Tech MDs: Improving User Experience of Electronic Health Record System

Rootwa Sagar
rrs8792@rit.edu

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Tech MDs: Improving User Experience of Electronic Health Record System

Tech MDs: Improving User Experience of Electronic Health Record System
A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Visual Communication Design

Rootwa Sagar
School of Design
College of Imagining Arts and Sciences
Rochester Institute of Technology
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Thesis Committee Approval

For, Tech MDs: Improving User Experience of Electronic Health Record System – Rootwa Sagar, MFA Candidate

Chief Thesis Advisor: Nancy Ciolek, Associate Professor
CIAS – School of Design

Associate Thesis Advisor: Chris Jackson, Professor
Associate Dean
CIAS – School of Design

Associate Thesis Advisor: Shaun Foster, Assistant Professor
CIAS – School of Design

External Advisor
Dr. Laurence Sugarman, Director of the Center for Applied Psychophysiology and Self-regulation (CAPS)

Administrative Chair: Peter Byrne, Professor
Administrative Chair
CIAS – School of Design
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Abstract

Electronic Healthcare record keeping can be daunting. The available software does not usually allow for clinicians to input information concordant with their clinical work-flow. This disrupts the clinician-patient encounter and can lead to frustration for both clinicians and patients. Because of this, the organic interaction between the patient and the clinician is not accurately recorded with available EHR systems. For example, the idiosyncrasies of individual patients—how and why they present certain information—as well as the clinician's response can be significant but are ignored by the demands of EHR data entry. Patient or person-centered care is increasingly recognized as a fundamental principle and value in increasing beneficial health outcomes. Therefore, EHR systems ought to allow both collaborative information entries with clinicians and follow the patient's lead in terms of setting priorities for care.

This user interface is designed to accommodate the recording of the organic interface that takes place between the clinician and the patient while patient-centric. It also accommodates all the patient records in a singular interface, and yet make the interface easy to understand and use. A significant amount of project is dedicated to understand the user work flow and develop information architecture to make the software mold to the needs of the user rather than the other way around.

Keywords:
Healthcare records
User interface design
User experience design
Electronic healthcare records
Information architecture
User work flow
Hospital
Doctor
1.1 Problem Statement

Electronic Healthcare Record (EHR) systems available in the market are industrial and administration centric. In contrast, the clinician-patient interaction is organic, idiosyncratic and personalized. Thus, when clinicians try to record this personalized interaction with an EHR, they encounter an inflexible, unresponsive categorical structure that accommodate the flow of the clinical encounter. Thus this information-rich interaction is reduced to a generalized, bland description common all over the system. This ultimately limits and frustrates the potential creativity, perception and individuality of the practitioner and the patient.

Additionally, input of information by the clinician in presence of the patient reduces the face to face interaction between the patient and practitioner, further decreasing their interaction.
1.2 Situation Analysis

The problem with EHR concept

In the EHRs available today, the interaction is administration centered. The system is driven by the output of billable service codes supported by diagnostic labels. All information entered prior to those outputs are organized in their support. This data is often very loosely related to the information about the patient’s behavior and priorities that the clinicians need to care for the patient. As a result, the doctor patient interaction is reduced to a generic template available in the EHR. These templates do not have the flexibility to record the ingredients that create the uniqueness of the interaction. Providing free text space to enter interaction dose not solve the problem for the practitioners as the interaction can be quite lengthy and customized data entry is ignored by the data processing system of the EHR, since it is out-of-template. Thus EHR use actually discourages the recognition and inclusion of patient-centered interaction.
1.2 Situation Analysis

The Problem with EHR interface

Most of the health care practitioners in the US today are unsatisfied or frustrated with the EHRs used in their clinical practices and hospitals. Their chief complaint is that the user interface does not follow the actual work flow of the clinical practice and thus they have to spend a lot of time completing redundant data entry which can be done by the administrative staff instead. Ultimately, clinicians’ impatience with the EHR can contribute to the overall work dissatisfaction for the practitioner and diminishing the benefit of the health care visit experience for the patient.

There are numerous softwares existing today, that do not fulfill the requirements for the practitioners. Competitive Analysis section discusses some such examples.
1.2 Situation Analysis

Competitive Analysis

NextGen

NextGen is the most well known software in the field. This software lacks proper input methods. To enter numerical information, multiple number pads are provided on the screen. This seems to be completely unnecessary for a computer screen. A new number pad besides each field takes up a lot of real estate and increases the memory load for the user which might lead to error. The user has to figure out where to input the data and which number pad to use to input the data.

Although, a lot of data is accommodated into a single screen which is convenient for a professional, but the icon design is outdated. There is too much detail to decipher the meaning. This is a good example to collect an inventory required in creation of a better UI design.
1.2 Situation Analysis

Competitive Analysis

PrognoCIS

Similarly, PrognoCIS is another well known EHR. This EHR is a bit more structured with some color coding in place. Although, there is a scope for better color coding to define the each block of information. In addition, this program lacks typographical hierarchy which makes it difficult for the viewer to concentrate on a particular element.

This program fits the bill for administrative purpose but the patient can get lost in the information overload.
1.2 Situation Analysis

Competitive Analysis

e-MDs

e-MDs is another software which is widely popular in the healthcare industry. This software provides a lot of space for free text which means the practitioner cannot talk to the patient while getting all the information into the software. Sometimes, such free text notes might be lost due to software errors which can lead to major frustration on part of the practitioner and the patient.
1.2 Situation Analysis

Competitive Analysis

Nuance

Nuance is a company that builds various products for healthcare industry. They have a wide variety of products that support speech recognition. According to the reviews found on the internet, some practitioners like this kind of software and can put up with the errors in the speech recognition while others find it to be annoying. One of the main highlights of a product by Nuance is that the clinicians can use their cellphones as microphones to dictate to the system. This means that the clinician does not necessarily have to be near a work station to get the notes digitized. It is one major breakthrough solution which when further pursued, can develop into something that can be of everyday use at a medical practice.
2.1 Survey of Literature

Physicians’ Concerns About Electronic Health Records: Implications and Steps Towards Solutions
By Mark Friedberg, Francis J. Crosson and Michael Tutty
March 11, 2014

This article discusses the doctor’s responses to a survey of open ended questions to gauge the professional satisfaction of doctors on integration on technology in health care system. Specific study for EHR was not carried out but most of the survey participants commented about EHR and thus the survey was reshaped to include findings specifically related to EHR. Most of the participants commented that the EHR did not follow the clinical workflow, is time consuming, reduces the face to face interaction with the patient and generates high number of alerts.

4 lesser know problems with EHRs
By Marla Durben Hirsch

The article outlines the hidden problems with the EHRs which are normally not apparent to the patients or the doctors. It helps understand the underlying risks of not closely monitored EHRs.

