Title
MD:Notes - Designing an Information Service for Public Hospitals

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MD:Notes

Designing an Information Service for Public Hospitals

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Abstract:
The hospital organization, containing a variety of clinical providers and supporting departments, is a complex service delivery system. This system requires a taxonomy of clinical documentation between the different clinicians and services for patient care coordination and billing justification. Our project, MD:Notes (where MD stands for 'multiple device') is about the design of a new application for physicians to enter progress notes, one component of all clinical documentation. This paper focuses on the user-centered research conducted at Highland and San Francisco General Hospital around the physicians, the primary stakeholders of the application. Our research demonstrates that a lack of mobility, difficult entry, transcription lag time and a lack of mandate to switch completely over to the electronic format is causing breakdowns that lead to poor service quality. While the design of the application is focused around the physicians, considerations must also be made to the secondary stakeholders, who are concerned with cost, reports for auditing and interoperability. Addressing the goals of all those in the service chain will lead to an application with a higher level of potential adoption.

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, 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 when injured or sick. Typically, these service encounters are routine examinations and involve some history gathering, basic physiological tests, possible 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.

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 this information taxonomy). 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 taxonomy of health care information documentation demonstrates the need to properly address the relevant context for designing an application. 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 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.

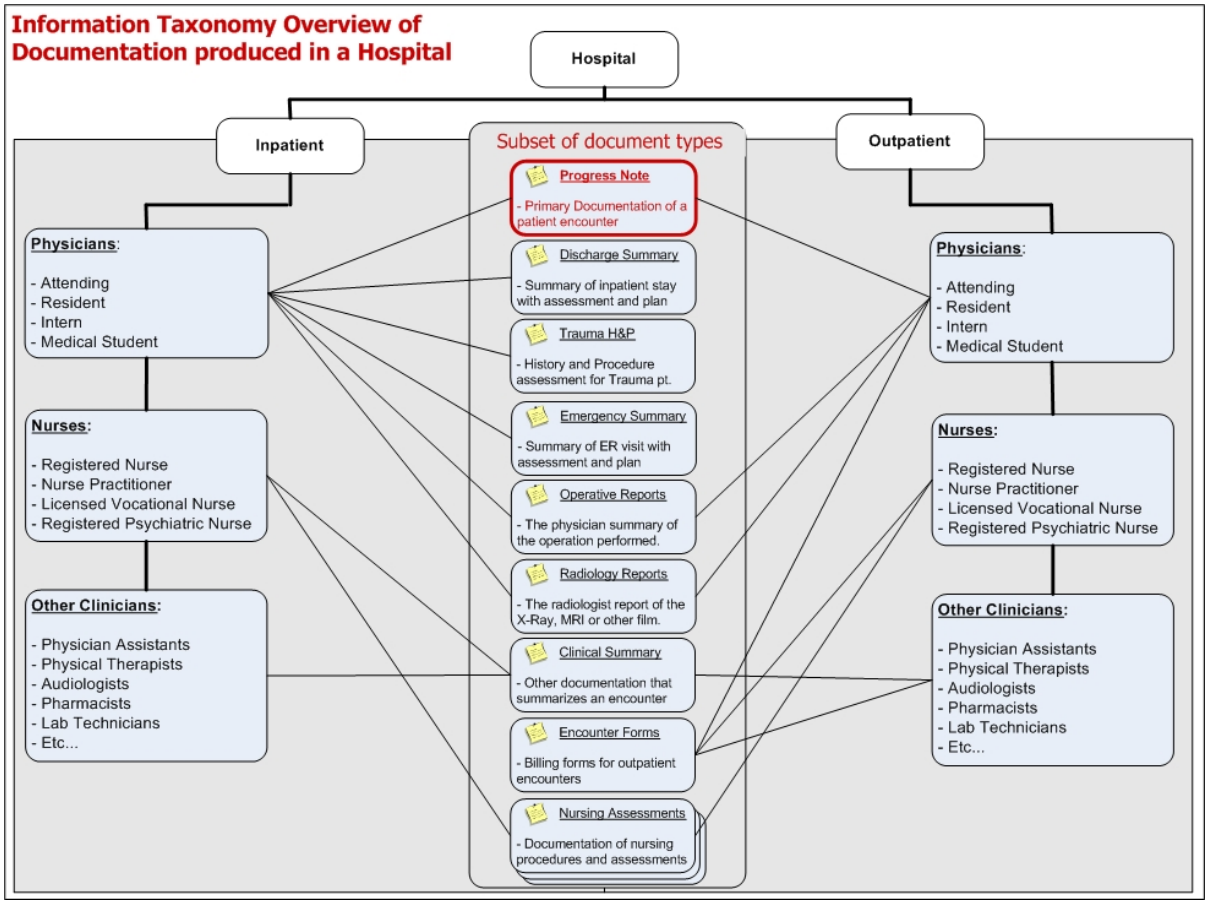


***Figure 1**: Demonstrates the breadth of possible document types produced in a hospital setting. This project is only dealing with the modeling of the progress note.*

The MD:Notes project is using the rapid contextual design process for defining a new progress notes prototype 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.

