **Nuance Communications Inc.**
- **MedQuist Inc.**
- **Transcend Service Inc.**
- **Winscribe Inc.**
- **Spheris Inc.**

Analysis and advantages:

Nuance Communications Inc:

Nuance is one of the largest providers of speech based solutions for businesses and consumers globally. They have many product offerings that include the leading speech recognition software, Dragon Naturally Speaking, and service solutions for a broad set of industries that involve speech-to-text processing. In March of 2007, Nuance purchased eScription Inc. for $363 million in their largest acquisition to date. eScription Inc. is a leader in products and business solutions that streamline the transcription workflow without impacting the current entry methods of the physicians. This acquisition will further enhance Nuance's product offerings and streamline their transcription services where they hope to capture $1 billion dollars of market share by the year 2011.[4] This would be a 66% increase in total revenue from their current

[4] Business Wire, "Nuance to Acquire eScription, Streamline Clinical Documentation Process to Save Healthcare Industry More Than $1 Billion by 2011." April 8th, 2008. **(**http://www.businesswire.com/portal/site/google/?ndmViewId=news_view&newsId=20080408005767&newsLang=en**).**

reported total revenue of $602 million in 2007.[5] With any merger, the acquisition presents challenges for the incorporation of the intellectual property and products into the existing Nuance line of service offerings. While Nuance is in a position to become the overall market share leader, there is potential for a disruptive technology to undermine the current service offerings.

Advantages (see Figure 4):

- **Dragon Naturally Speaking (Medical):** Nuance has the leading speech-to-text engine that offers a medical version that provides improved accuracy by including a dictionary of specialized terms. The engine can be deployed on a variety of Microsoft operating system platforms, along with Citrix integration. Another feature is the support for Bluetooth wireless microphones.

- **Variety of healthcare MT service solutions:** Nuance targets a variety of products for different clinical services (Powerscribe for Radiology and Pathology, ExSpeech and iChart for medical records, and ExSpeech, Dragon Naturally Speaking and Enterprise Workstation for general inpatient and outpatient documentation). Each of these product offerings incorporates all three methodologies mentioned above depending on the organization's capabilities and requirements (client side, server side and the hybrid approach).

- **Strong platform and service partners:** The Nuance product offerings are built on the Microsoft platform which is currently used by the majority of healthcare organizations. Also, they incorporated their healthcare services with some of the leading EMR vendors, such as AllScripts, NextGen, ChartLogic and Epic which is the basis of Kaiser's new multi-billion dollar medical record system.

[5] Nuance Press Release, "Nuance Announces Fourth Fiscal Quarter 2007 Results." November 15th, 2007. (http://www.nuance.com/news/pressreleases/2007/20071115_q4.asp).

Features:	NUANCE	MedQuist	WinScribe Smarter Dictation	Transcend	Spheris
Client-side speech recognition for handheld devices	No	No	No	No	No
Client-side speech recognition for desktop medical transcription applications	**Yes -** Enterprise Workstation and PowerScribe	**Yes-** Enterprise Speech and SpeechQ for Radiology	**Yes**	No	**Yes -** Clarity Platform
Server-side speech recognition for medical transcription applications	**Yes –** Enterprise Express and ExSpeech	**Yes -** DocQment Ovation	**Yes**	**Yes**	**Yes -** Clarity Platform
Hybrid solution offerings for transcription services	**Yes-** Enterprise Express and ExSpeech	**Yes –** DocQment Ovation	**Yes**	No	**Yes**
Internally developed, proprietary speech-to-text engine	**Yes -** Dragon Naturally Speaking (DNS)	No - Uses Phillip's Speech Magic	No - Uses Nuance's Dragon Naturally Speaking	**Yes -** BeyondTXT	**Yes -** Clarity Platform
Supports multiple handheld devices	**Yes**	**Yes**	**Yes**	No	**Yes**
HL7 communication integration and HIPAA compliance	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Notes are based on XML representations of the patient to allow easier data transformation	No	No	No	**Yes -** Based on CDA documents	No
Supports site specific template creation for medical workflow	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Utilizes web architecture principles for information transfer	**Yes**	**Yes**	No	**Yes**	**Yes**

Legend:
= Industry Leader

Figure 4: *This table demonstrates the different service and product offerings of the five leading medical transcription companies. The grey background represents those companies that currently have the competitive advantage in the identified service offering.*

MedQuist Inc:

While MedQuist Inc. total revenues for 2007 are only about 60% of Nuance, 84% is generated from medical transcription technologies and services.[6] They offer a leading ASP solution that delivers MT services to healthcare organizations over the network, while MedQuist maintains all the necessary hardware and personnel. The primary service offering is called DocQment Enterprise Platform which is a hybrid approach to transcription. All of the clinician sound files are sent across the network to MedQuist who processes them with Phillip's Speech Magic speech-to-text engine and then provides an easy interface for transcriptionists to listen to the recording and correct the remaining mistakes.

[6] MedQuist Inc., "Form 8K." Financial Statement for the United States Security and Exchange Commission, filed February 22nd, 2008. (http://ccbn.10kwizard.com/xml/download.php?repo=tenk&ipage=5484267&format=PDF)

Advantages (see Figure 4):

- **Integration of multiple devices:** There are three different devices that the MedQuist platform supports. Two are digital voice recorders and the third is the PhysAssist IQ PDA, an IPAQ Pocket PC that was developed specifically for MedQuist. All of the devices are able to record audio files that can later be synched to the ASP platform for transcription. The PDA has the ability to sink wirelessly via HTTP should this be available within the healthcare organization.
- **HL7 integration and HIPAA compliance:** A MedQuist whitepaper titled, "DocQment Ovation and HIPAA" explains the great lengths to which the company emphasized HIPAA compliance by encrypting all audio files and patient information being relayed across the network. Because of the ASP solution, these files are being sent outside the organization and MedQuist documents the detailed methodology to abide by HIPAA standards.

Transcend Services Inc:

Transcend has a much smaller total revenue ($42.5 million in 2007) then both Nuance and MedQuist, since it only offers two different transcription solutions. The first solution is providing outsourced human medical transcription. It's important to note that this is a US based transcription service. Medical information will not travel across the US border which is currently a HIPAA violation. The second solution is BeyondTxt. The BeyondTxt service is hybrid approach that combines an automated speech-to-text engine for first pass translation, followed by human correction.

Advantages (see Figure 4):

- **Uses an XML database linking the clinical document architecture**: Transcend offers the creation of an XML database that links usable data. This is the first company to report employing the creation XML documents from automated transcription. The website does not make it clear whether this creates HL7 messages that can incorporate into an electronic medical record.

Winscribe Inc:

In a recent article by Claire McEntee on the stuff.co.nz website, this New Zealand software company is looking to float a public offering on the London or New Zealand stock exchange to raise capital for a new product to extend the market.[7] Their current annual revenue is just under $50 million and they hope, with projected sales for the upcoming year, this figure will double. They employ a variety of transcription services and are looking to expand on their product and service offerings, as well as compete in other global markets. Some of their product offering include software for Blackberry smartphones, PDAs, and integrated client-side and server-side speech recognition solutions.

[7] McEntee, Claire. "Winscribe plans float to fund expansion." Stuff.co.nz on April 11th, 2008. (http://www.stuff.co.nz/4396921a28.html)

Advantages (see Figure 4):

- **Incorporation of customizable templates**: For the document processing component of Winscribe's overall MT solution, they offer user-defined templates for each type of report. These templates provide over 900 different variable types that can be imported upon creation for each type of clinical document.

Opportunities:

As observed above, there are already many well established companies in the area of medical transcription that maintain a significant amount of market share. While the market appears saturated with vendors, there are still many opportunities for future product and service innovation that would differentiate MD:Notes from the other service offerings. Some of these competitive advantages have already been built into the first version of the MD:Notes application, while others are identified for future iterations.

Current:

1. **Modeling the patient in XML:** This allows for two distinct advantages to storing the notes in a relational database. The first advantage is in the mapping of notes to HL7 messages for sending to other applications. A schema allows for simple dynamic generation of a the HL7 text file required for incorporation of messages in the electronic medical record system (see the chapter, "Mapping from MD:Notes to the EMR" for further details). Relational databases are much more rigid and adding fields or expanding the data model requires serious modification to the existing transformation process. Second, this allows for new methods of retrieval should templates be added for different inpatient or outpatient note types. Clinicians could easily filter across any element within the template and view only pertinent sections across a variety of note dates. Currently, only Transcend Services Inc. uses XML for modeling the note.

2. **Simple interaction design based on service or schedule**: The majority of clinicians enter notes based on those patients seen during outpatient encounters or associated to particular service on an inpatient census. The MD:Notes application default screen upon login is based on the clinician's default schedule or census. This greatly reduces the amount of interaction required to retrieve these patients for the purpose of entering notes. Of course, a patient search feature is still included should the clinician decide to enter a note for a patient outside of their default location.

Future:

1. **Client side speech-to-text processing on a handheld device**: Due to project time limitations, our team only started looking at the potential for including this feature. However, we believe that the future of the MT industry is headed in this direction. While the hardware necessary to achieve accurate translation is not yet available in handheld devices,

the current outlook seems promising. There are several departments at UC Berkeley already experimenting with rudimentary applications and the potential for accurate client side speech recognition seems promising in the next several years as memory and CPU for handheld devices increase.

2. **Designing for a variety of platforms**: Our proof-of-concept application is built using open source languages (PHP, XML and Java), web server (Apache) and database modeling the EMR (MySQL). While this provides the organization with a lower cost of ownership and less dependence on software vendors, we realize that many organizations already have complex systems requiring those solutions provided by software vendors. In addition, they might not have the technical resources to manage new technology. The next generation of MD:Notes should be built for deployment on a variety of servers and platforms. The database component is only a model, so querying the reporting version of the EMR should not be a technical roadblock. Keeping the XML intact allows the healthcare organization an open platform for additional customization. Also, this might allow third-party vendors, or internal decision support teams to produce new visualizations for the physicians.

References:

1. Business Wire, "Nuance to Acquire eScription, Streamline Clinical Documentation Process to Save Healthcare Industry More Than $1 Billion by 2011." April 8th, 2008. (http://www.businesswire.com/portal/site/google/?ndmViewId=news_view&newsId=20080408005767&newsLang=en).

2. International Data Corporation, "U.S. Medical Transcription Outsourcing 2004-2008 Forecast and Analysis." December, 2004. Report #32609.

3. Nuance Press Release, "Nuance Announces Fourth Fiscal Quarter 2007 Results." November 15th, 2007. (http://www.nuance.com/news/pressreleases/2007/20071115_q4.asp).

4. MedQuist Inc., "Form 8K." Financial Statement for the United States Security and Exchange Commission, filed February 22nd, 2008. (http://ccbn.10kwizard.com/xml/download.php?repo=tenk&ipage=5484267&format=PDF)

5. McEntee, Claire. "Winscribe plans float to fund expansion." Stuff.co.nz on April 11th, 2008. (http://www.stuff.co.nz/4396921a28.html).

6. Phillips, David. "Transcend Services: Transcribing Profits." 10Q Detective. July 10th, 2007. (http://10qdetective.blogspot.com/2007/07/transcribing-profits-with-transcend.html).

MD:Notes | **Contextual Inquiry**

May 8th, 2008
School of Information, University of California Berkeley
Final Project Report

Jill Blue Lin, Zachary Gillen

Abstract:
The purpose of this section is to describe the results of our contextual inquiry around progress notes at two public hospitals. We interviewed a total of 14 people from two public Bay Area hospitals. These individuals include attending physicians, residents and nurses, as well as people with an administrative role in the hospital.

In this paper, we discuss the methods and tools used by the hospitals for progress notes, the need for a complete transition to electronic records, and issues around adoption of technology. We also propose a list of key takeaways for designing our product, MD:Notes.

Acknowledgements:
This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team member is Katherine Ahern. See "MD:Notes – Designing an Information System for Public Hospitals" for a summary of the report.

Thanks to Bob Glushko, our adviser on the project.

Introduction

Our project is primarily focused on how two public hospitals in the Bay Area work with progress notes. Progress notes are notes written by a physician to describe the patient's condition during the visit, the physician's assessment and plans for treatment. These notes are an important part of a patient's medical history.

Before beginning design on MD:Notes, our application for creating progress notes, we first needed to understand how physicians at our client hospitals worked with progress notes. We conducted contextual inquiry interviews at two Bay Area public hospitals. For the purposes of maintaining anonymity, we refer to the hospitals as Hospital A and Hospital B. Both hospitals are public hospitals with limited funding.

Following is a summary of the hospitals' practices around progress notes.

- Both hospitals rely primarily on charts, or paper medical records. These charts are frequently missing, which creates a problem for physicians who need to review a patient's history.
- Although both hospitals have tools for creating electronic progress notes, most physicians prefer to write notes by hand
- The hospitals' tool for creating progress notes are difficult to use, and sometimes don't support physicians' workflows.

In this paper, we discuss the methods and tools used by the hospitals for progress notes, the need for a complete transition to electronic records, and issues around adoption of technology. We also propose a list of key takeaways for designing our product, MD:Notes.

Research Subjects

In doing our contextual inquiries, we focused mostly on our primary stakeholders, physicians who enter and retrieve notes and nurses who retrieve notes. In order to gain a more complete understanding of how the hospitals handle progress notes, we also interviewed a few secondary stakeholders: people from accounting and the IS department.

We selected users from a wide range of job titles and responsibilities around progress notes. We interviewed a total of 14 people from both Hospital A and Hospital B. Our interviewees included attending physicians, residents and nurses, as well as people with an administrative role in the hospital. Shown below is a table of users, job titles and progress note responsibilities.

User	Organization	Job Title	Responsibilities Around Progress Note
U01	Hospital A	Vice Chairman of Surgery	Enters progress notes (outpatient only). Reviews and signs off on residents' notes
U02	Hospital A	Licensed Vocational Nurse	Retrieves and prints notes for physicians' review
U03	Hospital A	Assistant Manager	Tracks status of patients, verifies that patient

			visits have an associated progress note
U04	Hospital A	Resident, General Surgery	None currently. In the past has written, reviewed, retrieved notes.
U05	Hospital A	Chief of Plastic Surgery	Writes and reviews notes
U06	Hospital B	Attending Clinical Professor of Medicine and Family Practice	Writes notes, looks up notes
U07	Hospital A	Assistant Professor of Surgery	Writes notes, co-signs notes
U08	Hospital B	Resident, General Surgery	None currently. In the past has written, reviewed, retrieved notes.
U09	Hospital B	OR Nurse	Writes nurse's operative notes
U10	Hospital B	IS Senior Clinical Program Analyst	Responsible for administering progress notes systems
U11	Hospital B	Director of Medical Information Systems	Coordinates systems for storage of all patient records (includes progress notes)
U12	Hospital B	Analyst	Retrieves progress notes for auditing purposes
U13	Hospital B	Director of Patient Accounting	Retrieves progress notes for auditing purposes
U14	Hospital B	Principal Engineer	Retrieves progress notes for auditing purposes

Description of Interviews

Each interview took between 1 and 2 hours, and was conducted at the user's general area of work within the hospital: private office, patient exam room, nursing station, break room, etc. The initial part of each interview was devoted to gathering the following information:

- Profile: age, job title, length of time at current position
- Computing devices used, both at home and at work
- Brief description of responsibilities around progress notes
- Methods used to enter and retrieve progress notes

For the majority of each interview, we asked the users to describe in detail the situations in which they enter and retrieve notes, and the steps they take to accomplish these tasks. Whenever possible, we asked if we could watch as they entered or retrieved a note in a real-work situation. In most cases, this was not possible because of patient confidentiality issues and users' time constraints.

In a few instances, we observed physicians working with progress notes between patient visits, or entering an addendum to an existing note outside their scheduled time for seeing patients. When we could not observe actual work around progress notes, we asked users to retrospectively describe their steps. Whenever we thought it appropriate, we asked users for copies of artifacts:

printed electronic progress notes, paper forms for progress notes, physician schedules with jotted notes, etc. In all cases, we blacked out all of the HIPAA identified 18 patient identifiers before copying the artifact.

Paper Charts vs. Electronic Records

Both hospitals store patient records electronically and in a paper format called a "chart." Both hospitals are transitioning to electronic records, but after approximately 8 years of transition, they still primarily rely on charts.

A chart is a manila folder containing documentation of a patient's medical history. A patient with a long medical history will have several charts, or volumes, but the hospital keeps only the most recent volumes on site. Older volumes are kept in long-term storage. A chart contains information such as referrals, physician's orders, photos, and any handwritten notes. Any documentation that the hospital's electronic record system cannot store is placed into the paper chart.

Stack of charts - photo by annzas (http://flickr.com/photos/annzas/2151972335/)

A patient's electronic medical record (EMR) is stored in the hospital's database. It contains information such as lab results, reports, and any progress notes entered electronically, in a format compatible with the hospital's system.

Screenshot of a patient's electronic medical record (EMR), taken from Hospital B's EMR system

A patient's chart and an electronic record contain overlapping but non-identical sets of information. Some documents found in the chart are not available electronically, and vice versa. Progress notes are an example of documents where some are available only in paper format while others are available electronically. These different formats for storing progress notes is one of the reasons physicians must refer to both the chart and the EMR when reviewing a patient's history.

Several problems arise from storing multiple versions of patient records:

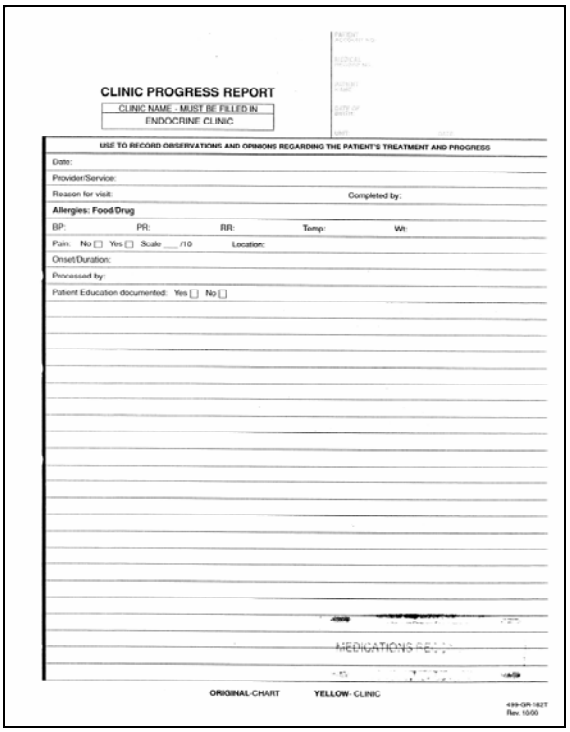
- Physicians and nurses must look in both the chart and the EMR to view a patient's complete history. This increases the time and effort required for both searching for and reviewing patient histories.
- Patient information is inconsistently redundant. At Hospital A, one user commented that some physicians and nurses print out electronic notes "because they look important," and include the printouts in the chart. This results in thicker charts, which then "flood the file room."
- The main problem is that the chart – the main source for a patient's history – is frequently unavailable to the clinic at the time of the patient's visit. (This is discussed in detail later in this paper.)

For the reasons described above, a complete transition from charts to electronic records would increase physicians' efficiency, and in turn would improve the patients' experience and quality of care.

Handwritten vs. Electronic Progress Notes

At both hospitals, writing by hand was the main method for creating progress notes. For many physicians, writing notes by hand is the easiest and fastest method, the method with which they are most familiar. At Hospital B, one user estimated that 70% of all notes are written by hand.

Handwritten notes are included in the paper chart; they are not converted to electronic notes. Handwritten notes are one of the reasons physicians must refer to charts for a patient's history.



CLINIC PROGRESS REPORT

CLINIC NAME - MUST BE FILLED IN
ENDOCRINE CLINIC

USE TO RECORD OBSERVATIONS AND OPINIONS REGARDING THE PATIENT'S TREATMENT AND PROGRESS

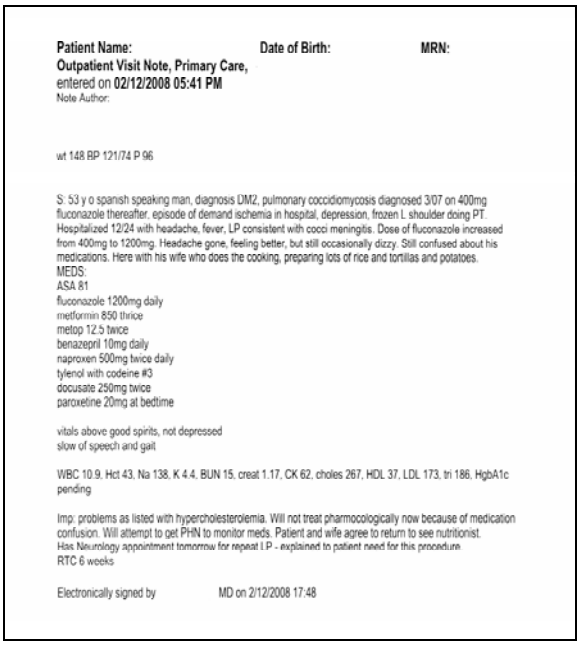
Date:
Provider/Service:
Reason for visit: Completed by:
Allergies: Food/Drug
BP: PR: RR: Temp: Wt:
Pain: No ☐ Yes ☐ Scale ___ /10 Location:
Onset/Duration:
Processed by:
Patient Education documented: Yes ☐ No ☐

MEDICATIONS

ORIGINAL-CHART YELLOW- CLINIC

499-OP-162T
Rev. 10/00

Paper form for handwritten note



Patient Name: **Date of Birth:** **MRN:**
Outpatient Visit Note, Primary Care,
entered on **02/12/2008 05:41 PM**
Note Author:

wt 148 BP 121/74 P 96

S: 53 y o spanish speaking man, diagnosis DM2, pulmonary coccidiomycosis diagnosed 3/07 on 400mg fluconazole thereafter, episode of demand ischemia in hospital, depression, frozen L shoulder doing PT. Hospitalized 12/24 with headache, fever, LP consistent with cocci meningitis. Dose of fluconazole increased from 400mg to 1200mg. Headache gone, feeling better, but still occasionally dizzy. Still confused about his medications. Here with his wife who does the cooking, preparing lots of rice and tortillas and potatoes.
MEDS:
ASA 81
fluconazole 1200mg daily
metformin 850 thrice
metop 12.5 twice
benazepril 10mg daily
naproxen 500mg twice daily
tylenol with codeine #3
docusate 250mg twice
paroxetine 20mg at bedtime

vitals above good spirits, not depressed
slow of speech and gait

WBC 10.9, Hct 43, Na 138, K 4.4, BUN 15, creat 1.17, CK 62, choles 267, HDL 37, LDL 173, tri 186, HgbA1c pending

Imp: problems as listed with hypercholesterolemia. Will not treat pharmocologically now because of medication confusion. Will attempt to get PHN to monitor meds. Patient and wife agree to return to see nutritionist. Has Neurology appointment tomorrow for repeat LP - explained to patient need for this procedure
RTC 6 weeks

Electronically signed by MD on 2/12/2008 17:48

Electronic note

Methods for Creating Notes

Both hospitals have tools for entering notes electronically – dictation, keyboard entry, and speech recognition. However, availability and adoption of these tools varies across clinics and from physician to physician.

Hospital A: At Hospital A, writing by hand and dictation are the only widely available methods for creating progress notes. (The Emergency Department uses a system that allows physicians to type notes, but this system is available only to ED. We did not interview anyone from the ED, and have not confirmed why this system is not available throughout the hospital. However, given Hospital A's shortage of IT staff, lack of resources and funding is a likely explanation.) Hospital A subscribes to a dictation service provided by a clinical documentation company called Spheris, who provides a service for physicians to make phone calls and records dictation. Spheris uses medical transcription professionals to transcribe the note. It takes approximately 2-3 hours before dictated notes are transcribed. Once a note has been transcribed, the physician receives an email with the transcribed note. The physician reviews the note, fills in any gaps in the transcription, makes any necessary edits, and then signs the note. Once the physician signs the note, it becomes part of the patient's electronic record. The note can no longer be modified; however, physicians can dictate an addendum to any note. Signed notes are stored in the hospital's EMR system, and are available for hospital-wide retrieval.

Although the dictation service was available to all clinics within the hospital, Surgery was the only clinic where a dictated note was mandatory. The Surgery clinic was headed by a physician who was on the board for recommending new technology, and was keenly aware of the inefficiencies of relying on paper charts. At all other clinics, dictating notes was optional, and most physicians chose to write their progress notes by hand.

Hospital B: At Hospital B, availability of tools for creating progress notes varied across the different clinics. According to the Director of Medical Information Systems, as a public hospital, the hospital receives the majority of funding for their operating expenses from the local city controller's office. Because Hospital B is a research hospital, many of its physicians are employed by the University of California (UC). This divides the staff and funding into two distinct groups, one backed by the city and the other by the UC system. Each group and clinic within the hospital can secure individual funding for projects they think are important.

One of the side effects of de-centralized sources for funding is a wide variation in tools and methods used for entering progress notes. Described below are the tools and methods Hospital B currently uses to enter notes:

Writing by hand: As with Hospital A, this is the main method for entering notes. Handwritten notes are kept in the patient charts only, and are not stored electronically. (Hospital B is currently soliciting bids for scanning patient charts into bitmaps. This is a pilot project, and only a selected group of charts will be scanned.)

Outsourced transcription services - WebMedix: The local city government funds the dictation and transcription of notes from select clinics: Gastrointestinal (GI), Renal, Pulmonary, plus a few others. A company called WebMedix provides transcription services. By contract, routine notes take up to 48 hours, and anything marked "stat" must be transcribed within an hour. WebMedix is currently exceeding its contractual obligations by turning around routine notes within 24 hours. Notes entered using this method are compatible with the hospital's lifetime clinical records (LCR), so these are stored electronically, available to the entire hospital.

Outsourced transcription services - other: The Trauma and Critical Care clinics use a different provider to transcribe their dictated notes. Unlike the transcribed notes provided by WebMedix, these notes are compatible with the LCR, and are not available to other clinics. Instead, these notes are printed and then included in the patient's chart.

Speech recognition - Dragon NaturallySpeaking: The Family Practice clinic has purchased Nuance's speech recognition software for their physicians to use on their PCs. Instead of relying on human transcribers, the physicians use the software to speak their notes into the computer, which are converted to text in real-time, and can be edited via a keyboard. However, notes created with this method are not compatible with the LCR. As a result, these notes are printed and then included in the patient's chart. Electronic versions of the notes are stored on the individual physicians' PCs and are not available to the rest of the hospital.

Speech recognition - Provation: The Orthopedics clinic uses Provation, an application which uses a speech recognition engine to fill in forms templates for operative and progress notes. Spoken notes are converted to text in real-time, and can be edited via a keyboard. Unlike the method using Dragon NaturallySpeaking described above, noted entered through Provation are compatible with the LCR, so these can be stored electronically, available to the rest of the hospital. The GI clinic also uses this application, but only for its procedural notes.

Net Access: The General Medicine clinic uses NetAccess, an application developed by Siemans using Lotus Notes, to enter progress notes via keyboard. Notes entered in NetAccess require no lead-time for transcription, are compatible with the LCR, and thus available to the rest of the hospital. Another advantage to using NetAccess is that physicians regularly copy previous notes, and modify them to create a new note, thus saving on the amount of effort required. General Medicine is the only clinic using NetAccess. Pediatrics tried this system, did not like the amount of typing required, and returned to writing all notes by hand.
Aids Clinic: The Aids Clinic at Hospital B developed an application through outside funding to track its patients. This application has functionality for entering progress notes via keyboard. As with NetAccess, notes require no lead-time for transcription and are compatible with the LCR and available to the rest of the hospital.

As seen by the list of methods described above, Hospital B is in transition between writing notes for inclusion in patient charts, and creating electronic notes that can be stored in the LCR. Although some clinics within Hospital B are using dictation/transcription services and speech recognition in order to make it easier for physicians to enter notes, many of these methods create notes that are not compatible with the hospital's LCR. These notes must still be printed onto paper and stored in the patient chart. For these notes, the method of entry may be improved, but for purposes of hospital-wide retrieval, they still function much like the traditional handwritten note. Retrieval of these notes is still tied to the physical presence of the chart.

Workflows for Creating Notes

As mentioned previously, for many physicians, writing notes by hand is the fastest method. Although a dictation/transcription service is available throughout Hospital A, most physicians still choose to write their progress notes by hand. To understand this preference for writing notes by hand, in this section we compare some sequence diagrams for creating handwritten and electronic notes.

Writing a note by hand:

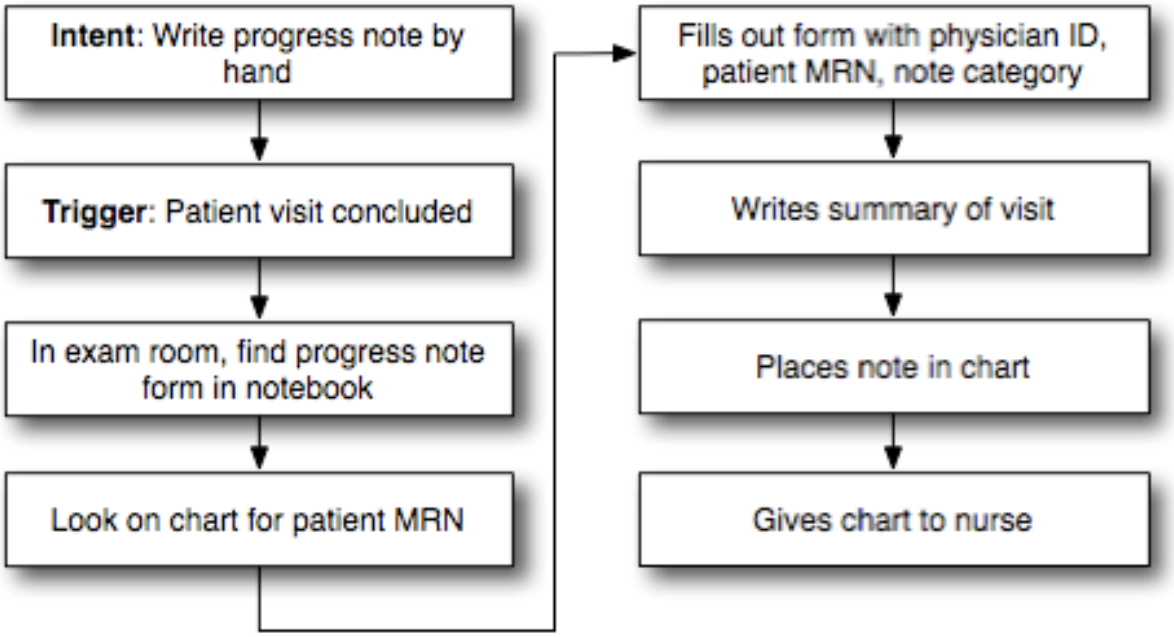


Figure 1 – Sequence for writing a note by hand in an outpatient clinic

Figure 1 shows the steps a physician, U05, takes to create a handwritten progress note. Creating a handwritten progress note is a straightforward process. After the patient visit, the physician writes a note on a printed form, places the note into the chart, and then gives the chart to the nurse.

Dictating a note (outpatient):
In outpatient clinics, patients come into the clinic without requiring an overnight stay. In the clinic we observed, physicians dictated their notes at dictation stations next to the nursing station. Each station had a landline phone as well as computer terminal, so that physicians can review both the patient's paper chart and electronic records before doing the dictation. There were two stations shared by many physicians; only rarely did a physician have to wait. Most physicians dictated notes immediately after seeing each patient. The physician we observed used a printed version of his patient schedule to look up the patient's MRN, which is required by Spheris prior to the actual dictation.