Electronic Health Records: The good, the bad and the ugly
By George Palma, MD, Medical Director, Simpler Consulting
October 14, 2013

This article lists down the various pros and cons of the EHRs which could help in understanding where the system is going right and where there is a scope of improvement. The author at last comments that in case of EHRs the bad and the ugly overrides the good and thus the hospitals should thoroughly evaluate the EHR before adopting and implementing it in their system.
2.1 Survey of Literature

**EHR systems pose serious concerns, report says**
By Joseph Conn  
June 24, 2013  
http://www.modernhealthcare.com/article/20130624/NEWS/306249952

The article describes in detail how the EHR could pose serious threat to a patient's life and how the doctors reacted to a survey conducted by the KLAS Enterprise, a Utah based health IT market researcher. Furthermore, the article describes how the healthcare industry is held accountable when an error occurs in an EHR, for which the EHR vendors should be held accountable.

**Fundamentals of Electronic Medical Record Design Part I**
By Margalit Gur-Arie  
Feb 11, 2013  

The basic functions that an EHR is supposed to carry out plus the fact that hoe they are not designed to do so is emphasized in this article. The writer lists the three functions and they ways in which these three objectives can be achieved.
2.1 Survey of Literature

Talking to Machines and Being Heard : A speech recognition primer
By Dave Rich
November 28, 2012
UX Magazine, Article No: 909

The article explains various modes of speech recognition. It goes into details of how to design a system for speech recognition, about the grammar and formation of the sentences, the technicalities, error handling etc.

Process Makes Perfect: Speech Recognition User Interface Design
The nine steps to a voice user interface design with rewarding user experience.
By, Stephen Keller
January 14, 2013
UX Magazine, Article No :937
https://uxmag.com/articles/process-makes-perfect-speech-recognition-user-interface-design

This article explains how a speech recognizing interface is created. It explains the structure of the interface, kinds of speech recognition interactions and grammar. It would help understand the process in order to make some crucial decisions while designing the interface.
2.1 Survey of Literature

Cognitive Psychology in and out of the Laboratory
By Kathleen M. Galotti

This book helps understand the human psychology which in turn helps forecast how the human brain would react to a certain interaction. It helps understand different aspects of memory load, cognition, knowledge representation and basic processing of the human brain.

Designing of Everyday Things – Revised and Expanded Edition
By Don Norman

This book explains the basic heuristic principals, the basic terminology used in the field of interaction design, the various errors caused by humans and the definition on types of errors and mistakes, and designing for a business world.

Personal names around the world
Intended audience: HTML content authors (using editors or scripting), script developers (PHP, JSP, etc.), schema developers (DTDs, XML Schema, RelaxNG, etc.), Web project managers, and anyone who is involved in the design of forms, databases and ontologies that capture people’s names.
Updated: 2011-08-17 19:22

https://www.w3.org/International/questions/qa-personal-names

An article about how different cultures around the world have different naming methods and how it can affect the design of a form for the name fields. How to collect the information so as to capture accurate data and leaving enough leeway for the exceptional user case scenario.
2.1 Survey of Literature

10 golden rules for digital icons
By Creative Bloq Staff
January 08, 2014

The article goes into detailed discussion about the process of designing icons. The factors like audience, the brands, consistency, size of the icons are all discussed in the article. This article helped get a good start on initiating the process of icon design.

How to master pixel perfect icons
by Justas
Aug 21, 2015
http://iconutopia.com/how-to-design-pixel-perfect-icons/

This article helped understand the nuances of creating icons with Adobe Illustrator. It goes into the depth of how to use the tools, What pre-sets to use, how to make the anti-aliasing minimal and finally exporting the icons correctly from Adobe Illustrator with the format of .svg and .png

Icon Grid: When And How To Use It?
By Justas
Jan 19, 2016
http://iconutopia.com/icon-grid-when-and-how-to-use-it-bonus-grids/

This article talks about the importance of using a grid when designing icons and how to decide what kind of grid to use. More importantly it talks about the difference between the construction lines and grid lines. It not only talks about following the grid lines but also throws light on when it is fine to ignore the grids in favor of aesthetics.
2.2 User Persona

Dr. Mark Richardson

Field of Specialty: Family Practice Physician

Demographics: Male
38yrs

Identifiers: Friendly
Calm,
Open to new ideas
Tech Savvy

Size of Practice: Medium Scale

Technological adaptivity: High

Objectives
To be attentive to patient when they are talking to him and also to record the important information that can be useful for the treatment.

Take on EHR:
I like the idea of EHR but I am not happy with actually implementing in my day to day use because it is rigid and time consuming. I have to make my notes and feed it into the EHR during after-hours and weekends. I insist on making my notes on paper because I am afraid my patients are going to feel ignored if I face my computer in their presence.

I also feel that these systems are designed to make things easier for the administrative and accounting staff and does not consider the versatility of each case and the nuances of an actual medical practice.
2.2 User Persona

Ms. Emma Rogers

Profession: School teacher

Demographics: Female
30 yrs
Married

Identifiers: Warm
Friendly
Likes to study psychology

Technological adaptivity: High

Objectives:
Has older parents she takes care of. Often accompanies them to the clinic. She herself gets consultation from the same clinic, so has an experience as an third party observer and as a subject.

Challenges:
Many a times, she feels that the practitioner is listening to her but is really not paying attention to the details she is giving him about the complaints she has. She feels as if her complaints are not heard because the practitioner is either busy figuring out what they should feed into the software or are fiddling around with the computer and are just taking the data that the software asks for. Her unique problems where not recorded or heard by the practitioner.

Take on the visit:
Having recently moved to the city, I am trying to find a practitioner I can trust. I have been disappointed twice now, because I feel the practitioner is not concerned with my complaints rather he/she is busy taking down their notes on their computer. I wish they could first talk to me about my ailment and then go ahead an record it because I feel as if it is a one way communication and the practitioner wants me out of their hair as soon as possible.
3.1 Factors to consider

**Easy accessibility**
An EHR system has many functions and thus, the most important part of design should be how to make the functions easily accessible during various scenarios that take place in the practitioner’s office.

**Hierarchy**
This area had a lot of scope of improvement when compared to the various products available in the market. General observation reveals that the layout missed the typographic hierarchy which made the data look too homogeneous and confusing for the user.

**Color Palette**
Being a medical application, it was important that the color palette be kept neutral. Using aggressive colors like red and orange in excess was to be avoided. Additionally, colors like green and yellow were avoided in general, as they can remind the users of sickness.

**Cognitive Design**
One of the most important advantage of using a software for data collection is that the machine learning could help the practitioner remind the important facts about the patient. In some fields of medicine, talking to the patient could unlock the mystery behind the ailment. Such factors are important for the practitioner to remember.

During other times, the repetitive nature of the ailment makes it necessary to access a particular part of the patient’s medical record. In such scenarios, the software’s ability to pull data and present it in a form that helps the practitioner recall the facts proves to be useful.