[1] Beyer, H. and K. Holtzblatt (1997). Contextual Design: Defining Customer-Centered Systems, Morgan Kaufmann. Pg 3

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 granularity of 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 on 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] 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 return trip to the same clinic. These customer inconveniences are not singularly tied to progress notes. However, our contextual interviews consistently demonstrate how note 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.

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

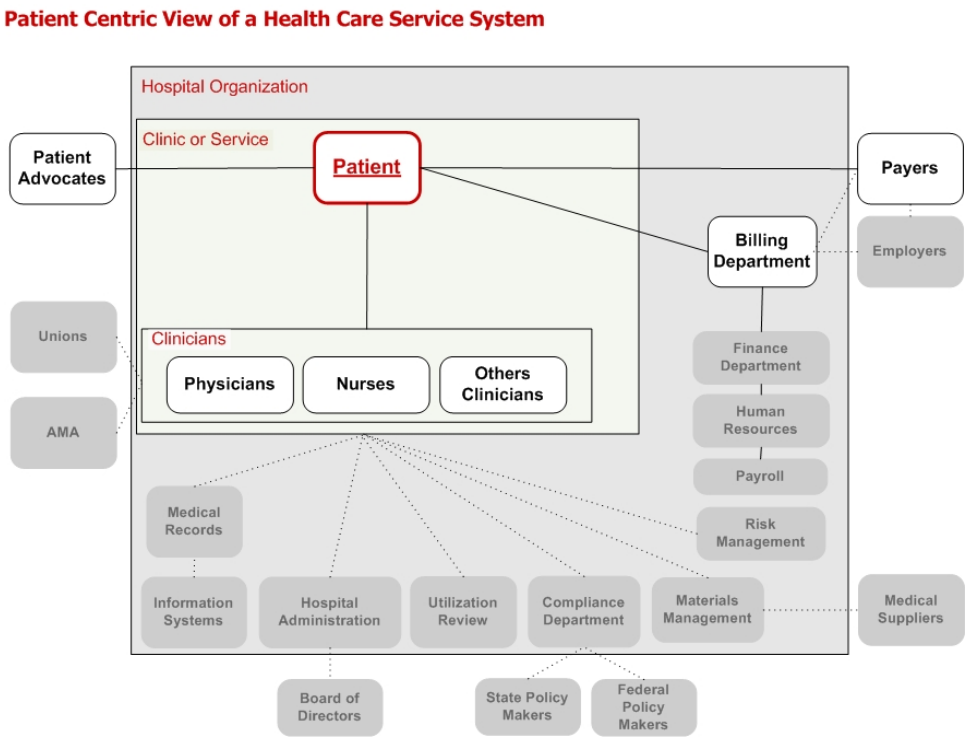


Figure 2: Illustrates the direct contacts of a service encounter where a patient perceives service quality within a health care system. Each layer shows the level of context from outside the organization, to the hospital, to the service or clinic where the encounter occurs.

Primary Stakeholder

The stakeholders of a system are "individuals or organizations who stand to gain or lose from the success or failure of a system; 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 centered on this group of stakeholders because they would be the primary users of the application and is discussed in detail later.

Importance of Secondary Stakeholders

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

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

- **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. 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.

- **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 with the progress note, and be able to effectively translate this note back to the Hospital's electronic record. Accounting for these dependencies will lead to an increased chance for adoption.

