Visualization of Chronic Diseases Overview in Electronic Health Records

Qualitative study of Physicians’ Requirements

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Affirmation

I hereby affirm that this Master thesis was composed by me, that the work contained herein is my own except where explicitly stated otherwise in the text. This work has not been submitted for any other degree or professional qualification except as specified; nor has it been published.

Sweden, August 18, 2014

__________________________________________________________
Andrea del Pilar Pérez Cruz
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ABSTRACT

BACKGROUND
The Electronic Health Record –EHR– was created, among other features, to support care continuity and assisting quality health care provision. Analysis of large patient data requires a tool that provides views of clinically meaningful interpretations of the data. During the last two decades, both IT and medical staff have worked together to fully accomplish this premise. Several visualization methods are widely used within the medical field, especially visualizing time-oriented data. However, physicians still perceive a lack in terms of EHR visualization, navigation and interaction in particular when the query time is short and patient record gets complex. The aim of the study is to elicit physician’s requirements regarding a practical and quick overview to visualize the care plan in chronic patients.

METHODS
Information elicitation is conducted throughout a qualitative descriptive study based on questionnaires and semi-structured interviews answered by 5 medical doctors: 2 internist, 1 neurologist and 2 general practitioners.

RESULTS
Opinions and insights of the interviewees were analyzed among the thematic data analysis technique. After codification phase, 5 themes emerged using thematic data analysis: 1. Daily common task performed with EHR, 2. Current presentation of the information on the EHR. 3. Care plan in Chronic Diseases (Care plan in EHR and Most common chronic diseases). 4. Summary Overview and 5. Suggestions to build the overview.

DISCUSSION
Given the temporal nature of the patient clinical data, timeline approach would enhance the possibility of getting in timely way only relevant information of the patient, leaving the level of detail displayed upon the user needs. The chronological nature of patient information is an advantage in data visualization. The familiarity of physicians with visualization systems as timeline, diagrams with temporal orientation data could be useful in visualization and navigation through the care plan in chronic diseases.

CONCLUSION
Physicians interviewed prefer a graphical interface in a timeline style instead of the traditional way of presenting information in text boxes. At the same time, they would prefer options to deploy a diagnostic list instead of a text describing the disease, since the graphics and plots permit better abstraction of information in comparison with a text without a given structure, even written in a non-formal way.

KEYWORDS: EHR, Chronic diseases, summary overview, visualization information, visualization techniques, time oriented data, time lines.
Contents

1. Background ............................................................................................................................. 8
   1.1. Electronic Health Records (EHR). ............................................................................................... 8
   1.2. Chronic Patient Definition .............................................................................................................. 9
      1.2.1. Chronic Diseases Overview in EHR .............................................................................. 9
      1.2.2. Care Plan in Chronic Diseases ...................................................................................... 10
   1.3. Visualization ......................................................................................................................................... 10
      1.3.1. Information Visualization ............................................................................................ 11
      1.3.2. Visualizing Time-Oriented Data in Medicine ......................................................... 12
   1.4. Problem statement ............................................................................................................................ 16
   1.5. Aim ........................................................................................................................................................... 17
   1.7. Research question .............................................................................................................................. 17

2. Method ................................................................................................................................... 18
   2.1. Research Methodology ................................................................................................................... 18
   2.2. Research Approach ........................................................................................................................... 18
   2.3. Data collection tools ........................................................................................................................ 19
      2.3.1. Semi-structured interviews .......................................................................................... 19
      2.3.2. Telephone interviews ...................................................................................................... 19
      2.3.3. Mailing physicians’ questionnaires ............................................................................ 19
   2.4. Sampling ............................................................................................................................................... 20
   2.5. Data analysis process ....................................................................................................................... 21
   2.6. Software tools ...................................................................................................................................... 22
   2.7. Ethical Considerations ..................................................................................................................... 23

3. Results .................................................................................................................................... 24
   3.1. Individual interview results. ........................................................................................................ 24

4. Discussion ............................................................................................................................ 38
   4.1. Methods discussion ............................................................................................................................ 38
   4.2. Findings .................................................................................................................................................
   4.3. Limitations and strengths of the study ........................................................................................... 39
   4.4. Reliability and validity .................................................................................................................... 40

5. CONCLUSIONS ...................................................................................................................... 41

References ......................................................................................................................................... 42

Appendix 1. Invitation letter. ........................................................................................................ 46
Appendix 2. QUIS: Questionnaire N.2 for UI satisfaction. ...................................................... 48
Appendix 3. Sketches designed using Pencil tool. ...................................................................... 49
Appendix 4. Semi-structured interview questions. ................................................................. 50
List of tables
Table 1. Characteristics of the study participants .......................................................... 21
Table 2. Summarization of findings after information codification. ..................................... 24
Table 3. Questionnaire results: Organization of information in EHR..................................... 28

List of figures
Figure 1. Early Time line browser displays data from a diabetic patient in three time lines: (a) a diabetes logbook record. (b) a portion of the patient’s personal calendar. (c) ‘9 L D N’ is a short-hand for the time of day: Breakfast, Lunch, Dinner, or Nighttime................................. 13
Figure 2. Example of Lifelines based on a real record ............................................................ 14
Figure 3. Screenshot of the implemented prototype for intensive care and long term patient treatment. .................................................................................................................................. 15
Figure 4. Using timeline to represent procedures and observations regarding Glaucoma....... 16
Figure 5. Research stages ....................................................................................................... 18
Figure 6. Diagram Codification of information after interviews ............................................ 25
Figure 8. Pointing out with the cursor where the summary overview is located in ‘Sofia’ EHR. 31
Figure 9. Up: Important events in a 40 years old patient as appendectomy, gallbladder surgery, bypass, hernia surgery are used as an example by Physician #3 to depict a desirable overview of life time line. She named it “Life Wave” ........................................................................ 36
Figure 10. Graphic made by Physician #3: There are 5 lines: Social background, family history lifestyle, surgeries and previous and current diseases. On the right corner, she wants to visualiza patient allergies. ........................................................................................................... 36
1. Background

1.1. Electronic Health Records (EHR).

Electronic Health Records –EHR– have become an effective instrument not only for medical diagnosis because it assists as support tool presenting and storing patient information, but also for the patient who benefits directly having the proper management of the disease. Benefits of the EHR over paper-based records include creation of new medical knowledge. Due to structured EHR content, statistics can be obtained and effective research can be done contributing to the improvement of international standards [1]. Hippocrates developed the first known medical record, in the fifth century B.C. He prescribed two goals:
• A medical record should accurately reflect the course of disease.
• A medical record should indicate the probable cause of disease [2].
Complementing ancient concepts, Stanley Raiser (1991) wrote that the purpose of the EHR is “to recall observations, to inform others, to instruct students, to gain knowledge, to monitor performance, and to justify interventions” [3].