Other times where this ability could come in handy, is when the practitioner has multiple patients with same ailment and medications. In such cases, the practitioner need not fill the details repetitively thus saving time and increasing the face to face interaction with the patient.
3.2 EHR Data Elements

Figure 3.1 Data elements - High level
3.2 EHR Data Elements

**Demographic Data**
- Patient name
- Previously registered name/Maiden name
- Individual identifier/Medical record number
- Universal patient health number
- Gender
- Race
- Address
- Telephone number
- Date of Birth
- Organization
- Admission date
- Transcriptionist/Data enterer name
- Transcription name

**Chief Complaint**
*(The reason for patient's visit in his/her words)*

**History of Present Illness**
- Symptoms
- Onset of symptoms
- Over the counter treatment
- Duration of symptoms

*Figure 3.2 Data elements - Demographic Data and Chief Complaint*
# 3.2 EHR Data Elements

## Patient History
- Hereditary diseases
- Mother health status, date & cause of death
- Father health status, date & cause of death
- Number of siblings
- Siblings health status, age of death and cause of death

## Family History
- Condition type
- Date diagnosed
- Age of onset
- Treatment
- Condition status

## Past Medical History
- Drug
- Dosage
- Route
- Quantity
- Quantity form
- Frequency
- Start date
- Stop date
- Prescribed by
- Proscription date
- Proscription number
- Pharmacy
- Allergic reaction

## Medications
- Allergy/sensitivity
- Reaction
- Severity
- Date of last occurrence
- Treatment

## Allergies
- Occupation
- Home environment
- Daily routine
- Dietary pattern
- Sleep pattern
- Exercise pattern
- Caffeine consumption
- Tobacco use
- Alcohol use
- Drugs usage

*Figure 3.3 Data elements - Patient History*
3.2 EHR Data Elements

Doctor’s Reviews

Review of Systems
- General
- Skin
- Head
- Eyes
- Ears
- Nose & sinuses
- Mouth & throat
- Neck
- Breasts
- Respiratory

Physical Examination

Vital Signs
- General Appearance
- Physical Findings

Diagnostic Findings
- Test
- Result/findings
- Result/findings date
- Interpretation
- Diagnoses
- Disposition

Assessment & Plan
- Treatment goals
- Procedure

Figure 3.4.1 Data elements - Doctor’s Reviews
3.2 EHR Data Elements

Physical Examination

Vital Signs
- Pulse
- Respiratory rate
- Systolic blood pressure
- Body temperature
- Height
- Weight
- Body mass index
- Head circumference
- Crown to rump length
- Pulse oximetry

General Appearance
- Appearance
- Body build
- Demeanor
- Hygiene

Physical Findings
- Skin
- Head
- Eyes
- Ears
- Nose & sinuses
- Mouth & throat
- Neck
- Thorax, anterior & posterior
- Breasts
- Lungs
- Cardiovascular
- Abdomen
- Male Genitourinary
- Female Reproductive organs
- Ano-rectal
- Musculoskeletal system
- Extremities
- Lymphatics
- Peripheral vascular
- Neurological
- Mental status

Figure 3.4.2 Data elements - Doctor's Reviews (Continued)
4.1 Design Solution

The chief purpose of the thesis is to create an improved patient practitioner interaction while co-creating the patient records. A better system would require a clear understanding of the user work flow at a clinic and careful layout of the information architecture.

In addition, the system is designed, so that it would remember the practitioner’s choices during the first visit. During the following visits, the system recalls the choices and presents them on the top, thus reminding the practitioner about the course of treatment and discussion during the previous visits.

Initially, the idea of using a voice recognition was being considered, but it could raise privacy concerns with healthcare. Plus the voice recognition technology is still too naive to be used for such a serious purpose. Most of the subjects raised concern that they would feel too conscious about sharing their health problems if they knew a software is trying to recognize their voice and trying to decode the information.
4.2 Design Ideation and Layout Plan

Initial design was based on the simple concept of dividing the data into three main segments i.e. Chief Complaint, Patient History/Behavioral Pattern and Practitioner’s Review (Figure 4.1). The sub-menus pertaining to each area would appear on the right hand side of the screen, while the other two areas could be accessible at the bottom of the screen. Moreover, in the sub-menus, once the data has been entered or the screen is visited, the menu would automatically appear on the left hand side of the screen to indicate that data entry had been initiated or completed. An ‘Overview’ button omnipresent on the screen would provide a segregated view of all data entered. This was a basic plan, which was followed through in the final design but was modified based on further research and user inputs (Figure 4.2 to Figure 4.8).

For the layout plan, the actual screen aspect ratio was not taken into consideration as this exercise was intended to define the functionality, grouping and layout of the elements.
Figure 4.1 High level view of data elements

- Chief complaints
  - Location
  - Severity
  - Duration
  - Timing
  - Context
  - Modifying factors

- Patient history/Behavioral pattern
  - Previous occurrences
  - Family history
  - Allergies
  - Operations
  - Immunizations
  - Belief of occurrence
  - Dietary habits
  - Regular medicines

- Practitioner Reviews
  - Vital stats
  - Observation
    (Palpation, Color, Size, Behavioral symptoms, Family behavior, Reactions, Reflexes)
  - Prescriptions
  - Dosage

Figure 4.2 Layout plan
Figure 4.3 Layout plan

Figure 4.4 Layout plan
Figure 4.5 Layout plan

Figure 4.6 Layout plan
Figure 4.7 Layout plan

Figure 4.8 Layout plan
4.3 Wireframes

These wireframes were created with the correct screen aspect ratio and incorporating additional EHR elements.

The chief categories were placed on the right side of the screen while the other functions were placed on the bottom of the screen (Figure 4.9). This system was quickly becoming too cluttered because of repetition (Figure 4.10 and Figure 4.11).

Thus, these screens were further refined to target a more unified look and better experience.

Figure 4.9 Chief categories on the right hand side with sub menus at the bottom

Figure 4.10 The categories which already have data input move to the top tabs
Figure 4.11 The categories which already have data input move to the top tabs
4.4 Wireframes Testing and Revision

In this final wireframe version (Figure 4.12 to Figure 4.19), all the Main Menu items were placed at the bottom of the screen and all the sub-menus were stashed in a right hand side menu that can be collapsed if required. The side menu still had the segregation to define parent menu for each one.

![Figure 4.12 Wireframe iteration 2](image)

**Chief Complaint** | **Patient History** | **Doctor’s Review**

**History of Current Illness**
Observation: Migraine Headache
Status: Active
Date diagnosed: <mm/dd/yyyy>
Age at Onset: 15 <years>

**Chief Complaint** | **Patient History** | **Doctor’s Review**

1) Chikungunya
   - Date Diagnosed: <mm/dd/yyyy>
   - Age of onset: 5 <years>
   - Treatment: Condition Status: Resolved

2) Malaria
   - Date Diagnosed: <mm/dd/yyyy>
   - Age of onset: 5 <years>
   - Treatment: Condition Status: Resolved