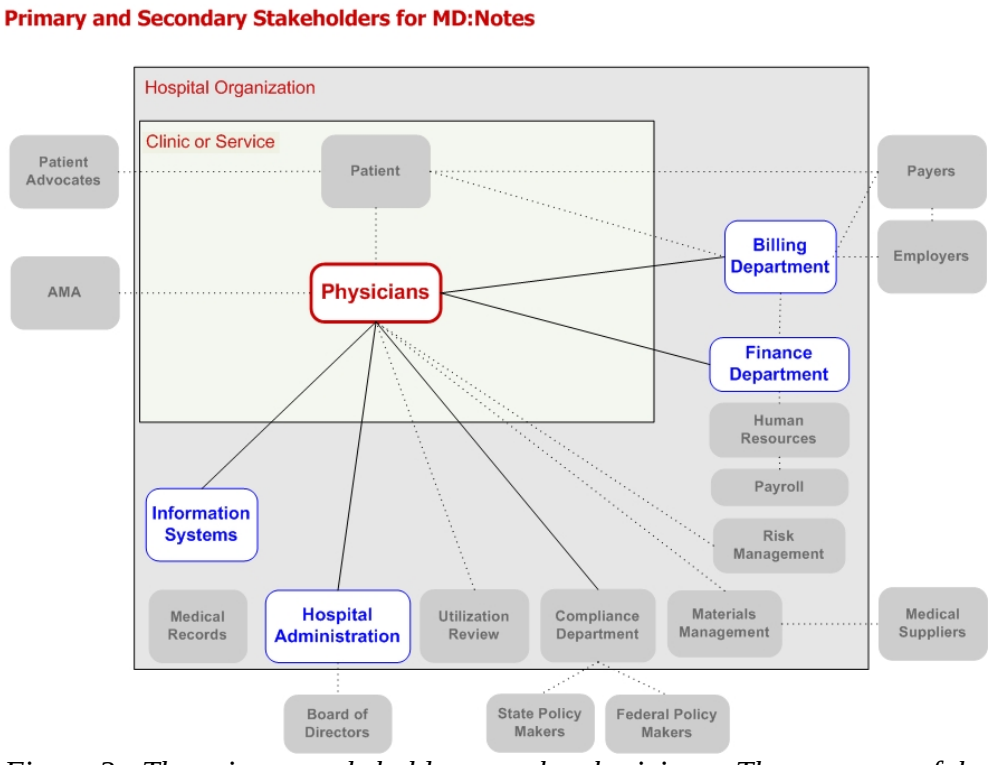


Figure 3: The primary stakeholders are the physicians. The concerns of the secondary stakeholders (represented in blue) need to be addressed for a proposed solution to be adopted.

Contextual Inquiry 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. However, 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 12 people from both Highland Hospital and San Francisco General Hospital (SFGH); including 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	Highland	Vice Chairman of Surgery	**Enters progress notes (out-patient only). Reviews and signs off on residents' notes**
U02	Highland	Licensed Vocational Nurse	**Retrieves and prints notes for physicians' review**
U03	Highland	Assistant Manager	**Tracks status of patients, verifies that patient visits have an associated progress note**
U04	Highland	Resident, General Surgery	**None currently. In the past has written, reviewed, retrieved notes.**
U05	Highland	Chief of Plastic Surgery	**Writes and reviews notes**
U06	SFGH	Attending Clinical Professor of Medicine and Family Practice	**Writes notes, looks up notes**
U07	Highland	Assistant Professor of Surgery	**Writes notes, co-signs notes**
U08	SFGH	Resident, General Surgery	**None currently. In the past has written, reviewed, retrieved notes.**
U09	SFGH	OR Nurse	**Writes nurse's operative notes**
U10	SFGH	-	**Responsible for administering progress note systems**
U11	SFGH	Director of Medical Information Systems	**Coordinates systems for storage of all patient records (includes progress notes)**
U12	SFGH	Analyst	**Retrieves progress notes for auditing purposes**
U13	SFGH	Director of Patient Accounting	**Retrieves progress notes for auditing purposes**
U14	**SFGH**	**Principal Engineer**	**Retrieves progress notes for auditing purposes**

Description of Contextual Inquiry Interviews

Each interview took between 1 and 2 hours, and was conducted at the user's general area of work within the hospitals: private office, patient exam room, nurses' 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
- Level of comfort with text messaging
- 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 patient identifiers before copying the artifact.

Charts vs Electronic Records

Highland and SFGH store patient records both electronically and in a paper format called a "chart". Both hospitals are in the process of moving to all-electronic records. The transition from paper to electronic records started many years ago (approximately 8 years ago for SFGH), but neither hospital is close to completing the transition. Both hospitals still rely primarily on charts, and only a portion of the patient record is stored electronically.

Figure 4 – Stack of charts (http://flickr.com/photos/annzas/2151972335/)

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, but the hospital keeps only the most recent charts on site. Older charts 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.

Figure 5 – Patient's electronic record. Screenshot of SFGH's Lifetime Critical Record (LCR) system

A patient's electronic record is stored in the hospital's database. It contains information such as lab results, reports, and any notes entered electronically, in a format compatible with the hospital's 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 a set of documents where some are available only in paper format while others are available only electronically. Handwritten progress notes are stored in charts, while electronic progress notes are stored in the electronic record. In reviewing a patient's history, physicians must refer to both the chart and the electronic record.