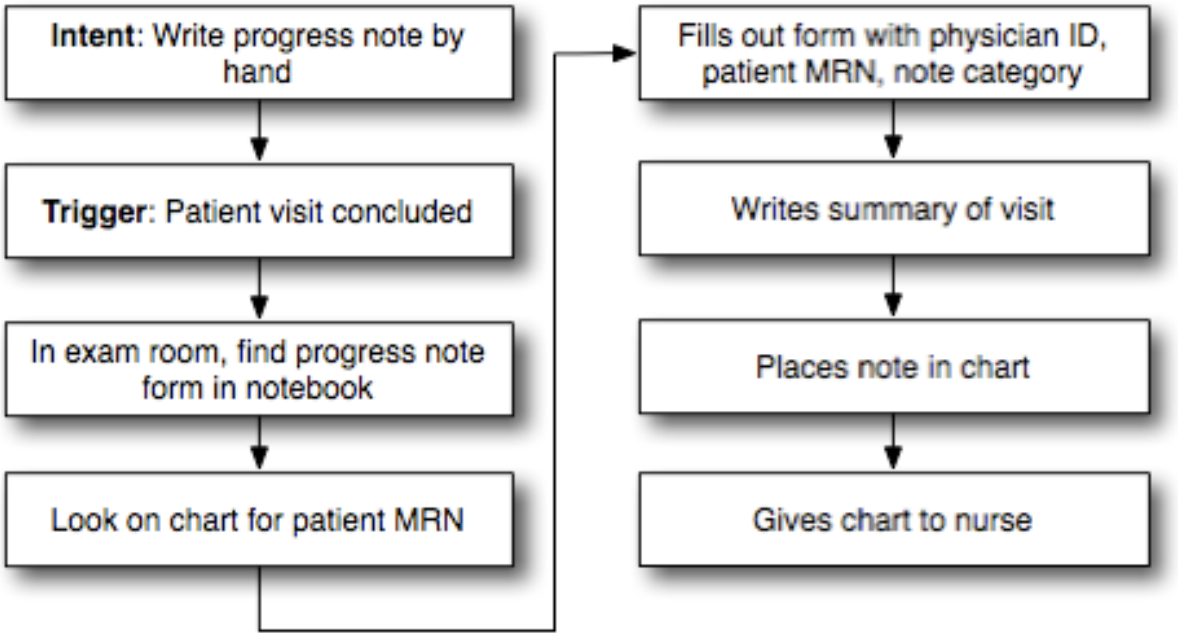


Figure 2 – Sequence for dictating a note in an outpatient clinic

Figure 2 shows the steps a physician, U01, takes to dictate a progress note in an outpatient clinic. In comparison with writing a note by hand, dictating a note requires many more steps.
To dictate a note, U01 first goes to a dictation station in a separate room. He then uses a landline phone to dial into the Spheris system and enter required identifying information - physician ID, clinic code, patient medical record number (MRN), etc. – using the touchtone phone. Entering the required information is time-consuming. Furthermore, because U01 know that the transcription service mis-categorizing notes, he repeats the identifying information by dictating it before speaking the actual note. (On the diagram, this is noted as **BD**, or a breakdown.)

As previously mentioned, once a note has been dictated, it typically takes 2-3 hours before the note is transcribed. Until the note has been transcribed, the dictated note is not available. Handwritten notes are available right away. This is a critical difference between dictated and handwritten notes.

For some types of notes, such as disposition orders, this delay is unacceptable. A disposition order is an instruction to the nurse describing the next step in the patient's care. Nurses need disposition orders to send patients to get lab tests, make follow-up appointments, and so forth. Because nurses need these orders before the patient leaves the clinic, the time required to dictate and then have the note transcribed makes dictation of the disposition order impractical.

As a result, even in clinics where most notes are dictated, disposition orders are still written by hand. In the Surgery clinic where dictating notes is required, physicians write disposition orders by hand and give these orders to the nurse before dictating a progress note. Disposition notes are included in the chart. The dictated progress note is eventually transcribed and then stored as an electronic record; these are not usually printed for inclusion in the paper chart.

In this case, the delay in availability caused by the time required for human transcription of dictated notes results in a chart and an EMR with different pieces of information: the chart contains the handwritten disposition order, while the EMR contains the progress note.

Dictating a note (inpatient):
The workflow for inpatient settings is very different from that for outpatient settings. For inpatient settings, physicians see patients who are staying overnight in the hospital. Instead of seeing patients one by one in an exam room, inpatient physicians have rounds, during which they walk around the hospital to examine the patients in their care.

Because Hospital A is a teaching hospital, the physician we interviewed was accompanied by residents as she made her rounds. During these rounds, she instructs the residents as she examines her patients. According to the physician, by law, residents are not permitted to work more than 80 hours per week. In order to give the residents enough time to complete all their other duties (carrying out the attending physician's orders regarding patient care) within the allotted time, she needs to complete her rounds quickly. For this reason, she does not have time to write or dictate progress notes between examining each patient. Instead, after she completes the initial round with residents, if she is not interrupted by any emergency, she immediately does another round in order to dictate notes.

Because inpatient physicians need to be mobile as they see patients during rounds, a stationary landline phone for dictation is not appropriate. For inpatient physicians, the workflow for creating a note is tightly interwoven with doing rounds and patient examination.

The physician we interviewed was the only physician at Hospital A involved in a pilot program using Spheris's mobile dictation product. Most other inpatient physicians wrote their notes by hand. This physician purchased her own PDA in order to be able to dictate notes in a mobile setting. Using her PDA, she can dictate notes during her second round if the hospital is "not too chaotic." If the hospital is too noisy during her second round, she jots down notes on a patient census - a list of patients currently staying in the hospital, ordered by case severity – and then finds a quiet place to do her dictations.

Even with the mobile product, she does not have enough time to dictate notes during the first round, and still has to do a second round in order to enter notes. She finds the dictation process cumbersome, since she can't rewind to make changes and often has to re-record multiple times. Even so, she thinks "it's better than what we had before, which was nothing."

Once she finishes her dictations, she synchronizes her PDA with her computer, and the dictations are sent to Spheris for transcription. Once they're transcribed, the physician makes any necessary edits before signing the transcription.

As seen in Figure 3 below, using the mobile dictation product results in several breakdowns: it's time-consuming to enter the patient MRN, select the correct work type, and then to dictate a note all at once without being able to make corrections.

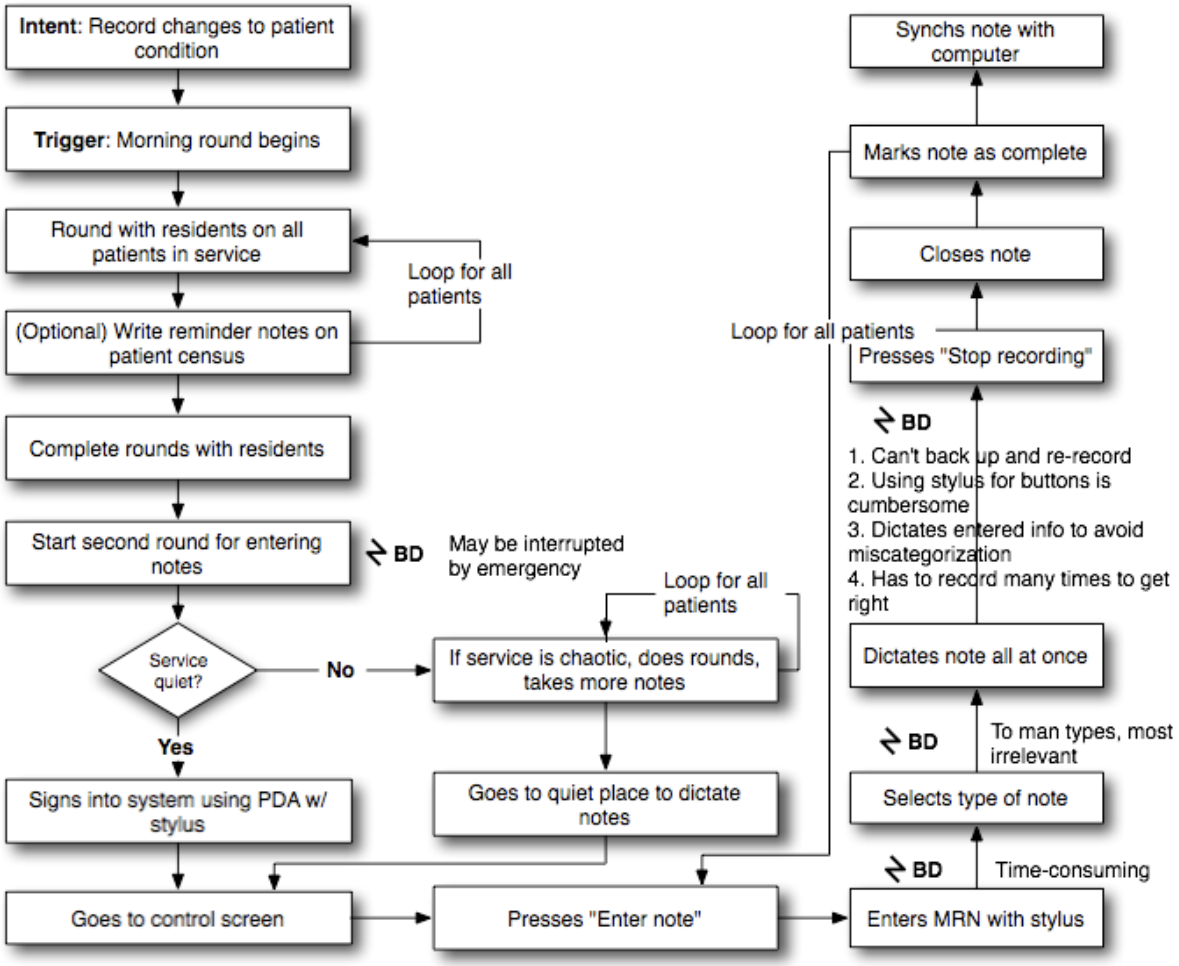


Figure 3 – Sequence diagram for an inpatient physician doing rounds and entering notes

Workflows for Retrieving Patient Medical Records

As discussed previously, both hospitals rely primarily on charts – this becomes problematic when physicians need to review a patient's medical history.

At both hospitals, physicians reported a high rate of missing charts, anywhere from 10% to 80%. When a chart is missing, both physicians and nurses devote a great deal of time trying to locate the chart. If the chart cannot be found, the physician must reconstruct a patient's history either by questioning the patient or by ordering new tests. According to one physician, missing charts are "really devastating"; they result in longer wait-time for patients, additional costs for repeated tests, inefficiencies for physicians and a decrease in the quality of patient care.

When we asked why so many charts were missing, many physicians said they had "no idea." However, Hospital B's Director of Medical Information Systems thought that the charts are not actually lost, but instead may be in the possession of another group. Many groups within the hospital need access to the charts. Researchers, the accounting department, and other clinics may

all be competing for the same chart. Patients may go to multiple clinics in a single day, and the chart may be in transit or waiting to be filed.

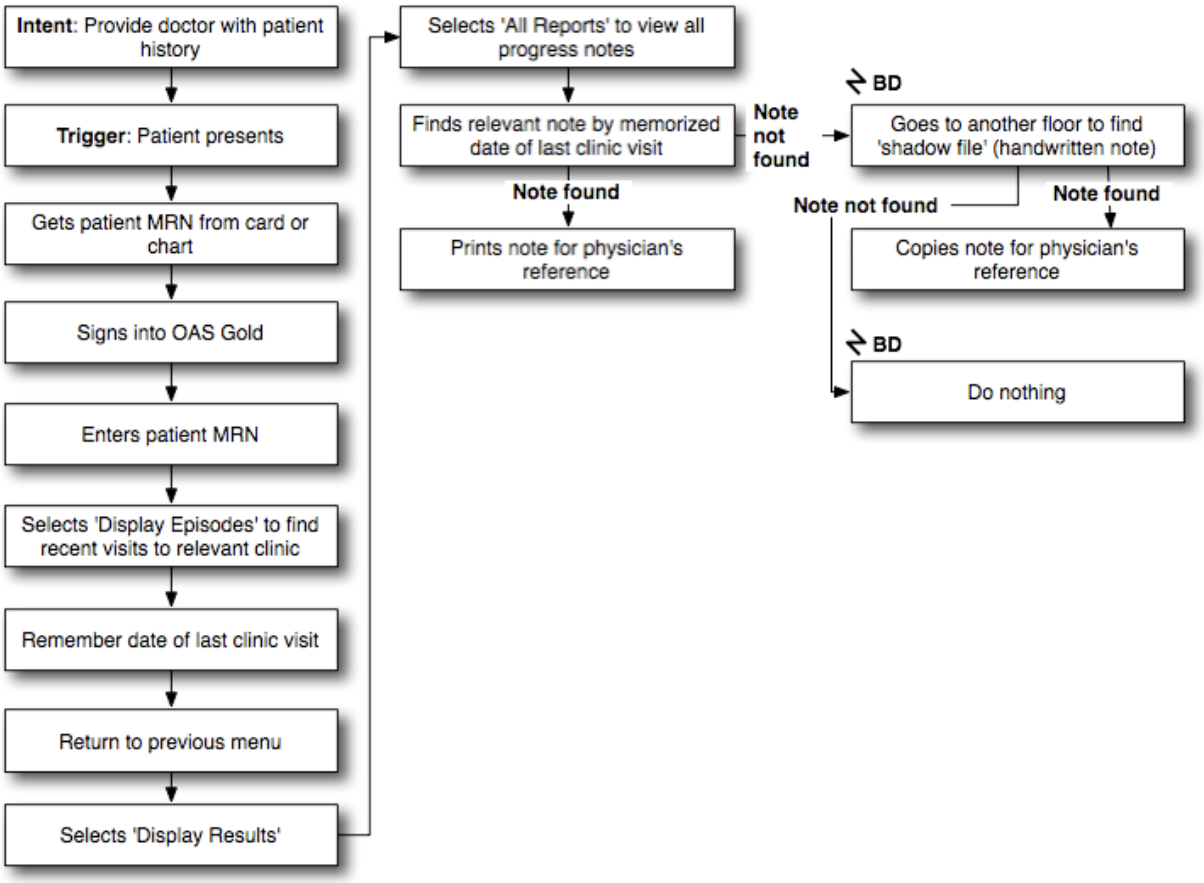


Figure 4 – Sequence diagram for a nurse looking for relevant notes

Figure 4 shows the steps a nurse, U02, takes to find a previous notes relevant to a patient's visit. Prior to a patient's visit at Hospital A, nurses consult the clinic's schedule in order to make sure that the clinic has a chart for each patient. Nurses typically do this as the patient presents (checks into reception), or early in the morning if they have extra time. Up to 15% of patients are add-ons or walk-ins, and are not included in the schedule. For these patients, looking for charts prior to the patient's arrival is not possible.

As previously discussed, a chart contains the patient's recent medical history. It is part of the nurse's job to help physicians familiarize themselves with the patient's history prior to the examination. For each patient, the nurse either looks for the chart herself, or asks a clerk to find the chart. In addition to searching for the chart, the nurse also searches for electronic records relevant to the patient's visit to the clinic. If no relevant electronic records are found, the nurse then looks for the 'shadow file', which is a copy of portions of the chart relevant to that particular clinic. The shadow file is a subset of the patient chart.

As seen in Figure 4, the nurse goes back and forth between the different system screens in order to find relevant information in the electronic system – he memorizes information from one screen for use in another screen. Although the electronic portion of the sequence is long, the nurse does not perceive a breakdown unless he can't find the information electronically and has to resort to physically going to look for the shadow file. (However, when we observed a physician attempting to use the system to find relevant notes, the physician was less familiar with the system and was unable to find the notes he was looking for.)

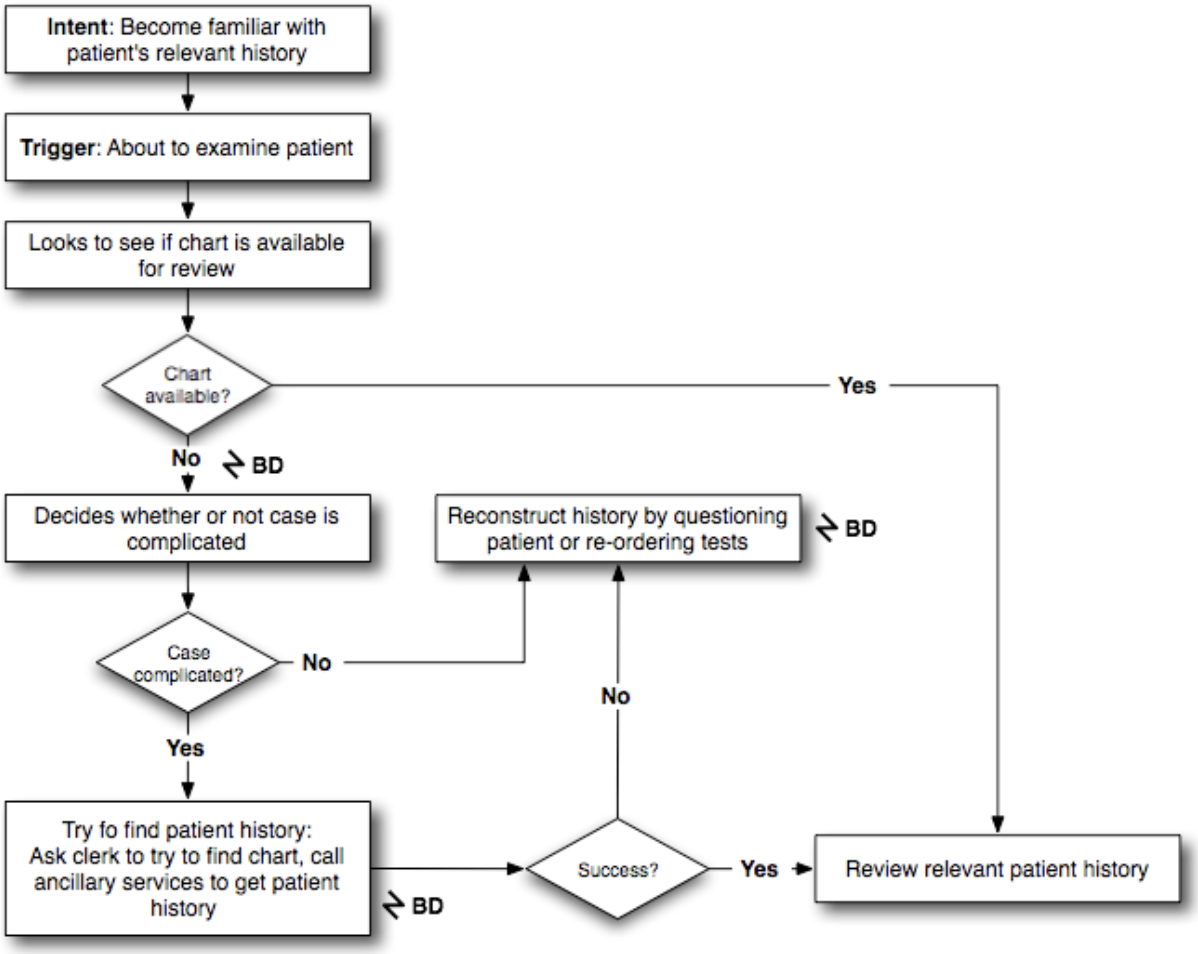


Figure 5 – Sequence diagram for a physician looking for a patient's medical history

According to one physician, U05, charts for his patients are frequently missing, as much as 80% of the time for some clinics. As seen in the Figure 5, if the chart is missing and U05 thinks the patient's case is complicated, he spends a great deal of time asking the clerk to look for the chart again, and calling other clinics to try to get faxes of the patient's history sent to his clinic. While he is looking for the patient's history, the patient must wait in the exam room. If U05 is unsuccessful in his search for the patient's history, he resorts to reconstructing the history by questioning the patient and/or re-ordering tests.

Clearly, the workflow described above is inefficient on many levels. The physician's time is wasted in searching for the patient's history. The patient's time is wasted by the long wait in the exam room; furthermore, all patients scheduled after this one have a longer wait time. Repeated tests are a waste of money and add to the total cost of care. Quality of patient care is decreased.

Schedules and Censuses

Outpatient physicians regularly refer to their schedules as they see patients. However, at Hospital B, the scheduling system is time-consuming for physicians to use. To print out his schedule for the day, an outpatient physician, U01, finds the schedule for the whole clinic, selects and copies the entries for his patients, pastes the selection into a Word document, and then reformats the document so that it will print properly. He then refers to this printed schedule throughout the day.

Before seeing a patient, U01 uses his schedule to look up the patient's name, and to know whose medical record he should be reviewing next. After seeing the patient, when he is ready to dictate a note, he refers to the schedule for the patient's MRN to enter into the dication system.

The scheduling system only handles patients who make in appointments in advance. Approximately 15% of patients are add-ons or walk-ins, so they are not shown on any schedule. For these patients, the nurse generates printed stickers with the patient's identifying number. The physician puts on of these stickers on his schedule, in order to have the patient's MRN when he's dictating a note.

Instead of schedules, inpatient physicians use censuses. The census is a list of patients the physician will see during rounds. Similar to the outpatient physician, the inpatient physician we interviewed, U07, uses a printed copy of her census. Her residents compile and print her schedule, likely using a cut-and-paste method similar to the one described above. Because the census is ordered by the patient's case severity, U07 visits the patients according to the order on the census, sometimes using the census to jot down notes. On her second round when she's dictating notes, she refers to the census for the patient's medical record number, which she needs to enter into the dictation system.

Because the schedule and census systems are not tied to the hospital's EMR and note dictation systems, physicians are less efficient in finding and creating notes. They can't use the schedule to search for or create notes by patients on the schedule, but instead must enter patient identifying information each time. Entering information using a touchtone phone is time-consuming and tedious. Because physicians work so closely with their schedules and censuses, tying these systems to the EMR and the note dictation systems would make it easier for physicians to find patient records and dictate notes.

Comparison of Note Entry Methods

So far, we have discussed four methods of note entry: writing by hand, dictation (via landline and mobile device), keyboard entry and speech recognition. In interviewing physicians, we found no consistency of preferred methods. Different physicians expressed strong preferences for the methods they felt to be the easiest and fastest. (However, it was our impression that most physicians preferred the method they were used to. It is not clear that their expressed preferences

reflected a natural inclination for that particular method, or that their preferences would not change if they spent some time using another method that was easy to use.)

In addition to physician preference, each method also has differences in terms of turnaround time, ease of retrieval, and so forth. The table below lists each method and its advantages and disadvantages.

Writing by hand	• Many physicians used to this, think this method is fastest • Can be done on the spot • Few preliminary activities (no sign-in, search for MRN, etc.) • No turnaround time – notes immediately available	• Some physicians find writing by hand too slow • Hard to retrieve handwritten notes (missing chart) • Handwriting may be hard to decipher • Notes on paper cannot be available to all locations at once
Dictation (landline)	• Some physicians think speaking notes is fastest • Dictated notes can be transcribed to electronic – easy to retrieve	• Some physicians are not used to dictating • Lead time required for transcription • Difficult to edit dictation – have to re-record the whole thing • Stationary landline does not support inpatient workflows • Entering sign-in, MRN, etc. using a touch-tone phone is time-consuming
Dictation (mobile)	• Some physicians think speaking notes is fastest • Notes can be transcribed to electronic – easy to retrieve • Can be used in inpatient settings	• Some physicians are not used to dictating • Lead time required for transcription • Difficult to edit dictation – have to re-record the whole thing • Entering sign-in, MRN, etc. with a stylus is cumbersome • Background noise can make this difficult
Keyboard entry	• Some physicians think typing notes is fastest	• Some physicians can't or don't like to type

	• Notes can be stored electronically – easy to retrieve • Easy to edit • Can copy/paste previous notes • No turnaround time – notes immediately available	• Keyboard entry may not be appropriate for in-patient settings
Speech recognition *We did not observe any physicians using this method. We are relying on feature descriptions of speech recognition products.	• Combines dictation and typing • Notes can be stored electronically – easy to retrieve • Easy to edit • Can copy/paste previous notes • No turnaround time – notes immediately available	• Background noise can make this difficult

Issues in the Adoption of Technology

Although methods for creating notes are available at both hospitals, writing notes by hand is still the dominant, most preferred method. Below are some of the main factors that affect the switch to entering electronic notes.

- **Lack of funding to adopt technology for the whole hospital**: As public hospitals, both Hospitals A and B do not have sufficient funding for all their technology needs. Furthermore, as previously mentioned, Hospital B receives funding from both the city government and the affiliated University. This leads to clinics using different, sometimes incompatible tools.

  At least partly because of insufficient and de-centralized sources of funding, neither hospital requires physicians to enter notes electronically. Since neither hospital requires physicians to create electronic notes, it is likely that physicians who have a strong preference for writing notes by hand will continue to do so.

- **Many physicians are not comfortable with technology:** Many physicians, especially older physicians, are not comfortable using computers. Users told us that there was "technophobia at senior levels" and that many physicians "don't know how to type." This, in combination with the lack of requirement for electronic notes, means that many physicians will continue to write notes by hand.

  However, the transition to electronic methods of entry will eventually happen. We observed that younger residents are more comfortable with technology and less willing to write by hand. As younger physicians replace older physicians, writing by hand will become an obsolete method; this transition could take years or even decades. Network or "tipping point" effects could help to speed this transition. One physician commented that she would dictate if

the X clinic would dictate. Getting some influential clinics to create electronic notes may motivate other clinics to follow.

- **Lack of time for physicians to learn new tools**: Physicians are mainly focused on patient care (as they should be). In the fast-paced setting of a public hospital, physicians lack the time to learn a new system for entering notes.

- **Lack of perceived need:** Some physicians don't connect their own preference for writing by hand to the difficulties in locating paper charts and the need to have complete electronic records. They thought writing by hand was the fastest method, and did not take into account time lost in searching for charts or reconstructing a patient's medical history.

- **Existing tools require too much overhead:** At Hospital A, for each note a physician dictates, he or she must enter a physician ID, patient MRN, clinic code, etc. Entering this information using a touch-tone phone is tedious and time-consuming. This, in addition to having to go to a special station to dictate notes, is a factor in some physicians' preference for writing notes by hand, as it requires far fewer steps.

- **Existing tools don't support physicians' workflows:** For dictated notes, there is a lag time of at least 2-3 hours before these notes are transcribed and become available. This lag time is unacceptable for some types of notes. In addition, landline dictation stations don't support the mobile requirements of physicians who do rounds in inpatient settings.

Key Takeaways for Design

Listed below are some of the key takeaways for designing a system that best supports how physicians work.

Multiple devices: There is a vast difference in the workflows of inpatient and outpatient physicians. Inpatient physicians see patients while they do rounds, while outpatient physicians see patients in exam rooms. Because inpatient physicians require a mobile product while outpatient physicians do not, our product needs to work on multiple devices – PC, PDA or mobile phones.

Multiple methods of note entry: Some physicians strongly prefer typing notes, while others have an equal preference for speaking the notes. In order to allow physicians to focus on patient care, and to minimize their having to learn a new method, our product should support multiple methods for creating notes.

Speech recognition replaces dictation/transcription: Because some notes are needed immediately, the lead-time required for transcribing a dictated note makes this method inefficient. Because human transcription is necessarily time-consuming, we propose using speech recognition instead. For the purposes of our product, we assume that speech recognition engines work at least as well as dictation/transcription for capturing spoken word and converting it to text.

Minimize system overhead: Because of the fast-paced environment of the public hospital, our product should have as little "overhead" as possible – fewest clicks, avoiding all unnecessary entering of information, using personalization on physician ID to pre-fill required fields, avoiding having to sign in for each note, and so forth.

Clinic schedule or patient census: Because physicians refer to the schedule or census as they see patients and enter notes, entry and retrieval of notes should be tied to the schedule or patient census. This would eliminate having to enter a patient MRN for each note. The schedule should allow for add-on and walk-in patients.

Copying previous notes: Because notes may not vary too much from visit to visit, our product should allow physicians to create a new note by copying and editing a previous note. Several physicians requested this feature

Linking lab and test results: Physicians currently look up lab and test results in the electronic medical record and record and intermediate note. Then, when dictating or writing a progress note, they include this information in the progress note from the intermediary note. Our product should allow for linking to the latest labs or other critical patient information.

Images: Some clinics, such as Wound or Plastic Surgery, take photos of patients to document progress. Because the electronic system cannot store photographs, any photos are stored in the paper chart. Our product will support the inclusion of images and other file types.

Reports: The product should produce some sort of consolidated report for billing and auditing. The requirements are still to be determined.

Conclusion

In our contextual inquiry, we interviewed 14 users from the two hospitals, with a variety of responsibilities around progress notes. We looked at why they primarily use paper charts, their methods of creating notes, and their workflows and breakdowns around creating and retrieving notes. We also looked at issues around the adoption of technology. Based our analysis of our interviews, we came up with a list of key takeaways for designing MD:Notes, an application for creating an finding progress notes. See Designing the Prototype for a full description of our design.

MD:Notes

Designing the Prototype

May 8th, 2008
School of Information, University of California Berkeley
Final Project Report

Jill Blue Lin

Abstract:

The purpose of this section is to describe the design of our prototype for MD:Notes, an application for physicians to create progress notes. Based on the results of our contextual inquiry, we derived some key takeaways for design, a vision of our product, and a hotlist of features.

Acknowledgements:
This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team members are Katherine Ahern and Zachary Gillen. See "MD:Notes – Designing an Information System for Public Hospitals" for a summary of the report.

Thanks to Bob Glushko, our adviser on the project.

Introduction

Our product, MD:Notes, is an application that improves the hospitals' processes for creating and retrieving progress notes. To inform our design, we used contextual inquiry (a user-centered design method consisting of observations occurring in the natural work context) in order to better understand physicians' workflows around progress notes.

Our project is primarily focused on how two public hospitals in the Bay Area. work with progress notes. Progress notes are notes written by a physician to describe the patient's condition during the visit, the physician's assessment and plans for treatment. These notes are an important part of a patient's medical history. For the purposes of maintaining anonymity, we refer to the hospitals as Hospital A and Hospital B.

For our contextual inquiry, we interviewed users from a wide range of job titles and responsibilities around progress notes. We interviewed a total of 14 people from both Hospital A and Hospital B. Our interviewees included attending physicians, residents and nurses, as well as people with an administrative role in the hospital. However, we focused primarily on physicians, as they are the primary users of our product. See "MD:Notes – Contextual Inquiry" for a complete description of our user studies.

Based on the results of our contextual inquiry, we derived a flow diagram of our product, as well as a list of desired features. We then created a paper prototype, conducted usability testing, and then designed the functional prototype for our application. In this paper, we describe our design, discuss the results of the usability test, and our final design for our prototype.

Visioning and Storyboarding

Based on our findings from our contextual inquiry, we created a storyboard for our proposed product.