Figure 4.13 Final wireframe
4.4 Wireframes Testing and Revision

Figure 4.14 Final wireframe

Figure 4.15 Final wireframe

Figure 4.16 Final wireframe
### 4.4 Wireframes Testing and Revision

**Figure 4.17 Final wireframe**

- **Patient Name**
- **Age**
- **Sex**
- **Additional Information**

**Family History**
- **Hereditary Diseases:** Diabetes

<table>
<thead>
<tr>
<th>Mother</th>
<th>Father's</th>
<th>Sibling/s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health Status:</strong> Throat Cancer</td>
<td><strong>Health Status:</strong> Diabetes</td>
<td><strong>Health Status:</strong> Healthy</td>
</tr>
<tr>
<td><strong>Age of death:</strong> 60 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reason of death:</strong> Throat Cancer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chief Complaint**
- **Patient History**
- **Doctor's Review**
- **Consolidate View**

**Figure 4.18 Final wireframe**

- **Patient Name**
- **Age**
- **Sex**
- **Additional Information**

**Vital Signs**
- **Physical Findings**
- **General Appearance**
- **Diagnostic Findings**
- **Assessment and Plan**

**Chief Complaint**
- **Patient History**
- **Doctor's Review**
- **Consolidate View**

**Figure 4.19 Final wireframe**

- **Patient Name**
- **Age**
- **Sex**
- **Additional Information**

**Family History**
- **Past Medical History**
- **Medications**
- **Allergies**
- **Social History**
- **Immunizations**

<table>
<thead>
<tr>
<th>1) Immunization Name</th>
<th>2) Immunization Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date:</strong> mm/dd/yy @</td>
<td><strong>Date:</strong> mm/dd/yy @</td>
</tr>
<tr>
<td><strong>Type:</strong> Intramuscular Injection</td>
<td><strong>Type:</strong> Intramuscular Injection</td>
</tr>
<tr>
<td><strong>Dose Quantity (value/unit):</strong> 50 mcg</td>
<td><strong>Dose Quantity (value/unit):</strong> 50 mcg</td>
</tr>
<tr>
<td><strong>Stop Date:</strong> Possible flu like symptoms for three days</td>
<td><strong>Stop Date:</strong> Possible flu like symptoms for three days</td>
</tr>
</tbody>
</table>

**Chief Complaint**
- **Patient History**
- **Doctor's Review**
- **Consolidate View**
4.5 Identity Design

Keywords for logo design:

- Paper Work
- Files
- Data
- Filing cabinets

Figure 4.20 Identity design ideation
4.5 Identity Design

Digital iterations

Figure 4.21 Digital iterations
4.5 Identity Design

Final Identity design with color *(Figure 4.22).*

This color palette was decided based on the user review collected during one of the user testing rounds.

*Figure 4.22 Final identity design*
4.6 Icon Design

While designing icons, an icon design grid was used (Figure 4.23). The purpose of the grid was to maintain the consistency in size and roundness of the corners.

Figure 4.23 Icon design grid and icon design
4.7 Typography

The type family to be used was required to be a simple, easily readable and sans-serif typeface. Also, it was required to be something that was widely available on all the systems. Different weights and variations were used to determine the hierarchy and harmony while keeping the design simple.

Source Sans Pro
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

Source Sans Pro Bold
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

Source Sans Pro Italic
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890
4.8 Features

Navigation
Easy and efficient navigation was the key to improve the usability of the product (Figure 4.24). In order to implement that, the use of tabs and collapsible menu system was made. The bottom menu was to be used to navigate through the different main parts. But in order to navigate to a particular menu item, either the side menu or the universal search bar could be used.

Moreover, the tabs facilitate the navigation within the same area of the software.

In this way, multiple ways of navigation is instrumental in increasing the usability.

Figure 4.24

1. Bottom menu
2. Side Menu
3. Universal Search Bar
4. Tabs
**4.8 Features**

**Consolidated view**

While examining the patient, the practitioner can be fine with working on one area of the data at a time; but in order to make a decision, the practitioner would require an overall view of the whole data chart.

Consolidated view would provide an overall view of all the collected data on a single screen (Figure 4.25). This way, the practitioner would not have to jump from page to page and make mental notes while taking decisions as this creates a memory overload which can affect the decision making and lead to errors.

![Figure 4.25](image)

1. Consolidated view
4.8 Features

Auto-fill text
This feature is in place to reduce the practitioners’ screen time and increase the face to face interaction with the patient. Any information the system has been fed in the past would be Auto-filled and would appear in red text (Figure 4.26). This way the practitioner would know to go over the data to eliminate any errors.

This system can also be useful to keep a track of the practitioner’s medical habits. They can observe trends and draw desired data for research purposes. One such instance would be, if the practitioner comes across a rare medical case, the software can be instrumental in finding similar case from the history for reference.

In other scenarios, if the practitioner gets similar cases frequently, they do not need to feed in the same prescription and lab tests repetitively; the software can take care of that, based on the symptoms and the allergies predetermined by the previous cases.

When the practitioner enters the allergy to Naproxen, the software pulls data about the allergic reaction from the data. This data is normally the most common reaction to the substance. The red color signifies that the data has been Auto-filled, so the practitioner can change the data if required. The text in the light blue signifies that the data has been entered by the practitioner.
4.8 Features

Document Library
Lab reports get outdated easily. Also, copying data from the lab reports manually increases the margin of error and is also time consuming. Document library feature (Figure 4.27) is designed to eliminate both the above problems. When the documents are uploaded into the document library, the software itself, reads the documents and fills the appropriate fields in the respective tabs. This way, when the practitioner’s office receives the lab reports via email, they are automatically assigned to the concerned patient and their data is auto filled; thus saving time, manpower and reducing the margin of error.

Figure 4.27 Document library page
4.8 Features

Home Page and Privacy
Home page consists of the practitioner’s schedule, additional notes, calendar and email inbox (Figure 4.28).

The home page is a customizable page where the practitioner can arrange the elements according to their liking. In addition, when the practitioner logs in after the nursing staff has logged out, the schedule and the details related to other patients is hidden (Figure 4.29). This visibility is toggled by the hide/view button on the top menu.

Figure 4.28 Home screen with visibility turned on
Figure 4.29 Home screen with visibility turned off
1 & 2. Visibility toggle button
4.9 Design Iteration 1: Color Palette

While deciding on a color palette, it was crucial to consider the patient’s psychological condition when they visit a clinic. It was to be a calm soothing theme so as not raise feelings of agitation and anxiety. Excessive use of colors like red, orange and yellow is avoided. Also colors like green and yellow were avoided so as not to remind someone of being sick. Various color palettes (Figure 4.30 to Figure 4.33) were presented to 10 users. Below are the votes distribution for each color selection.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 4.30
4.9 Design Iteration 1: Color Palette
4.10 Design Iteration 2: Privacy + Vocabulary

Some users had concerns about the vocabulary used in the software. For instance, they did not like the word ‘Status’ used in the Chief Complaint area. But further discussion with the medical practitioner revealed that the word should be kept as it is, because the program is primarily designed for professional use.

On the home page, some users had a concern about the privacy. When the practitioner logs in, their home screen showed their schedule, which would even be visible to the patient.

In order to solve this problem, an iteration was carried out to set the hidden mode as default when logging in (Figure 4.34). The practitioner can toggle the visibility with the click of a button if required.