Handwritten Notes

Figure 6 –Form for handwritten note

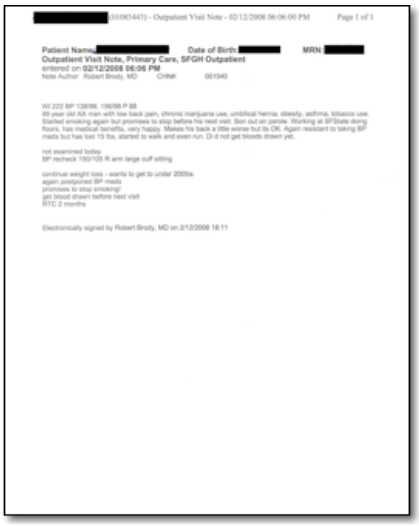


Figure 7 – Electronic note

Writing progress notes by hand is still the primary method at both hospitals. At SFGH, the Director of Medical Information Systems estimates that 70% of all notes are written by hand. At Highland Hospital, all notes, with the exception of notes from a handful of clinics and services, are handwritten. For many physicians, writing notes by hand is the easiest and fastest method, the method they are most familiar with. (See *Figure 8* for a sequence diagram of steps a physician takes to write a note by hand.) Handwritten progress notes are written onto a paper form, and then included in the paper chart only. Handwritten notes are not converted to electronic notes.

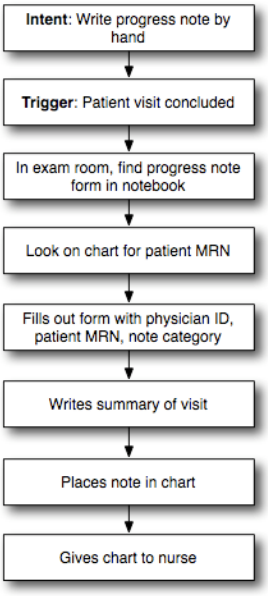


Figure 8 – Sequence diagram for writing a note by hand

Electronic notes - Dictation

Both Highland and SFGH 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. At Highland Hospital, dictation is the only widely available method for entering electronic 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 ED, and have not confirmed why this system is not available throughout the hospital. However, given Highland's shortage of IT staff, lack of resources and funding is a likely explanation.) Highland Hospital subscribes to a dictation service provided by Spheris.

Out-patient Settings

In out-patient settings, 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 nurses' station. Each station had a landline phone as well as computer terminal, so that physicians could 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.

The clinic we observed was one of the few that dictated notes; it was headed by a physician who was on the board for recommending new technology, and who was keenly aware of the inefficiencies of relying on paper charts. At this clinic, physicians dictated notes nearly every time they examined a patient. However, even with this high rate of dictation, physicians still wrote disposition notes by hand. A disposition note describes the physician's assessment and plan for treatment. Nurses need disposition notes in order to send patients to get lab tests, make follow-up appointments, and so forth. Because nurses need these notes before the patient leaves the office, the time required to dictate and then have the note transcribed (2-3 hours) makes dictation of the disposition note impractical. As a result, before dictating a progress note, physicians write disposition notes by hand and give these notes to the nurse. Disposition notes are then included into the paper 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.

To dictate a note, physicians use a landline phone to dial into the Spheris system and enter required information - physician ID, clinic code, patient medical record number (MRN), etc. – before speaking their notes into the phone. As mentioned above, 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. 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. See *Figure 9* for a sequence diagram showing the steps one of our

users takes to enter a note. It takes more steps to dictate a note than it takes to write a note by hand. Furthermore, dictated notes often get miscategorized, so physicans enter categorization information via DTMF as well as repeat the information during dictation. (On the diagram, this is noted as **BD**, or a breakdown.)

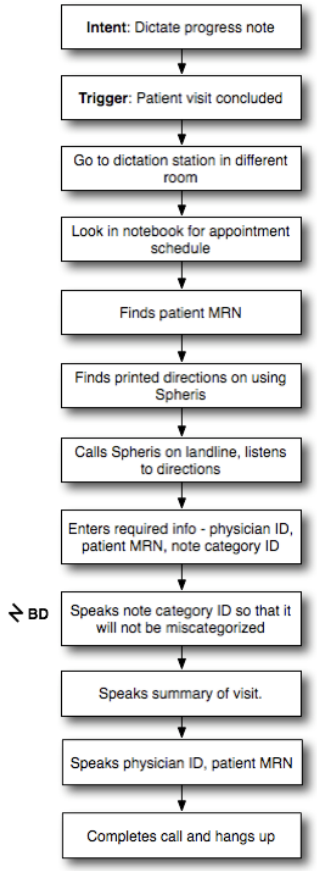


Figure 9 – Sequence diagram for dictating a note in an out-patient clinic. **BD** *is a breakdown*