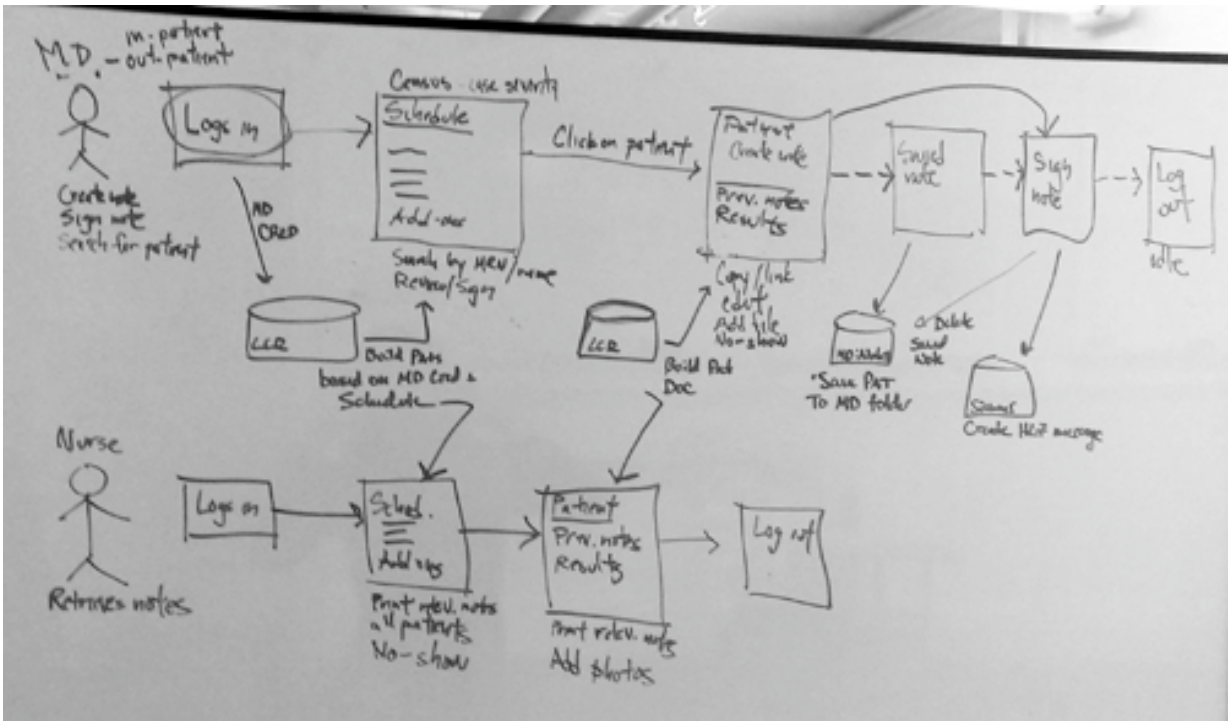


Figure 1 – Storyboard for MD:Notes

Figure 1 shows how physicians and nurses can use our product to select patients from a schedule, view previous notes and create notes (physicians only). Users can also search for individual patients by name and medical record number (MRN), but using the schedule is the default method. Our storyboard also shows functionality for copying notes, linking to test results, attaching images to a note, reviewing and then signing a note. Once a note is signed, it is stored in the hospital's electronic medical record system.

List of Features (Hot List)

Next, we came up with a list of features we wanted our product to support, or a hot list:

Supporting different work settings and preferences:

- **Multi-device application**. To support both inpatient and outpatient physicians, our product will work on both PC/laptops and mobile devices. Inpatient physicians write notes as they do rounds, so they need a mobile solution. Outpatient physicians write notes in the exam room after patient visits, so they can use a PC or laptop.
- **Client-side speech recognition engine on both the PC and mobile versions.** This will allow for both speaking and typing notes using the same interface. Physicians expressed strong preferences for either typing or speaking (dictating) notes. By using speech recognition, our product supports both methods. (For the purposes of our product, we assume

that speech recognition engines work at least as well as dictation/transcription for capturing spoken word and converting it to text.)

Immediate availability of notes:

- **Client-side speech recognition engine on both the PC and mobile versions.** In addition to allowing for multiple methods for creating notes, using speech recognition also eliminates the time lag required for human beings to transcribe notes. (For the purposes of our product, we assume that speech recognition engines work at least as well as dictation/transcription for capturing spoken word and converting it to text.)
- **Instant availability for disposition order**. Physicians should be able to create notes, which are then immediately available to nurses in the clinic.

Schedule- or census-based work:

The physicians we observed regularly referred to their schedules as they examined patients. (A census is used in inpatient settings. It is a list of patients ordered by case severity.) Our product should integrate information from the hospitals' scheduling systems.

- **Schedule / census as basis for note creation and retrieval**. Entry and retrieval of notes should be tied to the schedule or patient census. This would eliminate having to enter a patient MRN for each patient or note.
- **Schedule-based clinic category applied to note**. Notes are often mis-categorized when physicians forget to select the correct clinic. Our product should use schedule information to select the physician's current clinic by default.
- **Schedule accommodates add-ons**. Up to 15% of Hospital A's patients are walk-ins or add-ons, and so are not included in the clinic's schedule, which is generated in the morning. Because our product allows physicians to find patients according to the schedule, the schedule needs to accommodate walk-ins and add-ons.
- **Reports based on schedule**. For tracking of patient care, our product should allow for reports based on the schedule to generate lists of patients who did not show up, lists of reminders for follow-up care, and so forth.

Productivity enhancements:

- **Copying previous notes**: Because notes may not vary too much from visit to visit, our product should allow physicians to create a new note by copying and editing a previous note. Several physicians requested this feature.
- **Incrementor or counter**. When physicians copy notes from one day to another, they run the danger of exactly repeating information that should be changed each day. For example, the note "1st day of intubation" is only accurate for the first day. For subsequent days the patient is intubated, it would be useful to have an incrementor that adjusted the day number each time the note was copied.
- **Linking lab and test results**: Physicians currently look up lab and test results in the electronic medical record. When dictating or writing a progress note, they include this information in the progress note. Our product should allow for linking to the latest labs or other critical patient information.
- **Forms for different clinics and services**. Different clinics and services include different types of information in their notes. It would be useful to develop forms for each clinic or service. In addition, patients frequently miss their appointments; these are called "no-shows",

and the hospital needs to follow up with these patients for treatment. It would be useful to develop a separate form for now-shows.

- **Images**: Some clinics, such as Wound or Plastic Surgery, take photos of patients to document progress. Because the electronic system cannot store photographs, any photos are stored in the paper chart. Our product will support the inclusion of images and other file types.

Paper Prototype

Next, we created a paper prototype of our product to test the two main functions of our product: entering a note and finding notes for a particular a patient. We created versions for both the PC and mobile device.

Because of our project's and users' time constraints, we tested only three users: two on the PC version, and two on the mobile version. (We tested one user on both versions.) Two users were from Hospital A, one from Hospital B. Two were outpatient physicians, one was inpatient. For the mobile test, we showed users an image of our target device, the Nokia 800, before conducting the test.

We told each user that the product was for creating and finding notes, and that they could create notes either by speaking or typing. We then asked them to accomplish two tasks - enter a note for a patient, and find a patient's previous notes - while speaking their thoughts aloud.

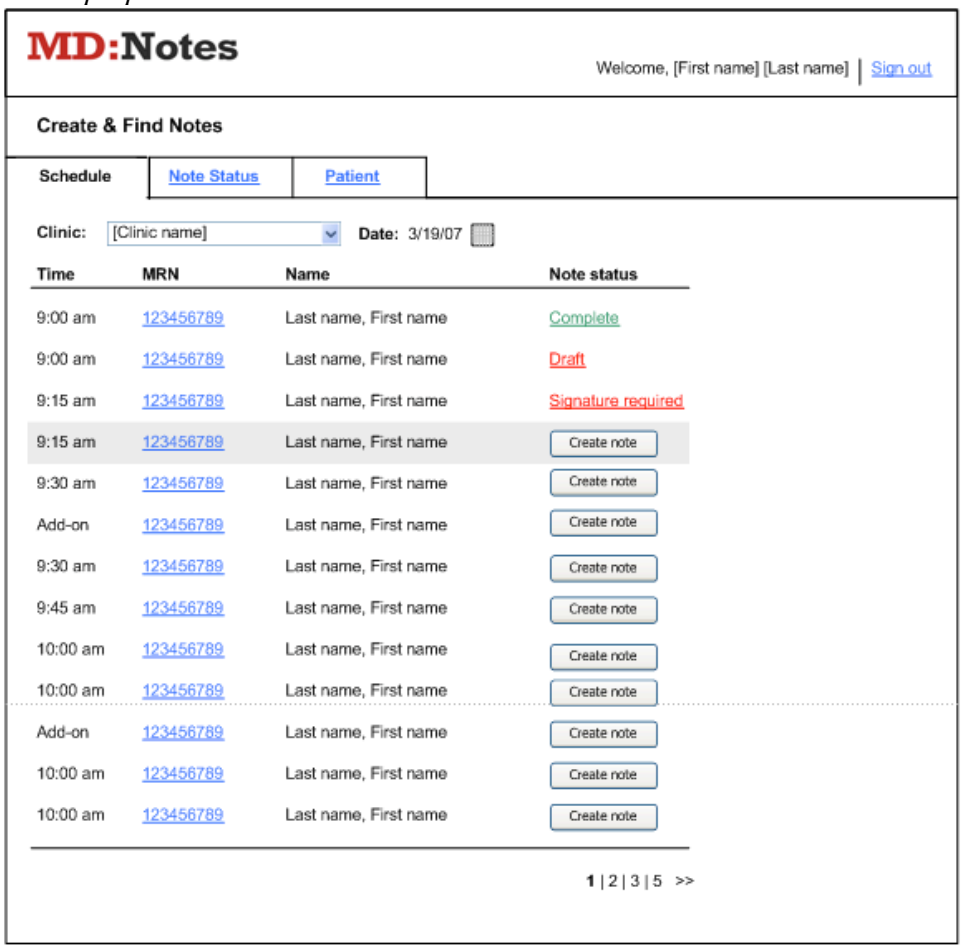
User Profiles

- **User1:** Older outpatient physician used to dictating notes, but who would very much like an option to type notes on a laptop.
- **User2**: Outpatient physician used to typing notes. This physician is very computer-proficient.
- **User3:** Inpatient physician used to dictating or typing notes. This physician is currently using the pilot mobile dictation product at Hospital A.

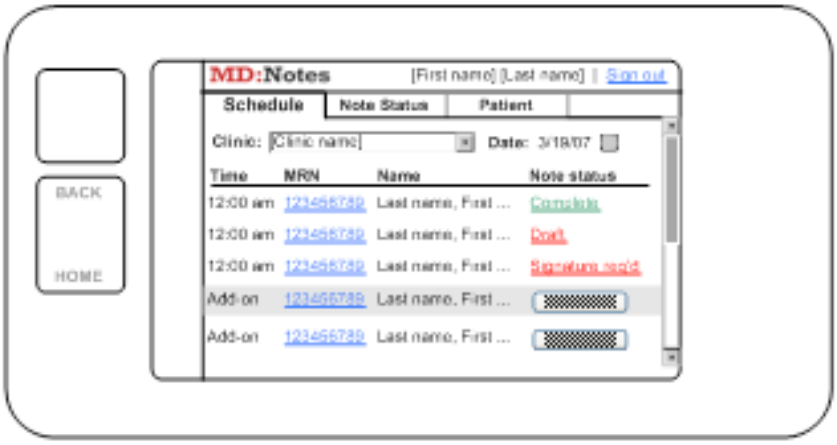
Schedule tab

Default view for outpatient physicians upon sign-in. (In-patient physicians use a Census tab instead). Patients are listed according to the physician's scheduled clinic.

PC/Laptop version



Mobile version



User reactions:

- User1, who was less comfortable with the computer than the others, did not understand the prototype screens. About the default schedule tab, User1 said, *"I would like a 'return to main menu' function. This main menu would allow me to look up more relevant information about the patient. Looking at this screen, I can't get all the information."* User1 did not think the prototype supported looking up information about a patient prior to creating a note. Our sense was that after his initial confusion, he was often not really looking at the screens.
- User2 and User3 had no major problems with the prototypes, and had a good understanding of how the prototype could support their workflows. About the default schedule tab, User2 said, "*I'm assuming that this is my schedule for the day. I would click on the name of the person. [To create a note,] I would click on the 'create a note' button*."
- All users said they looked for a patient's name first, instead of the MRN.
- Users were confused that this screen had both a hyperlinked patient MRN as well as a Create note button, and weren't sure what the difference in resulting screens would be.

Design modifications:

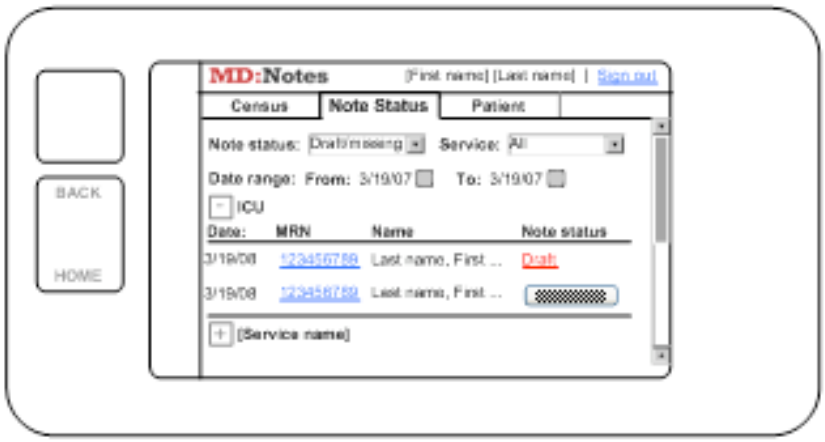
- Patient name should be displayed before the MRN. Name should be hyperlinked instead of MRN.
- Remove the Create note button – users need to review a patient's history before they create a note
- Add some instructional text explaining this screen

Note status tab

This view allows physicians to quickly see which of their notes are incomplete.

PC/laptop version

Mobile version



User reactions:

- The Note Status tab initially confused User2 when he noticed it while on the Schedule tab. *"I'm confused by 'note status.' But, I'm going to ignore that for now."* When he explored this tab later, he understood that the view could be used to show all the notes he hadn't completed.
- User2 thought the Time column was not useful, and that date range was unnecessary as long as items were listed in chronological order, with an option to reverse the order.
- User2 was also concerned that making it easy for people to find unfinished notes could encourage people not to finish their notes. *"People should keep up on their notes. If you're making it easier for people to find a particular note, they might have less incentive to keep up with signing their notes. I could see why this might be tempting, but it's bad to let your notes accumulate."*

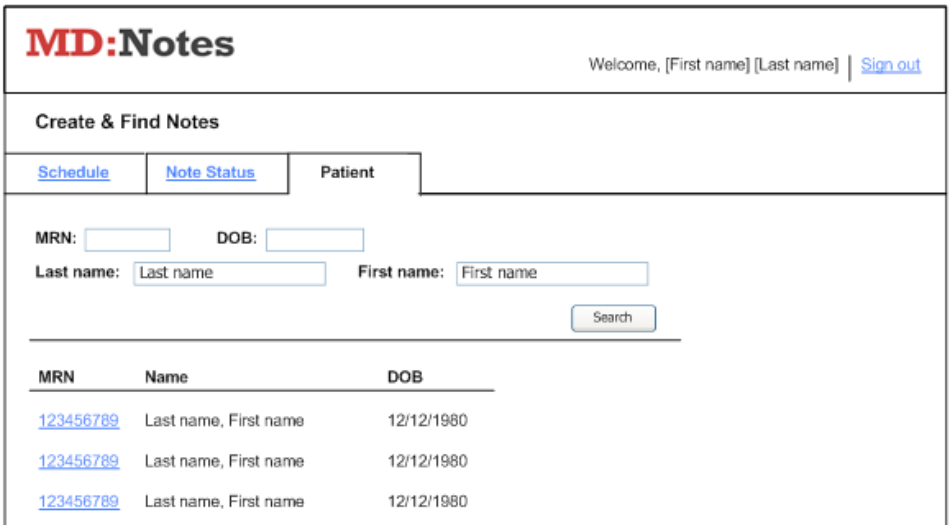
Design modifications:

- The view shown on this tab is very similar to that shown on the schedule tab. We decided to remove this tab and include a 'Note status' dropdown on the Schedule tab instead.

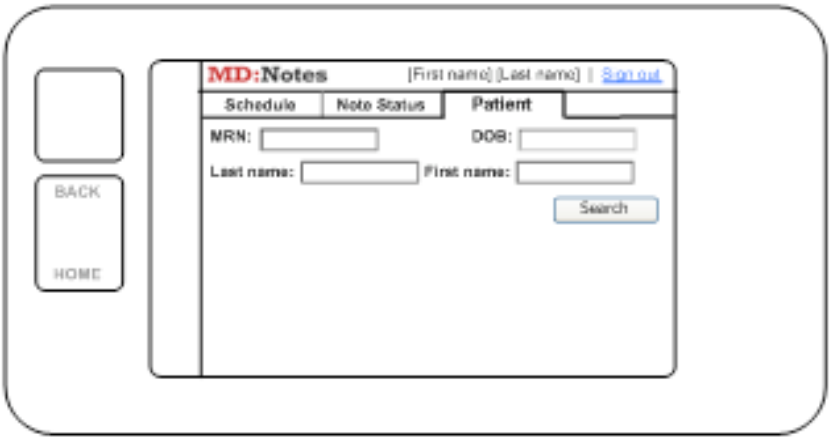
Patient tab

From this view, physicians can search for patients. If the search parameters result in more than one result, a list of results is displayed. Otherwise, we are directed to the relevant patient page.

PC/Laptop version



Mobile version



User reactions:

- Users would search by name before MRN.
- Instead of DOB (date of birth), age or age range would be more useful.
- Searching by address would also be useful.

Design modifications:

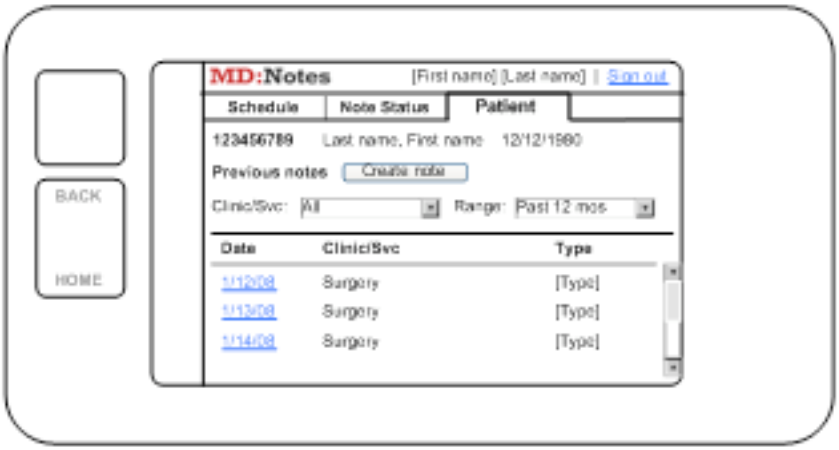
- Name should go before MRN
- Use a set of age ranges instead of DOB
- Provide search by address options under “More search options”

Patient page

This page lists previous notes written for a patient. Physicians can read previous notes as well as create a new note.

PC/laptop version

Mobile version



User reactions:

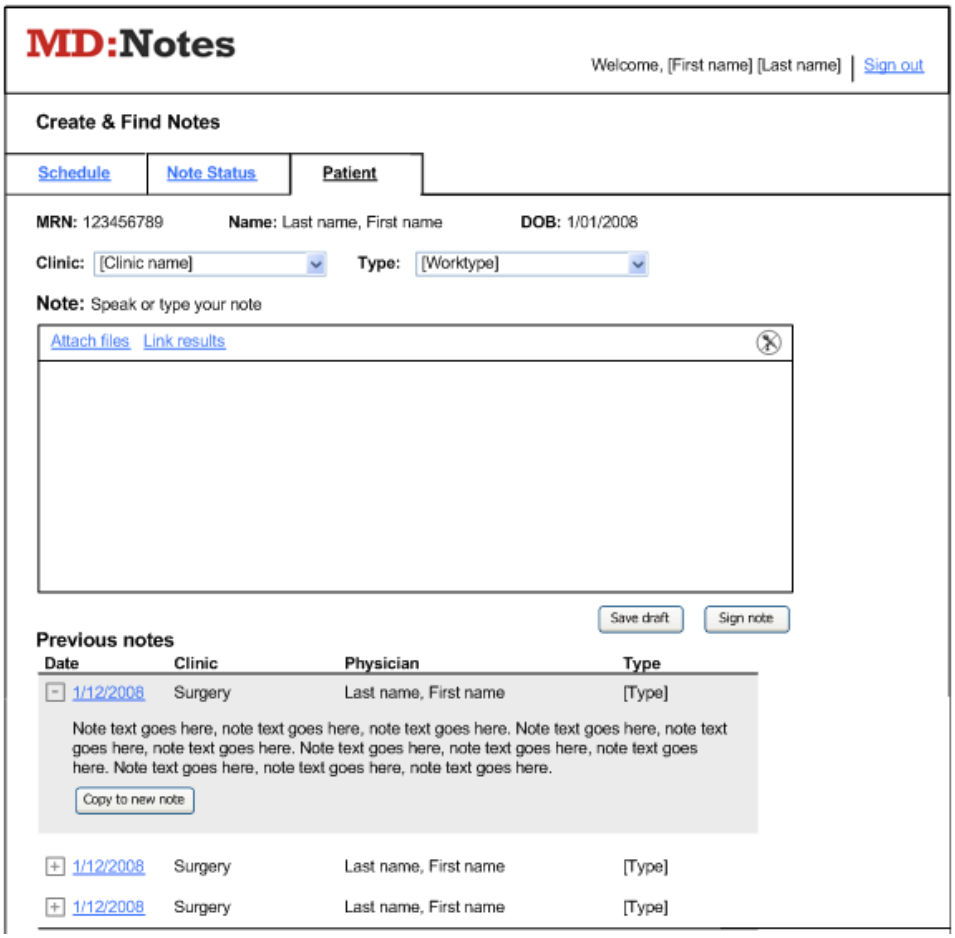
Users were confused by the layout around the Previous notes heading; the close proximity of the ‘Create note’ button confused them.

Design modifications:

Move the ‘Create note’ button out of the Previous notes section and into the patient information section. Add a heading for ‘Patient information.’

Create notes

From this page, physicians can speak or type notes, attach files, and link to lab results. In addition, physicians can view previous notes and copy them to a new note.



Mobile version

User reactions:

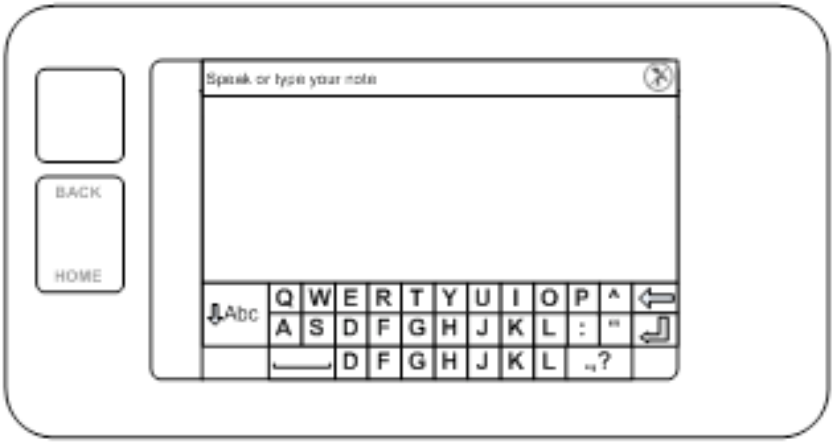
- **Copying previous notes**: Some user specifically requested this feature, but other users were less certain. They thought it would be useful, but were concerned that it could result in poor-quality notes, especially from less-experienced residents. From User1, *"It's a double-edged sword, because I think it paralyzes thinking. It might be a valuable function for certain clinics, but I would want this feature disabled. … I would want my residents to write a complete new note. [If they're copying a note], I'm afraid they're going to miss something important."*
- **Attach files**: Users agreed that attaching image files would be useful, but were concerned that if other types of files were allowed, this could detract from the quality of the notes. From User2, *"If you let people attach results without incorporating into the note, it might not be useful … the note could become unwieldy."*
- **Microphone icon (PC version only):** Users understood that the microphone icon would turn on/off the recording functionality.
- **Starting the note (mobile version only):** On the mobile version, users were unclear how they could begin to create a note.

Design modifications:

- **Copying previous notes**: We decided to keep this feature, pending additional user testing
- **Attach files**: This will be changed to 'Attach image'.
- **Starting the note (mobile version only):** Confusion around how to start a note may not be an issue with a functional version on an actual mobile device. This is something that can be tested only after we have a functional prototype.

Entering notes (mobile only)

When users have activated the text field, the text field fills the screen and the keyboard is available.



User reactions:

- Users understand that the microphone icon is used to turn on/off recording.
- Users would like the ability to hide the keyboard in order to have more space for entering notes – this user would dictate notes instead of type.
- Users were unsure how to return to the previous view for saving the note.

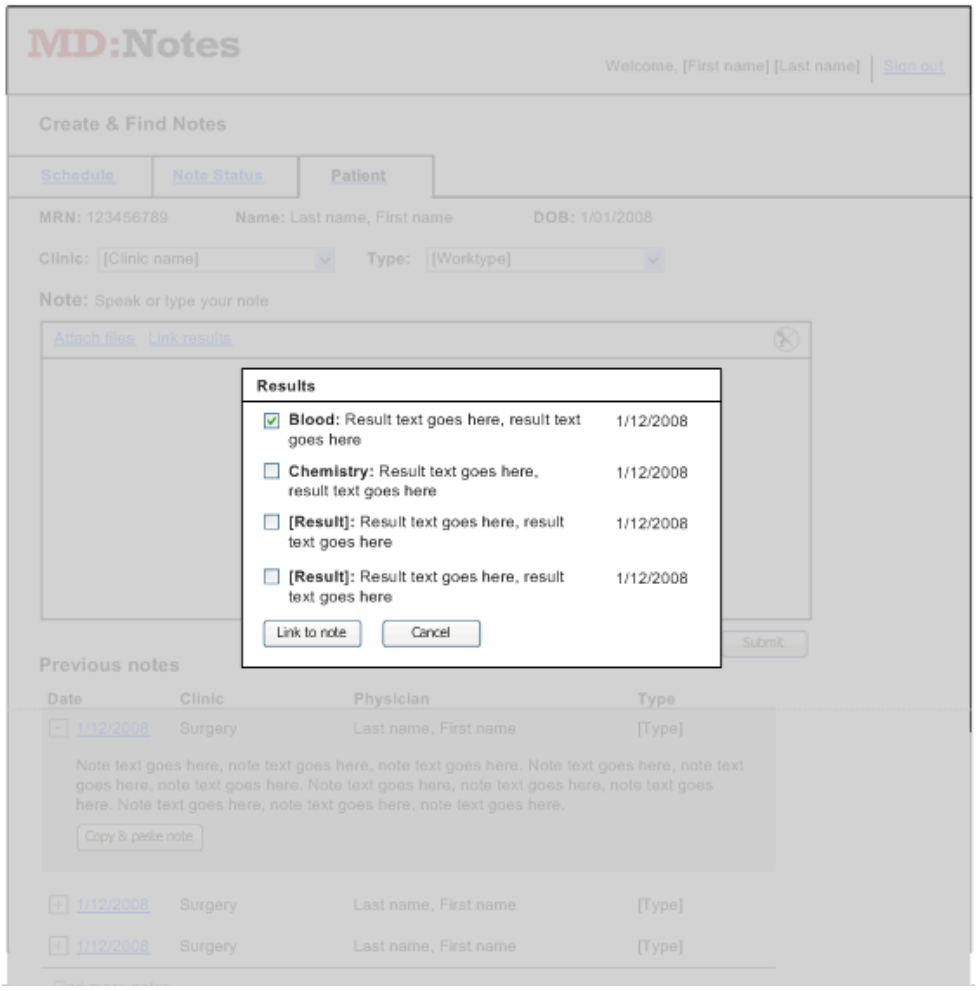
Design modifications:

- Add a button for hiding/showing the keyboard.
- Functionality for returning to the previous view after entering a note is controlled by the mobile device. We can test around this issue only when we have a functional prototype.

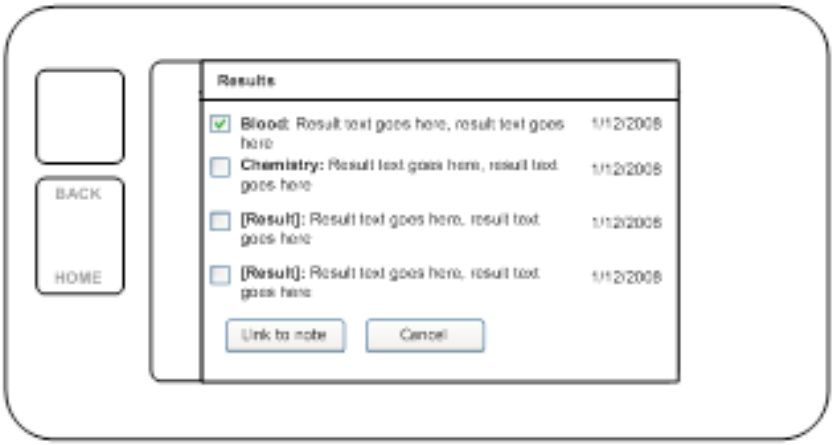
Linking Results

From this page, physicians can select a lab result to be inserted into a note.

PC/laptop version



Mobile version



User reactions:

For most types of lab results, users would not want to insert the entire note, but instead would want to copy relevant portions of the result into the note. Users need to be able to browse for specific lab results – this is a long list.

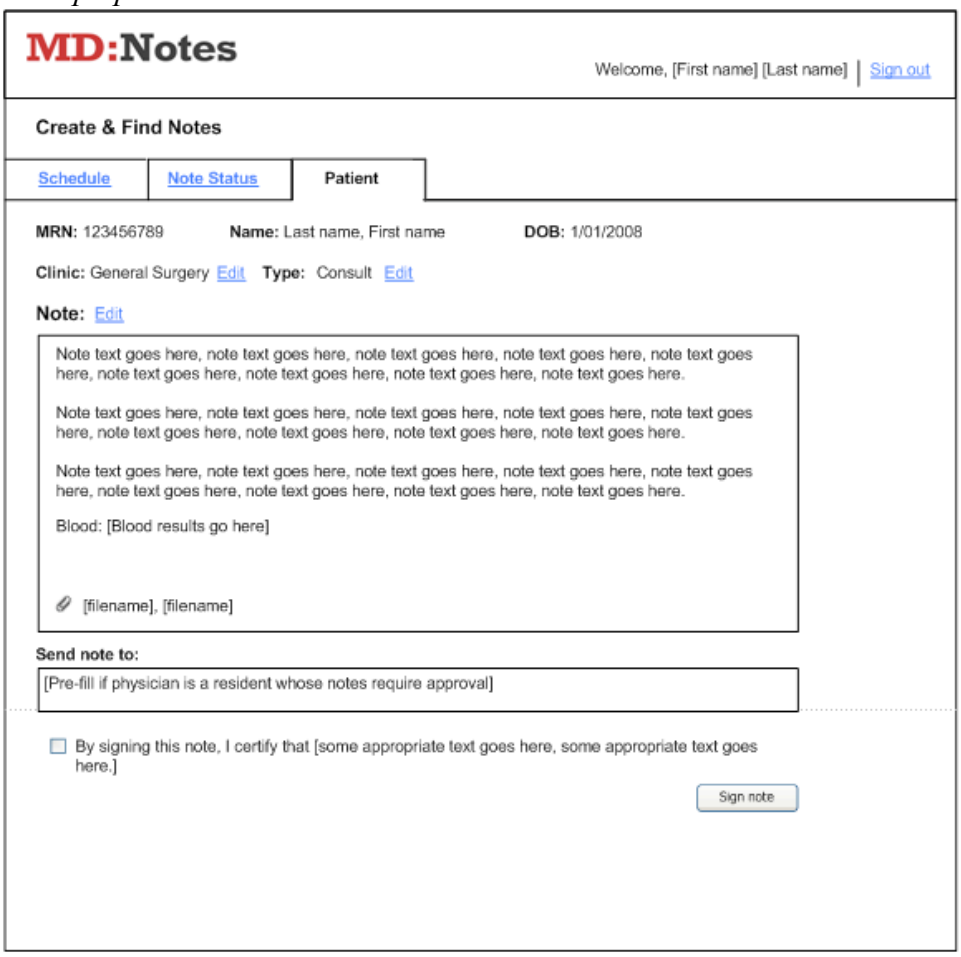
Design modifications:

We decided to remove this functionality from the prototype. Providing lab results in our system would mean duplicating large portions of the hospital's database. We will look at this issue again in the next version of our product.