Professional users were concerned about feeding the data about General Appearance in front of the patients. They were concerned about the scenario when the patient was in a rather unflattering condition; for instance, they cannot say the patient looked ‘tired’ or ‘worn down’ in front of the patient. It would ruin the practitioner/patient trust and communication and the patient would close up.

The solution to this was, before logging out, the practitioner was asked if they would like to enter any information before proceeding (Figure 4.35). Thus, the practitioner can wait for the patient to leave before they log out.

Figure 4.34 Home page with visibility turned off
4.10 Design Iteration 2: Privacy + Vocabulary

Figure 4.35 Pop up dialogue box that appears before the practitioner logs out
4.11 Design Iteration 3: Document library

A live prototype was tested with users. This prototype included all the sections and the consolidated view of all the sections. The users were asked to click through the prototype to see if they understood how to navigate. The users found side menu to be very useful.

As per user’s suggestion, icons were added to the upper menu items (Figure 4.36 and Figure 4.37).

One of the medical professionals suggested adding a document library, where all the documents, old and new would be stored and the all the information from the documents would be auto filled into the fields.

This feature was added along with the function to unpin the document, so the data of the old document does not keep appearing on the active screens; although the document still lives in the document in the library, but in a dormant form for future reference if required (Figure 4.38).

Also, a ‘home’ screen was designed and an icon was added to the upper menu. This screen would be used for the practitioner to navigate through the software.

![Figure 4.36 Screen design before iteration 3](image-url)
4.11 Design Iteration 3: Document library

Any document that is emailed to the practitioner’s office with a lab report attachment, gets added to the document library, and thus appears on the Document Library page. The document can be easily un-pinned from the email or in the document library.

![Image of the document interface](image.png)

Figure 4.37 Screen design after iteration 3. Icons added on the top menu, home page designed and document library added.
4.11 Design Iteration 3: Document library

Figure 4.38 Inbox design with an option to un-pin document.
4.12 Prototype

Using the mocked up screens and inVision app, a prototype was created to imitate almost all the behavioral patterns of the actual software. Below is the link to the prototype:

https://invis.io/EAB8YKJ24

Figure 4.39 Sign in screen design
4.13 Future Considerations

Patient side Login and Data management
Developing an app or patient side portal could save a lot of time at the medical office. The patient can input their basic information before the appointment. This way, the office staff can re-assign their time to other activities.

Universal Data Entry
A single source where all the patient data would be stored from around the country and each patient has a unique number which would be valid all throughout the country. This way, the repetitive data entry can be prevented, plus mis-communication of data is avoided while changing doctors.

Voice Recognition
At this point in time, voice recognition is not well developed to pick up the free speech around the room. The margin of error is high which can be dangerous in a doctor’s office. Plus, confidentiality is a bit dubious in terms of voice recognition as patients are still weary of someone/something listening to their conversation.
4.14 Conclusion

It is important to understand that Electronic Health Care recording system is merely a tool for medical practice. This thesis, takes the existing system designed by engineers and hospital managers and adds the user feedback from the medical practitioners to shape a better experience. The work here re-introduces the patient driven healthcare charting by simplifying the UI.

After various considerations, it was decided that this project would be developed for a general medical practice, such as Family Medicine. Next step would be coding this application to see how it performs in the real world. And then, going forward, there is a scope for developing custom design for other fields of medicine.

While researching for the project, I realized that even the most complex data can be made legible and with better design. This requires a great deal of planning and an understanding of the user’s needs. In addition, I also understood that user input is the most important ingredient of a good UI design.
Appendix

A1 Permissions
A2 User testing and feedback
A3 Ideation documents
A4 Thesis proposal
A5 Bibliography
A6 Acknowledgment
A1 Permissions

Permission to use photograph

Rootwa Sagar (RIT Student) 4:22 AM (20 hours ago)
to nmehta25, Neel, neel1190

Hello Neel,

I am currently working on my graduate thesis for MFA in Visual Communication Design. I am working on the developing a User Interface for the Electronic Healthcare Record Systems. I would like to ask for your permission to use your picture as a sample user.

The use of the picture will only be for the academic purpose.

Looking forward to your reply.

Thanks,

Rootwa

Neel Mehta 9:29 AM (15 hours ago)
to Rootwa

Hi Rootwa,

Feel free to use my picture for any academic purpose.

All the best.

Regards,

Neel Mehta.

Click here to Reply or Forward
A1 Permissions

---

Permission for use of picture

**Rootwa Sagar (RIT Student) <ms8792@rit.edu>**

4:23 AM (20 hours ago)

Hello Swati,

I am currently working on my graduate thesis for MFA in Visual Communication Design. I am working on the developing a User Interface for the Electronic Healthcare Record Systems. I would like to ask for your permission to use your picture as a sample user.

The use of the picture will only be for the academic purpose.

Looking forward to your reply.

Thanks,

Rootwa

**Swati**

4:37 AM (20 hours ago)

Dear Rootwa,

You are free to use my picture. I have no objection against it.

Kind Regards,

Swati

Sent from my iPhone

---

Click here to Reply, Reply to all, or Forward
A2 User Testing and Feedback

In total three rounds of user testing were carried out.

Round 1
Following were the questions asked for Round 1. Total 4 laymen and 2 medical practitioners were interviewed.

Questions to the laymen:
1. How do you feel about the medical practitioner using a computer when you are in their office?
2. What do you think the practitioner doing on the computer?

Questions to the medical practitioners:
1. What do you think about the EHR?
2. Could you share your thoughts on what you like and what you don’t like about the system? and why?
3. What improvements would you like to see in the system?

Layman 1
Gender : Female
Age: 25
Occupation: Student

Response to Questionnaire:
1. I understand why they need to use the computerized system, but sometimes I feel a little bit ignored with some practitioners. Some of them have better bedside manners than others so they are considerate, but I have come across some who are interested in just feeding the data on the screen rather than concentrating on what I say.
2. I know that they are taking the notes about what I said, but I am not sure if they got everything I said. I am a bit insecure when they do not communicate with me openly.

Layman 2
Gender: Male
Age: 23
Occupation: Student

Response to Questionnaire:
1. I don’t mind the use of computer in the office as long as they use it for taking my history. My general physician is awesome at communicating with me. Normally, he would talk to me about my ailment and then based on my response he would feed the data into his system. But I have visited other doctors over the time and it was annoying when he was working on the computer screen while talking to me. I was not sure if he was listening to me
2. For keeping a record of my medical history.

Layman 3
Gender: Female
Age: 41
Occupation: Administrative Assistant

Response to Questionnaire:
1. I am not a big fan of the screen in the doctor’s office. I do not feel comfortable talking to the doctor because of lack of eye contact. Plus, I am not sure if I am an annoyance or am supposed to speak while they work on screen.

2. I hope they are working on my medical record.

Layman 4
Gender: Female
Age: 33
Occupation: Reception manager

Response to Questionnaire:
1. Well, I would rather the doctor talk to me first. It feels like I am talking to a person who does not want to hear from me. My doctor nods and makes appropriate sounds along the way while working on the computer and also asks questions, but then while I am answering, he starts entering the data in the computer. I know its a substitute to writing but somehow, computer screen feels impersonal to me.