In-patient Settings

The workflow for in-patient settings is very different from that for out-patient settings. For in-patient settings, physicians see patients who are staying overnight in the hospital. Instead of seeing patients one by one in an exam room, in-patient physicians have rounds, during which they walk around the hospital to examine the patients in their care. Because SFGH is a teaching hospital, the physician we interviewed was accompanied by residents as she made her rounds. 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 duties 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 each patient visit. 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 in-patient physicians need to be mobile as they see patients during rounds, a stationary landline phone for dictation is not appropriate. The physician we interviewed was the only physician at Highland involved in a pilot program using Spheris's mobile dictation product. Most other in-patient physicians write 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 "synchs" 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. (See *Figure 10* for a sequence diagram of the steps a physician takes to do rounds twice, and then dictate notes. See *Figure 11* for a sequence diagram for dictating using a mobile device.) As seen in *Figure 11* 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.

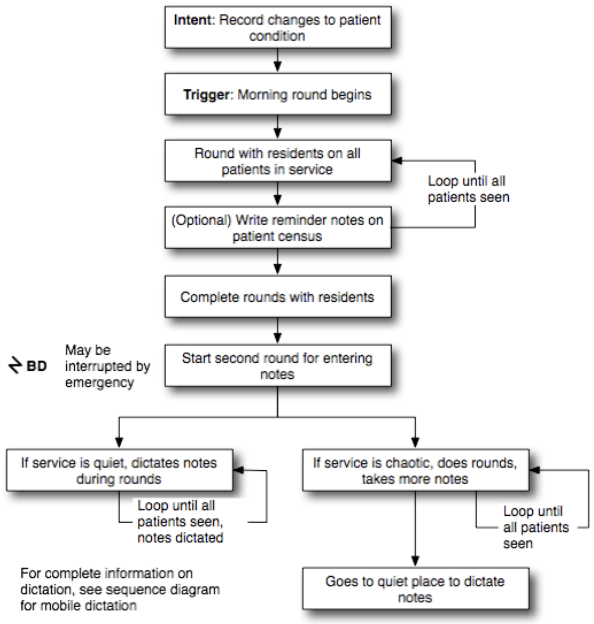


Figure 10 – Sequence diagram for doing rounds and then dictating notes in an in-patient service

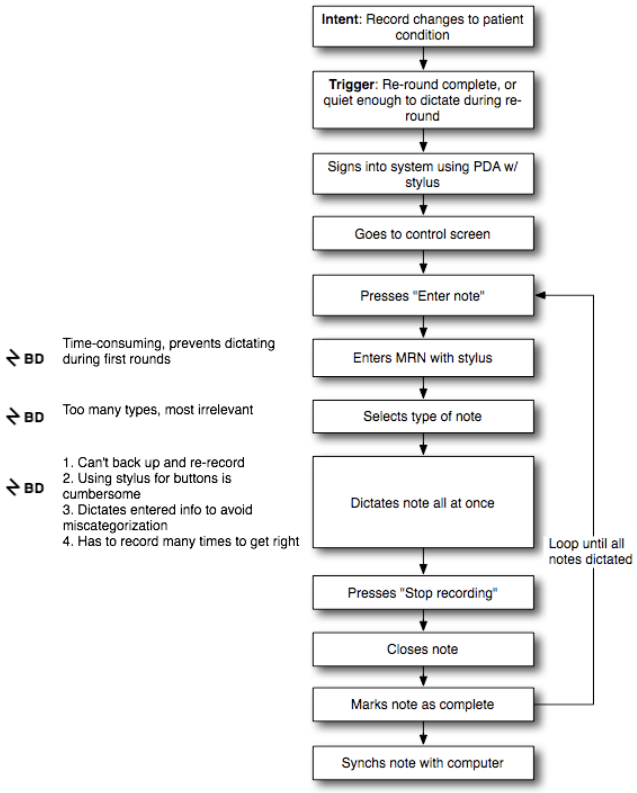


Figure 11 – Sequence diagram for dictating notes using a mobile device

Retrieving Charts and Electronic Records

Prior to a patient's visit at Highland Hospital, 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 patients presents (checks into reception), or early in the morning if they have some 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 discussed above, 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 the chart. The shadow file is kept in a room on a different floor from the clinic. As seen in *Figure 12* below, the nurse goes back and forth between the different system screens in order to find relevant information in the electronic system. 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.