Sign note

From this page, physicians can sign a note and copy other physicians.

PC/laptop version



Mobile version

User reactions:

- Users commented that prior to signing a note, they would have to re-enter a password.
- U02 expected to have to specify which departments should print and file the note.
- U03 thought the check-box for "By signing a note …" was unnecessary.

Design modifications:

- Add a password text field.
- Remove the check-box for "By signing a note …".

Summary of Paper Prototype Test Results

User 02 and User 03 had no major problems with the paper prototype of our design. User 02 commented that the product would be faster than the mobile dictation product she was currently using because she did not have to enter patient information each time she wanted to create a note. Both users understood how the product would support their workflows.

For User 01, however, the default Schedule view was different from the way he was used to working. He was used to copying his schedule from the overall clinic schedule, pasting it into a separate document, and then referring to this printed document throughout the day to get patient medical record numbers for looking up previous notes, and entering new notes into the dictation system. User01 was confused by all of the screens, and thought the product did not support the way he was used to working; he wanted the prototype screens to exactly reflect the order of steps he was took to create notes. Our sense was that after his initial confusion, he became frustrated and was no longer really looking at the prototype.

We think that User01's reaction may likely be similar to that of other physicians who are not comfortable with using computers. This is the classic dilemma of how to design software for novice users without creating a product that is cumbersome for more advanced users. Ultimately, we decided to stay with our more flexible workflow – not all users follow the same workflow as User01 – and provide a bit more instructional text for novice users.

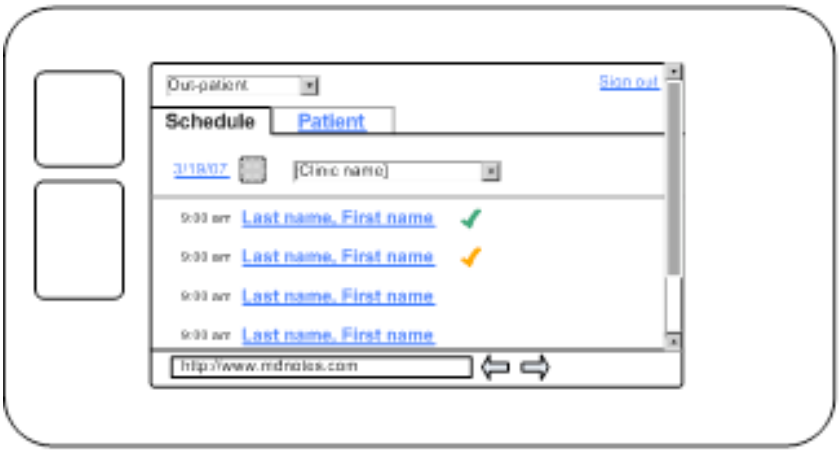
In our contextual inquiry, we identified that the combination of systems that are difficult to use, physicians who are not comfortable with computers, and physicians' lack of time to learn new systems was a key inhibitor for adoption of technology. Once we develop a functional prototype, we need to do further testing with physicians who are novice users in order to create a product that minimizes the learning curve.

Design for the Functional Prototype

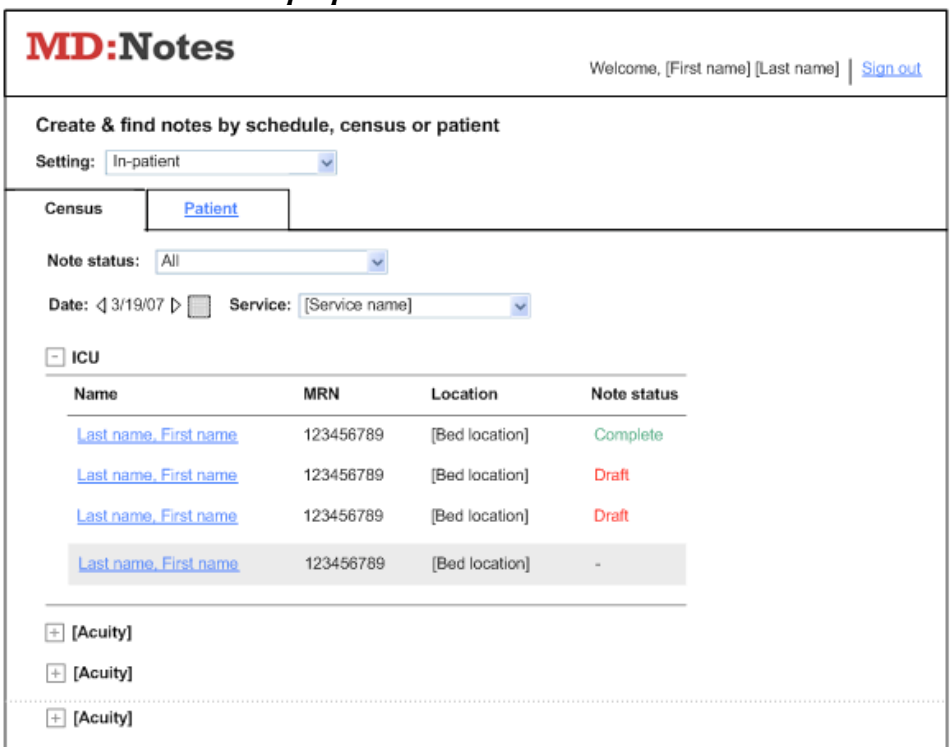
Following are screens of the revised design for the functional prototype, including visual designs. In the revised mobile version, in order to simplify the screens, we removed the branding, as well as the ability to find notes by 'Note status.'

Schedule view - PC/laptop version

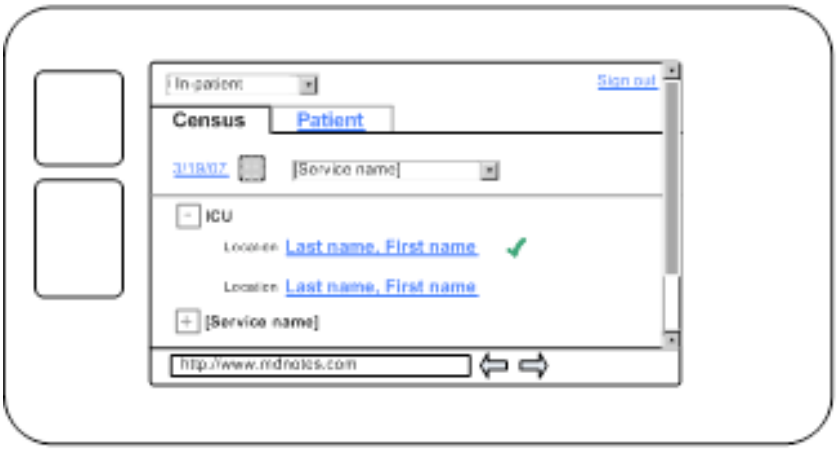
Schedule view – Mobile version



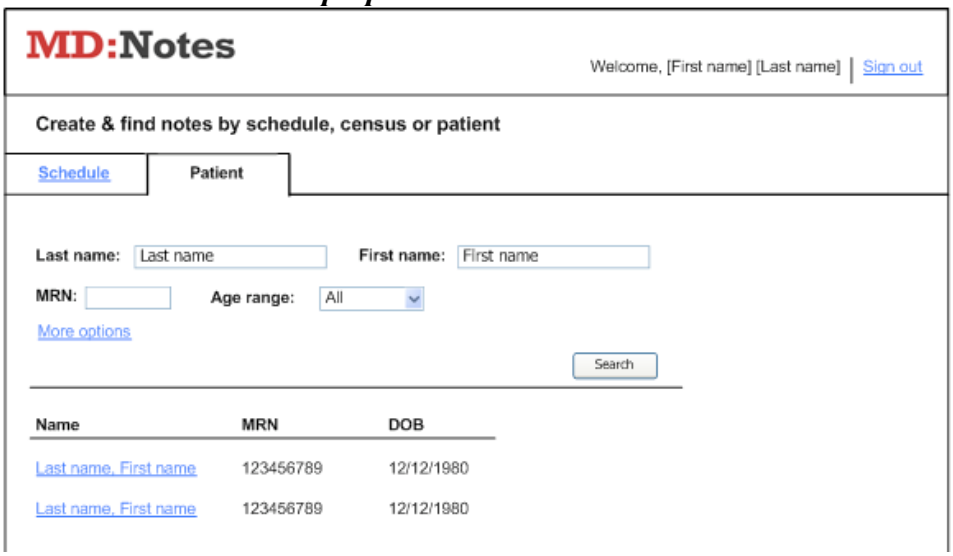
Census view – PC/laptop version



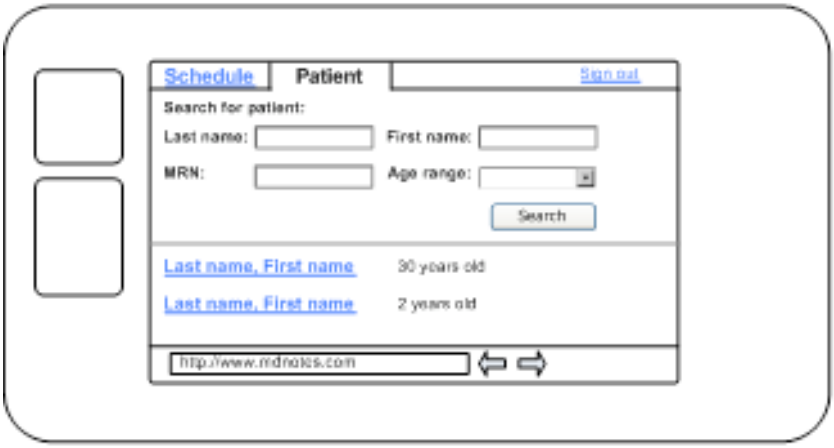
Census view – Mobile version



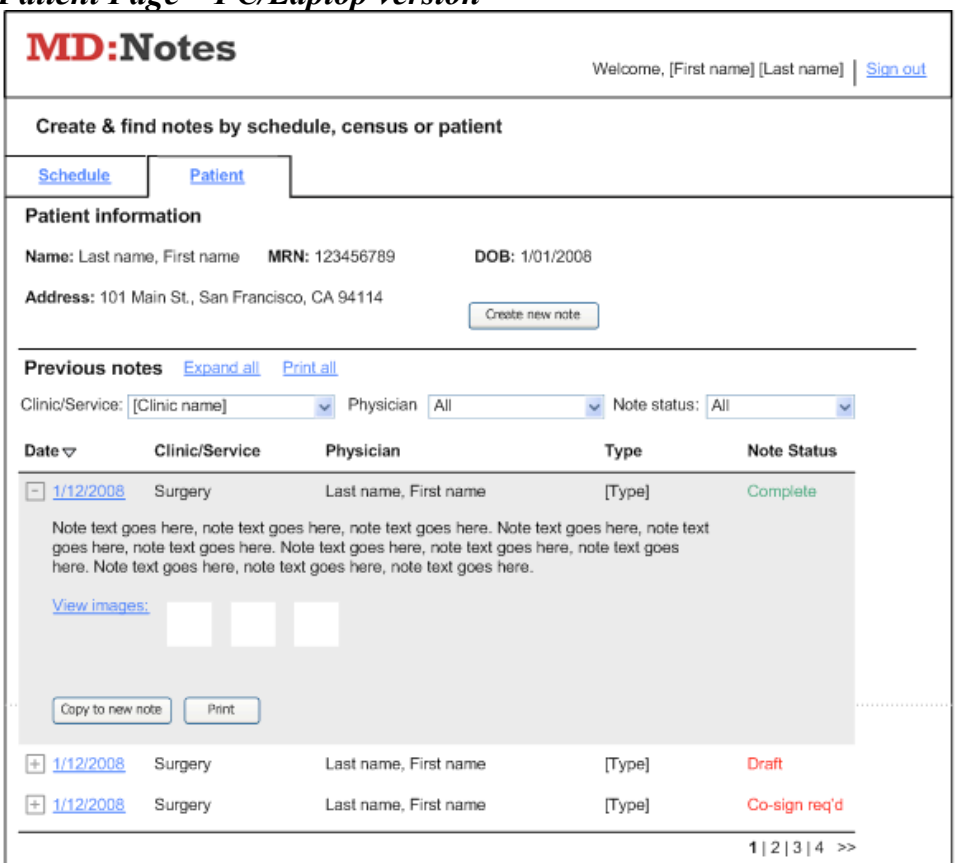
Patient Search – PC/laptop version



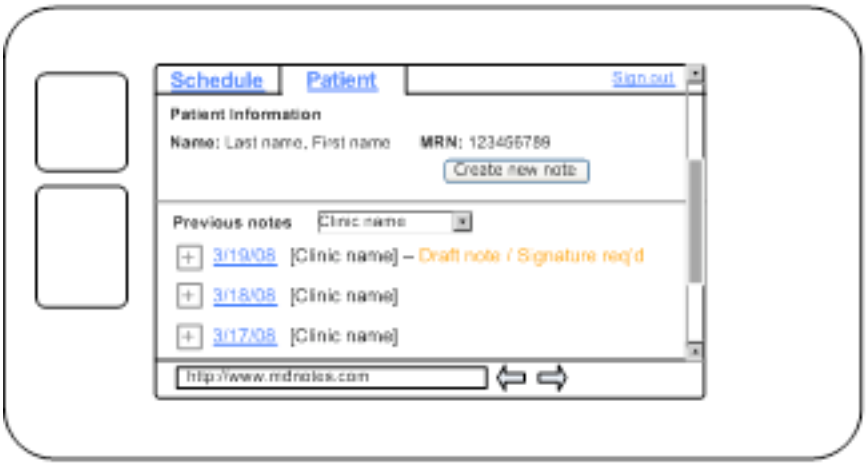
Patient Search – Mobile version



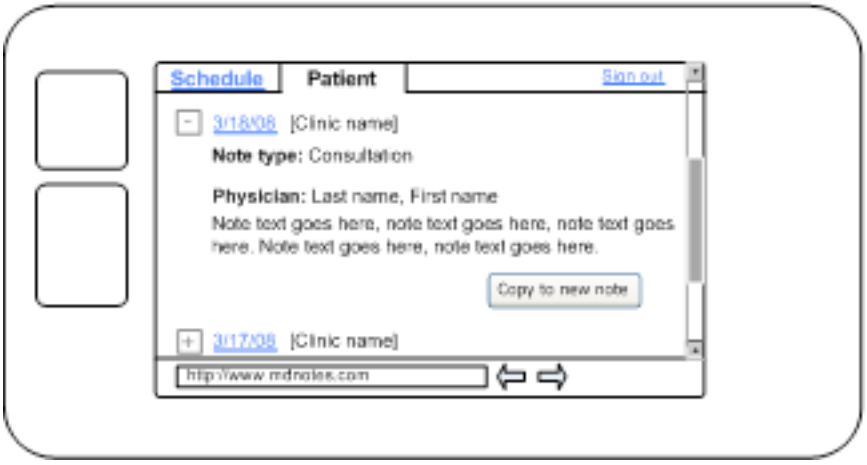
Patient Page – PC/Laptop version



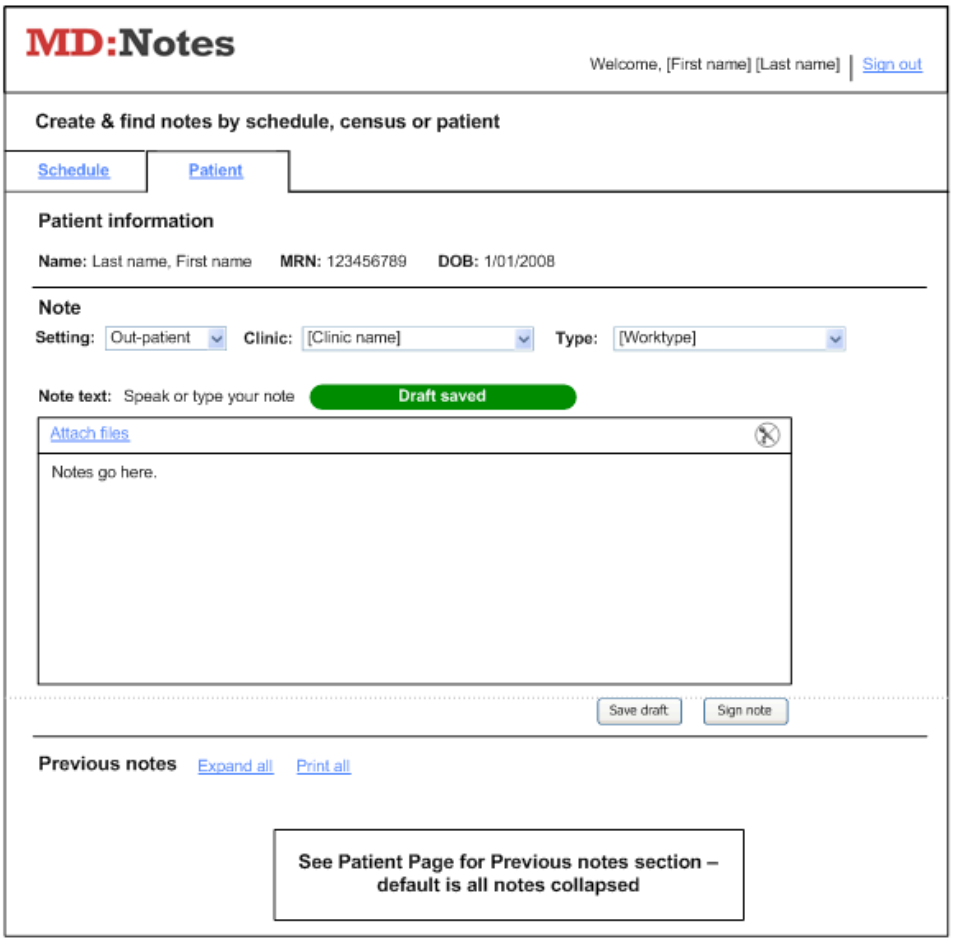
Patient Page – Mobile version



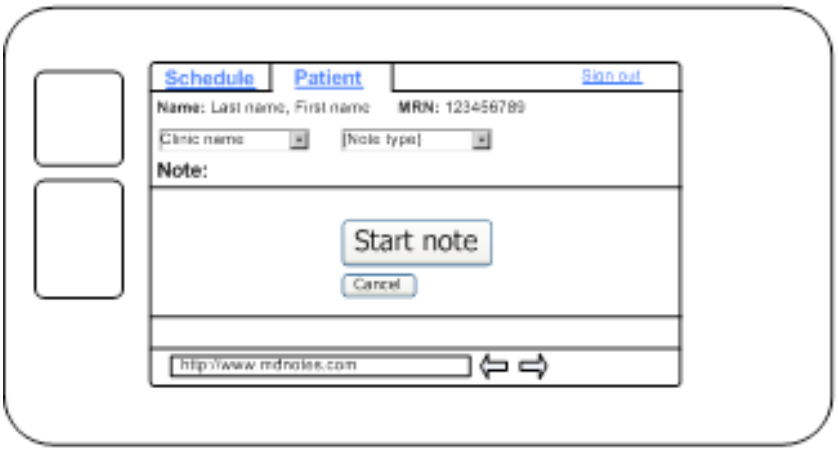
Patient Page with expanded note – Mobile version

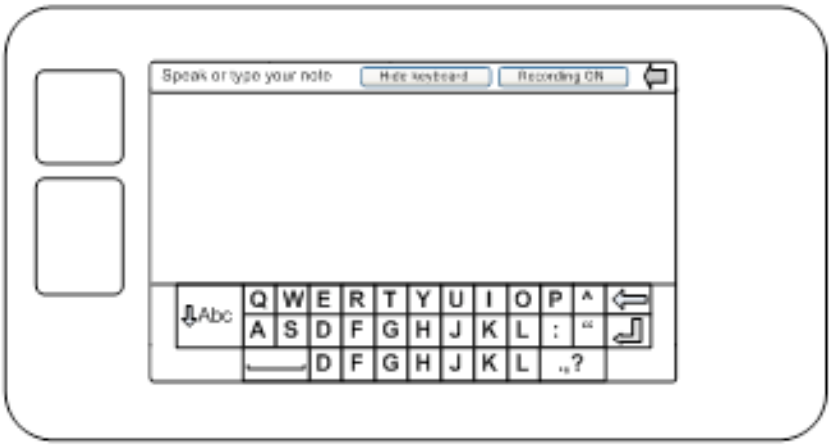


Create Note– PC/laptop version

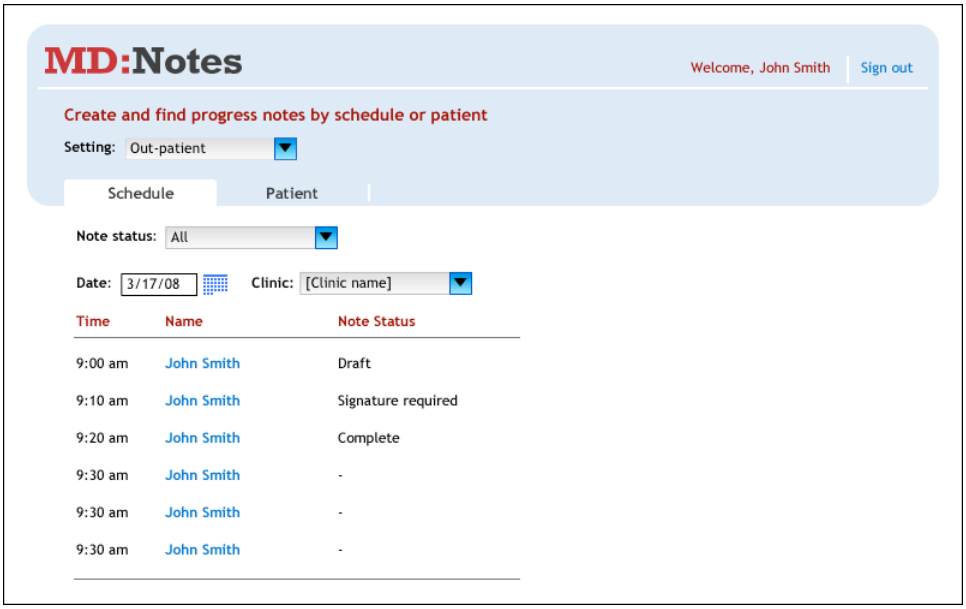


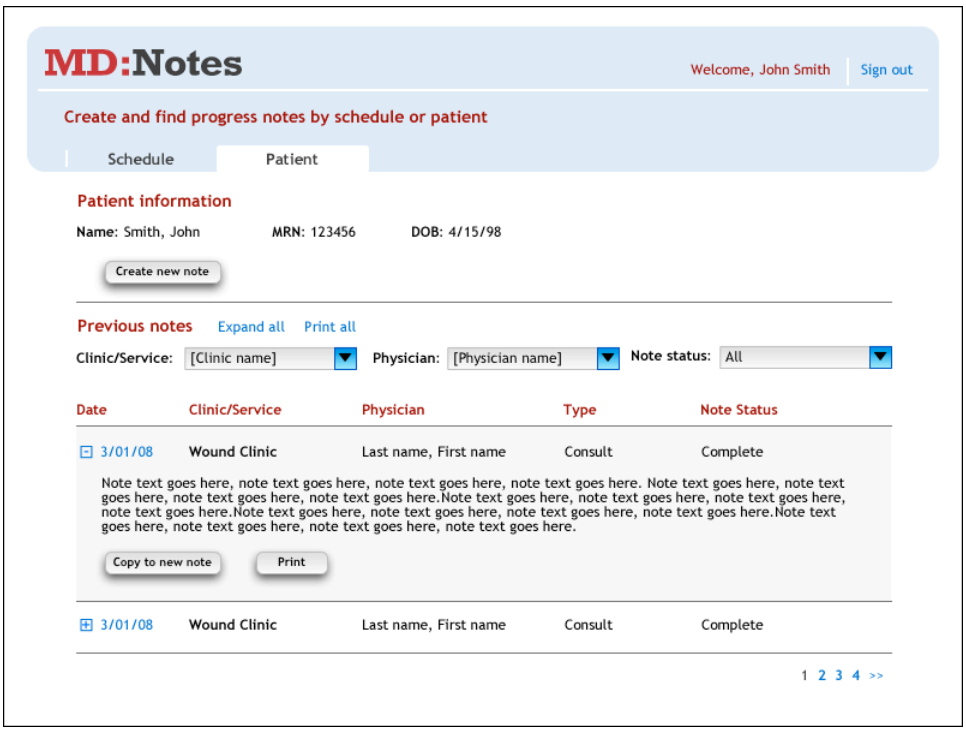
Create Note– Mobile version





Visual Designs





Conclusion

Based on our contextual inquiry, we created a paper prototype with features that support both inpatient and outpatient physicians' workflows. Of the three users we tested, two had no major problems. One user, a user with less computer proficiency than the others, did not understand the prototype. We believe his reaction may be similar to that of other physicians who are novice computer users.

In our contextual inquiry, we identified physicians' lack of comfort with technology as one of the issues in adoption of technology. It is important that our product be easy to use for this population of physicians. With a paper prototype, users cannot easily explore the product's features. With a functional prototype, novice users may be able to browse the features and develop a gradual understanding. We need to test our product with novice users once we have a functional prototype.

Using speech recognition on a mobile device is one of the main innovations of our product. By using client-side speech recognition, we avoid the time lag resulting from dictation and transcription, as well as allow for multiple methods of note creation (typing and speaking) within the same interface. Testing the efficacy of speech recognition interactions cannot be done with a paper prototype. Especially on the mobile device, where little to no prior work on client-side speech recognition exists, we need to evaluate the specifics of these interactions using a functional prototype.

MD:Notes

HIPAA, Patient Privacy, and implementation of MD:Notes

May 7th, 2008
School of Information, University of California Berkeley
Final Project Report

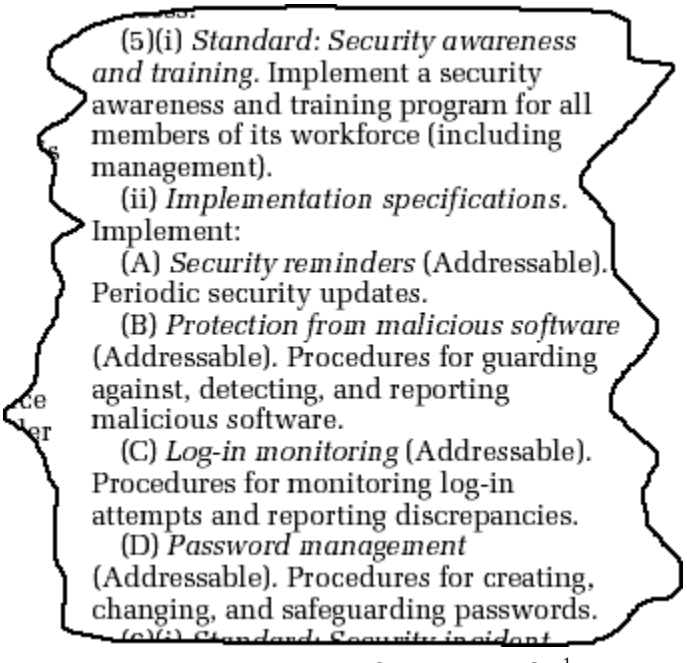
Katherine Ahern

Abstract:

This section summarizes some patient privacy considerations in implementation and deployment of a patient information capture tool.

HIPAA

In 2000, President Bill Clinton described privacy protections included in the Health Insurance Portability and Accountability Act: "The new rules we release today protect the medical records of virtually every American, they represent the most sweeping privacy protections ever written, ...This action is required by the great tides of technological and economic change that have swept through the medical profession over the last few years. ...So, the rules that we release today have been carefully crafted for this new era, to make medical records easier to see for those who should see them, and much harder to see for those who shouldn't." HIPAA discusses in detail features that must be implemented for hospitals to comply with patient privacy legislation.



(5)(i) *Standard: Security awareness and training.* Implement a security awareness and training program for all members of its workforce (including management).

(ii) *Implementation specifications.* Implement:

(A) *Security reminders* (Addressable). Periodic security updates.

(B) *Protection from malicious software* (Addressable). Procedures for guarding against, detecting, and reporting malicious software.

(C) *Log-in monitoring* (Addressable). Procedures for monitoring log-in attempts and reporting discrepancies.

(D) *Password management* (Addressable). Procedures for creating, changing, and safeguarding passwords.

Fig 1: some HIPAA implementation rules[1]

[1] Cosaint company website, http://www.cosaint.net/rules/hipaa.html

Why should we protect medical data?

Risks to individuals include:

- Employer discrimination, loss of livelihood
- Blackmail
- Restricted travel, marriage in the case of HIV
- Criminal charges if knowingly transmit HIV

These risks (and other factors) can contribute to individuals avoiding getting tested in the first place, which can lead to individuals failing to get proper treatment, and also increased spread of disease when it is unknowingly transmitted. Insecurity in medical systems has terrible implications both for individuals and for society.

Employers and insurers are using new techniques to find out who is going to generate the most claims. Although there are laws protecting workers from being fired for health conditions, the economic incentive for employers to keep health care costs down is considerable.

Risks to Doctors and Hospitals of unsecure data

The Privacy Rule of HIPAA establishes regulations for the use and disclosure of Protected Health Information (PHI). PHI is any information about health status, provision of health care, or payment for health care that can be linked to an individual.[2] A person who knowingly violates the Privacy Rule may:

• be fined not more than $50,000, imprisoned not more than 1 year, or both;
• if the offense is committed under false pretenses, be fined not more than $100,000, imprisoned not more than 5 years, or both; and
• if the offense is committed with intent to sell, transfer, or use individually identifiable health information for commercial advantage, personal gain, or malicious harm, be fined not more than $250,000, imprisoned not more than 10 years, or both.[3]

[2] Code of Federal Regulations section 164.501
[3] Rada, R. (Roy), HIPAA@IT Essentials: Health Information Transactions, Privacy, and Security, 2nd Edition

Implications in the implementation and future work of MD:Notes

Although we did not implement access controls and auditing of viewing patient information, the way we emulated a hospital's electronic medical record system, and our login and rendering implementation, supports role-based access controls and auditing. This supports the idea that an electronic medical record can offer superior privacy and accountability to paper records.

We decided to place our web application over secure socket layer to demonstrate our commitment to privacy, however our prototype implementation is not meant to demonstrate a fully secure system, but more to show the feasibility of the key features of our contextual design.

Conclusion

Any tool built for a hospital must comply with regulations and ensure adequate patient protection. We did not implement security fully for the MD:Notes prototype web application, nor did we intend to. Our technology and architecture support full security features in future work.

MD:Notes

Implementation of the MD:Notes prototype

May 1st, 2008
School of Information, University of California Berkeley
Final Project Report

Katherine Ahern and Zachary Gillen

Abstract:

The purpose of this section is to describe our thought processes and research implementing the MD:Notes prototype web application. There are a lot of choices available when deciding how to implement an information system, with different costs and benefits associated with each one. Our prototype demonstrates key features of our contextual inquiry, demonstrates our interaction design, and shows how issues of interoperability, connectivity, and sufficiency can be addressed.

Acknowledgements:

This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team member is Jill Blu Lin. See "MD:Notes – Summary" for a summary of the report.

Thanks to Bob Glushko, our adviser on the project.

Implementing a schedule/census based design

When starting the development of the prototype application for entering progress notes, we turned to the 'key takeaways for design' section of the contextual inquiry and the wireframes from the low-fidelity prototype. The primary feature driving the layout of the wireframe interaction is the inpatient census and outpatient schedule view. The idea here is that all clinicians work in a specific specialty, whether inpatient or outpatient. For example, one physician might be an attending for the trauma surgery inpatient service, while also seeing patients once a week for the outpatient vascular surgery clinic. On days when this physician is scheduled to work in the vascular surgery clinic, they are going to want to have their default page in the application show them their schedule of patients. This will greatly reduce the amount of time required for interaction with the system as opposed to looking up patients individually. On other days with the physician is working in the inpatient trauma surgery wards, the default view will show this service with patients listed in order of acuity (the sickest, or most critical patients are shown first).