EHR involves the incorporation of new information technologies and telecommunications to the core of health activity. Making a compilation of the most accurate definitions, the EHR could be defined as: “a virtual repository of information regarding the health status of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorized users. Its primary purpose is the support of continuing, efficient and quality integrated health care and it contains information, which is retrospective, concurrent, and prospective. EHR systems can also provide additional functionality, such as interactive alerts to clinicians, interactive flow sheets, and tailored order sets, all of which cannot be done be done with paper-based systems. An EHR system adds information management tools to provide analysis of aggregate data both for care management and for research.” [4]. Consequently, the information generated during the encounter patient-professional, became part of an integrated clinical information system. Although software used today, do the task of displaying, storing and managing information, a new model is needed to quickly locate information on the EHR. Generally physicians are overwhelmed by the amount of information contained in the EHR mainly when patient information is based on free texts because it decreases visual perception [5]. New visualization methods of clinical information should incorporate time features and be intuitive for the clinicians [6].
1.2. Chronic Patient Definition

According with the European Chronic Disease Alliance (ECDA) a chronic disease is defined as a “non-communicable disease or conditions of long duration (lasting three months or longer) and generally slow progression, linked by common risk factors such as tobacco, physical inactivity, nutrition, alcohol, environment, and are largely preventable. About one-fourth of people with chronic conditions have one or more daily activity limitations, often understood as a hindrance or inability to perform major activities in one’s life [7]. They also extend to certain mental disorders such as depression and schizophrenia, to defined disabilities and impairments not defined as diseases, such as blindness and musculoskeletal disorders [8].

Chronic diseases are the largest cause of death. In 2002, the leading chronic diseases, cardiovascular disease, cancer, chronic respiratory disease, and diabetes, caused 29 million deaths worldwide [8]. Within chronic diseases, cardiovascular diseases (CVDs) remain the biggest cause of deaths. More than 17 million people died from CVDs in 2008 and more than 3 million of these deaths occurred before the age of 60 and could have, in a great measure, been prevented. The percentage of premature deaths from CVDs ranges from 4% in high-income countries to 42% in low-income countries, leading to growing inequalities in the occurrence and outcome of CVDs between countries and populations [9].

As described above, efforts to effectively coordinate and manage chronic illnesses have been hampered by a number of barriers, including a fragmented health care system and the need for more coordination across sites of care; the difficulty which people with chronic illnesses have in paying for their care; the current reimbursement system does not reward key elements of chronic illness care; and the need for enhanced medical and nursing training and education, which places an increasing focus on chronic care.

Our health care system is currently not well equipped to address these concerns. Because of the highly fragmented nature of health care, patient information is stored in many locations, primarily in paper-based forms with limited access. As a result, clinicians often do not have comprehensive patient information at the point of care, when it is most needed. It also impedes having the necessary information to measure performance and facilitate quality improvement of patient populations.

1.2.1. Chronic Diseases Overview in EHR

A basic EHR can be integrated with modules of different specialties such as laboratory and complementary studies specific to the needs of each end-user. But not always all this information is relevant. Sometimes physicians do not want to navigate through numerous screens or jump between different applications, instead want a fast access to a unified view of the patient and to
bring them up and record all clinically relevant information on patients in different areas of activity. EHR can provide knowledge about guidelines and safety, information about patient conditions, treatments and other pertinent characteristics. While important, these are not sufficient to ensure effective chronic illness care. According to chronic care models, special information and processes are needed, including tracking measures of health over time and giving feedback about progress. Little is known about how to create and successfully implement a comprehensive EHR system that will positively impact care coordination for patients with complex chronic illnesses. [10]

Studies have shown that physicians tend to focus on the overview to get a general sense of the situation but in many cases, as Lifelines 2, the overview is only available in the form of temporal summaries suggesting additional overviews could be beneficial [11]

1.2.2. Care Plan in Chronic Diseases

The European Committee for Standardization, CEN, regards topics related to continuity of health care, includes in the document the shorter term 'care' and it is often used as a synonym for the longer term 'health care'. Examples of this are: 'continuity of care', 'subject of care', 'episode of care', 'period of care', 'care plan', 'programme of care' [12]. Care planning is often discussed as a means of improving quality of care and providing structure to the care process [13].

“Care Plan” has been defined thus, as that system which encompasses all the activities whose primary purpose is to promote, restore, or maintain health. This includes more than performing procedures on subjects of care. It includes also, for example, the management of the information about patients, their health status and their relations within the health care framework [12]. The goals of chronic care are not to cure but to enhance functional status, minimize distressing symptoms, prolong life through secondary prevention and enhance quality of life. Another feature of case management is the goal of reducing the use of (unplanned) hospital care through the development of care or treatment plans that are tailored to the needs of the individual patient who is at high risk socially, financially and medically.

The chronic disease care plan also enables the physicians to strategy and coordinate the health care of patients with chronic conditions, including patients with these conditions who require multidisciplinary team-based care from a general practitioners and at least two other health or care providers.

1.3. Visualization

Visualization embraces both image understanding and image synthesis. That is, visualization is a tool both for interpreting image data fed into a computer, and for generating images from complex
multi-dimensional data sets. It studies those mechanisms in humans and computers, which allow them in concert to perceive, use and communicate visual information. Visualization unifies the largely independent but convergent fields of:

- Computer graphics
- Image processing
- Computer vision
- Computer-aided design
- Signal processing
- User interface studies

In simple words, visualization is the transformation of data or information in images to explain and communicate ideas. Scientific visualization is based on the use of images. From this point of view, the general view has always existed. The use of visualization tools in science dates back several centuries ago when the Mayans used schematic drawings and calendars, and even arithmetic astronomical observations [14]. Graphic aids for thinking have an ancient history. Evolution of computers is making possible graphic depictions that automatically assemble thousands of data objects into pictures, revealing hidden patterns. It allows diagrams that move and reacts. These, in turn, create new methods for amplifying cognition, which is the acquisition or use of knowledge.

1.3.1. Information Visualization

According to Card “the use of computer supported, interactive, visual representations of abstract data to amplify cognition” is called Information Visualization, IV [15]. It mostly focuses on abstract information and enables human beings to get more information easily, to get sense of the information and also to make decisions based on the information in a relatively minimum time [16]. Information visualization is still an inductive method in the sense that it is meant to generate new insights and ideas that are the seeds of theories, but it does it by using human perception as a very fast filter: if vision perceives some pattern, there might be a pattern in the data that reveals a structure [17].

In the early seeking of improvement of visualization techniques, Shneiderman proposed the “golden rule” in the Information Visualization. He called it “Visual Information Seeking Mantra”, which consist in: overview first, zoom and filter and details-demand. It defined the basic principle to design visual interfaces. He described taxonomy of information visualization, along two dimensions: data type and task. Within the task dimension of the classification seven high –level task were identified: overview, zoom, filters, details on demand, relate, history and extract. Thus, it was needed that designers can select appropriate techniques to meet given requirements. Since then, this assumption has been used to create and improve new ways of visualize data [18].
Information visualization aims to make the user an active element in pattern recognition, allowing him to detect what would pass unnoticed through alternative recognition [19] and particular information visualization systems have been presented by researches with the aim to solve physician’s problems when abstracting important information from a wide EHR. Information visualization has the potential to address those issues and deliver much-needed cognitive support.