2. They are taking down my medical history for sure, because I have seen them do it.

Medical Practitioner 1
Gender: Male
Response to Questionnaire:

1. I like the concept of EHR, but I don’t like the way it is being implemented today. I would like to rather take my handwritten notes and then transfer it to the digital version but that is time consuming. Plus, it is difficult to communicate with the patient while taking notes on the system.

2. I like the fact that everything is digital so the margin of error is minimized. I think the systems available today are created for the administrative purpose rather than the medical purpose. If I don’t take the notes while patient is in the office, I have to stay back after hours or spend time on weekends to complete all the paperwork.

3. I would like a system that is focused on medical note taking rather than the function of administrative staff.

Medical Practitioner 2

Gender: Female
Age: 46
Specialty: Family Physician

Response to Questionnaire:

1. I wish the system was more intuitive and easy to use. These systems have set templates for each condition, but it is not possible to have everything in a templated format.

2. I like that I can draw out anyone’s data I want with the search function. This becomes very time saving in cases of emergency and saves a lot of time. The fact that I don’t like is that I am limited by the templates. I do not have the free rein to feed the data that is special to each patient.

3. I would like to have an option to be able to enter the customized data for each patient. Free text is good to have, but no one really goes to read the free text, plus when you have to feed everything in the free text areas, the text becomes jumbled up and data is difficult to find.
Round 2
Round 2 was carried out to decide on the color palette of the interface. Mostly non-medial members were tested for this round. In total, 10 people were interviewed to make a decision on the color palette. They were asked the following questions:

1. Which color palette do you prefer?
2. Give a reason for your selection

Person 1
1. Sample 2
2. I like the colorful look of it.

Person 2
1. Sample 4
2. I like that everything is in one color.

Person 3
1. Sample 1
2. I have seen the greenish blue color in lot of hospital related material. Lilac seems like different color choice.

Person 4
1. Sample 4
2. I don't know why I like it.

Person 5
1. Sample 2
2. Turquoise is my favorite color. I think the combination of turquoise and red looks good.

Person 6
1. Sample 1
2. I think it has a calming look to it. It looks elegant.

Person 7
1. Sample 4
2. I like that it is monotonous.
**Person 8**
1. Sample 1
2. I like it because I think it looks good.

**Person 9**
1. Sample 4
2. The red is very distracting in Sample 2 and Sample 3. I like Sample 1 but Sample 4 is my favorite.

**Person 10**
1. Sample 4
2. It looks like a no-nonsense theme.
Round 3
This round was carried out with both the audience groups i.e. laymen and the medical practitioners. 2 laymen and 2 medical practitioners were interviewed during this round.

Medical practitioners were asked to perform the following tasks:

1. After reading the Chief complaint of the patient, check if they have any allergies.
2. View their additional information.
3. Check the family history.
4. See what medicines they have been taking in the past.
5. Check their lab reports.
6. Go to the consolidated view.
7. Prescribe the appropriate medicine and procedures.

Laymen were walked through this tasks while narrating what is happening and based on their questions and their understanding, appropriate changes were made.

Medical Practitioner 1
Performed the tasks successfully with no external help

Medical Practitioner 2
Performed the tasks successfully with no external help

Layman 1
Had a comment about the language of the program. They thought that language was technical.

Laymen 2
Understood the things happening in the software.
A3 Ideation Documents

What do doctors feel about EHR?

Doctors feel frustrated:

- User interface flow does not match clinical workflow.
- Time consuming data entry which could be done by the administrative staff.
- Reduced face-to-face interaction with the patient.
- High number of alerts makes them numb to even important alerts.

Only one in five would go back to paper record keeping — they just want a better system.

India:

- Not convinced about the benefits of EHR.
- High cost to be paid to vendors + buying computers + work load increases for when the staff is trying to learn new system.
- People are not technologically literate.
- English is not primary language.
Eric Wilcox
Ashley Geoghegan

Primary  Specialty  Emergency
Registration  + Schedule
In Fridge
Triage (assessment of injury)

Full Patient Form
Filled by Patient

Vitals (age, weight)
Preliminary history (mostly problem based)

Clinician
Practiced
Doctor

Note: Need to include the patient's history.
- Reduced interaction
  Sometimes some patients need special approach.
  For eg. A lot can be defined about the care of the patient by how he interacts with the doctor/practitioner.
  If the system preserves their flow, the practice can get some help in terms of dispens & recall for future visits.

Situation
- Design based on attitudes
  - Basically funnels down to a system that is helpful helpful to the admin rather than the patients
  - No space to record the patient's behaviour.
  - Free text means doctor painfully types everything while patient has to sit and wait. (Some doctors patient starts to get admitted as well like checking FB etc.)
Problems

History

<table>
<thead>
<tr>
<th>Gout</th>
<th>Nov 10, 2012 - Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial diagnosis</td>
<td>Nov 19, 2012</td>
</tr>
<tr>
<td>Total duration</td>
<td>Nov 16, 2012</td>
</tr>
<tr>
<td>Procedure</td>
<td>Tests &amp; Examinations</td>
</tr>
<tr>
<td>Medications</td>
<td></td>
</tr>
</tbody>
</table>

What to watch for

Used workflow

- Patient enters the clinic & history is taken by the nurse
  - Doctor enters the office
  - Takes a note
  - A full understanding of the previous
  - The patient history is recorded as was important to the patient
The doctors view the order to know what is most important to the patient.

How do they co-create the chart & history?

How important is it to have that interaction?

In the field of psychology it's very important.

Sometimes doctors have to go on their lunch break in order to document everything.

Define family practice.

Search for EIR designs.

Doctor-patient interaction after work.
Feedback
active areas
colour set
grid - clothesline
Feedback
active areas
color set
grid - cloth
Emergency - Flu

Nurse as attendant
Filled form

DOB marital + basic info
date verification
Asked what is prob.

Allergens
What all symptoms
and more -> same things
screening - 2 - 3 pm
Associate doc

Checkup & Tests

Meets.

Drug test.

lot 57 delays,
emergency to clinic, MDs etc.
will keep all this private

rest nurse teacher
Chief Complaint

Migraine headache with blinding pain and sensitivity to light

History of current illness
Observation: Migraine headache

Status: Active
Date: 1/21/20x
Age at onset: 8 years

Immunizations | Allergies | Past Illness | Encounters | Resolved Complaints

Doctor's Review

Patient History
Patient Nurse fills form at entry.

- Projected onto screen in the doctor's room.
- Doctor reads while the patient settles into the bed cabin.
- Doctor and patient talk about the problem e.g., headache.
- Doctor taps on the diagnostic button.
- Screen with tag options - headache, nausea, vomiting, fever, blurry vision, eyes, dryness, etc.

Doctor adds tags as patient discusses.
Patient can also see tags and can suggest what to add.

After the chart is completed, the doctor points it to the left.

A small version on the left.

One by one all the charts are filled.

To have an overview of all the charts before prescribing the medicines, press a button to help with overview.