Implementing this feature requires the MD:Notes prototype to access many different core data components and their relationships. In particular, it requires the following:

- The clinician master table list relevant demographic information, title and identifiers.
- The patient master table list relevant demographic information and medical record number (This is the term for the unique patient identifier used across many different hospital systems).
- The master schedule relates a clinician, date, time, service and patient
- The hospital census relates clinicians, location, service and patients.

At first, our team discussed the possibility of modeling all this information in xml and driving the interaction from this source. However, there were several reasons why the team ultimately decided against implementing the overall structure in xml.

MD:Notes is not trying to recreate an electronic medical record

Most hospitals already have a version of an EMR installed where this information is the authoritative source. Our prototype is to provide a mechanism for easier note entry, not trying to reinvent the underlying electronic record system.

Highly transactional information: This information is constantly updated in the medical setting and inherently transactional. Schedules are updated, patients are moved to various rooms and services, patients change addresses, and physicians change titles or services frequently. Our prototype wanted to minimize the amount of data stored outside the electronic record, preventing another vertical silo of information that could be out-of-synch with other sources.

As a result, we decided that all information coming from these sources should be based on queries to the electronic medical record. The benefit is that because all information is being updated in the EMR real-time, our application would have current schedule and census information for the clinician at every screen refresh or call to the database. The problem with this method is gaining direct access to these proprietary systems, or slowing down performance on the live EMR. Most institutions are beginning to implement reporting (OLAP or replication) servers for internal decision support and reporting applications that mirror the electronic medical record. Hospital B has already built an ad-hoc reporting database and is currently in the process of purchasing the vendor's complete reporting solution. We believe that Hospital A will eventually follow this same path, as all healthcare organizations have an ever increasing need for access to critical patient information and application development outside of what's provided by the service vendors. For the purposes of the final project and building a prototype to display to the public, the decision was made not to implement the database queries directly to the actual OLAP EMR of Hospital B. Getting the appropriate permissions to develop inside the hospital's firewall and information privacy concerns were outside the scope and time requirements for this project. Instead, we decided to build a MySQL representation of the OLAP EMR with only the tables and test content appropriate for our application (see Figure 1).

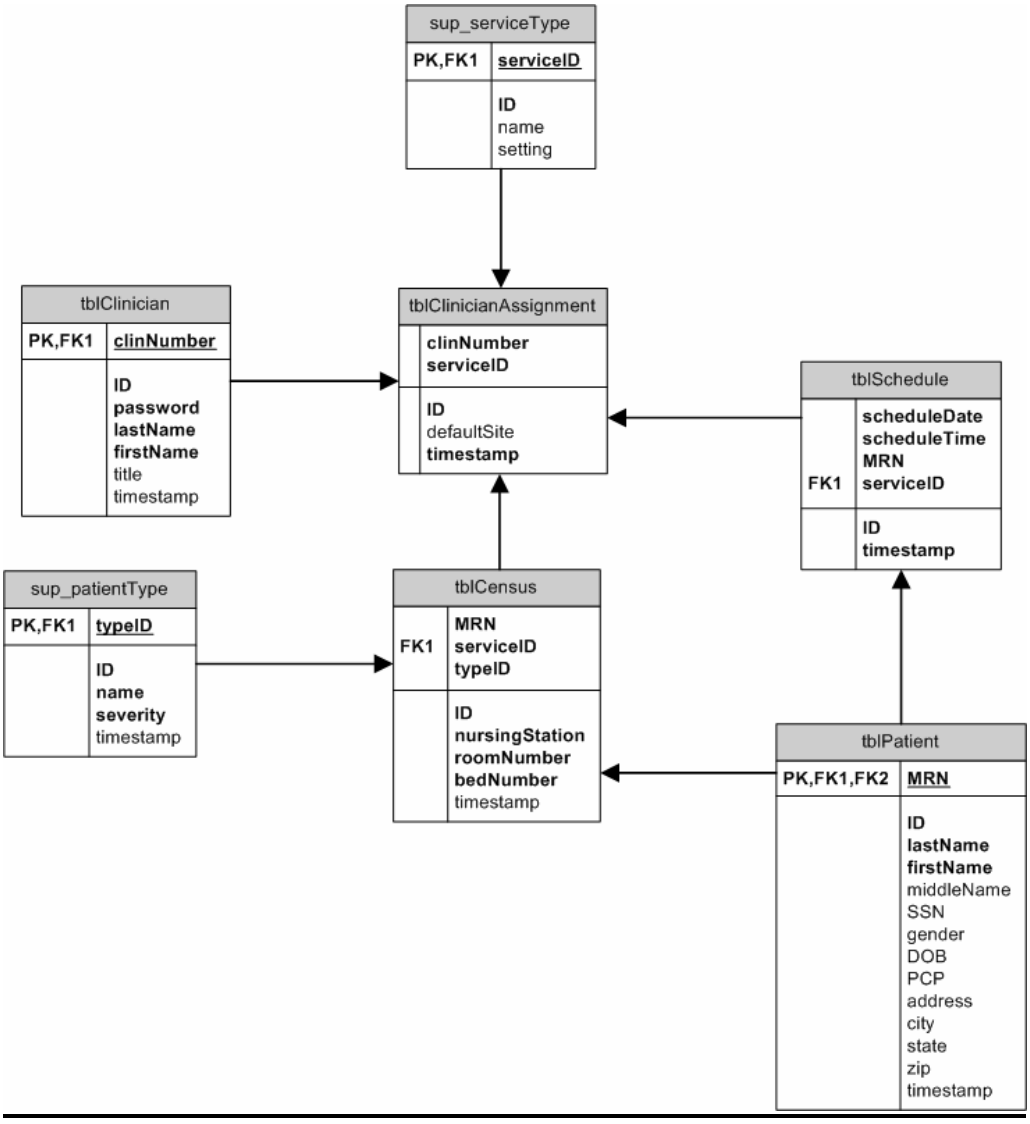


Figure 1: *The ER Diagram of the MySQL database representing the hospital's electronic medical record.*

We decided to develop a database that would emulate the kinds of relational systems a hospital would already have in place. Elements of the user interface such as clinic/service name are populated from a table, as they would be in a hospital setting. Associations like doctor name and id are also best captured relationally, for system performance reasons.

This is highly transactional; if we were to implement this in an xml system we would need constant streams of HL7 data, which would be redundant because those streams already exist.

Why XML

We chose XML because we are capturing narrative information. A hospital is document-centric. XML supports an automatable, standards-based system.

The incorporation of templates for future notes makes XML an ideal, extensible platform. In our Roadmap to Deployment report, we discuss future work in which more of the document spectrum will be represented, because notes can be very structured in one department and unstructured in another.

While this could be captured in a relational database, the retrieval benefits of XML allow a variety of templates, aggregations, and recombination for new visualizations.

Model development

We developed a model for a patient. It is a loose model. Our intention is not to recreate all the possibilities of a patient's records with the hospital, but to show how we can capture notes in an XML patient record. Our model is an incomplete model by design – we don't include financial information, lab results, etc. It is extensible in that these could be added, but we concentrate on clinical note capture.

Encoding

Our patient model and note model are encoded in the same document, which helps clarify the relationship between note and patient and prevents some errors, including multiple patients being associated with one note.

We did not put very many restrictions on our encoding. We can't predict what is coming from the EMRs, and all we are capturing is the note. Our intention is not to perform validation of the information coming from the EMR, and we presume that information has its own validation.

Displaying patient data from XML

The most elegant and quick way to style XML is with XSLT, but you can also pick out values from XML with PHP. We named our XML files with the MRN number of the patient, for example “Harrison Ford’s MRN is 87654322. We took the MRN number from post data in our application to read previously created files with MRN numbers as their names.

Capturing form data into XML

We captured form data with PHP and used PHP 5 operations to create well-formed XML.

Conclusion

The MD:Notes prototype web application demonstrates the functionality of key features, demonstrates interaction design, and provides a framework for future work.

MD:Notes

Technical Design Choices and a Roadmap to Deployment of the MD:Notes Project

May 1st, 2008
School of Information, University of California Berkeley
Final Project Report

Katherine Ahern and Zachary Gillen

Abstract:

This section summarizes our key design choices and provides a roadmap from our technical design and prototype solution to a deployable application. Healthcare is an information intensive enterprise where the capture and retrieval of clinical notes is a key part of patient care. While our prototype application includes some features that streamline the process for note entry and retrieval, there are several others that could further enhance our product in future versions.

Acknowledgements:

This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team member is Jill Blu Lin. See "MD:Notes – Summary" for a summary of the report.

Thanks to Bob Glushko, our adviser on the project.

Progress Notes and the Document Type Spectrum

Progress Notes contain a mix of narrative descriptions of patient disposition (the doctor's observations), and data that can be either narrative or transactional (blood pressure, pulse, lab results, etc.). A Document Engineering approach can model the integration of these kinds of data, so doctors can get the full range of information they need during an actual examination: "Many people have contrasted narrative types of documents that mostly contain text with transactional types that mostly contain data, and they typically conclude that documents and data require different terminology, techniques, and tools in XML vocabulary development. But narrative and transactional documents are often closely related, either by structural transformation or by business processes. The emerging discipline of Document Engineering proposes a document-centric reformulation of traditional data analysis, and recasts its formal and specialized methods like normalization to apply equally to narrative-style documents. At the same time it takes the best practices of document analysis and applies them to understanding information components identified in transactional contexts."[1]

In the current prototype, the only field that is manually entered or updated by a clinician is the actual progress note 'content' text box. This is currently an area where a large amount of unstructured text can be entered. Our model of the patient allows the addition of future templates for various clinics or services. For example, the trauma clinic could decide to model a progress note into a SOAP (Subjective, Objective, Assessment and Protocol) format. This type of SOAP note is typical in the clinical setting and allows a little more structure for clinicians to enter various components of a progress note. The advantage of supporting these templates is the shift towards narrative to more structured text and the powerful retrieval potential of xml. For example, it would be easy to generate transformations to allow physicians to look across only the 'Assessment' portion of all progress notes for a patient.

Another area for future development is the incorporation of result information which is extremely transactional. Many clinicians expressed interest in being able to drag in 'Laboratory Objects' that would automatically populate these fields with the latest laboratory results for that patient. For example, a physician is entering a progress note and wants to add the latest CBC (Complete Blood Count) panel into the note. This panel includes seven or more different blood tests (hemoglobin, hematocrit, white blood cell count, etc.), and by dragging this object from a results set, it could automatically populate all the values for each test. This kind of functionality

[1] Glushko, Robert and McGrath, Tim: Document Engineering. (Massachusetts Institute of Technology, 2005)

reduces the amount of time required for physicians to write down lab results and copy them directly into the note. Even further out would be the incorporation of a rules based engine connected to the results that would recognize values outside of the normal range. Anything unusual might be displayed in orange font, while results that are critical might be red.

Implementing Transformations: XSLT and MySQL

We originally proposed using XSLT to show how the XML document modeling the patient data can be created from HL7 data from legacy systems. We ended up deciding that it made most sense to simulate the hospital electronic medical record with a MySQL database that directly drives the application interaction. For example, associations of doctors with their primary clinic, which populates parts of the UI, or the list of possible sites for a progress note. We encountered some performance problems with XML parsing in PHP 5, which further supported the idea of getting the data directly from a relational system rather than pulling it into a document first. PHP is a great prototyping language, but for a scalable, maintainable hospital system Java (or another technology) would certainly be a better choice.

Using XML to model the patient proved valuable in its ease of translation to the HL7 standard, showing how XML can support interoperability, as discussed above.

Possibly the most important aspect of our application is that it be able to synthesize data from all the different systems in the hospital - clinics, radiology, lab results, imaging systems, etc. and present the data to the physician without the physician having to guess which departments to contact to request patient data. We made the decision to handle this in the application rather than have the XML document modeled with the first physician request. This would probably remain even as a more secure and robust systems were implemented, but it might also be dependent on how the legacy systems are implemented.

Currently many of the hospital's systems are not connected, and our aim is to connect them. We hope we have shown a possible method for integration, defined as the controlled sharing of data between any connected applications or data sources.[2] In a hypothetical deployment case, the information from the disparate systems would first go into the authoritative EMR (via HL7 messaging) and then our application will be accessing the reporting server, the OLAP cube or data warehouse.

[2] Glushko, Robert and McGrath, Tim: Document Engineering. (Massachusetts Institute of Technology, 2005)

In the key takeaways for design report, we described how a clinical progress notes product should support multiple methods of entry on multiple devices - XML supports using a single model for all different client devices. We also mentioned linking to lab and test results - an example of integrating transactional with narrative data in XML.

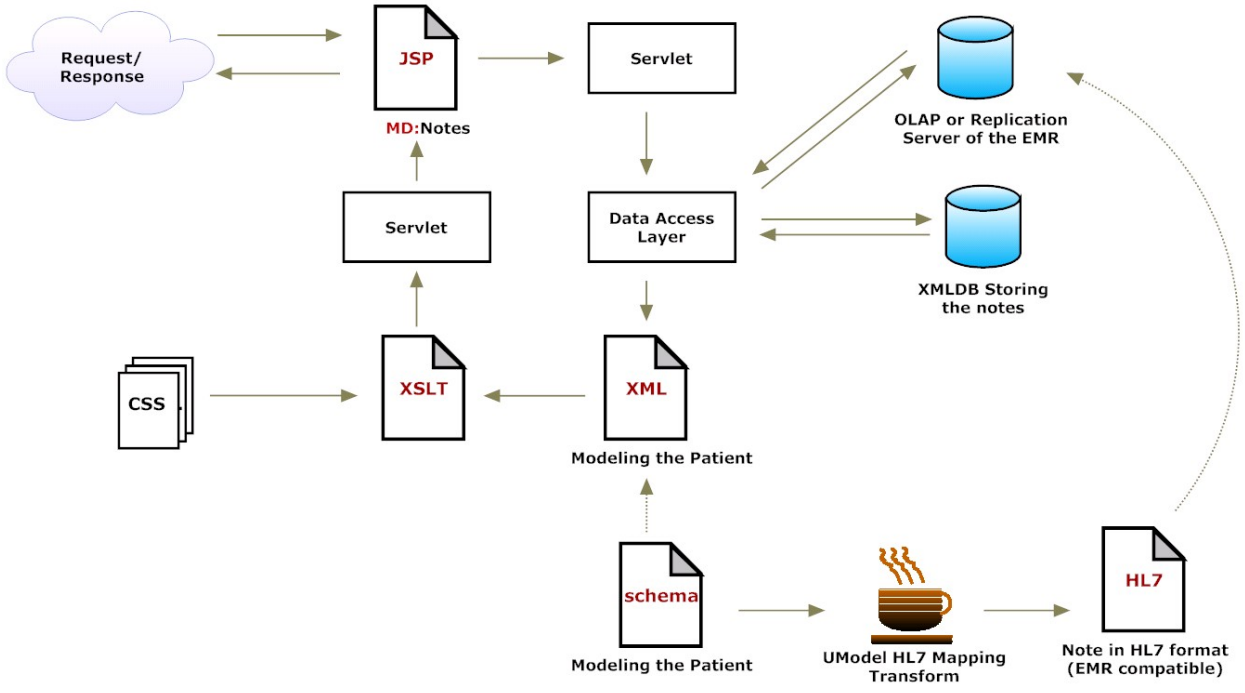


***Figure 1**: Description of how MD:Notes would be deployed*

Implications of the Interoperability Mandate

In "Privacy Protection and Technology Diffusion: The case of Electronic Medical Records", Amalia Miller and Catherine E. Tucker write, "The network benefit of EMR comes from hospitals being able to exchange information with each other about patient histories. This is particularly important for patients with chronic conditions who wish to see a new specialist. It is also important for emergency room patients with chronic conditions who wish to see a new specialist. It is also important for emergency room patients whose records are stored elsewhere."[3] Any technical architecture proposed should have some clear path to support this

[3] Miller, Amalia R. and Tucker, Catherine, "Privacy Protection and Technology Diffusion: The Case of Electronic Medical Records" (February 5, 2008). NET Institute Working Paper No. 07-16 Available at SSRN: http://ssrn.com/abstract=960233

kind of interoperability. This is a discussion of network benefits at the intra-hospital level, but the same is true if one considers different departments of a hospital a network. The same conditions that make XML so effective for interoperability between business systems are true for hospitals, once issues of security and privacy have been addressed.

In our prototype, we show an example of modeling a patient in XML. We use this to show how XML can help satisfy issues of multi-device support, connectivity, interoperability, and sufficiency. We also show the transformation from our schema to HL7 (as discussed in "Mapping from MD:Notes to the EMR"). This shows how we satisfy some of the issues of interoperability in a hospital environment.

Supporting Multiple Devices

One avenue we explored to support multiple devices is WURFL. "The WURFL is an XML configuration file which contains information about capabilities and features of many mobile devices."[4]

Possibly the most important aspect of our application is that it be able to synthesize data from all the different systems in the Hospital - clinics, radiology, lab results, imaging systems, and present the data to the physician without the physician having to guess which departments to contact to request patient data. In our application, the data would be requested from the many different systems, and a single document with all patient lab and exam results would be created. Currently at Highland hospital many of these systems are not connected, our aim is to connect them. Via this method we will achieve integration - "Integration is the controlled sharing of data and business processes between any connected applications or data sources."[5]

In our needs assessment with Highland Hospital, one of the greatest challenges to doctors that we found is the need to contact numerous departments to recreate patient data that isn't available. For example, a plastic surgeon in the wound clinic described how he estimates only about 20% of patients have a chart available at the time of examination. This physician frequently has to quickly become familiar with the patient's history before examination, sometimes requiring faxes from other departments, questioning the patient, or performing procedures that have already been performed.

[4] Description of WURFL from http://wurfl.sourceforge.net
[5] See supra 2, p. 136.

Using the PHP scripts associated with WURFL to check device capabilities doesn't support loose coupling of data and presentation (a single script uses if statements to check device capabilities and serve content, rather than a separation of content and presentation). In MD:Notes we decided that loose coupling will better support a future integration process with legacy systems: since a carefully modeled XML document supplies patient data in a coherent and human-readable form, the task of getting patient data from multiple systems into a single source is much easier than if a programmer has to dive deep into a complicated PHP script.

Conclusion

As mentioned in our implementation report, hospital systems are notoriously expensive. New technology, data management techniques, and project management techniques are bringing down cost and time-to-market in the private sector, and hospitals are putting huge amounts of resources into improving their information management. We hope our reports will be helpful for the development and deployment of future systems.

MD:Notes

Mapping from MD:Notes to the EMR

May 1st, 2008
School of Information, University of California Berkeley
Final Project Report

Zachary Gillen

Abstract:

This section describes the methodology to map our schema instance to the Health Level 7 standard for healthcare. Both Hospital A and B utilize this messaging standard for sending information to the Electronic Medical Record (EMR). To prevent MD:Notes from becoming another silo of information, it must have the ability to send these messages to the EMR. First, we identified the core components from the HL7 specification. Once accomplished, we identified those unique information attributes required by the vendor's EMR at Hospital A and B. We used Altova MapForce to translate the schema into the desired HL7 version 2.4 specifications. Using MapForce allowed extensibility for future changes and additions to the messages, while providing an easy mapping tool that automatically generates the parsing and translation code.

Acknowledgements:
This report is part of a team project for a Master's Degree at the School of Information, UC Berkeley. The other team members are Katherine Ahern and Jill Blue Lin. See "MD:Notes – Designing an Information System for Public Hospitals" for a summary of the report.

Introduction to HL7:

The MD:Notes application must meet the needs of the secondary stakeholders for it to be taken seriously within the hospital setting. In particular, the administration and information system departments require that notes be entered into the electronic medical record (EMR). This is both for compliance and to prevent further vertical silos of information. While both hospitals continue to maintain a paper chart, the goal is to transition completely over to the electronic record. Therefore, all new digital applications need to send information to the EMR. For this reason, it's critical to demonstrate that the MD:Notes prototype can generate progress note messages that are compatible with the hospital's EMR.

The EMR system accepts Health Level 7 version 2.4 compliant messages at both Hospital A and B. Health Level 7 is a global organization of experts that create the standards for information exchange and management of electronic health information. An example of these message types is ADT (admissions, discharges and transfers) which updates all the systems as to current patient location, or of a patient encounter. The problem with version 2.x is that messages are not semantically interoperable because it lacks an explicit information model.[1] This means that all messages of a particular type, such as the ADT, might not have the same number of fields in each message coming from different systems (see Figure 1 for an example). In other words, while there is an underlying model that forces some fields to be required and others optional, there is flexibility with interpretation as to the meaning. Also, version 2.4 allows optional fields to be added to the model. As a result, version 2.x of HL7 has critical limitations that require organizations to maintain external documentation to interpret messages. As a result, the Health Level 7 standards body introduced version 3.0 which added clinical document architecture (CDA) and semantic interoperability. The problem with version 3.0 the amount of complexity required to generate a single message. For the majority of inter-organizational messaging, version 2.x remains the standard.

In creating this mapping, it was important to apply document engineering methods for harvesting the particular components and developing the core model, with the addition of additional 'contexts' as components are added for different message types.[2] Developing the core model of components began with identifying the three documents that identified the necessary components.

1. The overall structure of the version 2.4 HL7 standard: While there are many components in the standard not utilized for sending a progress note, this still provided the framework for determining the three core sections; message header, patient information and observations.
2. Those fields and default values expected by the EMR: Both hospital A and B have the same EMR vendor, so the structure and expected values of progress note messages are identical. The EMR expects particular required fields and default values for delimiters, identifiers and other means to associate the message.

[1] Dogac, A., T. Namli, et al. (2006). "Key Issues of Technical Interoperability Solutions in eHealth." Proceedings of eHealth 2006 High Level Conference Exhibition and Associated Events,, Malaga, Spain, May.
[2] Glushko, R. and T. McGrath (2005). Document Engineering, MIT Press.

3. The MD:Notes schema for mapping the progress note: Our schema maps over the individual messages created by the physicians. Certain components will need to be mapped into the appropriate fields expected by the HL7 standard and the corresponding EMR requirements.

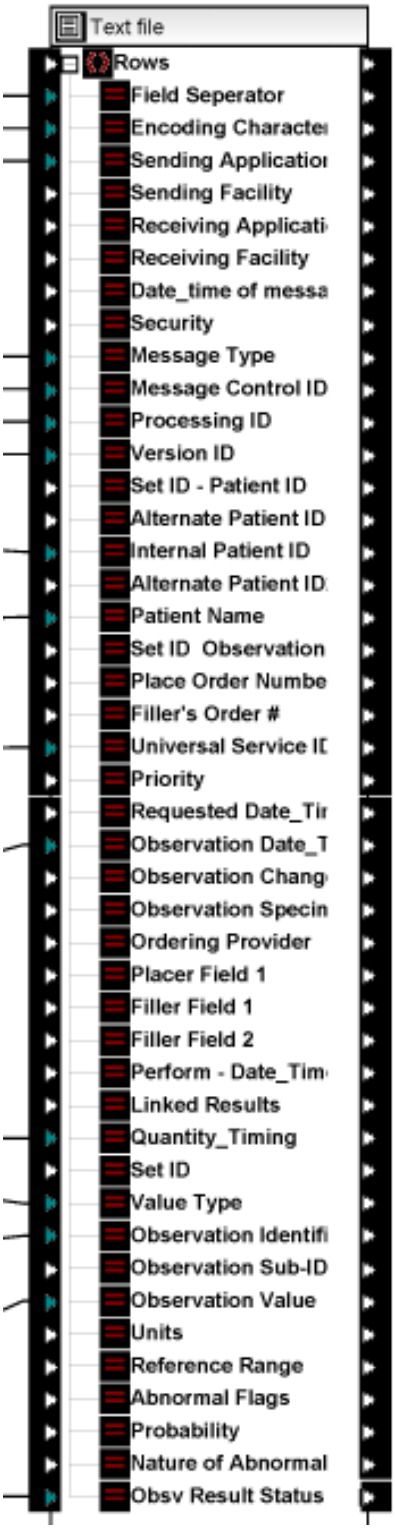
.MSH|□\$|PCO||||||ORU|ProgressNotes|P|2.3.PID|||12345678□HospialA||Cara□Thrace.OBR||||PCO1□Progress Note|||200803051333|||||||||020SAE.OBX||TX|Action Point|| In for 3x/wkly meds. Usual neat appearance/grooming, pleasant, positive mood. "I'm doing very well." Went to stims rehabilitation party and enjoyed herself. Planning to continue w/ stim group activities: "I always meant to check them out before (while actively using) and never could get around to it." Said this group a better match for her than the cylon association, though brought cylon meeting schedule for this writer. Also has new primary counselor on galactica , named Lieutenant Gaeta. Stated that she believes she will be more honest than she has been with a female counselor: "I just charm the men, though I don't intend to." Also noted that the new counselor is very attractive; this writer suggested that she bring that up during their sessions. "I was so busy I forgot my meds yesterday." Today's AM meds DOT. Given ARVs though Thurs. Unable to dispense ACV and Mirtazepine d/t insurance issue. Client stated that she "doesn't really need Acyclovir" and may have small supply of Mirtazepine left at home. RTC Friday 3/7/08 Electronically signed by Zachary Gillen 3/6/2008 13:52|||||F.

***Figure 1**: Example HL7 version 2.4 progress note message in the appropriate format for entering into both Hospital A and B's electronic medical record system.*

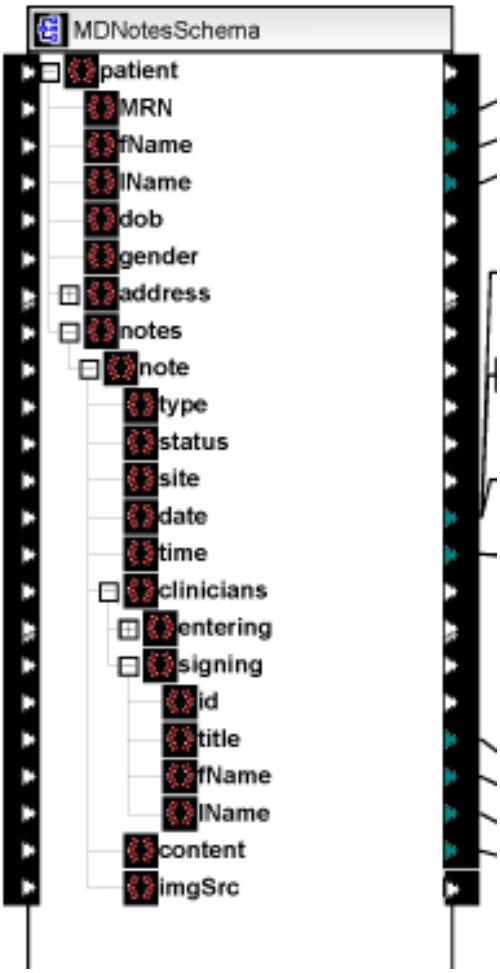
After analyzing these three document groups, a mapping table was generated to identify the core components necessary for output to the EMR. This is shown in Appendix 1. Once the components were identified, we had to create a method for producing the HL7 pipe-delimited flat file. Instead of writing a translation script that would be cumbersome to update with new iterations of the schema (as templates are added, or additional attributes or elements are added to further model the patient), we decided to use the Altova MapForce tool generate the translation code. Should additional templates be added to the schema, they can be concatenated to the 'content' component already mapped to the HL7.

Process for creating the mapping in Altova MapForce:

1. Create the output text file modeling all expected components (whether valued or not) for the electronic medical record. This is based on the consolidated document in Appendix 1.



2. The next step was adding the schema generated for modeling the patient in the MD:Notes application. This will be the source of information to map over to the HL7 text file.



3. The final step was creating the mapping between the components. Part of this was generated by including constant values expected by the EMR, and some came from conversion from the schema. Below is a sample of the translation business logic (see Figure 2).

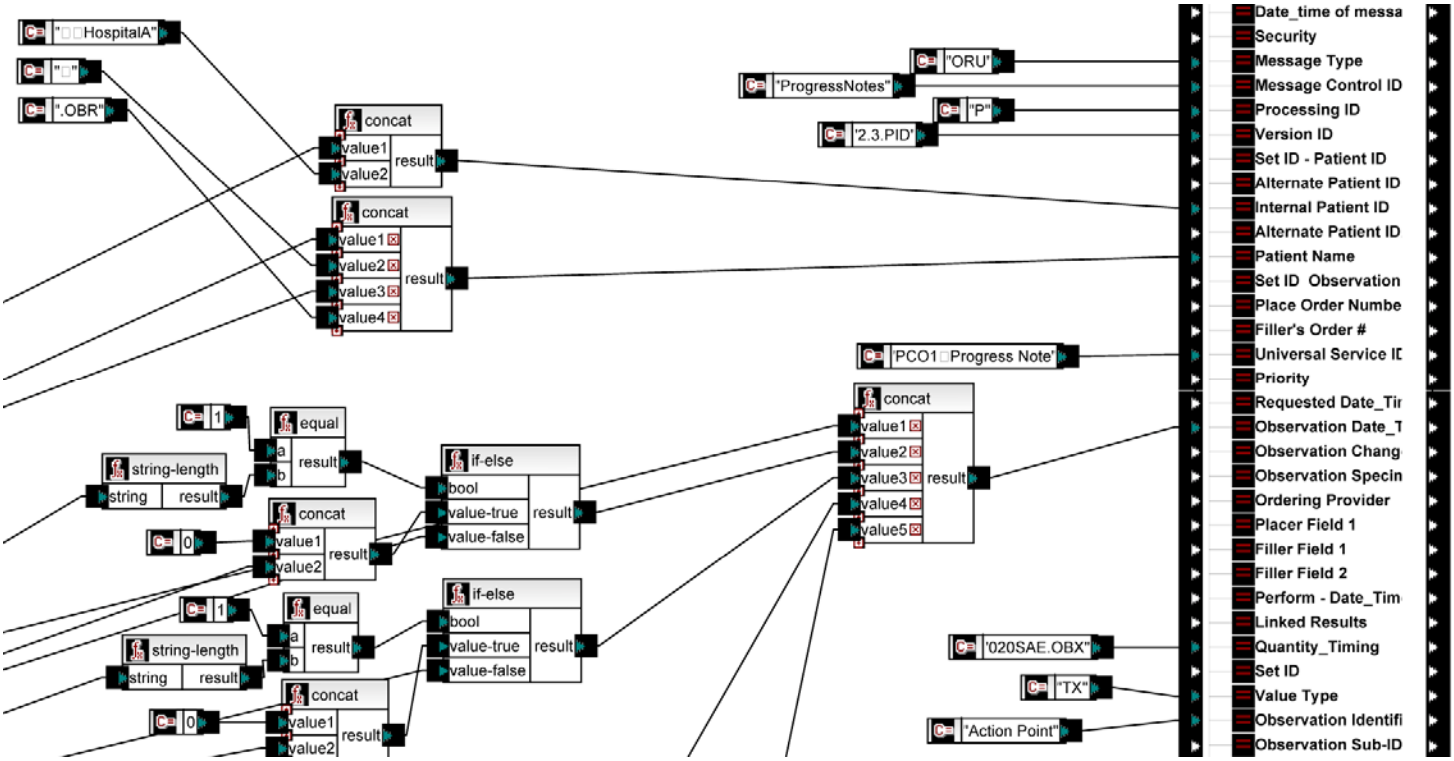


***Figure 2**: A portion of the completed Altova MapForce HL7 mapping component*

Logical information flow for generating the HL7:

For the MD:Notes application, the HL7 message would need to be generated once a clinician enters a new progress note. The progress note is first added into the XML document representing the patient under the element <notes> (see Figure 2). Once a new note has been saved, a routine will check every couple of minutes for new notes that have been added. If new notes are found, Java code that was produced from the MapForce translation and saves the HL7 runs and performs the necessary conversion based on the model of the patient. The Java routine will save a new HL7 text file into a staging folder. This is then ready to be exported to the patient's electronic record.