1.3.2. Visualizing Time-Oriented Data in Medicine

From earliest times, the notions of ill health and its treatment have been linked to those of the observation and interpretation of data. Whether we consider the disease descriptions and guidelines for management in early Greek literature, or the modern physician’s use of complex laboratory and X-ray studies, it is clear that gathering data and interpreting their meaning are central to the health-care process [3]. Data are central to all medical care. All medical-care activities involve gathering, analyzing, or using data. Data provide the basis for categorizing the problems a patient may be having and also help a physician to decide what additional information is needed and what actions should be taken to gain a greater understanding of a patient’s problem or to treat most effectively the problem that has been diagnosed. Medical temporal data type has a particular relevance in Information Visualization [20]. The alternative visual representations of time-oriented data are closely connected to the available display space and the required information content. The information space and display space are tied by the complexity of the data to be visually explored and the tasks the users want to accomplish.

Many of the visualization systems proposed are based on time-oriented approaches due chronological behavior of the disease. In 1991, Cousins and Kahn [21] proposed a time-line, (see Figure 1) prototype for diabetes data management providing a basic framework for manipulating temporal data.
In 1997 a web prototype of LifeLines was started between IBM Research and the University of Maryland in order to design a computerized patient record. They demonstrated how Lifelines can be useful in presenting a structured patient chart, and how it can facilitate navigation and analysis of the computerized medical record. In LifeLines, (see Figure 2) the medical record is summarized as a set of lines and events on an adjustable timeline. Lifelines provide a compact overview of the relevant events and intervals, organized into different screen areas, each one dedicated to a different aspect of the medical record [22].
In 2004, Miksch and Ragnar [23] presented different interactive visualization techniques, including the often mentioned Lifelines, to explore and navigate the data and its temporal dimensions which enable the users to reveal the data at several levels of detail and abstraction, ranging from a broad overview to the fine structure (see Figure 3).
A significant number of visual representations have been proposed over the years, where the visualization of temporal information has been considered in different contexts. Argüello and Pérez used semantic web technologies and HL7 Clinical Document Architecture (CDA) to provide well-defined interfaces that help physicians to visualize ophthalmologic clinical data over the time. As showed in Figure 4, a timeline is used to show patient tests results relevant on glaucoma, in this case, result of ophthalmoscopy is deployed above the timeline.
Relating events on time plays an important roll in getting an overview of a record [6]. An enjoyable user interaction is considered a key element in information visualization. In a usable EHR, the visualization shall allow users to explore available data at various levels of abstraction, create a greater sense of engagement with data, encourage the discovery of details and relations which be difficult to notice otherwise [18].

This is the case of visualization and tracking of chronic diseases in the EHR. With a well-integrated and designed visualization, the physician should be able to display a simple but useful overview of the diseases treated and at the same time track them using current guidelines. Analysis of clinical management processes, and the search for the temporal patterns requires a tool that provides aggregate views of clinically meaningful interpretations of the longitudinal data [24].

1.4. Problem statement

Modern information technology can store enormous amounts of medical data. EHR offer the potential to improve patient care and enhance the efficiency of clinicians by making more data available when and where it is needed. The challenge becomes to provide the necessary data and to display it as clinical information that allows the physician to make correct and efficient decisions. Health professionals usually need to, carefully select pieces of information combined in a specific way. In case of patients having more than one diagnosis, it is challenging for the physician, follow the evolution of each disease among the time. Usual care is not doing the job; dozens of surveys and audits have revealed that sizable proportions of chronically ill patients are not receiving...
effective therapy, have poor disease control, and are unhappy with their care [25]. Researchers in
Mayo Health System Translation Project demonstrated that the delivery of planned care either
alone or in conjunction with an electronic management system in a primary care setting improved
metabolic outcomes in diabetic patients [26].

Despite heavy expenditures, care for chronic diseases is poor. Treatments known to be beneficial
are provided about 50% of the time and ineffective treatments may be given 20%–30% of the time
[27]. Usually patients have to encounter different physicians every time they go to the hospital.
Since time is critical, both in terms of costs and medical treatment, intelligent ways of condensing,
aggregating and interpreting information solutions must be found for translating the vast amounts
of data into meaningful information that health professionals can use. [28]

Currently there is a lack regarding visualization in a timely way of the chronic diseases in the
EHR. As An and Wu discus on “Level of detail Navigation and Visualization of EHR” an effective
method for quickly locating and retrieving useful information is needed [4]. An intuitive time-
oriented system that allows easy abstraction of the information may be extremely useful for
physicians and the diagnosis could be more aptly, focusing solely in relevant and concerning
disease information, especially if it is a multi sick patient [29]. Yet, there is not a simple overview
"tool" to visualize and make a quick differentiation between diseases in treatment of diseases
never followed up before. Towards contribute to European Observatory on Health Systems and
Policies and the CONT SYS, 2007 standards [12], within chronic diseases; the implementation of
effective visualization techniques in EHR becomes predominant.

1.5. Aim
The aim of the study is to identify physicians’ requirements and needs, specifically, the need to
have a useful time-oriented visualization aid through the chronic patient care plan in the EHR.

1.6. Objectives
- Find clinical priorities regarding chronic diseases care plan overview in the EHR.
- Forming a base for building concepts in visualization on the chronic diseases overview.

1.7. Research question
Which are physicians’ main requirements for visualize and navigate through the chronic patient
care plan in the EHR?
2. Method

2.1. Research Methodology

Depending on the purpose of research, scientific research projects can be grouped into three types: exploratory, descriptive, and explanatory. A descriptive methodology research is conducted during the course of this study. This kind of methodology is often used in new areas of inquiry, where the goals of the research are to get to know the situations, customs and prevailing attitudes through the exact description of the activities and processes and to scope out the magnitude or extent of a particular problem [30].

![Research Stages Diagram](image)

Figure 5. Research stages.

2.2. Research Approach

This study is conducted following a qualitative inductive research approach. The qualitative approach aims to understand social phenomena in natural (rather than experimental) settings, giving emphasis to the meanings, experiences, and views of all the participants [31]. Qualitative research often involves a smaller number of participants. This may be because the methods used such as in-depth interviews are time and labor intensive but also because a large number of people are not needed for the purposes of statistical analysis or to make generalizations from the results.
2.3. Data collection tools.
Qualitative data is collected through direct encounters with individuals. In this study, primary data is collected through semi-structured interviews and e-mail questionnaires. Questionnaires are used in this study to collect primary data from healthcare professionals. The aim is to gather valid, reliable, unbiased and discriminatory data from a representative sample of respondents.

2.3.1. Semi-structured interviews
For the present study, the participants, a staff of five persons answered a set of questions. Three of them, answered the questions in 30 minutes while the other two did it in 45 and 70 minutes. This method of collecting data is usually carried out in a structured way. After the interview, the participant got a transcribed copy of the interview in order to check possible mistakes. Before the interview a concise outline was sent to the potential participants in order to give a justification of the study. See Appendix 1.

2.3.2. Telephone interviews
This method of collecting information involves contacting the participants on telephone itself. Even this is not a very widely used method; it plays an important role particularly, when the interview has to be accomplished in a very limited time. One of the five respondents was interviewed by telephone due she is located in other country.