Can temporarily remove some charts from overview.
1809

SLAB (eugypt / 52 serif)

Clavus
officin.
Epiph.

Eth
e

Patient History

Doctor Review

Chief complaint is typed.
- Light blue is when you need to
  select something.
- Red is when things to be
  typed.
- Green box is selection.
- Dark blue is something that
  you cannot change.

Observation is typed.
- Status defined.
- Date.
- Age.
New Patient

New Patient's
Entry data

Old Notes

Retrieve data

Keep or change data

Change data

Universal History
A4 Thesis Proposal

Thesis Proposal

Tech MDs
Improving User Experience of Electronic Health Record System

Rootwa Sagar
MFA Visual Communication Design
School of Design | College of Imagining Arts and Science
Rochester Institute of Technology
December, 2015
Thesis Committee Approval

Chief Thesis Advisor:
Nancy Ciolek, Associate Professor, CIAS – School of Design

______________________________
Signature of Chief Thesis Advisor Date

Associate Thesis Advisor:
Chris Jackson, Professor, Graduate Director, CIAS – School of Design

______________________________
Signature of Chief Associate Advisor Date

Associate Thesis Advisor:
Shaun Foster, Assistant Professor, CIAS – School of Design

______________________________
Signature of Associate Thesis Advisor Date

External Advisor
Dr. Laurence Sugarman, Director of the Center for Applied Psychophysiology and Self-regulation (CAPS)

MFA Thesis Candidate:
Rootwa Sagar, Visual Communication Design

______________________________
Signature of MFA Thesis Candidate Date
Abstract

Electronic Healthcare record keeping can be daunting. The available proprietary does not usually allow for clinicians to input information concordant with their clinical work-flow. This disrupts the clinician-patient encounter and can lead to frustration for both clinicians and patients. Because of this, the organic interaction between the patient and the clinician is not accurately recorded with available EHR systems. For example, the idiosyncrasies of individual patients—how and why they present certain information—as well as the clinician’s response can be significant but are ignored by the demands of EHR data entry. Patient or person-centered care is increasingly recognized as a fundamental principle and value in increasing beneficial health outcomes. Therefore, EHR systems ought to allow both collaborative information entries with clinicians and follow the patient’s lead in terms of setting priorities for care.

This thesis project aims to design a touch-based user interface which would be both patient-centric and accommodate the recording of the organic interface that takes place between the clinician and the patient. It would also accommodate all the patient records in a singular interface, and yet make the interface easy to understand and use. A significant amount of project would be dedicated to understand the user work flow and develop information architecture to make the software mold to the needs of the user rather than the other way around.

Keywords:
Healthcare records
User interface design
User experience design
Electronic healthcare records
Information architecture
User work flow
Hospital
Doctor
Problem Statement

Electronic Healthcare Record (EHR) systems available in the market are industrial and administration centric. In contrast, the clinician-patient interaction is organic, idiosyncratic and personalized. Thus, when clinicians try to record this personalized interaction with an EHR, they encounter an inflexible, unresponsive categorical structure that accommodate the flow of the clinical encounter. Thus this information-rich interaction is reduced to a generalized, bland description common all over the system. This ultimately limits and frustrates the potential creativity, perception and individuality of the practitioner and the patient.

Additionally, input of information by the clinician in the presence of the patient reduces the face to face interaction between the patient and practitioner, further decreasing their interaction. [1]

This thesis will focus on developing a system where the patient requirements would guide the information flow of the system, but still documenting all the necessary information that the doctor would like to record.
Situation Analysis

The problem with EHR concept
In the EHRs available today, the interaction is administration centered. The system is driven by the output of billable service codes supported by diagnostic labels. All information entered prior to those outputs are organized in their support. This data is often very loosely related to the information about the patient’s behavior and priorities that the clinicians need to care for the patient. As a result, the doctor patient interaction is reduced to a generic template available in the EHR. These templates do not have the flexibility to record the ingredients that create the uniqueness of the interaction. Providing free text space to enter interaction dose not solve the problem for the practitioners as the interaction can be quite lengthy, require time to be taken from the patient to describe, and such free text, customized data entry is then ignored by the data processing of the EHR, since it is out-of-template. Thus EHR use actually discourages the recognition and inclusion of patient-centered interaction.

The Problem with EHR interface
Most of the health care practitioners in the US today are unsatisfied or frustrated with the EHRs used in their clinical practices and hospitals. Their chief complaint is that the user interface does not follow the actual work flow of the clinical practice and thus they have to spend a lot of time completing redundant data entry which can be done by the administrative staff instead. Ultimately, clinicians’ impatience with the EHR can contribute to the overall work dissatisfaction for the practitioner and the diminishing the benefit of the health care visit experience for the patient. [2].

Existing Softwares
There are numerous softwares existing today, that do not fulfill the requirements for the practitioners. NextGen is one of the very well known software in the field. This software lacks proper input methods. To enter numerical information, number pad is provided on the screen. This seems to be completely unnecessary for a computer screen. Additionally, for each numeric entry, new number pad is provided, which takes up a lot of real estate and increases the memory load for the user which might lead to error. The user has to figure out where to input the data and which number pad to use to input the data.
Similarly, PrognoCIS is another well known EHR. This EHR is a bit more structured with some color coding in place. Although, there is a scope for better color coding to define the each block of information.

e-MDs is another software which is widely popular in the healthcare industry. This software provides a lot of space for free text which means the practitioner cannot talk to the patient while getting all the information into the software. Sometimes, such free text notes might be lost due to software errors which can lead to major frustration on part of the practitioner and the patient.

Nuance is a company that builds various products for healthcare industry. They have a wide variety of products that support the speech recognition. According to the reviews found on the internet, some practitioners like this kind of software and can put up with the errors in the speech recognition while others find it to be annoying. One of the main highlight of a product by Nuance is that the clinicians can use their cellphones as microphones to dictate to the system. This means that the clinician does not necessarily have to be near a work station to get the notes digitized. It is one major breakthrough solution which is further pursued, can develop into something that can be of everyday use at a medical practice.
Survey of Literature

Physicians’ Concerns About Electronic Health Records: Implications and Steps Towards Solutions
By Mark Friedberg, Francis J. Crosson and Michael Tutty
March 11, 2014

This article discusses the doctor’s responses to a survey of open ended questions to gauge the professional satisfaction of doctors on integration on technology in health care system. Specific study for EHR was not carried out but most of the survey participants commented about EHR and thus the survey was reshaped to include findings specifically related to EHR. Most of the participants commented that the EHR did not follow the clinical workflow, is time consuming, reduces the face to face interaction with the patient and generates high number of alerts and messages.

4 lesser know problems with EHRs
By Marla Durben Hirsch

The article outlines the hidden problems with the EHRs which are normally not apparent to the patients or the doctors. It helps understand the underlying risks of not closely monitored EHRs.