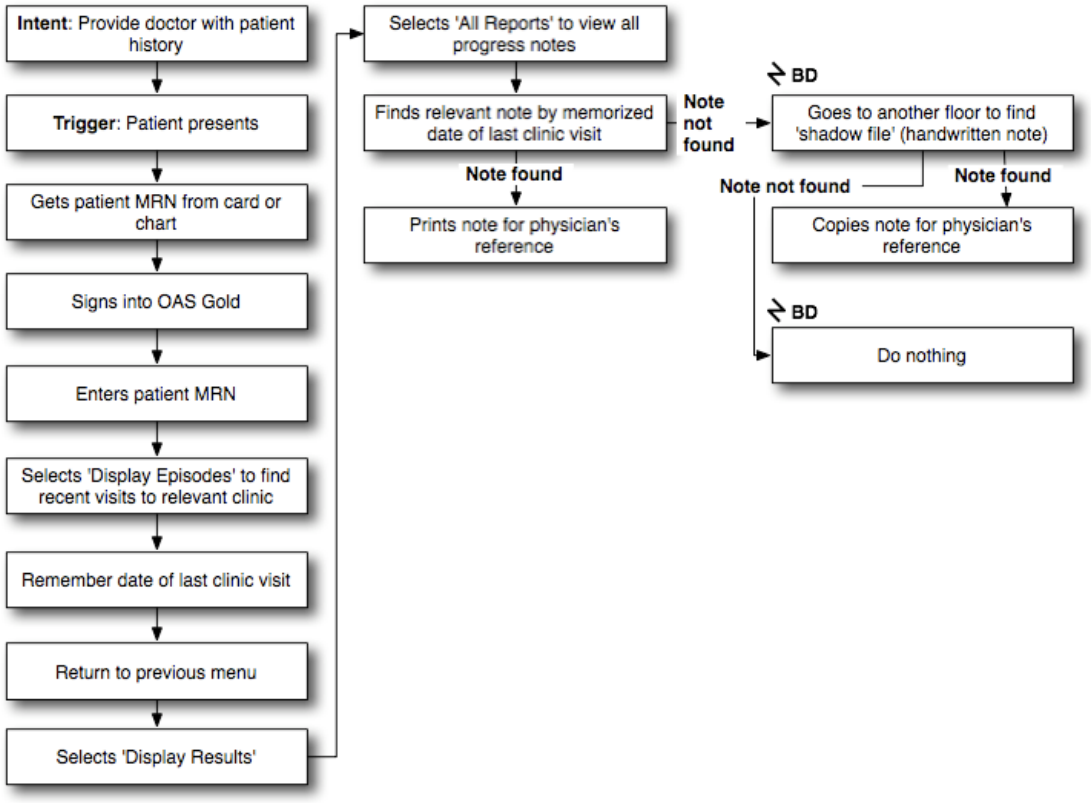


Figure 12 – Sequence diagram of a nurse's steps as he looks for relevant progress notes for a patient's visit

According to one Highland physician, on a typical day anywhere from 10% to 50% of patient charts are missing. A missing chart "is really devastating," as the physician must then reconstruct the patient's history, either verbally with the patient or by re-ordering tests. The physician also calls other clinics in the hospital to get faxes of relevant test results, or goes to the clerk directly to ask her to look for the chart again. For patients with missing charts, both the nurse and the physician spend a great deal of time looking for or reconstructing information. Missing charts directly affect patients' wait-time as well as the cost of care.

When we asked why so many charts were missing, many physicians said they had "no idea." However, SFGH's Director of Medical Information Systems told us that the charts are not actually lost, but instead may be currently unavailable to the clinic requesting the chart. 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.

Physicians at Highland reported a much higher rate of missing charts than physicians at SFGH. Since both hospitals rely on paper charts, we are not sure why the problem is much more prevalent at Highland. Nevertheless, storing patient records electronically

would eliminate the competition for access to the physical chart, and thus would greatly alleviate the problem of missing charts.

San Francisco General Hospital

At SFGH, tools and methods for creating progress notes varies across the different clinics. According to the hospital's Director of Medical Information Systems, as a public hospital, SFGH receives funding from the city of San Francisco. As a research hospital, SFGH also receives funding from the UC system, specifically UCSF. Groups and clinics 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 SFGH currently uses to enter notes:

1. **Writing by hand**: As with Highland, this is the main method for entering notes. Handwritten notes are kept in the patient charts only, and are not stored electronically. (SFGH 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.) Approximately
2. **Outsourced transcription services - WebMedix**: The city of San Francisco funds the dictation and transcription of notes from select clinics: Gastrointestinal (GI), Renal, Pulmonary, plus a few others. Transcription is provided by a company called WebMedix. 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 formatted and mapped to fit within the hospital's lifetime clinical records (LCR), so these are stored electronically, available to the entire hospital.
3. **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 not mapped to fit within the LCR, and are not available to other clinics. Instead, these notes are printed and then included in the patient's chart.
4. **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 mapped to fit within 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.
5. **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 mapped to fit within 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.