2.3.3. Mailing physicians ‘questionnaires
Important part of an information system is user interface. Its quality may be evaluated in many different ways, e.g. user experience tests, cognitive walk-through, eye tracking valuation or questionnaires. On the present study, researcher performs questionnaires, which is a method for the elicitation, recording, and collecting of information about users and their experience about the system usage. This kind of ordered survey provides feedback from the point of view of the system’s user. With them, the researcher gathers:

- Attributes (e.g. personal characteristics, such as age, gender, educational level, occupational status)
- Behaviour and events: Questions about behavior e.g. how is a daily labor routine. It may refer to past, current or (intended) future behavior.
- Beliefs/knowledge: “what they think is true”
- Attitudes/opinions/reasons etc: “what people say they want”; “how people feel about something”
Questionnaire called QUIS, Questionnaire for User Interface Satisfaction used, was developed at the University of Maryland and originally has 27 questions. [32,33]. Questionnaires are mailed to the respondents with a request to return after completing the same. Before applying this method, a Pilot Study for testing the questionnaire is conducted which reveals the weaknesses, if any. The questionnaires were sent after the interview with the purpose of complete the information gathered during the interview. Types of questions are: numeric open-end and text open-end. Each question is a rating on a ten-point scale with appropriate anchors. The sheet has a number of questions that should be answered according with the software they use to register EHR on the daily work as clinicians. Scale of 1-9, contains 10 qualifying items:
1: strongly disagree
9: strongly agree.
NA: means "Not Answer"
Due two of the respondents did not understand English terminology used on questions 10 to 26, only answers 1 to 9 were took into account for the results.

2.4. Sampling

Sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population [34].

There are three primary kinds of samples: the convenience, the judgment sample, and the random sample. They differ in the manner in which the elementary units are chosen. For this study, snowballing, a purposive sampling, one of the most common sampling strategies in qualitative research, is utilized in order to select the participants. Snowballing, also known as chain referral sampling, is a type of purposive sampling and group participants according to preselected criteria relevant to a particular research question. In this method, participants or informants with whom contact has already been made, use their social networks to refer the researcher to other people who could potentially participate or contribute to the study [35]. During the first stage, five physicians were contacted using snowballing purposive sampling technique. In order to know if they were willing to collaborate with the study, a brief explanatory text via e-mail, was sent to every one of them. Rong Chen, as a Director of Health Informatics in Cambio, referred there of them: two specialists in internal medicine and one neurologist. The researcher contacted two general practitioners: one works in Stockholm County and the second one works in a different country.
<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Gender</th>
<th>Occupation</th>
<th>Experience (years)</th>
<th>Work place</th>
<th>EHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician 1</td>
<td>Male</td>
<td>Specialist in Internal Medicine and endocrinology</td>
<td>25</td>
<td>Motala Vårdcentral</td>
<td>Cambio Cosmic</td>
</tr>
<tr>
<td>Physician 2</td>
<td>Male</td>
<td>Specialist in Internal Medicine</td>
<td>11</td>
<td>Motala Vårdcentral</td>
<td>Cambio Cosmic</td>
</tr>
<tr>
<td>Physician 3</td>
<td>Female</td>
<td>General practitioner</td>
<td>14</td>
<td>Tensta Vårdcentral</td>
<td>Take Care</td>
</tr>
<tr>
<td>Physician 4</td>
<td>Female</td>
<td>General practitioner</td>
<td>10</td>
<td>Colsanitas</td>
<td>Sofia</td>
</tr>
<tr>
<td>Physician 5</td>
<td>Male</td>
<td>Specialist in Neurology</td>
<td>10</td>
<td>Karolinska Sjukhuset</td>
<td>Take Care</td>
</tr>
</tbody>
</table>

Table 1. Characteristics of the study participants

2.5. Data analysis process

Data analysis began with the process of moving from raw interviews to evidence-based interpretations that are the foundation of the current report. The organization and processing of the data within the process of qualitative data analysis is an important task for extracting, the data roughly, those who really have an important significance in relation to the study objectives and establish relationships between the data provided to make higher abstraction seeking propositions, models or theories. Once the interviews were conducted, recorded and transcribed, they were analyzed and interpreted with the thematic data analysis technique, which pretends, characterize experiences of participants by general insights from the whole data. Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data. It minimally organizes and describes data set in (rich) detail. Thematic data analysis was performed through six phases, described below [36].

Phase 1: Familiarization with the data.
Before start coding, it is important to familiarize with the data. This, in most cases, is some acquired after collecting the data and if any transcript. Still, a complete reading of all data provides a complete and integrated view of the material.

Phase 2: Generating initial codes
The encoding process itself, consists in identifying words, phrases or paragraphs that are considered have a remarkable significance in relation to the study objectives. Codes identify a
feature of the data that appears interesting and refer to “the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon.

Phase 3: Searching for themes
Consists in the reunification of all those codes or labels that share the same meaning. This step will lead to the identification of categories or themes or the identification of that describe the essence of an experience. Analyze the codes, and consider how different codes may combine to form an overarching theme.

Phase 4: Reviewing themes
Check in the themes in relation to the coded extracts and the entire data set, generating a map of the analysis. During this phase, it will become evident that some candidate themes are not really themes.

Phase 5: Defining and naming themes
Begins with a satisfactory thematic map of the data. At this point, themes are refined to be presented on the report. By define and refine ”we mean identifying the essence” of what each theme is about (as well as the themes overall), and determining what aspect of the data each theme captures.

Phase 6: Producing the report
Starts when a set of fully worked-out themes is completed and involves the final analysis and the written report. The presentation of results is produced according to a narrative perspective, in the sense that is developed through description of events and experiences, often using the same words of the respondents for not alter the material collected and convey to the reader the immediacy of the situations described [37].

2.6. Software tools
Microsoft Excel is used to tab questionnaires and to analyze data. Ecamm Call Recorder is an add-on for Skype, which automatically transforms audio and video calls into QuickTime movies. Ecamm was needed to record Skype audio-call done with the physician outside of Sweden.
For prototyping GUI, Pencil Project Beta version of 2.0.6 was used. Pencil is a open source GUI prototyping tool which allows to o lay out, sketch, analyze and finalize mockups using a wide range of elements, including common shapes, basic web elements, Sketchy GUI, stencils and more. These can be exported in PNG, SVG, HTML, PDF and ODT file formats for applications in
various development domains. Basic sketches done using Pencil, were used to show “chronic
diseases overview model” but only two physicians saw it. See Appendix 3.

2.7. Ethical Considerations

All participants were informed about the research. Since some of them are in other countries, no
informed consent document was signed. All the participants have confirmed their voluntary
participation in the study. For interviews, it is intended to get participants physical copy of the
informed consent. However, the collected information will be anonymous to protect participants’
integrity.
3. Results

3.1. Individual interview results.

Once the semi-structured interviews of the five participants were transcribed with enough detail, into written text, codification was done to retrieve what the interviewees have said about the identified concepts, themes, and events. An overview of the findings after the codification of information is showed in the table below.