Electronic Health Records: The good, the bad and the ugly
By George Palma, MD, Medical Director, Simpler Consulting
October 14, 2013

This article lists down the various pros and cons of the EHRs which could help in understanding where the system is going right and where there is a scope of improvement. The author at last comments that in case of EHRs the bad and the ugly overrides the good and thus the hospitals should thoroughly evaluate the EHR before adopting and implementing it in their system.
Survey of Literature

**EHR systems pose serious concerns, report says**
By Joseph Conn
June 24, 2013
http://www.modernhealthcare.com/article/20130624/NEWS/306249952

The article describes in detail how the EHR could pose serious threat to a patient’s life and how the doctors reacted to a survey conducted by the KLAS Enterprise, a Utah based health IT market researcher. Furthermore, the article describes how the healthcare industry is held accountable when an error occurs in an EHR, for which the EHR vendors should be held accountable.

**Talking to Machines and Being Heard : A speech recognition primer**
By Dave Rich
November 28, 2012
UX Magazine, Article No: 909

The article explains various modes of speech recognition. It goes into details of how to design a system for speech recognition, about the grammar and formation of the sentences, the technicalities, error handling etc.

**Process Makes Perfect: Speech Recognition User Interface Design**
The nine steps to a voice user interface design with rewarding user experience.
https://uxmag.com/articles/process-makes-perfect-speech-recognition-user-interface-design
By, Stephen Keller
January 14, 2013
UX Magazine, Article No :937

This article explains how a speech recognizing interface is created. It explains the structure of the interface, kinds of speech recognition interactions and grammar. It would help understand the process in order to make some crucial decisions while designing the interface.
Cognitive Psychology in and out of the Laboratory
By Kathleen M. Galotti

This book helps understand the human psychology which in turn helps forecast how the human brain would react to a certain interaction. It helps understand different aspects of memory load, cognition, knowledge representation and basic processing of the human brain.

Designing of Everyday Things – Revised and Expanded Edition
By Don Norman

This book explains the basic heuristic principals, the basic terminology used in the field of interaction design, the various errors caused by humans and the definition on types of errors and mistakes, and designing for a business world.
Design Ideation

Welcome Page

Chief complaints
- Location
- Severity
- Duration
- Timing
- Context
- Modifying factors

Patient history/Behavioral pattern
- Previous occurrences
- Family history
- Allergies
- Operations
- Immunizations
- Belief of occurrence
- Dietary habits
- Regular medicines

Practitioner Reviews
- Vital stats
- Observation
  (Palpation, Color, Size, Behavioral symptoms, Family behavior, Reactions, Reflexes)
- Prescriptions
- Dosage

CHIEF COMPLAINT

PATIENT HISTORY

DOCTOR’S REVIEW
Methodical Design

The chief purpose of the thesis is to create an improved patient doctor interaction while co-creating the patient records using the touch based interface EHR. A better system would require a clear understanding of the user work flow at a clinic and careful layout of the information architecture.

In addition, the system would be designed, so that it would remember the practitioner’s choices during the first visit. During the following visits, the system would recall the choices and present them on the top, thus reminding the practitioner about the course of treatment and discussion during the previous visits.

Additionally, speech recognition would be added to the system, so the practitioner and the patient can maintain the one on one interaction, while the system takes note for the practitioner. With speech recognition, it is important to understand that limited choices of selection could give accurate result rather than open choices.

The implementation of this project will be done using Adobe Illustrator and Invision app or Axure. Adobe Illustrator would be used to create the visual elements for the project, while Invision app or Axure will be used for prototyping the design.

Classes like Foundation of Human Computer Interaction have been attended to further extend the scope of knowledge required for this thesis project. Helpful inputs from associate advisor, who is an MD by profession would prove to be valuable in terms of user feedback.

Speech recognition

This system would be using ASR (Automatic Speech Recreation) type of system. ASR system is the one that converts the recorded speech to text. This system is going to be a speaker dependent system which means that the system would know the user and would be trained by the user to expand its vocabulary and understand the pronunciations.[3] The concept of introducing the speech recognition to the system is fairly new for the project. Further research would be conducted to determine the ways of use and implementation strategy.
Implementation Strategy

To fulfill the purpose of the project, user work flow will be defined in an orderly manner using flowcharts. In order to understand the user work flow, medical health care professionals will be consulted. After a good understanding an asset list would be created to define the needs of the functionality of the software. This asset list would be used to create a well planned information architecture which would lay the foundation to the interactive work flow of the system. The layout of the system would also depend on the kind of speech recognition technique that would be used. Followed by this will be the designing of low fidelity wire-frames, which will be put through user testing to accommodate the user feedback. The visual style of the software would be the next step which would be followed by high fidelity prototype and user testing. Required improvements would be made after this user testing.

This interface would aim to produce an improved user experience for the healthcare practitioners and the patients. Typographical Hierarchy, Color coding, user flow and interaction principles would be used to solve the problems of visual cognition to make the user interface more friendly and versatile to handle all the various aspects of EHR.

Contribution to Design

EHR needs to record a humongous amount of information. Once the information is recorded, it needs to be presented in a structured manner for the viewer to make sense of it. If successful, this project would demonstrate the ui and ux design used in case the amount of information is large. Data presentation is most crucial part of the project, thus it will contribute the field of information design as well.
Dissemination

This thesis project was the brain child of a thorough discussion with a doctor building a multi-specialty private hospital in India. They have employed a team of software engineers to make an EHR according to their requirements. At this point, this thesis would not be co-ordinated with them, but after the completion of the thesis, the project will be co-ordinated with the new software to launch a new update.

Evaluation Plan

One of the thesis committee member is a practicing MD, who has substantial experience with using an EHR. His advice and experience would be used throughout the project. Furthermore, the doctor’s team in India will be available for user testing and evaluation.

Pragmatic Considerations

Most of the project is virtual so the expected spending would be only for printing the thesis document. Though, it should be noted that the expenses are subject to change depending on the scope and final deliverables of the project.

Publishing: Bound copies of the thesis $100

Implications

Based on the research up till now, it is very clear that the clinicians are not happy with the kind of EHR that is being used currently. In order to design the system that is envisioned, speech recognition could make a big difference in terms of usability. It would help regain the social interaction between the clinician and the patient. It might be bit difficult to code the system with analytics but it is possible. It should be noted that the speech recognition and analytics are complex processes and thus it might increase the overall cost of the software.
Amendments

For this thesis further on, the subject matter will be condensed to a particular field of medicine in order to get a clarity of requirements while designing. This will also serve as a parent design to take the project further if and when required.

In order to present the thesis design, in place of a prototype, a video is being considered. Both the methods are still being evaluated.
Bibliography

1. **EHR systems pose serious concerns, report says**
   By Joseph Conn  | June 24, 2013

2. **Physicians’ Concerns About Electronic Health Records: Implications and Steps Towards Solutions**
   By Mark Friedberg, Francis J. Crosson and Michael Tutty March 11, 2014

3. **There are many factors to consider when designing speech recognition applications.**
   by Dave Rich
   Article No.:909 | November 28, 2012
A5 Bibliography


Personal names around the world, Updated:2011-08-17, accessed September 9, 2016, https://www.w3.org/International/questions/qa-personal-names


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