6. **Net Access**: The General Medicine clinic uses Net Access, an application developed by Siemans using Lotus Notes, to enter progress notes via keyboard. Notes entered in Net Access require no lead-time for transcription, are formatted to fit within the LCR, and thus available to the rest of the hospital. Another advantage to using Net Access 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 Net Access. Pediatrics tried this system, did not like the amount of typing required, and returned to writing all notes by hand.
7. **HERO**: Ward 86 (AIDS clinic) uses HERO, an application developed in-house to track its patients. HERO has functionality for entering progress notes via keyboard. As with Net Access, notes require no lead-time for transcription, is mapped to fit within the LCR and available to the rest of the hospital.

As seen by the list of methods described above, SFGH 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 SFGH 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 formatted and mapped to fit within 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.

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 find different methods to be the easiest and most efficient. In addition to physician preference, each method also has differences in terms of turnaround time, ease of retrieval, and so forth. The table lists each method and its advantages and disadvantages.

Method	Advantages	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)**
Dictation (landline)	• Some physicians think speaking notes is fastest	• **Some physicians are not used to dictating**

	• Dictated notes can be transcribed to electronic – easy to retrieve	• **Lead time required for transcription** • **Difficult to edit dictation – have to re-record the whole thing** • **Stationary landline not appropriate for in-patient settings** • **Entering sign-in, MRN, etc. via DTMF 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 in-patient 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 • Notes can be stored electronically – easy to retrieve • Easy to edit • Can copy/paste previous notes • No turnaround time – notes immediately available	• **Some physicians can't or don't like to type** • **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 electronic notes are widely available at Highland Hospital and somewhat available at SFGH, writing notes by hand is still the dominant method at both hospitals. 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 SFGH and Highland do not have sufficient funding for all their technology needs. Furthermore, as previously mentioned, SFGH receives funding from both San Francisco and UCSF. At least partly because of insufficient and de-centralized sources of funding, neither hospital requires physicians to enter notes electronically. Several physicians thought writing by hand was the fastest method. Other doctors, especially residents, were comfortable with the tools available to dictate or type notes. 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. However, even without a requirement to enter notes electronically, the transition to electronic methods of entry will eventually happen. We believe 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 to learn new system: 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. Physicians at Highland who expressed frustration at the high number of missing charts also preferred writing notes by hand. They thought this method was the fastest, and did not take into account time lost in searching for charts or reconstructing a patient's medical history.

System overhead: At Highland, for each note a physician dictates, he or she must enter a physician ID, patient MRN, clinic code, etc. Entering this information using DTMF 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. As previously mentioned, several physicians said they thought writing by hand was the fastest method.

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.

Linking lab and test results: Physicians currently look up lab and test results onto an intermediate note. and then include this information in the progress note.

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

XML: An appropriate technology for hospital information services

As we discussed above in the description of San Francisco General's adoption of speech recognition software, notes created with speech recognition software are not formatted and then mapped to fit within the hospital's lifetime clinical records (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. We propose that this is one example of a problem of interoperability.

A lack of interoperability can be considered a breakdown in the "back stage" of the hospital information service. "A focus on the service encounter implies a sharp distinction between the interactions between the customer and provider that are part of the service encounter and other activities that precede it to make it possible. The former comprise the "front stage" and the latter the "back stage," which are separated by the "line of visibility," so-called because, by definition, any activities or services that are invisible to the customer are behind the line."[6]