<table>
<thead>
<tr>
<th>Physician</th>
<th>Patient classification using colors</th>
<th>Patient classification using numeric scale</th>
<th>Use ICD-10 codes in overview</th>
<th>Include risk factors in the overview</th>
<th>Include surgeries in the overview</th>
<th>Visualize contacts with the wards</th>
<th>Include examination by systems</th>
<th>Availability to make feedback of prototypes</th>
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Table 2. Summarization of findings after information codification.

Participant’s insights were analyzed across the interviews to formulate a description of the setting, always focusing on the research question: Which are main physician’s requirements for visualize and navigate through the chronic patient care plan in the EHR? Opinions and insights of the interviewees were introduced among the data analysis and results. After codification phase, 5 themes emerged using thematic data analysis.

1. Daily common task performed with EHR.
2. Current presentation of the information on EHR
3. Care plan in Chronic Diseases
   - Care plan in EHR.
   - Most common chronic diseases.
4. Summary Overview
5. Suggestions to build the overview
Theme 1: Daily common tasks performed with EHR.

To ensure an in-depth understanding of work practice and information flow in chronic disease care, it was considered important to roughly describe physician’s duties and the role of the EHR in the real scenario where they are daily used. In order to take a decision and adopt the most proper treatment plan for the patient, all physicians rely on different types of information and contents within the medical record. The EHR, as a unified personal record, is filed electronically with patient care information, in all cases in which clinical care (emergency, primary care, specialty, hospital admissions, etc.) is required. Physicians interviewed, gave a brief outline about main tasks performed daily through the EHR and were gathered under the Theme 1.

- Log in
- Patient history
- Family history
- Allergies
- History of previous diseases
- Review by systems (eyes, ears, mouth nose and throat, respiratory, musculoskeletal)
• Diagnostic tests
• Diagnosis
• Plan of treatment

Physician #3 and #5 start the session directly from the EHR of the patient since secretaries in the Hospital admission do “Login”. The rest have to “Login” in the system and fill the information. Four physicians interviewed, agreed with filling Anamnesis, which includes: consultation reason (symptoms), demographic and social information, family history, allergies, history of previous diseases, general systems review, send requests to CT scan and laboratory (if it is required) test and finally diagnosis. Physician #3 emphasized on patient current consultation reason saying: “If I want to make a good diagnosis, I have to listen carefully patient’s concerns. I think it is a good way to start to establish the connection between previous diagnosis and current reason of consultation and be ready to make the diagnosis. The reason of consultation will determine what kind of information I will look for on the record”

Physician #4, as a hospitalist doctor, mainly:

“check medical referrals, evolution notes, admission information and vitals”.

They type the information but in some cases, three of them can make audio records and the secretaries transcribe it later on, unless it has to do with the clinic summary. They mentioned also review of lab test and check summary of last referral because two of them, work mostly with elderly patients.

Theme 2: Current presentation of the information on EHR

Since the current investigation pursues a better-structured way to analyze information on the EHR, part of the interview was centered on the description of the design and structure of the information on the current EHR systems. Even though the respondents do not use the same software, they all concur saying that the information should have a better structure. Two of the physicians who use ‘Take Care’ affirm that the information within the record has a better structure compared with some others as ‘Cambio Cosmic’ or ‘Journal 3’. However physician #4 said:

“It is a complex system. The system is not adapted for primary care. The medication system, called ‘medicinks module’, was made to work at the hospitals but not in primary care. I don’t
need to know that the patient has an infusion because we don’t prescribe infusions. Instead I need to know that the patient has a medicine for the hypertension and he will have it always. The system does not show that but a list of the current medications. If the doctor interrupts one medication but he/she forgets to remove it from the system, then it will be displayed on the system every time the record is open. That is why we have to ask to the patient about some medications.”

The physicians who use ‘Cambio Cosmic’ think in general that the system has a poor structure because they usually do not find the information easily. Physician #1 said, “It has a terrible construction… It is the same thing when it comes to medications: we are not using a lot of the words we can use because no one has told us how to use it so everyone is now just has been surviving with the system instead of use it in the correct way… I can go up and look here and look at it in dynamic views and if I can go down here I can find the diagnosis or where this one is coming from. So I can through different ways find a lot of information but I have to take deep tours all the time to compensate because the system contains a lot of information but it is hard for me to get access to it and it is not in a structured way”

They also consider that they underestimate the system:

“Everyone is doing things and documenting without traceability so cannot find it again. That is one of the biggest problems of Cambio. The system can do so much more than we are using it for.”

During the interview they pointed out that they have had to learn by themselves about the system. They have their own way to operate the system:

“Everyone one has his/her own way to write”.

Physician #3 uses a system called ‘Sofia’ which she describes as “Practical and easy to use because only relevant information is placed in the screen. All the EHR components are placed in a logical order among the journal compared with others” (Healthy Cloud).
After finishing the interview, the respondents fulfilled a questionnaire in order to get a general sight of the EHR they are working with. They had to rate features like organization of the information on the EHR, being 1 ‘confusing’ and 9 ‘very clear’. According with the table below interviewees feel more confident with ‘Take Care’ and ‘Sofia’.

<table>
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<tr>
<th>Interviewee</th>
<th>Software</th>
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Table 3. Questionnaire results Question #8 Screen: Organization of information in EHR

**Theme 3: Care plan in Chronic Diseases.**

When asking questions about care plan in Chronic Diseases, it was necessary to inquire, which are the most common chronic diseases they are used to face with the patients they treat daily. That is the reason to subcategorize the theme 3 into: Care Plan and most common chronic diseases.
- Care Plan
During the first interview, the researcher realized that the concept of “Care Plan” could have different interpretations. That is the reason why a short explanation was introduced on the coming interviews.
Patients seen by the interviewees are mostly adults or elderly people. In fact, the goal of “ALMA, program” is to ensure proper care to older patients with complex care needs who require close cooperation between hospital and primary care in western Östergötland. Two of the interviewees work with ALMA program in Motala. It aims to avoid hospitalizations and admission in the emergency care. To the question “Do you have sort of Care Plan option in your EHR?”
Physician #1 working with ‘Cambio Cosmic’ said:
“We have it. We don’t use. I guess we could use it. We have ‘Vård Plannering’. No one is using it.”.
Physician #2:
“Today is very hard to get this view”.
The other three respondents have encounters with all different kind of patients and they affirm not to have such a utility within the EHR.

- Most common chronic diseases
Because the type of patients seen by respondents is a mostly adult, chronic diseases are often found. The question about “which chronic diseases you consider, are the most common?” was required because a list could be included in the overview instead to have all the possible diagnoses for a patient. After a short explanation about why it would be helpful for the current research to have a list, physicians mentioned some of them according with their experience:
- Hypertension
- Hypercholesterolemia
- Heart failure
- Kidney failure
- Ischemic diseases
- COPD
- Asthma
- AF
- Endocrine diseases
- Stomach diseases
• Colitis
• Cancer
• Diabetes
• Mental and behavior disorders.