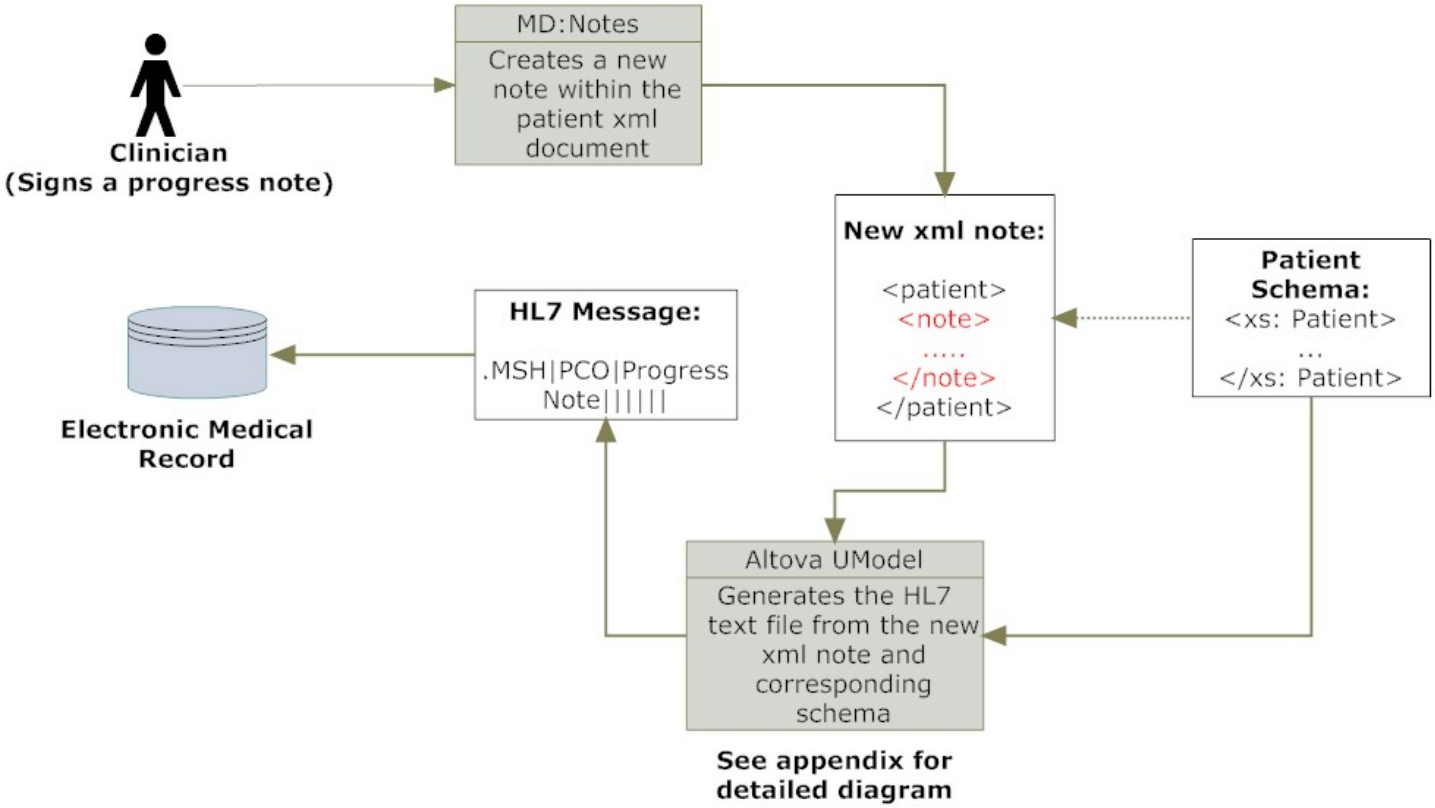


***Figure 3**: Information flow diagram (Trigger = Entry of a new progress note)*

Implementation Considerations:

Should this application get deployed, we would use a messaging engine and send this to an ftp server sitting within the hospital's demilitarized zone. From here, the messages can be retrieved by a process initiated by the EMR. This mapping exercise demonstrates that the MD:Notes' output is compliant with the electronic medical record system at both hospital A and B.

References:

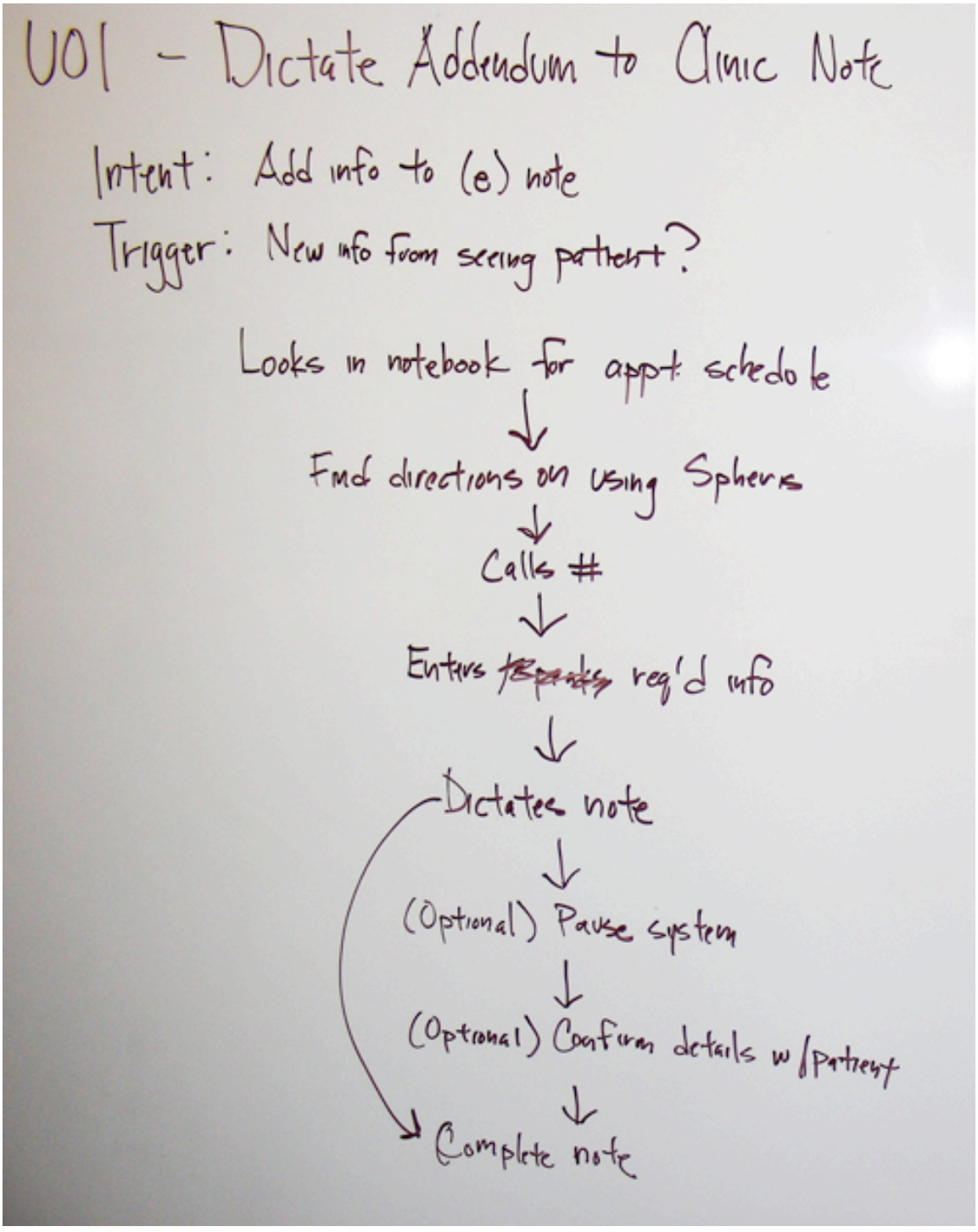
1. Dogac, A., T. Namli, et al. (2006). "Key Issues of Technical Interoperability Solutions in eHealth." Proceedings of eHealth 2006 High Level Conference Exhibition and Associated Events,, Malaga, Spain, May.

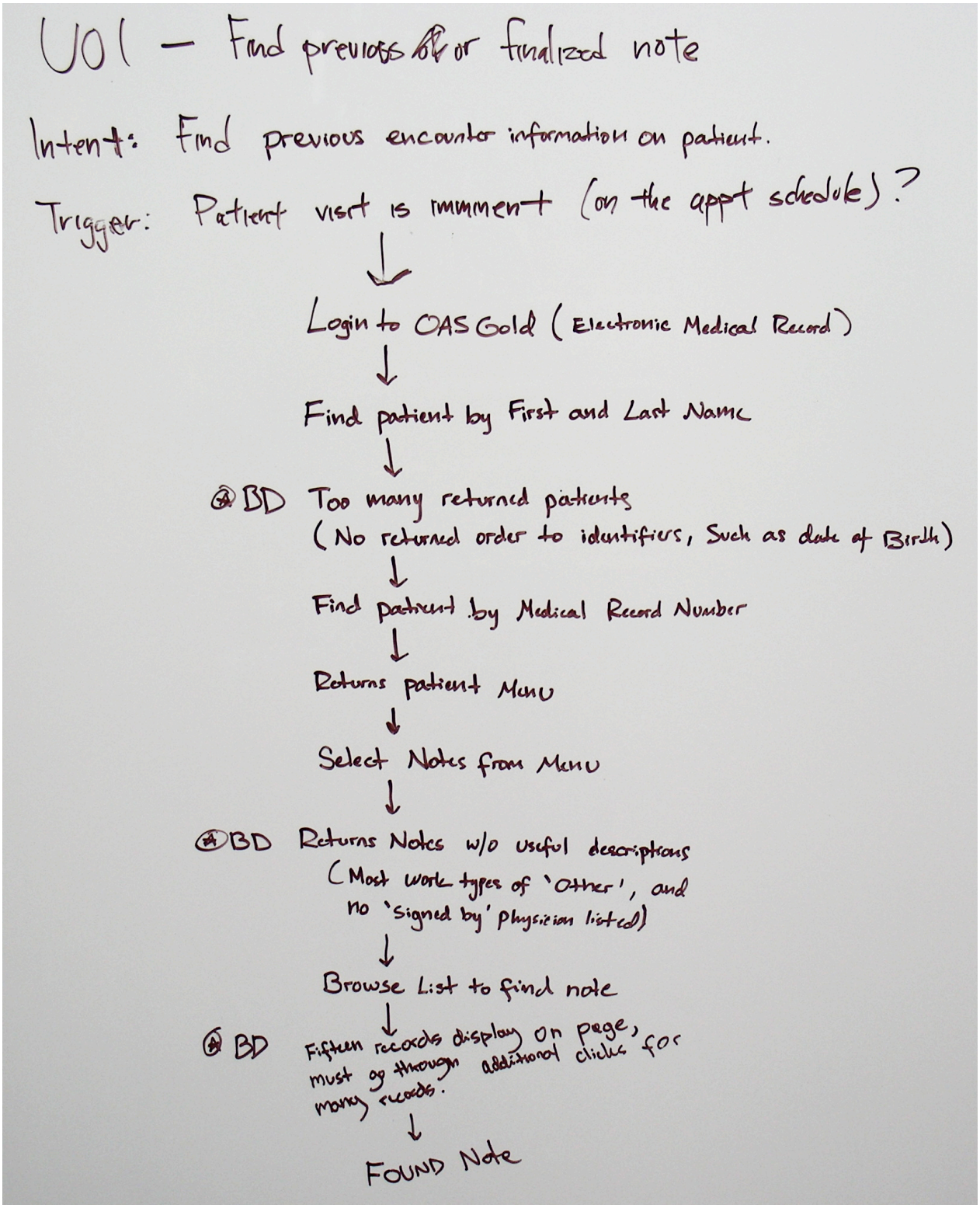
2. Glushko, R. and T. McGrath (2005). Document Engineering, MIT Press.

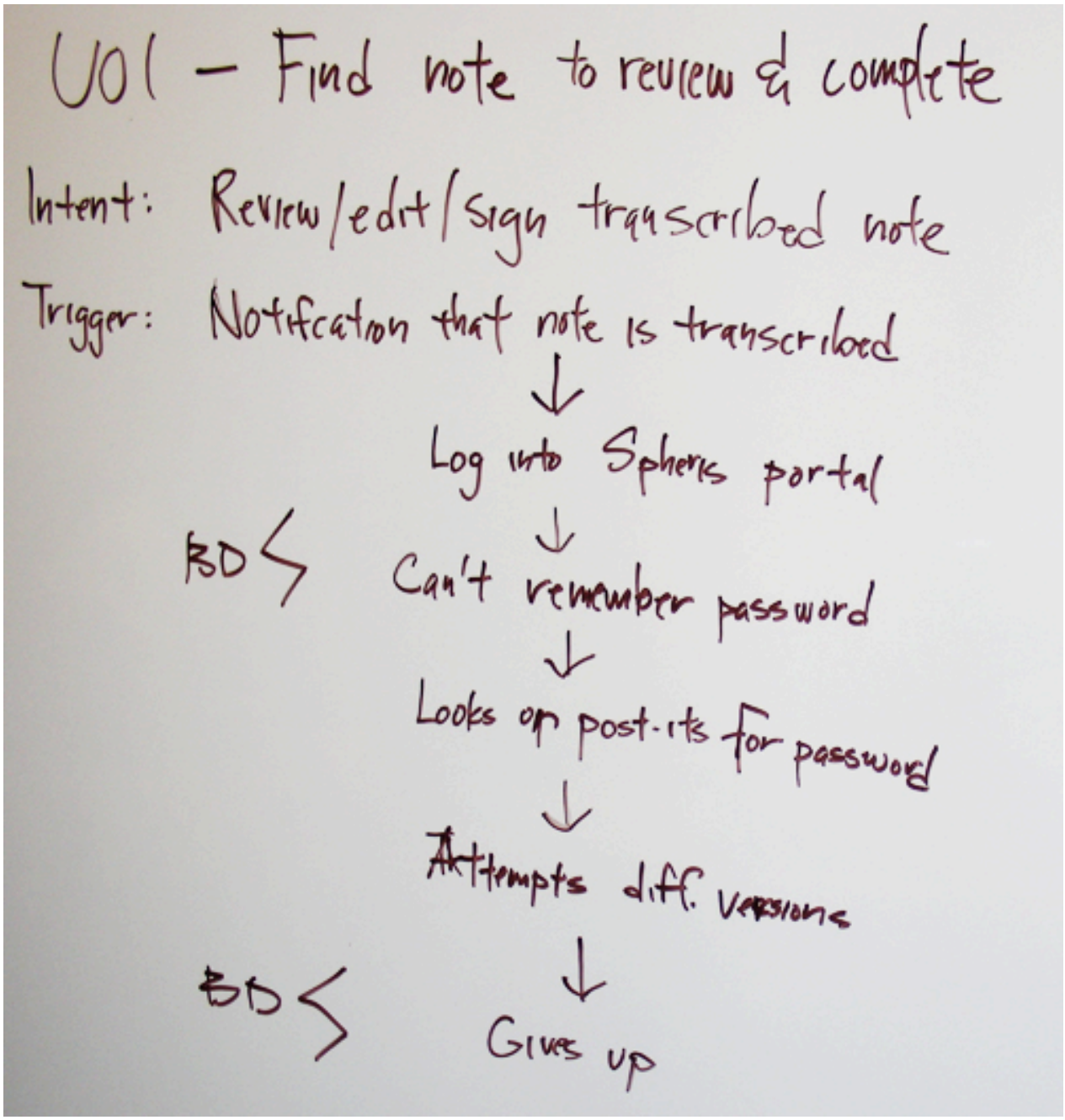
Appendix A

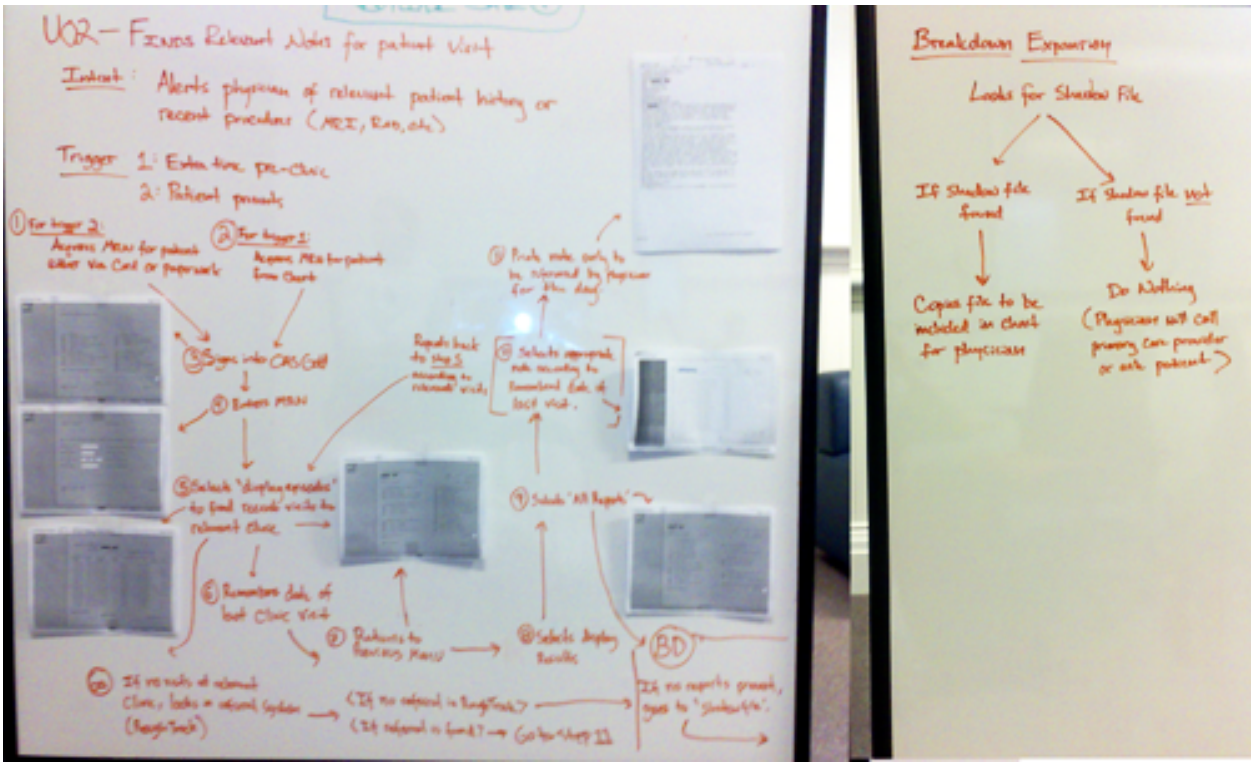
Individual Sequence Diagrams

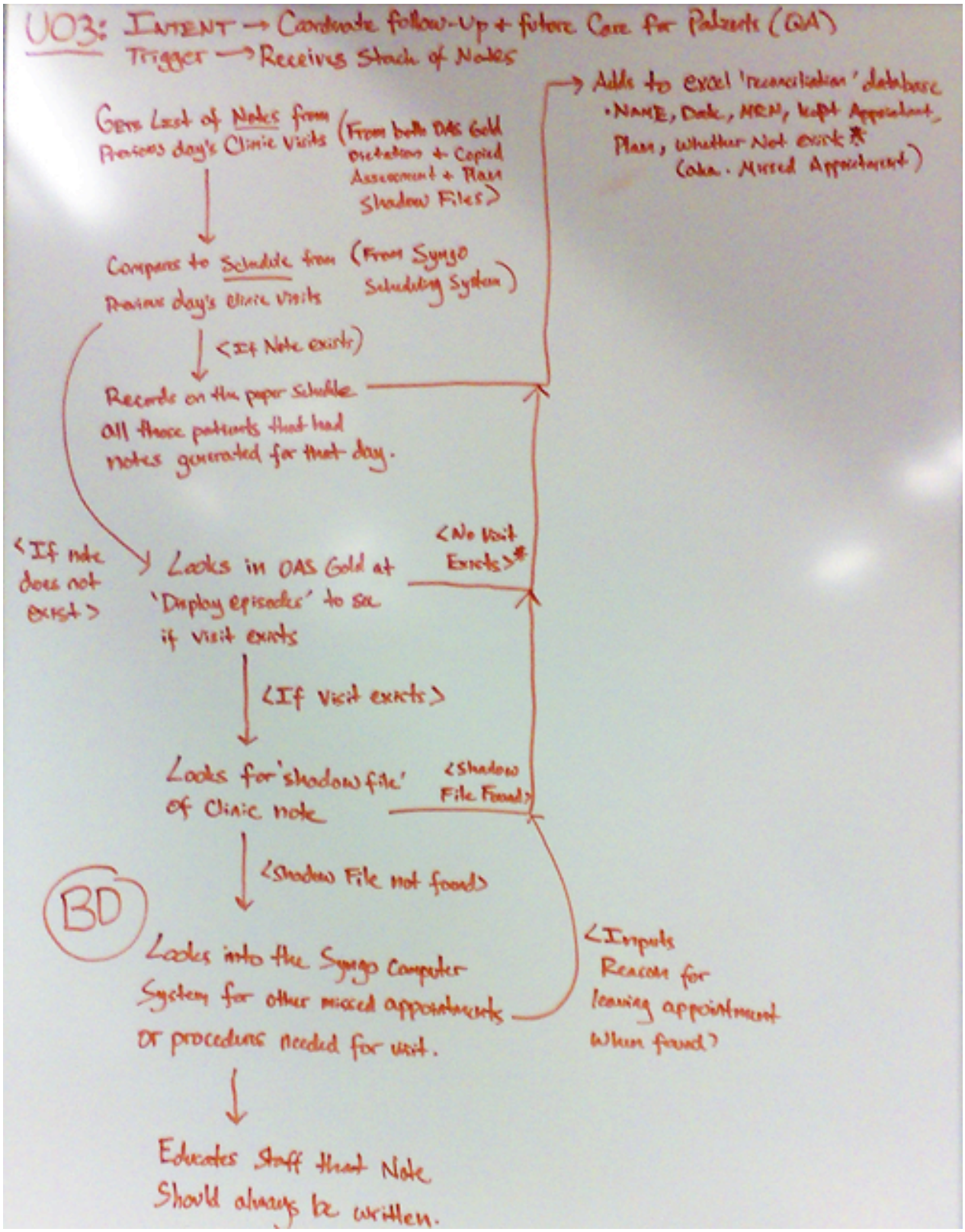
The following are sequence diagrams captured during our contextual inquiry.

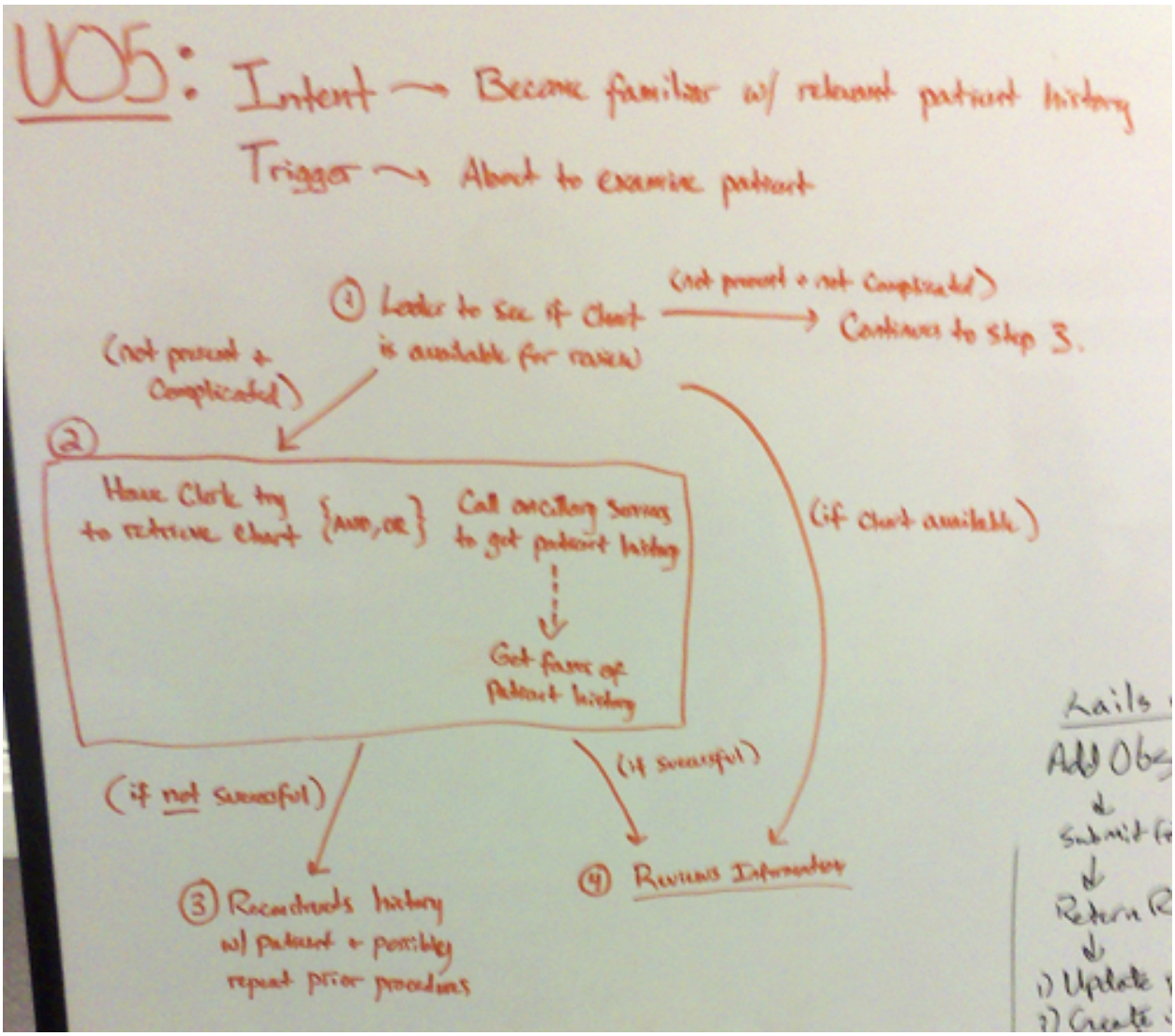


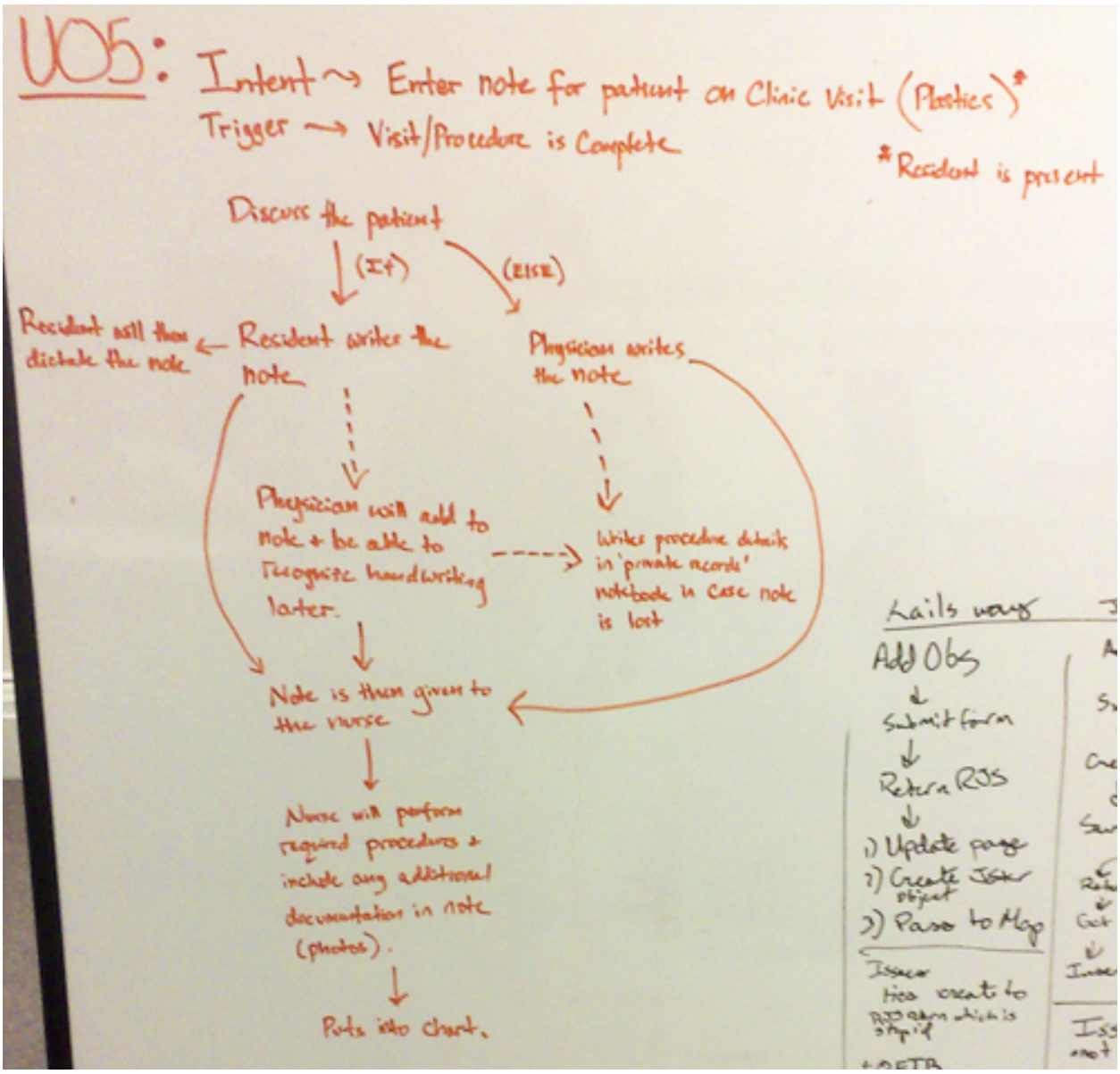

UO1 – Find previous or finalized note
Intent: Find previous encounter information on patient.
Trigger: Patient visit is imminent (on the appt schedule)?
Login to OAS Gold (Electronic Medical Record)
Find patient by First and Last Name
BD Too many returned patients
(No returned order to identifiers, such as date of Birth)
Find patient by Medical Record Number
Returns patient Menu
Select Notes from Menu
BD Returns Notes w/o useful descriptions
(Most work types of 'Other', and
no 'signed by' Physician listed)
Browse List to find note
BD Fifteen records display on page,
must go through additional clicks for
many records.
FOUND Note