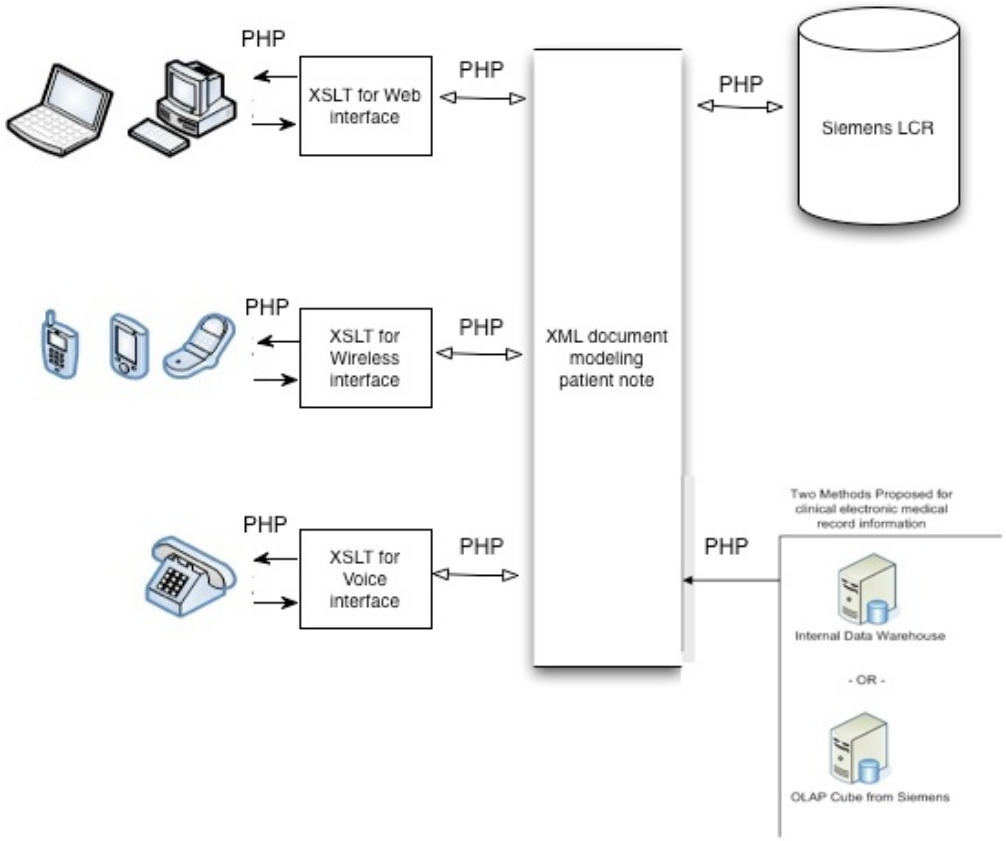
Since dysfunction in doctor's access to patient data means the doctor has to ask the patient about his or her medical history, functions that should be performed in the back stage are moved to the front stage. In Service System Design, this is considered a failure. Several of our doctor users expressed feelings of embarrassment when they had to ask a patient about, for example, what medications the patient was on.

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."[7]

[6] Glushko, R. J. and L. Tabas "Bridging the "Front Stage" and "Back Stage" in Service System Design."
[7] Glushko, R. and T. McGrath (2005). Document Engineering, MIT Press.

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."[8] 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.

Our prototype architecture



In our prototype, we will be showing an example of modeling a patient in XML. We will be using this to show how xml can help satisfy issues of multi-device support, connectivity, interoperability, and sufficiency. The XML document modeling the progress note

We will be using XSLT to show how the XML document modeling patient data can be created from HL7 data from legacy systems. The data currently trapped in disparate

[8] Tucker, C. and A. Miller "Privacy Protection and Technology Diffusion: The Case of Electronic Medical Records."

systems will be integrated in our system, supporting the interoperability that is at the heart of Document Engineering. If deployed, the information from the disparate systems will 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.

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 by PHP, and a single document would be created. Currently many of these systems are not connected, and our aim is to connect them. We hope to show a possible method for integration, defined as the controlled sharing of data between any connected applications or data sources (Glushko and McGrath: 2005). 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.

In the key takeaways for design section above, we described how a clinical progress notes product should support multiple methods of entry on multiple devices - the combination of XML, PHP, and XSLT 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.

Conclusion

Our project, MD:Notes, is about the design of an information service system for public hospitals, specifically a service for entering and retrieving progress notes. Prior to beginning our design, we use contextual inquiry to more fully understand the needs and work processes of our primary stakeholders, the physicians and our secondary stakeholders, IT and hospital administration.

The hospitals' reliance on paper charts creates huge inefficiencies when retrieving patient medical records. Both San Francisco General and Highland Hospitals are transitioning between paper and electronic records. Both hospitals have tools for creating electronic progress notes, but adoption of these tools is not widespread, and most physicians still write notes by hand. Our research finds the following main issues around universal adoption:

- Lack of central mandate to create all-electronic notes
- Electronic systems that are difficult to use
- Unacceptable lead time for transcriptions
- Systems don't address mobile requirements for in-patient settings
- Many physicians are most comfortable with writing notes by hand

Our proposed solution, a multi-device application that uses speech recognition and text-based entry methods, addresses most of these issues. By designing a service that allows

for multiple entry methods on multiple devices, we aim to provide physicians with better tools for creating and retrieving electronic notes. Although some physicians will continue to write notes by hand, it is our expectation that a well-designed service can be used to convince more and more physicians to create electronic progress notes.

While the design of the application is focused around the physicians, considerations must also made to the secondary stakeholders who are concerned with cost, reports for auditing and interoperability. Addressing the goals of all those in the service chain will lead to an application with a higher level of potential adoption.