Physician #2 suggested: “diseases but there are no so common like Crohn’s disease, colitis and so on. Can be interesting. Also endocrine diseases also are interesting. Malignances”

Physician #3 was specific when mentioning Diabetes. She said “Diabetes Mellitus Type II”

Physician #5, said: “Eventually diabetes. Is increasing. It is not the most common but you should be aware of it. COPD I am not sure if is the most common but you can write it.”

Theme 4: Summary Overview

Current summary overview

Taking into account that respondents do not use the same EHR software, the inquiry about a summary overview on the EHR were important in order to have a basis and establish possible changes or future suggestions regarding current summaries available. Four of them said not to have an overview of the summary in the record. For physicians 1 and 2, using ‘Cambio Cosmic’, if they may look for any kind of patient summary, they may look the discharge made by the physician who met the patient in the last visit.

They said:

Physician #1: “No. I think everyone is looking for it. I try to write it down quite often: patient history with the diagnosis, which is very short and narrative form. Today everyone is doing like this: this is one of my colleagues doing summary (showing the screen on the computer) of the patients’ history diseases but here I cannot find them and then I have to go through all until I find the summary of the patient. It is not supposed to locate here. It is supposed to be located here in medical background”

Physician #2: “Perhaps there is some kind of function somewhere in Cosmic but no one uses it. I am not sure if you have this kind of summary. I don’t think so... Mostly if it is an elderly patient I look the latest or I look the last ‘sammanfatning’ or summary of the last doctor. So I check the latest when he left the hospital or when you read some ‘remiss’ discharge to another clinic then you do this summary so I for check those places in the system where you can find the summary it is not ten years old and perhaps this summary is correct. Doctor can see some diagnosis in it. Very manual”.

‘Take Care’ users, have a similar approach when exploring patient’s summary.
Physician #3: “The HC is an active document and no summary is commonly typed but usually the doctor used to make a summary of what happened and add diseases that the patient has had recently”.

Physician #4: “We have something called ‘Discharge Summary’ at the bottom of the record. There we can find the latest information of the patient. We can filter it by date”

Physician #5: “The problem with Take Care is that you have to repeat the information many times. For instance you always have to write previous diseases of the patient. It could come automatically and you don’t have to write it again. You could have a template and you have basic diseases and then you just add the new stuff. All the time you have to go back and take a random journal file to see what are the diseases of the patient or sometimes you go to the list of diagnoses which is also repeated all the time: every year, every time the patient meets a doctor, he tells the doctor he has diabetes so when you look the diagnosis is a lot of ‘diabetes’ every year”.

Figure 8. Pointing out with the cursor where the summary overview is located in ‘Sofia’ EHR

Theme 5: Suggestions summary overview
Summary overview of the patient is a minimum data set, which includes the most important clinical data necessary to ensure a safe healthcare. This overview provides to the physicians, the essential information needed to gain a quick and depth enough overview of patient medical status. The concept ‘overview’ is clear for all the interviewees but certainly each of them have different needs and perceptions about how this overview should be. The last part of the interview was devoted to listening to the most immediate needs of physicians regarding possible summary overview and suggestions for improving issues faced with their EHR. Much valuable information was obtained in this part of the interview not only because spontaneously reveals what physicians have always wanted to have in the EHR but also because they were questioned theirs selves about the need for this custom tool. Below, two sub-topics will be described to facilitate interpretation of results.

1. Essential contents in the Summarization overview.
   - General information about the patient: name, date of birth and gender.
     Physician #3, emphasized on the importance of the social background of the patient: “I need to know who the patient lives with in order to give or not certain treatment. If it is about an elderly patient with stroke, I could not send him home for rehabilitation because he is not going to have the support he may need”

   Most relevant clinical patient data:
   - Allergies
     Physician #4: “…We have within the Hospital an easy way to detect if the patient is allergic or he/his is anticoagulated. We recognize them because they wear a red wristband. Maybe it could work in the overview. Use a kind of red flag to be aware of it. Moreover I consider absolutely useless to display immunization schedule and therapies such physical therapy, occupational therapy and speech therapy”

     Physician #5: “…There should be like a little corner with the previous diseases and allergies and this important interaction medication problems, anticoagulation and you know directly when you open it”

   - Risk Factors
     Physician #5: “…You should get all the risk factor for cardiovascular diseases or stroke. Everything should be there. Smoking habits: just yes or no. Not with detail. Of course alcohol. Anticoagulants: yes or no”

   - Current medical diagnoses.
Physician #2: “A good summary. That is chronic diagnoses, earlier diseases, and earlier inpatient episodes. That is also interesting.”

Physician #5: “Main organs: kidney, brain and if there is immune diseases like dermatologic diseases but not fractures or accidents. Just if it is important. Cancer of course”

- Surgeries in the last six months.
  However, physician #4 admitted: “I consider old surgical procedures, should not be shown every time on the summary unless it is strictly related with the reason of consultation”

- Current medications
  Physician #1: “I think the overview is very important because most of the medications and treatments are based on kidney functions so I will have to know if the kidney function is ok so I can choose the medications. I have to take that into consideration and it goes for all of this different diseases”.
  Physician #2: “One thing is the actual medication now is also interesting, I mean early medications. If we have just five minutes to get the view here and now then is the medication you have just now and then you can click in this way earlier. That is another way but if you want now, the problem, the interesting thing is what would you take from the medication now?”
  Physician #3: “Medications are very important. It would be great if we could have only a short list of the current medication”
  Physician #4: “A list of current medications, including prescription the patient is taking”

- Lab tests
  One of the specific questions in overview contents was to included lab test and medication but no one mentioned it. They focused on medications and diagnosis mainly.

- Visualize contacts with the ward
  ‘Cambio Cosmic’ users consider convenient to have a filter to visualize patient’s contacts in the ward depending on specialty. Physician #2 said: “You could start from the diagnosis and not from the physician’s clinic. If you are a doctor and work in a health care center, I look at the symptoms and then I search very wide but if you work as a cardiologist then you look after cardiologist’s notes. We have different needs”

2. Visualization suggestions systems.
After having a general idea of what the respondents want to have on the overview, we wanted to know their opinions about some proposals that we consider useful in the abstraction of information in the EHR. Answers to the question about include a patient classification on the overview were divided.

- **Use ICD 10 as standard classification on the overview**

  Physician #2: “I think we have very different way to work … the physicians… It is good when you have a system that fits so many physicians as possible. It is rather why to start and perhaps just the chronic diseases or how do call it? In ICD 10, you start from A, B, C, D, E perhaps… and diabetes is E and psychological diagnoses is F. That is the system we work with. Perhaps it could be a system to range chronic diseases for some physicians. Because what is the most important disease you don’t know. That depends on the symptoms of the day. If you are tired and F diagnoses like depressions and chronic recidivating depressing is very important as diabetes. It is easier to have it from ‘A’ until ‘Ö’ in Sweden. Perhaps is easier for me. For this kind of screen then I can click like you said and find information and I get an overview of what the diagnoses are. That would fit me.”

  Regarding ICD10 codes: physician #5 said: “I don’t think is very important but of course it helps the physician when doing the summary. When you are dictating and you send the patient home then you look immediately what is the code. I think is good. It simplifies work” while physician #3 and #4, agreed saying: “It could work for me but I rather have to read the diagnosis instead of the code”

  Physicians 1, 2, 3 and 4, think that abstraction of information could be improved deploying a list of diseases.