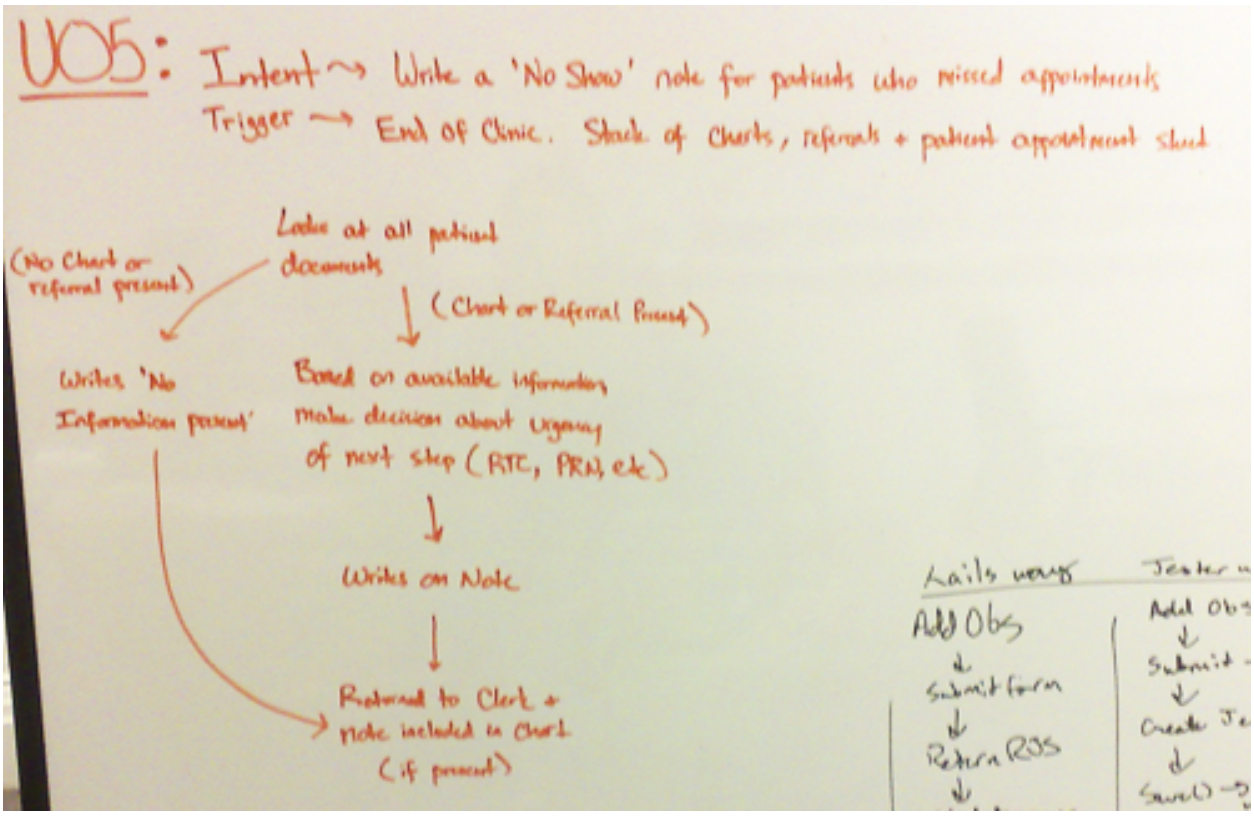

UO1 – Find note to review & complete
Intent: Review/edit/sign transcribed note
Trigger: Notifcation that note is transcribed
Log into Spheris portal
BD
Can't remember password
Looks up post-its for password
Attempts diff. versions
BD
Gives up

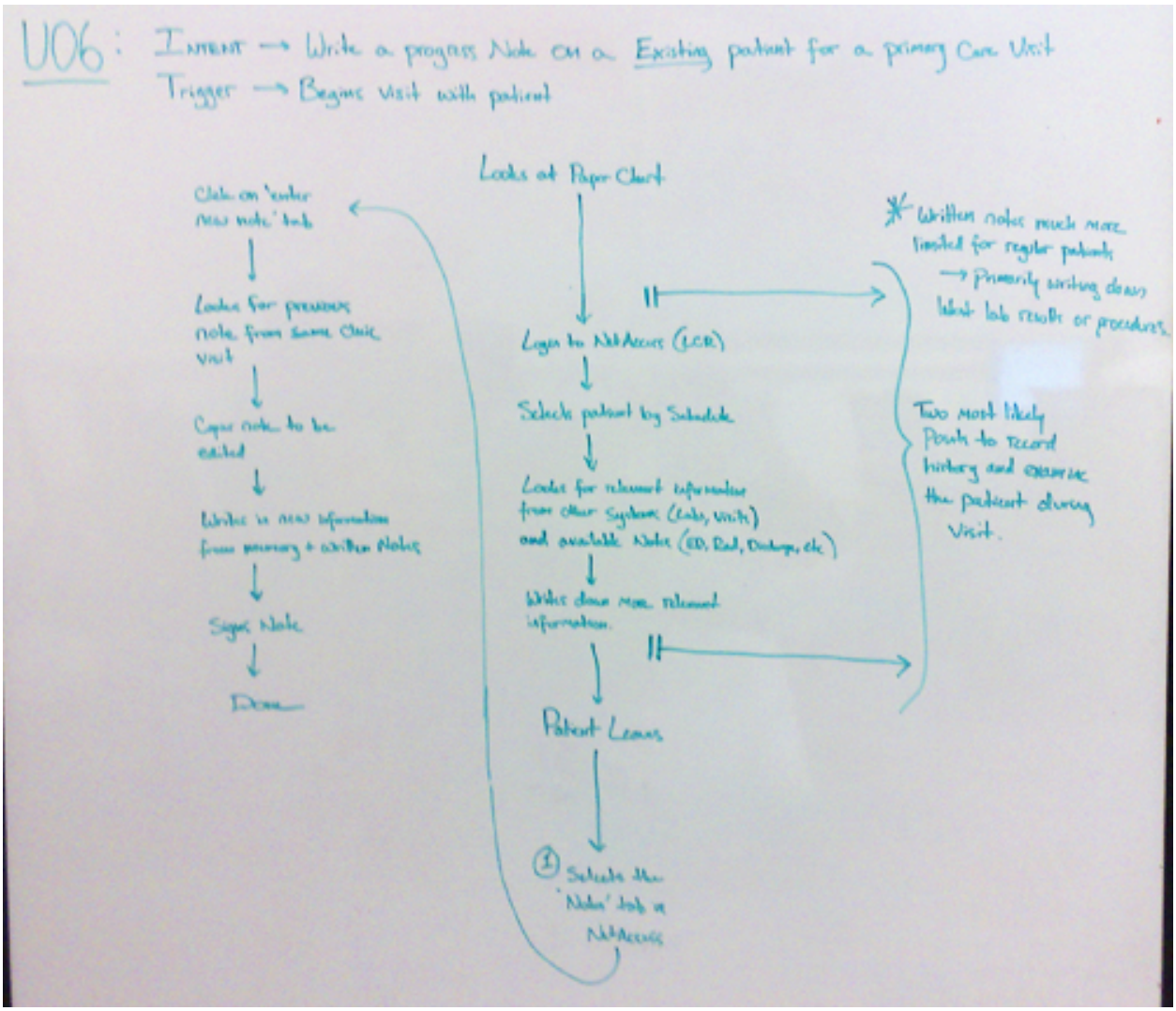

UC2 – Finds Relevant Notes for patient Visit
Intent: Alerts physician of relevant patient history or recent procedures (MRI, Rad, etc)
Trigger 1: Enters time pre-clinic
2: Patient presents
Breakdown Expansion
Looks for Shadow File
If Shadow file found
If Shadow file not found
Copies file to be included in chart for physician
Do Nothing
(Physician will call primary care provider or ask patient)

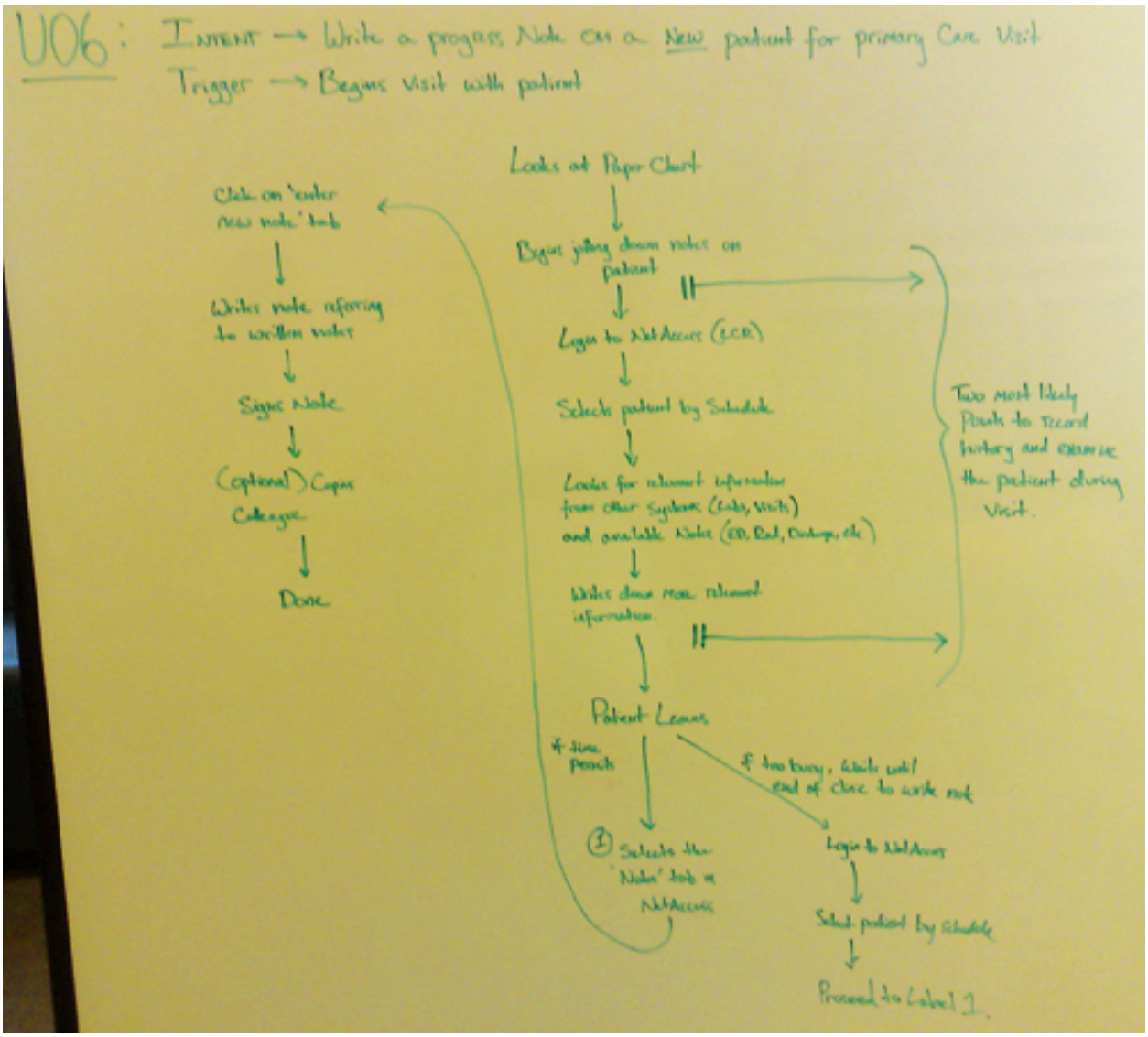

UO3: Intent → Coordinate follow-up + future Care for Patients (QA)
Trigger → Receives Stack of Notes
Gets List of Notes from Previous day's Clinic Visits
(From both OAS Gold Dictations & Copied Assessment & Plans Shadow Files)
Compares to Schedule from Previous day's Clinic Visits
(From Syngo Scheduling System)
<If Note exists>
Records on the paper Schedule All those patients that had notes generated for that day.
→ Adds to excel 'reconciliation' database
• NAME, Date, MRN, Kept Appointment, Plans, Whether Not exist *
(aka. Missed Appointment)
<If note does not exist>
Looks in OAS Gold at 'Display episodes' to see if visit exists
<No Visit Exists>*
<If visit exists>
Looks for 'shadow file' of Clinic note
<Shadow File Found>
<Shadow File not found>
BD
Looks into the Syngo Computer System for other missed appointments or procedures needed for visit.
<Inputs Reason for leaving appointment when found>
Educates staff that Note Should always be written.

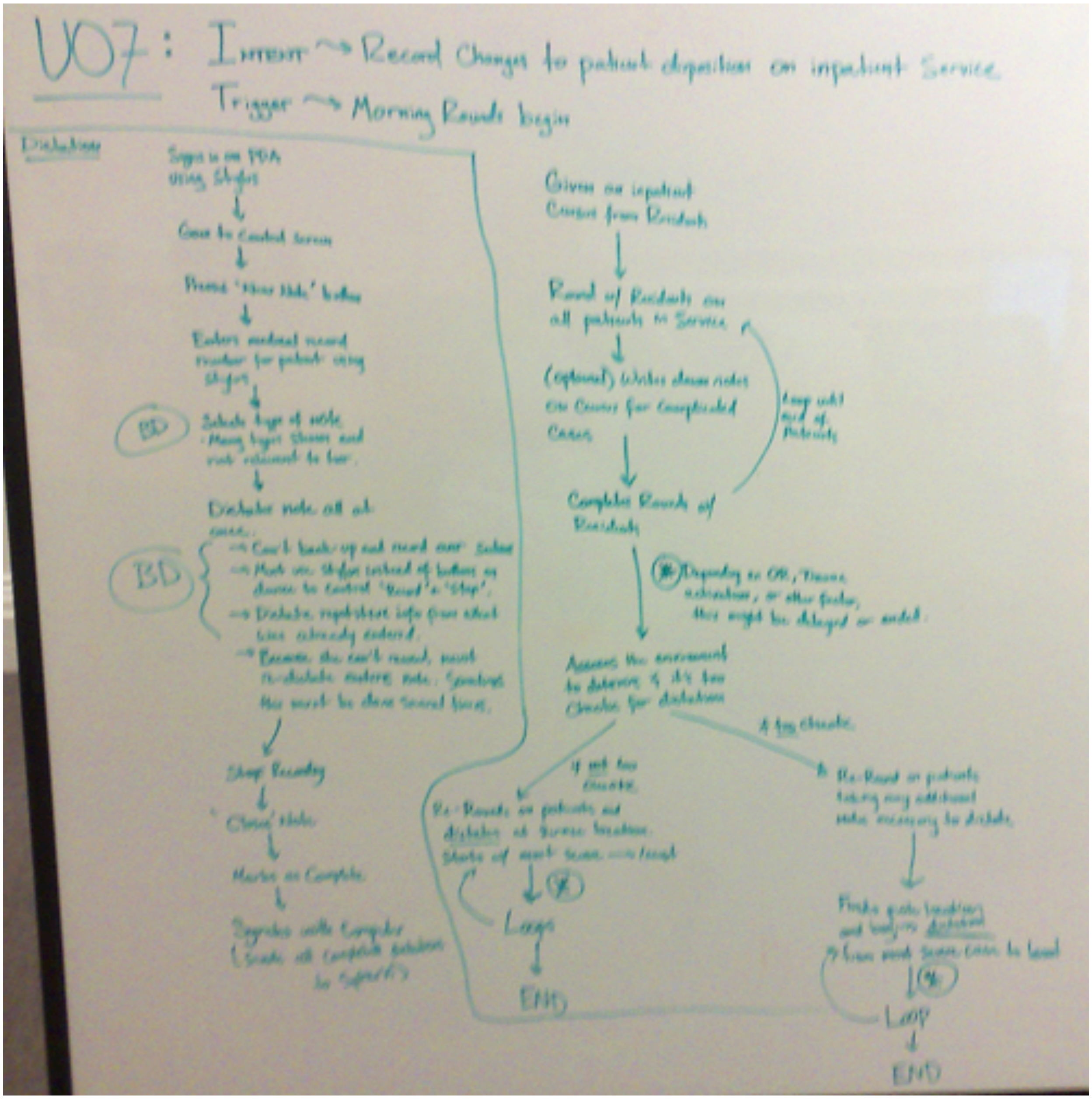

UC5: Intent → Become familiar w/ relevant patient history
Trigger → About to examine patient
1 Leader to see if chart is available for review
(not present + not Complicated)
Continues to step 3.
(not present + Complicated)
2
Have Clerk try to retrieve chart {AMB, OR}
Call ancillary Servers to get patient history
Get faxes of patient history
(if chart available)
(if not successful)
(if successful)
3 Reconstructs history w/ patient + possibly repeat prior procedures
4 Reviews Information
Rails
Add Obs
Submit
Return
1) Update
2) Create


UC5: Intent → Enter note for patient on Clinic Visit (Plastics)*
Trigger → Visit/Procedure is Complete
*Resident is present
Discuss the patient
(If)
(ELSE)
Resident will then dictate the note
Resident writes the note
Physician writes the note
Physician will add to note & be able to recognize handwriting later.
Writes procedure details in 'private records' notebook in case note is lost
Note is then given to the nurse
Nurse will perform required procedures & include any additional documentation in note (photos).
Puts into chart.
Kails way
Add Obs
Submit form
Return RJS
1) Update page
2) Create JS object
3) Pass to Map


UC5: Intent ~> Write a 'No Show' note for patients who missed appointments
Trigger ~> End of Clinic. Stack of charts, referrals + patient appointment sheet
Looks at all patient documents
(No Chart or referral present)
(Chart or Referral Present)
Writes 'No Information present'
Based on available information, make decision about urgency of next step (RTC, PRN, etc)
Writes on Note
Returned to Clerk + note included in chart (if present)
Kaila's work
Add Obs
Submit form
Return ROS


UC6: Intent → Write a progress Note on an Existing patient for a primary Care Visit
Trigger → Begins visit with patient
Looks at Paper Chart
Logs to NebAccess (ECR)
Selects patient by Schedule
Looks for relevant information from other Systems (Labs, Visits) and available Notes (ED, Rad, Discharge, etc)
Writes down more relevant information.
Patient Leaves
1 Selects the 'Notes' tab in NebAccess
Clicks on 'enter new note' tab
Looks for previous note from same clinic visit
Copies note to be edited
Writes in new information from memory + written Notes
Signs Note
Done
* Written notes much more limited for regular patients → Primarily writing down latest lab results or procedures
Two most likely Points to record history and exam for the patient during Visit.


UC6: Intent → Write a progress Note on a New patient for primary Care Visit
Trigger → Begins visit with patient
Looks at Paper Chart
Begins jotting down notes on patient
Logs to NebAccess (LCD)
Selects patient by Schedule
Looks for relevant information from other Systems (Labs, Visits) and available Notes (ED, Rad, Discharge, etc)
Writes down more relevant information.
Two most likely Points to record history and exercise the patient during Visit.
Patient Leaves
If time permits
If too busy, Waits until end of clinic to write note
1 Selects the 'Notes' tab in NebAccess
Logs to NebAccess
Selects patient by Schedule
Proceed to Label 1.
Clicks on 'enter new note' tab
Writes note referring to written notes
Signs Note
(optional) Copies Colleague
Done


U07 : Intent ~> Record Changes to patient disposition on inpatient Service
Trigger ~> Morning Rounds begin
Given an inpatient Census from Residents
Complete Rounds of Residents
Loop
END
END

Appendix B - Consolidated Sequence Diagrams				
REVIEW PATIENT HISTORY				
Triggers: **1. Patient checks in** **2. Nurse has extra time**	**Overall intent:** **Provide patient with appropriate care**			
Activities	**Intents**	**Strategy 1**	**Strategy 2**	**Strategy 3**
Look for relevant patient history	To retrieve a subset of all patient information that's relevant for the particular encounter			
	Find correct patient	Get patient name or MRN from schedule	Get MRN from health card, patient chart, or paperwork	
	Make sure person is authorized to view patient info	Log into OAS Gold	Log into OAS Gold	
	Find correct patient	Find patient by first and last name		
		Look through list of returned patient. BD: Too many, no identifiers (DOB)		
		Enters MRN	Enters MRN	
		Looks at Patient Menu	Looks at Patient Menu	
	Find information relevant to visit	Select 'Notes' from menu		
		Looks at list of returned notes BD: No useful descriptions (Most are type 'Other', no info on signing physician)		

Activities	Intents	Strategy 1	Strategy 2	Strategy 3
Look for relevant patient history (cont)	Find information relevant to visit (cont)	Browse list to find relevant note. BD: 15 records displayed on page, must go thru additional clicks for many records		
				Look to see if chart is available
				Chart not available - ask clerk to retrieve chart
				Chart not available - call ancillary services, get faxes of patient history
				Clerk can't find chart - reconstruct history with patient
	Find visits to a particular service or clinic		Selects "display episodes" screen to find the relevant for the specific clinic	
			Remembers date of last clinic visit	
			Returns to previous menu	
			Selects "Display Results"	
			Selects "All Reports"	
		Finds correct note	Selects appropriate note according to remembered date from last visit	
			Prints note to be reviewed by the physician	
	Find referral information		No visits exist to relevant clinic, decides to look in referral system	
			Referral is found in Roughtrack, prints note for physician	

Activities	Intents	Strategy 1	Strategy 2	Strategy 3
Look for relevant patient history (cont)	Find paper version		No referral is found in Roughtrack, decides to look for shadow file	
			Finds shadow file	
			Copies file to be given to the physician	
			Does not find shadow file	
				Ancillary services faxes info, physician reviews info
			Does nothing	
Review relevant patient history	Understand reason for patient visit			
		Reads note		Chart is available, reviews relevant info in chart

Appendix C - Consolidated Affinity Notes		
Purpose of Note		
	We use notes to justify billing	
	U06-31	Components of the notes in most places are for billing and are very standardized, this is not the case for the typed outpatient note
	U05-47	More detailed note can result in being able to enter higher billing code
	U06-52	Advantages of the template is that it can be used to drive the billing component
	U09-10	Documentation about all details about procedure required by state or Joint Commission (JCAHO hospital accreditation - Federal)
Contents of a note		
	We have a huge variation in note contents	
	U07-63	Writes very complete notes - type A paranoia
	U04-05	Sometimes they capture the minimum (the morning note)
	U05-33	Sometimes the last 4 or 5 notes are "no show" notes
	U06-28	Different forms for initial & subsequent visits. Initial visit form much longer - 4 pages
	U01-21	he likes the free form information (in Spheris) because there are so many
	U05-35	For 'no-shows', the note will consist of instructions for future patient scheduling
	U03-10	If patient checked in but was not seen (i.e. imaging was not ready), this should be captured by a progress note
	We include lab results, stats, etc. in our notes	
	U06-04	Best progress notes applications integrate information from other systems
	U06-37	Would like to be able to view labs and write notes at same time
	U08-05	Looks at chart and vital signs to see if anything happened overnight, write down lab results, then examine patient, write down notes by hand that am - SOAP note
	U06-30	Ideally, you would automatically be able to pull in information from other systems (labs, etc)
	U06-35	Writes up info that he looked up (labs, etc.) and types into note
	U06-02	Creating a p-note requires gathering data from lots of places
	U04-26	Would like to be able to link to studies to support recommendations
	U06-03	Would like to integrate labwork into p-notes
	We include photos and sketches with notes	
	U08-36	Need patient consent before taking a picture
	U05-14	Likes the Canfield medical photo management tool
	U04-24	Sometimes he draws pictures by hand
	U06-48	Dermatologists and wound specialists include images with note
	U05-11	Photographs are included in the chart
	U05-12	Takes photos more often in private practice
	U05-13	Would like to take more photos, but time constraints and no dedicated camera for Highland
	U04-25	Would love to take photos
	U08-37	For wound clinic, pics document progression of wound
	U08-35	Sometimes tapes pics to note - in OR
When we create notes		
	During visit	
	We create notes during and after a patient visit	
	U05-05	Writes notes both in front of patients and when not with a patient
	U01-40	He would like to enter progress notes in the room with a patient
	U05-07	If he has a lot to write, he answers patient questions and then leaves to write the

	U05-56	Recording notes in front of patient could be off-putting, but really depends on how it's done
	U05-06	Whether to write in front of the patient depends on the length of the note
	U09-13	Often will take notes about times or other things on green scrubs
	U06-36	Takes notes as he's talking to patient
	U08-16	Sometimes needs to take notes during visit - 4-5 lines on chart, then use for
	After clinic/rounds	
	For new patients, we create notes at the end of clinic	
	U06-06	It's important to know if it's a new patient, or a returning patient
	We prefer not to create notes during a visit	
	U04-34	Doesn't like to look at chart while with a patient, likes to have "good rapport"
	We create notes immediately after an outpatient visit	
	U08-15	In clinic, dictate notes after visit
	U06-11	Writes note in exam room after patient leaves
	U05-48	Best would be if he dictated note himself after seeing patient
	U06-10	Not good at waiting until later to write note - will forget
	U05-03	After doing procedure writes the notes
	U06-07	Writes the note after seeing the patient
	U08-22	At Highland, always write or dictate note immediately after visit - nowhere to store chart, have to put away
	U06-12	Might require patients to wait longer because he does not wait until clinic is over to enter notes
	U09-14	Writes documentation after patient already anaesthesized
	U08-03	For clinics, either write notes after every visit, or write them all at end of day
	U06-13	Will sometimes wait until the end of the clinic to enter new patient notes because they take longer
	U06-15	Residents will often wait until the end of the clinic to do all their notes
	U04-20	Progress notes entered all at once, because of problems going back and forth
	I don't take notes during a patient visit	
	U04-35	Doesn't feel the need to take any notes while with a patient
	U07-14	Remembers most patient details, so don't need to jot down much
	U01-11	He adds handwritten notes to the printout of the Word document, as a reminder to himself before seeing the patient (but not as any kind of reminder during note
	U07-60	Don't need to look up notes, since she is the only one in in-patient dictating. Don't need to look up own notes - photographic memory
	I enter inpatient notes on second round because of time constraints	
	U07-08	During 2nd round, if quiet then dictates as walking around
	U07-01	Do notes after completion of rounds
	U07-16	Sometimes, trauma activation, OR or clinic interrupts, so can't do 2nd round right
	U07-04	Will do rounds with residents, then after residents leave, do rounds again to dictate notes
	U09-01	Doctors write hand-written notes during inpatient rounds
Not enough time		
	I work quickly so patients don't have to wait so long	
	U01-02	Waiting room full, average wait may be an hour or more
	U05-57	Space issue - need to turn over exam rooms quickly so other patients can be seen
	U05-44	Patient will often wait while the chart is being fetched by the clerk
	We don't have time to do all notes	
	U07-20	Census ordered by case severity - sickest people first (ICU --> Step-Down --> Surgery Service)
	U07-06	There are 8-10 people on each of two surgery services at Highland (so, the most to round on would be 8-10)

	U07-18	Dictates notes for sickest people first
	U07-19	Tries to dictate notes for all, but sometimes doesn't have time
	U07-15	If time allows, does 2nd round immediately
	U07-05	ICU patients - 4 to 15 total
	U07-48	Dictation for jotting notes? Still slows down residents
	U07-21	Rather have notes for sick patients than regular cases
	U04-04	Any specific event to the patient should be documented, but isn't because of time
	U07-03	Residents limited to do 80 hour work week - have to fit everything in - can't stop to do notes during rounds
How we enter notes		
	System limitations	
	We want to make corrections when dictating notes	
	U07-46	Dictates up to 8x - if error, hard to go back, so just delete and start again
	U07-39	Would like to re-record as dictating
	U07-50	Slowest part of dictating is making corrections
	U07-45	From "draft" folder, really hard to get note - freezes up
	U07-36	With system, can't back up and re-record easily - locks up PDA
	U07-37	Dictates everything at once without making corrections, then waits for transcript to
	We want to copy previous notes	
	U06-22	Notes created outside the lotus application cannot be copied and edited
	U06-23	Much faster to copy notes for patients he sees on a consistent basis
	U06-01	When doing a p-note, easiest to copy previous then edit it
	U04-31	Would like to see a "cut and paste" feature
	U04-37	Often copies and pastes from previous days' notes (particularly with a long term patient for whom there aren't a lot of changes)
	U06-09	If it's someone else who practices the same way (entering notes electronically) then he will pull up that previous note
	U06-17	Systems shows previous notes - can copy prev note into new note
	U04-36	Internists write the best notes, likes to copy those
	We don't always have a computer available	
	U08-29	Typing - "pain in the ass" no computer at bedside, have to handwrite then type up, import a lot of stuff - faster to hand write
	U01-42	In every patient room, there is a computer but they aren't necessarily networked, possibly not even working?
	Sometimes it's too noisy to dictate	
	U07-02	Method of entry will be different or less chaotic in the ICU as opposed to the Wards
	U07-07	During 2nd round, if too much noise, writes down notes for complicated cases, then goes to quiet place to dictate
	Our systems are too hard to use	
	U01-07	He uses Spherus for dictation, and must follow lengthy directions for Spherus use each time
	U06-32	Progress notes app a "little klugey", goes down - that's why in-patient has not
	U05-26	Would love to use the computer if there was a good system (this may not be
	U06-33	Progress notes app requires additional enrollment. Meaning, physicians are not automatically added to the system
	U04-18	Barrier to text entry mostly because of limitations with curr. system
	U01-25	he didn't remember his password to log onto Spherus because he has so many different ones, no way to retrieve password
	U03-07	User can't print notes from her computer - has to go to another computer
	We have too much overhead before we can enter a note	
	U07-34	A lot to key in for entering a note

	U07-38	Hard to use stylus to navigate - rather have buttons
	We want automation of info retrieval for notes	
	U06-50	Would like macros to do repetitive stuff
	U07-64	Copy previous notes - would like counter - "post-op day 2" - day should change
	U06-34	Progress notes app does not have spell checking
	U06-53	Best system would have a combination of templates and free-text
	U07-65	Counters to measure how long central lines have been in - intubation in for x number of days - would be helpful
	U04-32	Likes VA templates
	U04-27	Uses symbols and acronyms often
Different methods of creating notes		
	We have separate dictation stations	
	U01-44	Occasionally he has to wait to dictate notes, maybe 10% of the time, but it isn't that frustrating
	U01-43	The room where they dictate notes was crowded, with 2 dictation stations and 2 screens for viewing
	U01-13	He calls Spherus on a landline phone
	Some of our clinics and services dictate notes	
	U06-26	In-patient service mostly handwritten or dictated
	U04-14	Operative notes, discharge summaries, and consult notes are dictated
	U08-26	Most clinics dictate to some extent, but surgery does all the time
	U01-38	Other types of notes include discharge notes (80% electronic, 20% by hand), operative notes (100% dictated), ED notes (ED notes 100% typed, with its own
	U08-25	Clinics that dictate: surgery, ER, radiologists, OR, trauma, discharge, multi-disciplinary team notes
	U02-13	Some clinics (i.e. in-patient) don't dictate notes at all
	U02-12	95% compliance in ortho(?) clinic for dictating notes
	U07-61	Surgery and ortho dictate, don't know about medicine or other clinics
	U05-16	Resident dictates notes after patient visit (except in wound clinic, where he writes
	U04-16	Don't want to dictate too much, because they don't want to run over service limit
	U04-09	Dictates op notes and discharge notes
	U08-24	Just surgery clinic dictating - not whole hospital
	We prefer to type notes	
	U01-41	He likes the idea of entering progress notes via laptop
	U04-17	Would type everything if he could
	U07-56	Some physicians would prefer to type instead of dictating
	U06-51	Prefers typing b/c can edit. With dictation, can't change as with typing
	U01-49	he said the ED notes are typed because 1. the staff can type and 2. they have a system that allows them to type
	U01-03	He would like a method of typing progress notes (Progress notes currently entered either by dictation or handwriting)
	Some notes are written by hand	
	U06-43	All the inpatient notes are in the paper chart and some of the consultant notes
	U05-04	Enters notes in paper form
	U04-10	Everything else (besides op notes and discharge notes) is handwritten
	U05-27	When there are no residents present, the notes are handwritten - dependent on paper chart system, which freq. fails
	U05-28	No computerized notes in wounds clinic (dependant on paper notes)
	U04-11	Daily progress notes usually written
	U04-13	Medications written