- **Patient classification using colors.**

  Physician #4: “We can see the EHR everywhere in the hospital. If I open the EHR and the background color is yellow then I know I have to deal with a chronic patient. In emergency triage we have a classification of the emergency with colors: red for the most urgent and blue for non urgent. We are also used to see some color flags in the patient room. It could be work also on the EHR”.

  Physician #5: “I wouldn’t do it without a proper study. I think you need a study to know where to put the cutoff”

- **Patient classification using numbers**

  Physician #1: “It is a medical department. It is quite different if you go to the primary care they will more often have on or two diseases and then is still... you have to get that information to get into the classification because is CHA VAS score for Atrial fibrillation is a summary from the
different diseases so the system must have got to the patient history and then you can figure out how the number and how the person is safely... I think it can be useful because it helps us to see how to sick is the patient. If it says number 4 or 5 so the patient is sick: why the high number or the low number so it contains some data of the medical conditions that has caused the sick patient. It should be a shortcut to the medical history or something in the design....”

Physician # 3:  I think it is a delicate issue. How to categorize a patient by a number? I think you cannot do such a think. “Patient” means multifactorial issues. It is impossible to label a patient with a number. We would have an enormous bias. As you said, in the surgery setting it could be valuable. Not for outpatient wards.”

Physician #5: “Number...I think before doing that you should do a study because there is a risk that you are going to discriminate patients to get the treatment. If you have a patient 5, as you say, the risk is that you induce the doctor to make decisions on this automatically generated information...I think you should do a very careful study where you would have to have a certain parameters. For instance a patient, who is with anticoagulants, is a high risk patient for surgery so in that case, those more simple classifications are good. This happens also with the text: you open the journal and you see many diseases and you think this patient is very sick but then when you look at the patient, the patient is ok. He has hypertension, he has diabetes and he is 90 years old and he walks alone, he goes and buys his clothes and food so why I shouldn’t treat this patient despite having a lot of diseases. So I think it is a bit dangerous to do that”

During the interview two of the techniques used in information visualization were showed to the respondents with the aim to know their previous experience with similar systems: visualization of hierarchical data through tree maps and visualization of time oriented data through time-lines.

• Visualization of patient status using Time-lines

Physician #3 proposed a set of lifelines indicating the importance of each one. After she did the lines, she realized that all the lines could be connected to one line on the bottom called: current reason of consultation: “It gives more visual interpretation of all the events among patient ‘s life and how they are affecting today his health. What I mean is that I can make a mental connection of all data displayed on the lines”
Figure 9. Up: Important events in a 40 years old patient as appendectomy, gallbladder surgery, bypass, hernia surgery are used as an example by Physician #3 to depict a desirable overview of life time line. She named it “Life Wave”.

Figure 10. Graphic made by Physician #3: There are 5 lines: Social background, family history, lifestyle, surgeries and previous and current diseases. On the right corner, she wants to visualize patient allergies.
Physician #4: “there is a huge amount of information that must be processed everyday. Lifelines would be the best way to display the information if the system could support it but I am afraid it won’t”

Physician #5: “It would be interesting in the outpatient clinic to look at the history: what has happened with the patient. How long has the patient had a chronic condition because it plays a role but in the acute setting maybe you just need to get a summary, what the patient has, not how long”

• Shortcuts
Respondents found valuable to include some shortcuts in the summarization overview in the EHR. They consider useful to have a binding tool linked to guidelines, medications and lab test.

Physician #2: “Today we have no connections with elderly care medications in the system called ‘Pascal’. Today we just click and we get into the system but you have to log in and it takes time. They are different. They are not connected yet. Perhaps they will, I think”

Physician #1: “Medications for me as a medical physician are very important. Surgeon does not care about the medications so he does not care about where he puts the medications of the patient because he is only interested in operating. There are different positions we will be interested in different words and what kind of information we are looking for.”

Physician #2 “If I can fill any data here so I would like to have a third road here then I can see “Medical background” and important parts for the patient”.

Physician #3: “ I would like to have three buttons: “Suspend”, “Continue”, “Modify” in the medication panel. I waste at least 50 % of the consultation time checking medications because a huge list is displayed every time I open the EHR”
4. Discussion

4.1. Methods discussion

The qualitative exploration method used in this study collects and identifies general background, themes and topics of the problem investigated. It was also useful to generate suggestions of related issues that should be examined in depth in future research. With this type of study, certain experiences, examined through some issues discussed above were documented. It is interesting to see how many thoughts, experiences and insights were revealed by physicians as the interview unfolds. Certainly this is the most fulfilling part of the study.

What at first intended to be a structured interview, was gradually becoming unstructured because every question covered many topics and was difficult to maintain a rigid structure interview. The qualitative nature of the study, allowed a more flexible interview, delving into those important areas. At the end some more information that was not initially thought were obtained. As the respondent was answering the questions, there were new and interesting questions that provided valuable input to the research.

Analyzing quantitative data and experimenting can answer many important questions, but these techniques have limits. Statistical summaries may not communicate, because numbers do not tell a story people easily understand. Furthermore, when a number is assigned to the answers, context can be lost, hence much of the richness and complexity that make research realistic, can be also lose.

4.2. Findings.

Thanks to the great advancement of technology in recent decades, access to the EHR is now accessible to everyone. During the interview, it was found that many of the barriers that physicians faced before regarding use of the EHR have been overcome. To manage the EHR means more than the ability of users to use a computer. The EHR is for physicians, the center of medical data that enable the extraction of the patient's health status information in a timely manner and that is the reason why, the user interface design, organization of information and even the design and layout of the screen influenced greatly the level of acceptance of EHRs. Most of the issues referred by the physicians had to do with the poor implementation process. They did not get an appropriate instruction when the system was executed for the first time in the organization. But complaints and lack of motivation go beyond the lack of instruction. They consider that some EHR are unintuitive and difficult to make self-learning. Complains also lie on the difficulty to find the discharge summary in the correct place. The medical staff is not aware of the tools designed for this purpose and so each one place the information at their discretion, generating repetitive data, making the process slower and the relevant information might be omitted. The idea of having an
“overview of the patient health care status” tool is not new for physicians. This alternative is currently available for some EHR. Those who lack this think that is a great idea and would be beneficial not only for them but also for the patients. Some of them seem skeptical because previous systems did not fulfilled their expectations and instead they have been struggling with the system in the extent they use it. Despite difference positions and perspectives of five interviewees, they all have the same perception concerning main tasks performed daily. The possibility to create a standardized method to visualize chronic diseases in a structured and intuitive overview becomes concrete.

Consistently with studies previously done [5] [15] [17], the findings in this study demonstrate an affinity for timelines. Regardless the setting used, physicians suggested it might be a useful visualization tool. Some of them have previously worked with diagrams arranged in a timeline.

Regarding the idea of categorizing the patient on the overview, not satisfactory in this regard comments were perceived. On the contrary, it is believed that this suggestion should be studied more thoroughly before being implemented since there are no studies to support this. The suggestion to include certain colors as part of the classification of the patient was gratefully accepted by the person working as a hospitalist practitioner. For her color of the “emergency TRIAGE” are familiar but for the other physicians, with this kind of classification system, patient condition could perhaps be under or over estimated. Physicians have the same perception regarding classification patient with the numerical scale.

We found that physicians are willing to collaborate in further research related with visualization and navigation in medical field. If so, they are willing to provide feedback on prototypes created based on their needs. They were reluctant to participate in long meetings but received in a good manner the idea to do the feedback from their offices through a web based interactive prototype.

4.3. Limitations and strengths of the study

A major limitation of the study was the availability of medical staff to interviewing. First, they were skeptical and did not have time for the interview. Due to time and availability, only five of the 10 physicians contacted, could actively participate in the interview. Although a larger number of respondents, had produced more fruitful results, physicians interviewed have enough experience to review and suggest alternatives in the construction of overview visualization prototype in the EHR.
In this study, the researcher directly and intentionally selected individuals of the population, taking a convenience sample; the risk of bias is implicit. They were chosen because their experience with the use of EHR and because they were referred by someone involved in the study.

4.4. Reliability and validity

Validity is a term that even reworked from various perspectives has remained central to the assessment of the quality or scientific of qualitative studies. The validity as synonymous of truth becomes the dividing line of the limit set between legitimacy and reliability of research. From a review of the main verification criteria to designate the legitimate contribution of qualitative research, Creswell (1998) and Johnson (1997) [37] identify three, which were used in the present study:

- Researcher as "detective"
- Extensive fieldwork: two of the interviews were done in Spanish, which is the mother language of the researcher, and were transcribed to Spanish and English. Three interviews were done in English. Despite many terms are in Swedish, all the information was transcribed to English.
- Validation from participants: Cooperation of respondents was sought to confirm the "objectivity" of the notes made after the transcription of the interviews, ensuring that the information recorded by the investigator matches or is consistent with what they said. The transcription was done as soon as it was done. All the information content on the audio record was fidelity transcribed, including idiomatic expressions.
5. CONCLUSIONS

With this research, main physician’ requirements and needs regarding time-oriented visualization aid through the chronic patient care plan in the EHR were found and described. The information gathered through the interviews, also showed priorities regarding chronic diseases care plan overview in the EHR.

Physicians interviewed prefer a graphical interface in a timeline style instead of the traditional way of presenting information in text boxes. At the same time, they would prefer options to deploy a diagnostic list instead of a text describing the disease, since the graphics and plots permit better abstraction of information in comparison with a text without a given structure, even written in a non-formal way.

The implementation of the summary overview in the EHR will improve the physician-patient time, but nowadays it is not a functional part of most of EHRs, lacking among the physicians the common use of a powerful tool. The physicians should be able to see a summary of the patient EHR through timeline information visualization, in order to abstract most of the information in a faster and simpler way. Some additional adjustments to it should also be available for the physician, like applying some information filter depending upon its specialization field and include a shortcut connected with guidelines to ensure a better treatment for the patient. Although the issue of the classification of patients turned out to be a little neuralgic for most respondents, studies could be done to assess the validity of this possibility because for some physicians the option is not entirely ruled out.

Given the temporal nature of the patient clinical data, timeline approach would enhance the possibility of getting in timely way only relevant information of the patient, leaving the level of detail displayed upon the user needs.
References


[18] Shneiderman B. The Eyes Have It : A Task by Data Type Taxonomy The Eyes Have It : A Task by Data Type Taxonomy for Information Visualizations. Systems Research. 1996.


Appendix 1. Invitation letter.

Electronic Health Records, EHR, involves the incorporation of new information technologies to the core of health activity but usually physicians are overwhelmed by the amount of information contained in the EHR mainly when patient information is based on free texts because it decreases visual perception. Although software used today do the task of displaying, storing and managing information, a new model is needed to quickly locate information on the EHR. A new way to visualize patient data, particularly chronic in patients, is pursued with this research. Health Informaticians build the bridge between IT and health care and in order to build a solid bridge, physician’s collaboration is essential. As health Informaticians, we want to know which are the needs in terms of visualization and navigation in EHR. The scheme below roughly describes the challenging task of the physician when encountering the patient. An accurate diagnosis should be done within a limited window of time. Such a challenging task could be accomplished by designing a practical EHR overview.
PHYSICIAN USING

INTUITIVE EHR PROTOTYPE

- Use encounter time in the most effective way
- Overview only strategic information
- "Patient Classification option" locates the patient within specific areas
- "Condition overview option" provides linked information about patient records
- Make information available for specialists and other practitioners

BENEFITS EHR OVERVIEW VISUALIZATION
Appendix 2. QUIS: Questionnaire N.2 for UI satisfaction.

<table>
<thead>
<tr>
<th>OVERALL REACTION TO THE SOFTWARE</th>
<th>1</th>
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<tr>
<td>3. Comment</td>
<td>frustrating</td>
<td>satisfying</td>
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<tr>
<td>4. Comment</td>
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<td>adequate power</td>
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<td>5. Comment</td>
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<td>6. Comment</td>
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<td>8. Highlighting simplifies task</td>
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<td>9. Organization of information</td>
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<td>very clear</td>
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<tr>
<td>10. Sequence of screens</td>
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<tr>
<th>TERMINOLOGY AND SYSTEM INFORMATION</th>
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<td>11. Use of terms throughout system</td>
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<td>14. Prompts for input</td>
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<td>15. Computer informs about its progress</td>
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<td>20. Performing tasks is straightforward</td>
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<th>SYSTEM CAPABILITIES</th>
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<tr>
<td>23. System speed</td>
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<td>25. System tends to be</td>
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<td>quiet</td>
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<td>26. Correcting your mistakes</td>
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<td>27. Designed for all levels of users</td>
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List the most negative aspect(s):
Appendix 4. Semi-structured interview questions.

1. Can you make a short description about yourself? Can you tell me your name, age, educational level and current position within the institution?

2. How many years have you been working as a medical doctor and how many years have you been working with EHRs?

3. Can you tell me, which EHRs have you used and which one are you using currently?

4. What are the main tasks you perform with EHR on the daily practice?

5. Do you think this EHR system actually fulfill physicians needs?

6. What do you think about structure and content of information in the EHR?

7. What do think about the organization of the information on the EHR?

8. Do you have any kind of summary tool on the EHR?

9. If not, which contents do you consider are important to visualize on the summary?

10. About chronic diseases could you mention the most common?

11. Have you heard about information visualization?

12. If yes, do you prefer any particular information visualization system? (I show two techniques widely used in medical domain visualization)

13. The ASA, American Society of Anesthesiology, adopted the five categories about physical status of classification system, being:

   1. Healthy person
   3. Severe systemic disease
   4. Severe systemic disease that is a constant threat to life.
   5. A moribund person who is not expected to survive without the operation.

Do you think it would be easier to abstract information from the EHR using a “patient classification” in the overview?

14. Do you consider it would be helpful to use colors as the emergency triage system in order to have a quick overview of the patient health status?

15. Do you have any special advice for further overview tool prototyping?