	U02-36	Anything past 12 months would go into the "hard copy medical records". Possibly not dictating then?
	U04-08	Tends not to dictate morning progress notes
	U06-27	In-patient service handwritten notes - use form
	U04-12	Orders written
	It takes me too long to type	
	U04-19	Generational differences in typing and comfort with technology
	U07-49	Typing - too slow. Dictation is much faster.
	U05-53	Would rather write or dictate than type - fastest
	We would like real-time transcription	
	U05-49	The ideal situation would be for resident to dictate a note and have real-time
	U06-54	Ideally would have voice recognition so text would appear and can edit
	U07-52	Used to use DragonSpeak to try to dictate notes. Used with voice recorder - lots of background noise - formats text so that it prints out on a p-note form. then puts in
	We don't like to dictate notes	
	U04-15	Can dictate anything, but don't
	U06-14	Some "luddites" dictate notes
	U05-55	In private practice, uses dictaphone and hands to employee to transcribe - otherwise don't get paid
	We prefer to dictate notes	
	U08-28	Prefer dictating for clinics
	U08-17	Dictated note more complete than chart note
	U08-18	Likes to dictate notes for clinic b/c sometimes chart is missing - in another clinic - so can look up notes earlier
	U08-02	Prefers dictation for H&P (history and physical) and consults
	U07-57	Her whole method of training is that you dictate progress notes
	U05-52	What would be best is to have a dictaphone where you could record notes and then synch later
	Handwriting notes works the best	
	U08-27	preferred method - morning rounds hand writing - quicker
	U05-50	Doesn't dictate b/c hasn't learned, used to handwriting on chart
	U05-51	"If I see my writing, I know what I was thinking [in the notes]"
	U05-08	Usually doesn't write more than 15-20 lines (20 lines at most)
	We don't like to hand write notes	
	U04-22	Hates to hand write but is often the best way to convey thoughts?
	U06-05	Only writes by hand when computer is down
	We need to be mobile in inpatient settings	
	U07-40	Mobile system pretty cumbersome, but better than what had before, which was
	U07-27	Residents don't dictate b/c landline doesn't work well w/ rounds, also need immediate turnaround
	U07-17	Need mobile product - don't have long stretch of time in front of computer, have to be in many places
	U07-53	Since she has Spheris on mobile, can't use landline
	U07-29	Uses pilot program with Spheris, using PDA
	U07-30	PDA is the one model Spheris works with - Palm - bought herself
Using info from schedule/census		
	Info on census often incorrect	
	U07-10	Census info inaccurate - list of patients is right, but info about patients is not
	U07-12	Unsure about where the information on the census actually comes from
	Add-ons not in my schedule	
	U03-12	Add-on patients are not shown on schedule; these are shown in Episodes

	U05-19	Add-ons and walk-ins not included in schedule (about 15% of patients he sees)
	Hard to generate schedule	
	U01-10	He cuts his particular schedule and pastes it into Word (the schedule is updated as new patients arrive, but he only prints his sched. that morning or the night before, so any new patients are added at the end with a sticker or as handwritten
	U01-09	He generates a report with everyones schedule (labor intensive process)
Required information		
	We enter & retrieve notes based on MRN	
	U02-04	Looks up patient by MRN - on card and paperwork
	U01-32	He searched in OAS Gold for a patient, the patient was hard to find because many patients have the same last name - it's easier to do a direct search of medical record number
	U01-18	he types medical record number into Spheris, followed by pound sign
	U07-32	Needs to press New Note button, then key in MRN
	U02-23	Needs to enter MRN multiple times while searching for relevant patient info
	We log into the system for entering & retrieving notes	
	U06-16	Has to log into LCR every time in between patients (patient privacy)
	U01-24	to look at a progress note he has to log onto Spherus
	U07-31	Logs in, then goes to control screen
	We enter relevant clinic & location info for finding notes later	
	U06-24	System remembers previous settings - has to remember to set clinic label when changing clinics
	U06-25	Clinic label is most important in retrieving notes, location also important
	U01-14	He enters location code into Spheris
	U06-20	When entering notes, has to make sure correct clinic is selected - often forgets and note is then mislabeled
	U06-21	Labeling notes is very important - By clinic, or service
	U07-41	Dictates physician name, service, note-type, patient name, MRN, then says it's not "trauma" - so it won't get miscategorized
	We enter the date into notes	
	U01-20	he dictates free form information very quickly, repeating everything already entered (i.e. medical record number and date of service)
	U07-42	Dictates date, time of round, then begins to talk about patient.
	We record the note's job # for future reference	
	U01-19	after typing medical record number into Spheris, he gets back an automated job number which he writes down on the schedule
	We enter work-type code into notes	
	U01-15	he enters worktype code into Spheris, usually the code for "consultation"
	U01-17	He would like to have many worktype codes available
Reviewing & signing notes		
	Criteria for review	
	I review transcriptions of my dictated notes	
	U01-29	once he can see the typed version, he reviews it and makes any edits and then electronically signs it and submits it to OAS Gold.
	U01-23	Sometimes when he views the transcription, things the transcriber didn't understand are bracketed
	I think it's important to see the whole note	
	U08-33	With small screens, can't see totality of note
	We create addumda for completed notes	
	U01-31	Once something is signed, he can't change the note but he can dictate an
	U04-21	Never crosses things out, adds addendums

	We share notes with colleagues	
	U06-40	Can send note to colleague for viewing or for co-signing
	Breakdowns with reviewing notes	
	We can't wait for the transcribed notes	
	U08-13	Talks to radiologist, other specialists as needed to understand patient history (i.e. if don't understand x-ray) - b/c of delay in dictated report. Don't want to wait a day
	U01-22	it takes Spheris 2-3 hours after entry before his dictation is transcribed
	U02-31	Disposition note - nurse follows orders on note
	U02-39	Even if doctor dictates note, doctor still has to hand-write disposition note
	U01-36	He thinks a progress note is crucial for patients and is time sensitive, and 100% of the progress notes are currently hand written
	U01-37	He does clinic notes (the ones that are transcribed), which are not time sensitive
	U02-30	Disposition note needs minimal info: assessment and plan
	U07-51	Turnaround time of dictated note is about 1 day
	U08-21	On chart, writes down next appt, patient has to go to clinic, etc. - gives to nurse
	U02-32	Can't use dictation for disposition note - transcript not available right away
	U02-33	Transcription of dictation takes about 4 hours
	U01-35	He has to write a note that is given to the nurse with next steps and patient disposition, which becomes part of the patient chart but is not captured electronically
	U05-10	Based on what is in the note, the nurse takes pictures or does pre-op, etc.
	U08-30	Dictating itself is not slower - turnaround time is slower
	U02-29	Disposition note is hand-written, given by doctor to nurse - says what patient needs to do next
	U08-20	At end of visit, verbally tells patient what to do
	We can't access audio dictation	
	U01-28	once he has recorded a dictation, he can't access the audio version (he can only view the transcription)
	We can't celete reviewed notes from the inbox	
	U06-46	Students notes for sign-off appear in his inbox
	Notes are signed or reviewed	
	We write notes that others review	
	U07-23	Less junior residents also sometimes write notes
	U07-24	More advanced residents write notes for more acute cases
	U08-09	Intern reviews med school student's note, signs name
	U08-01	Low level and junior progress notes are responsible for writing progress notes for in-patient non-acute settings every morning
	U08-08	Intern gets in first, sees patient and writes note
	U07-25	On weekends, "any warm body" writes the note
	U08-04	In-patient progress notes are written by intern every am before start of rounds
	U07-22	Residents don't dictate notes - junior level and physician assistants write them
	U08-06	Junior level checks intern's notes
	I review others' notes	
	U07-59	Does not 'batch sign' like other doc - reads each one before signing
	U05-54	Rarely would there be a problem with a resident's note that would need correcting
	U05-46	Usually sees patient with resident, then resident writes note - so no need to review
	U05-45	Picks up resident's progress to add 2 or 3 lines - recognize own handwriting in future
	U05-37	Only glances at resident's note for review
	U06-41	Needs to review student's notes, not residents notes
	U01-30	He reviews resident notes (residents do 4 out of 5 of the clinic dictations) and countersigns them
	U08-07	Chief eyeballs residents' notes

	U07-66	Signs off on her resident's notes - reads and edits, then signs with digital signature.
	U05-02	Residents enter notes - both handwritten and dictate - and he reviews handwritten notes and signs off
	U07-28	A licensed physician is a second or third year resident who has passed all their
	Preferred sequence for completing notes	
	I think it's more efficient to finish notes immediately	
	U06-39	More efficient to finish and sign note right away
	We start notes for completing later	
	U07-43	Presses "close" and then "complete" at end of note - goes to file to synch with
	U07-44	If presses "incomplete", goes into "draft" folder
	U06-38	Can "Hold" notes for completion / retrieval later - in case interrupted
	U07-67	Note is available in OAS Gold before she signs it
Reviewing patient history		
	I gather/review patient chart and relevant electronic info prior to encounter	
	U05-41	Clerk's responsibility to order charts - day in advance
	U05-42	Medical records pulls chart requested by clerk
	U02-38	Prints roughtrack info for doctor's convenience
	U02-22	Prints out notes to expedite the process, make visits go more smoothly
	U02-21	Doctors don't always look up notes prior to seeing patient
	U02-40	As a nurse, does not enter notes - only finds and retrieves for doctors
	U02-03	If he has time, he looks up patient info in advance (i.e. that morning)
	U02-03	If he doesn't have extra time (most of the time), he looks up patient info as they
	U02-09	Prints relevant notes and reports, includes in chart just for the day's visit
	U05-17	Focuses on patient chart, doesn't review residents' notes
	U08-14	After initial review when patient comes in, don't really need to look stuff up on
	U02-02	He looks up patient information relevant to the current visit
	U08-12	When patient initially comes in, looks up past reports, progress notes, old labs,
	U02-01	He looks up patient information on the computer - OAS gold - (including notes) before patient's visit, or right when patient presents
	U08-19	Looks at chart from nurse, then goes to look up stuff electronically - takes 5 to 30 minutes - looks at everything
	U07-62	Interested in op notes and discharge notes when patient first admitted - in OAS Gold
	U08-34	Rarely prints out note
	U02-20	Prints notes so doctors can review it
	Where we look for patient history	
	We look in both chart & EMR to get relevant info	
	U08-11	Lab results not in chart - in computer system
	U06-44	Looks in both paper chart and computer for patient info
	U05-01	Looks in the patient chart for the notes available, but will have others pull the electronic notes
	U06-42	More and more all the information is in the electronic record and not in the paper
	U06-45	Sometimes there is duplicate information in the paper chart and the electronic chart
	U04-33	Looks at computer even when there's a paper chart
	U03-15	Medical assistant puts together packet of clinic progress notes - includes electronic versions, copies of handwritten shadow files
	U05-29	For new patients, chart has consultation form from referring physician
	U08-10	Chart has section for progress notes - included in chart
	We look for notes from the relevant clinic	
	U02-14	Looks for episodes in relevant clinic, remembers date, uses date to decide which note on results list is the relevant one
	U05-31	Can figure out the relevant notes by which clinic originated them

	U02-05	Looks at last note in relevant clinic
	U02-25	Looks at date and hospital clinic code to determine if note is relevant
	U02-07	Looking at the Assessment and Plan portion of the relevant clinic note to determine what other notes pertain to this visit
	U05-30	In surgery, very "problem-focused," looking for notes on that exact problem (often the last 3 or 4 notes from relevant clinic)
	U06-18	When retrieving notes, looks at labels of notes - clinic
	U01-33	It would be helpful if the results showed what the service was, the name of the
	We get patient info from schedule to enter/retrieve notes	
	U05-18	Charts should be pulled for all patients on schedule
	U07-09	Jots down notes on patient census - list of patients in currently service
	U07-11	Important part of census is name, location (what bed), MRN
	U07-13	Residents print out census for doctor before beginning rounds
	U03-13	Design idea: notes should be closely tied to schedule
	U03-14	Design idea: Schedule should accommodate walk-ins and add-ons
	U01-26	he refers to the file folder of printed schedules with his handwritten notes as his "peripheral brain"
	U06-19	Searches for notes by schedule
	U01-08	Before starting progress note, he looked at paper copy of his schedule to find out which patient he would do dictation addendum on
Latest notes are most relevant for retrieval		
	Only previous few months of notes are relevant to us	
	U05-32	Scans last 3 or 4 notes for what's relevant
	U06-08	For follow-up visits, looks up prev. note
	Notes older than 12 months old are not relevant to us	
	U02-19	Only concerned with notes within last 12 months
Breakdowns in retrieving notes		
	We have too many apps for patient data	
	U01-06	He keeps a list of applications other groups in the hospital use with at least 20 different applications
	U02-37	Rough-track referral system - has info about referred patients
	U01-50	the ED system is called WellSoft
	U01-05	He uses too many applications to get patient data
	U09-18	Nursing operative notes use completely different system from doctor's notes
	U09-08	The ORMIS system is all nursing documentation, physicians still enter their own
	We reconstruct patient history	
	U05-21	When there is no chart, medical history reconstructed from memory or repeated exam (this is very time consuming)
	U05-22	Must call other clinics or services to see if patient has been seen
	U05-23	Really "devastating" when he has to call to get fax to reconstruct the chart
	U05-24	Makes calls during patient visit
	Paper chart often not available to us	
	U05-20	Sometimes there are clinics where less than 20% of patients have charts
	U05-25	20% charts is typical (any given day, between 10-50% charts present)
	U08-23	Often, patient has no chart - 85% - 90%
	U05-43	Sometimes asks clerk for missing chart - 50% of time, then they can find chart
	U01-46	Being unable to find notes quickly adds to wait time for everybody
	Chart may be incomplete, but we have no way of knowing	
	U05-34	Sometimes chart is incomplete (i.e. there's no recent information)
	U05-36	Keeps private records for referring to procedures performed because of lost notes
	U05-40	If missing notes not written by him, would not know it was missing

	We look for shadow files when notes are missing - takes a long time	
	U02-17	Looking for "shadow file" - goes to different floor, different clinic - takes a long time
	U02-27	Shadow file is useful - sometimes dictation doesn't get done - so good to have hard copy
	U02-28	Uses shadow file if dictation not available
	U02-11	If notes are not in the system, he looks in the "shadow file" - paper copy
	U02-26	Keeps "shadow file" but in process of eliminating for certain clinics
	When we dictate, system often miscategorizes notes	
	U07-33	Needs to select type of note, but most types shown are not relevant (Kaiser)
	U07-35	System miscategorizes note - has to speak/dictate correct categorization
	U01-16	Spherus categorizes as "other," regardless of worktype code
	Our notes are too difficult to retrieve	
	U02-35	"Surgeons are very particular people. If it's not there in front of them, they don't see
	U01-45	He is frustrated that he can't find progress notes, because they're all marked "other," and sometimes he must sort through many notes
	U01-47	he is frustrated there is so little information on the initial screen, so he has to look through a lot of notes to find the right one
	Medical record numbers sometime merge and are reused	
	U02-24	Sometimes (rarely), MRN changes for the patient, or diff patients have the same
	I successfully retrieve notes	
	I 'm very comfortable w/ the hospital's system	
	U02-10	Subject finds it easy to locate relevant notes in system, if they are in there (dictated).
	U02-15	Use hotkeys in OAS gold
	U02-16	Does not use buttons at top of OAS gold application (print, back, etc.)
	U02-18	Needs only minimal computer functionality
	U02-34	Does not perceive difficulties/inefficiencies in using OAS Gold - seems easy and straightforward
	U02-06	If relevant clinic note is not available, Looks at note from referring clinic
	U03-16	Uses OAS Gold to 'Display Episodes'
Reporting		
	We manually create spreadsheets to track patient care	
	U03-01	At end of every clinic, clerk(?) copies hand-written notes and prints transcribed notes for tracking of patient plans
	U03-02	She manually creates a spreadsheet of all patients with status info - MRN, patient name, date, appts kept, not kept, follow-up info, schedules, whether or not there is a note
	U03-03	The important component for the tracking the status is the 'Plan' portion of the note
	U03-06	Laborious for central appointments to pull individual notes instead of paging through a days worth of clinic notes
	U03-08	She manually checks spreadsheet to make sure patients follow up on any future appointments
	U03-09	Maintains spreadsheet of patients who did not keep appointment - hospital calls these patients to reschedule
	U03-11	Spreadsheet is important for other clinics, referring physicians, etc. to check on patient treatment
	U03-17	Compares patients shown in Episodes with paper stack of notes - determine which notes are missing
	U03-18	Compares patients shown in Episodes with Reports - determines which notes are missing
	U03-19	Compares patients shown in Episodes with those in Syngo (schedule) - determines add-ons and then looks for notes
	U01-27	he created a standalone document in Excel of patient problems, outside of Spherus

	We add notes to patient chart	
	U05-09	Turns over the progress notes to the clinic nurse when patient leaves
	U05-15	Notes should go into the chart and then to medical records after he gives them to the nurse, but many notes don't get into chart - get lost
	U09-17	The OR nurses documentation gets printed out and added to the paper chart
	U03-05	Progress notes also given to another department as hard copy - they don't know how to get electronic versions
	U01-34	When he found the record he was looking for, he observed that some doctors print the note, and add to the patient chart, which is redundant and wasteful and creates extra filing
Views on technology in general		
	We don't think cellphones are reliable	
	U04-28	Cell phones "sucks for text messaging," not trustworthy/reliable
	U04-30	Cellphones not good for dictation
	U01-39	He didn't trust the idea of a mobile device because of dropping and interference
	SMS for notes would take too long	
	U04-03	Comfortable with text messaging
	U08-31	Text in note? No, takes too long
	We don't think handwriting recognition works well	
	U08-32	Handwriting recognition? If it worked well.
	U07-47	Jotting notes into PDA? Only if it could recognize handwriting really well, didn't have to use handwriting recognition technology - too slow. can't keep up during rounds
	We adopt technology slowly	
	U01-48	he couldn't even conceive of being able to get pictures of patients and patient injuries, because that seems so far out of reach compared to the kinds of things he can get currently. "That is like asking a starving person in Africa if they like truffles."
	U01-51	he thinks there is technophobia particularly in inpatient wards, and estimates 50% would not adopt a new system
	U01-52	he thinks there are political reasons for why physicians might never be required to adopt new technology
	U07-54	Only one in hospital using PDA on Spheris
	U07-55	Others curious about her PDA, and where she got it, but not eager to get it
	Our personal devices not tied to hospital system	
	U06-49	Uses PDA to create personal schedule - not tied to hospital schedule
	U07-58	Can't use PDA for retrieving notes
	U04-01	Can't network in from home (no VPN, no access)

Appendix D - XML instance of patient, 87654322.xml


```
<?xml version="1.0" encoding="ISO-8859-1"?>
<patient xmlns:xsi=" HYPERLINK "http://www.w3.org/2001/XMLSchema-instance"
http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="MDNotesSchema.xsd">
        <MRN>87654322</MRN>
        <fName>Harrison</fName>
        <lName>Ford</lName>
        <dob>1965-07-10</dob>
        <gender>Male</gender>
        <address>
                <street>123 Lea Ave</street>
                <city>Berkeley</city>
                <state>CA</state>
                <zip>94707</zip>
        </address>
        <notes>
                <note>
                        <type>Operative Report</type>
                        <status>Complete</status>
                        <site>Plastic Surgery</site>
                        <date>2008-04-26</date>
                        <time>22:48:00</time>
                        <clinicians>
                                <entering>
                                        <id>123</id>
                                        <title>MD</title>
                                        <fName>Zach</fName>
                                        <lName>Gillen</lName>
                                </entering>
                                <signing>
                                        <id>123</id>
                                        <title>MD</title>
                                        <fName>Zach</fName>
                                        <lName>Gillen</lName>
                                </signing>
                        </clinicians>
                        <content>
   INDICATIONS:   This patient is a 60-year-old gentleman who was brought in
   by the paramedics as a 900 activation to the emergency department after
   suffering a gunshot wound to the right groin and the patient was noted to
```

be without a palpable pulse or measurable blood pressure in the field, and had been down for approximately 10 minutes prior to arrival of EMS.

At arrival in the emergency department, the patient was in pulseless electrical activity without a measurable blood pressure, bilateral saphenous cutdowns were performed and fluids were infused. The patient was given multiple rounds of epinephrine, vasopressin and bicarbonate. He went into ventricular tachycardia and was shocked. CPR was continued. After infusing 4 units of packed cells, as well as several liters of saline, as well as the medications and continued cardiopulmonary resuscitation the patient did regain a pulse with a measurable blood pressure. At that time, the patient was brought emergently to 401 for operative exploration of a single right groin gunshot wound from which he was actively bleeding in the emergency department.

</content>
<imgSrc/>
</note>
</notes>
</patient>

Appendix E, the MD:Notes schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs=" HYPERLINK "http://www.w3.org/2001/XMLSchema"
http://www.w3.org/2001/XMLSchema" targetNamespace="patient">
	<xs:element name="patient">
		<xs:complexType>
			<xs:sequence>
				<xs:element name="MRN" type="xs:integer"/>
				<xs:element name="fName" type="xs:string"/>
				<xs:element name="lName" type="xs:string"/>
				<xs:element name="dob" type="xs:string"/>
				<xs:element name="gender" type="xs:string"/>
				<xs:element name="address">
					<xs:complexType>
						<xs:sequence>
							<xs:element name="street"
type="xs:string"/>
							<xs:element name="city"
type="xs:string"/>
							<xs:element name="state"
type="xs:string"/>
							<xs:element name="zip"
type="xs:string"/>
						</xs:sequence>
					</xs:complexType>
				</xs:element>
				<xs:element name="note" minOccurs="0"
maxOccurs="1000">
					<xs:complexType>
						<xs:sequence>
							<xs:element name="status"
type="xs:string"/>
							<xs:element name="type"
type="xs:string"/>
							<xs:element name="location">
								<xs:complexType>
									<xs:sequence>
<xs:element
name="id" type="xs:int"/>
<xs:element
name="name" type="xs:string"/>
```

```
                                                    </xs:sequence>
                                                </xs:complexType>
                                            </xs:element>
                                            <xs:element name="site"
type="xs:string"/>
                                            <xs:element name="date"
type="xs:string"/>
                                            <xs:element name="time"
type="xs:string"/>
                                            <xs:element name="clinicians">
                                                <xs:complexType>
                                                    <xs:sequence>
                                                        <xs:element
name="entering">
        <xs:complexType>
                                                            <xs:sequence>
                                                            <xs:element
name="id" type="xs:int"/>
                                                            <xs:element
name="title" type="xs:string"/>
                                                            <xs:element
name="fName" type="xs:string"/>
                                                            <xs:element
name="lName" type="xs:string"/>
        </xs:sequence>
        </xs:complexType>
                                                        </xs:element>
                                                        <xs:element
name="signing">
        <xs:complexType>
                                                            <xs:sequence>
                                                            <xs:element
name="id" type="xs:int"/>
                                                            <xs:element
name="title" type="xs:string"/>
                                                            <xs:element
name="fName" type="xs:string"/>
                                                            <xs:element
name="lName" type="xs:string"/>
```

```
        </xs:sequence>

        </xs:complexType>
                                                                    </xs:element>
                                                                </xs:sequence>
                                                            </xs:complexType>
                                                        </xs:element>
                                                        <xs:element name="content"
type="xs:string"/>
                                                        <xs:element name="imgSrc"
type="xs:string" minOccurs="0"/>
                                                    </xs:sequence>
                                                </xs:complexType>
                                            </xs:element>
                                        </xs:sequence>
                                    </xs:complexType>
        </xs:element>
</xs:schema>
```

Appendix F: Consolidated content from document harvest

= **Core component**

Sequence #	Name	Description	HL7 - Version 2.x **Standard**	Hospital A and B **Included**	Hospital A and B **Required**
MSH-1	**Field Separator**	This field defines the delimiter that the sending system uses to indicate the beginning and end of a field.	Yes	Yes	Yes
MSH-2	**Encoding Characters**	This field defines the other delimiters used in the message. The encoding characters are defined in the following order. For the standard implemented by both Hospital A and B, the encoding characters are static and as follows (□/$). The following list represents the character order as expected by the application. 1. Component separator 2. Repetition separator 3. Escape character 4. Subcomponent separator	Yes	Yes	Yes
MSH-3	**Sending Application**	This field contains the sending application (e.g., a laboratory system), and is one of several HL7 fields that are needed to uniquely identify a result. This value is static and for Hospital A and B, the value is 'PCO'.	Yes	Yes	Yes
MSH-4	**Sending Facility**	This field identifies the sending facility (i.e., the facility that "owns" the result, or the facility with which the patient was associated at the time of the result). This field works with the MSH-3 field to link the message to a specific organization and sending facility.	Yes	Yes	No
MSH-5	**Receiving application**	Available for interface with lower level protocols.	Yes	No	No

MSH-6	**Receiving facility**	Identifies the receiving application among multiple identical instances of the application running on behalf of different organizations. See comments: sending facility.	Yes	No	No
MSH-7	**Date/time of message**	Date/time that the sending system created the message. If the time zone is specified, it will be used throughout the message as the default time zone.	Yes	No	No
MSH-8	**Security**	In some applications of HL7 this field will be used to implement security features.	Yes	No	No
MSH-9	**Message Type**	This is an HL7-required field. The receiving system uses this field to know which data segments to recognize and, possibly, the application to which to route this message. This field should be valued to 'ORU' for Hospital A and B. It will be recognized by the electronic medical record.	Yes	Yes	Yes
MSH-10	**Message Control ID**	This is an HL7-required field. It is valued with a number or other identifier that uniquely identifies the message. For the progress note application, the EMR is expecting to see the value 'Progress Note' which will remain static	Yes	Yes	Yes
MSH-11	**Processing ID**	This is an HL7-required field. It is used to decide whether or not to process the message as defined. Allowable values are as follows: D Debugging T Training P Production For both Hospital A and B, this will be valued to 'P' as the results will be placed in the production EMR.	Yes	Yes	Yes
MSH-12	**Version ID**	This is an HL7-required field. It is valued with the version of HL7 being used to create the message. It should be valued to 2.2. This is the end of the message header stream, and will be concatenated with 'PID' which indicates the transition to the next section. For both Hospital A and B, this will be a static field as follows: '2.2.PID'.	Yes	Yes	Yes

PID-1	**SetID - PatientID**	For those messages that permit segments to repeat, the Set ID field is used to identify the repetitions. For example, the swap and query transactions allow for multiple PID segments would have Set ID values of 1, 2, then 3, etc.	Yes	No	No
PID-2	**Alternate Patient ID**	Deviates from the length for the HL7 field as defined in the HL7 Standard.	Yes	No	No
PID-3	**Internal Patient ID**	This field is a repeating group and can contain multiple patient identifiers. This field is required, and is one of several HL7 fields that are needed to uniquely identify a result.	Yes	Yes	Yes
PID-4	**Alternate Patient ID**	This field can contain a patient identifier. It is an optional field and is not required for processing.	Yes	No	No
PID-5	**Patient Name**	This field contains the patient name, which is used by LCR in error processing and when name checking is turned on using Profile Record. The first component PID-5 contains the patient last name, and the second component contains the patient first name.	Yes	Yes	Yes
OBR-1	**Set ID Observation Request**	For the first order transmitted, the sequence number shall be 1; for the second order, it shall be 2; and so on.	Yes	No	No
OBR-2	**Placer Order Number**	The first component of the OBR-2 field identifies an individual order segment. It is assigned by the placer and identifies an order uniquely among all orders from a particular ordering application. The second component of the OBR-2 field is the application ID, which is uniquely associated with an ordering application. The components in this field are used in priority/demand and abnormal result document printing.	Yes	No	No
OBR-3	**Filler's Order #**	This field contains the transaction ID that identifies the specimen on the sending system. If available, it is one of several HL7 fields that are needed to uniquely identify a result.	Yes	No	No
OBR-4	**Universal Service ID**	This is a required HL7 field. When a Lab system sends microbiology sensitivity results, the observation ID for the sensitivity battery observation term is sent in this field. In other cases, the observation code (or a portion of the observation code) is sent in this field on the OBR segment instead of in	Yes	Yes	Yes

		OBX-3. This should be valued to 'Progress Note'.			
OBR-5	**Priority**	Not used. Previously priority (e.g., STAT, ASAP), but that information is carried as the sixth component of *OBR-27-quantity/timing*.	Yes	No	No
OBR-6	**Requested Date/Time**	Not used. Previously requested date/time. That information is now carried in the 4th component of the *OBR-27-quantity/timing*.	Yes	No	No
OBR-7	**Observation Date/Time**	This field contains the clinically significant date and time of the observation. The date is required; the time is optional. Typically, this field contains the date and time the specimen was drawn. It is sent in the format YYYYMMDDHHmm, where "YYYY" is the year, "MM" is the month, "DD" is the day, "HH" is the hour, and "mm" is the minute.	Yes	Yes	Yes
OBR-10	**Observation Change ID**	This field contains the ID of the person responsible for reporting the test result for the observation (i.e., usually the person who performed the test).	Yes	No	No
OBR-15	**Observation Specimen Source**	The first component of the OBR-15 field contains the source code (e.g., blood, urine) for the specimen as a coded-entry (CE) data component (a triplet).	Yes	No	No
OBR-16	**Ordering Provider**	The first component of the OBR-16 field provides the ID number of the provider who ordered the test. The second component of the OBR-16 field specifies the provider's last name. The third component contains the provider's first name, and the fourth component contains the provider's middle initial..	Yes	No	No
OBR-18	**Placer Field 1**	This field contains a user field on the message for the order placing system to put data (e.g., data that can be used to generate or route a document).	Yes	No	No
OBR-20	**Filler Field 1**	This field overrides the priority code in OBR-27. If OBR-20 is valued and its value is also defined in Profile Record PRLPO, the printing of priority results is triggered regardless of the priority code.	Yes	No	No
OBR-21	**Filler Field 2**	This field contains Patient Location and Ordering Location, which are used for document routing.	Yes	No	No
OBR-22	**Perform - Date/Time**	The first component of this field contains the date a result was performed, and the secondcomponent contains the time. This	Yes	No	No

		field is used in abnormal result and printing.			
OBR-26	**Linked Results**	This field is used only for microbiology sensitivity results. It contains the name of the organism associated with the sensitivity result. This field is defined as a coded entry (CE).	Yes	No	No
OBR-27	**Quantity/Timing**	This field provides the order priority code that is used to trigger priority/demand documents. This is required and the default value is "020SAE."	Yes	Yes	Yes
OBX-1	**Set ID**	Sequence number. For compatibility with ASTM.	Yes	No	No
OBX-2	**Value Type**	This field contains one of the following HL7 value types accepted by the system. The value type in OBX-2 specifies the type of result being sent in OBX-5. The default value for this field is "TX."	Yes	Yes	Yes
OBX-3	**Observation ID**	In classic HL7 format, the code system for component 1 would be CPT-4, and the code system for component 4 would be the local coding system. The default value for this component is "Action Point."	Yes	Yes	Yes
OBX-4	**Observation Sub-ID**	This field uniquely identifies an observation. When microbiology results are sent, it is used to identify an isolate within a culture report.	Yes	No	No
OBX-5	**Observation Results**	This field contains results that are evaluated and stored based on the value in OBX-2. This is the critical field where all the text for the progress should be entered. It is required.	Yes	Yes	Yes
OBX-6	**Units of Measure**	This field specifies the units of measure that are available to appear on documents.	Yes	No	No
OBX-7	**Reference Rage**	The range of possible values for the OBX-5 field.	Yes	No	No
OBX-8	**Abnormal Flag**	There are two components that make up field OBX-8. These are: Abnormal Flag. This component contains the abnormal flag from the sending system. If this component is valued, the result is abnormal. If this component is not valued, the result is normal.	Yes	No	No
OBX-1	**Probability**	Unknown	No	No	No
OBX-1	**Nature of Abnormality**	Unknown	No	No	No
OBX-1	**Obsv Result Status**	This field contains a code that LCR uses as an indicator of result status (e.g., pending, final, corrected). This should	Yes	Yes	Yes

		default to “F” for Final.			