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Visualization of Task Planning to Give Medical Professionals an Overview of the Patient's Current Situation in a Treatment

Master's thesis in Master of Science in Informatics
Supervisor: Pieter Jelle Toussaint
June 2019

Master's thesis

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Abstract

Electronic health records (EHRs) are widely used in the health sector today. With modern technology, new systems to improve the way healthcare professionals are working are constantly being developed. Standardized clinical pathways are widely researched. OpenEHR introduced recently a specification for managing standardized clinical pathways called Task Planning.

This thesis investigates a tool for visualization of an up-to-date instance of a plan of treatment for a specific patient that is structured according to the openEHR Task Planning specification designed to give physicians in their working situation an overview of the patient's current situation in a treatment.

During this project, a semi-structured interview was conducted, and a prototype was developed and presented for physicians in order to gather requirements physicians would have for such a tool. The results show that physicians were positive to the information level and the way that information was visualized in the proposed prototype.

Sammendrag

Elektroniske pasientjournaler (EPJ) er mye brukt i helsesektoren i dag. Med moderne teknologi, nye systemer for å forbedre måter helsepersonell arbeider på blir stadig utviklet. Standardiserte pasientforløp er mye forsket på. OpenEHR introduserte nylig en spesifikasjon for håndtering av standardiserte pasientforløp kalt Task Planning.

Denne oppgaven undersøker et verktøy for visualisering av en up-to-date forekomst av en plan for behandling av en spesifikk pasient som er strukturert i forhold til openEHR Task Planning spesifikasjonen som er designet for å gi leger i sin arbeidssituasjon en oversikt over pasientens nåværende situasjon i en behandling.

I løpet av dette prosjektet, en semi-strukturert intervju ble gjennomført, en prototype ble utviklet og presentert for leger for å samle krav leger har for et slikt verktøy. Resultatene viser at legene var positive til informasjonsnivået og måten informasjonen ble visualisert på i den foreslåtte prototypen.

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Abbreviations

EHR - Electronic health records
EMR - Electronic medical records
eSP - Electronically standardized patient pathways
TP-VML - Task Planning Visual Modeling Language
NSD - Norwegian Centre for Research Data

CHAPTER 1 INTRODUCTION

Traditionally, health records have been written on paper. With the appearance of modern technology, multiple systems have been created to manage and store health records in a digital format. Many health care organizations have adopted electronic health records (EHRs) for this purpose. The electronic patient journal is a direct digital translation of the paper version of the patient journal. All notes concerning patient treatment are saved chronologically in a journal system for a given patient. That leads to many lines of text where the essential information is hidden in lines of unstructured text. Today, getting an overview of the patient's treatment plan and patients condition is a time-consuming process.

As technology advances, it opens up for new opportunities for making electronic health records better. In 2012, The Norwegian government decided that there should be one journal for each person in "Meld. St. 9 (2012-2013) 'Én innebygger - én journal' " (regjeringen.no, 2019) The idea is that all necessary health information must follow the patient throughout the patient's clinical pathway independent of different health organizations.

Standardization of clinical pathways is shown to decrease the total costs and reduce the length of stay without negatively affecting the quality of a patient's treatment (Lion et al., 2016, Zehr et al., 1998). The standardization of clinical pathways has been researched from a graphical perspective. Aigner et al. (2008), Roque et al. (2010) researched the Information Visualization in health care sector and standardized clinical pathways was featured. AsbruView and CareVis were systems mentioned for visualization of clinical pathways.

1.1 Motivation

DIPS is a Norwegian company working on digitalization of the the Norwegian health sector. DIPS has an agreement with three of four regional health trusts (DIPS, 2019). DIPS have based their product on openEHR standards and is currently using structured health data as a foundation in several fields. Now they want to investigate the standardized clinical pathways in order to expand their product. The openEHR works currently on developing a specification for structuring standardized clinical pathways called Task Planning. Task Planning is developed as an extension of the openEHR data structure.

The lifecycle of Task Planning can be described in the four following stages.

1. **Creation of the prototypes of plans of treatment:** Templates or prototypes of standard plans of treatment is developed and published. The prototypes are structured, generalized, descriptions of care of a condition for a typical patient. The prototypes are created based on one or more clinical guidelines that describe in detail how to deal with specific situations within a condition. This stage will normally be performed by the Directorate of health and medical staff resulting in a set of standardized clinical pathways for several situations.

2. **Construction of a plan for given patient:** One or more plan prototypes are turned into a concrete plan for a specific patient, customized to the patient's condition, and activated. This stage will normally be performed by a physician or other medical professional after a patient's condition is known.

3. **Using a standardized plan in a working situation:** An instance of a treatment plan for a specific patient is used by the physicians in their working situation. The standardized plan contains fine-grained, up-to-date, planned tasks to be performed to achieve a particular goal.

4. **Using completed plans for quality assurance and improvement of plans** Completed plans are analyzed and compared in order to quality assurance of pathways and improvement of the prototypes.

To allow domain experts to interact with the Task Planning specification, a graphical representation of the code structure is needed. There are different aspects and requirements for graphical representation for stages stated above as the purpose of interacting with task planning data structure and the required information vary in all stages. Task Planning Visual Modelling Language is the visualization language created by openEHR that is designed for giving the user an easier understanding of the whole structure of a static plan and might be relevant during the creation of the plan prototypes, described in the first stage. At this stage, understanding the whole structure and being able to see all possibilities in a plan could be required.

When physicians are working with patients, the situation is different than when a static plan is created, giving other requirements for the information needed to be graphically presented. Today, openEHR Task Planning is still under development and the physician's perspective of interacting with Task Plans has not been investigated. This thesis will concentrate on the third stage presented above, investigating a tool for the graphical representation of a dynamic plan that shows the up-to-date information about the current situation of a specific patient and his treatment plan.

1.2 Goal

The goal of this project is to design and develop a graphical representation of an up-to-date instance of an activated plan that is customized to a specific patient in order to give physicians a quick overview of the patient's current situation in the treatment.

1.3 Research Questions

The research questions that will be investigated in this thesis are given below:

> **RQ1:** What kind of information about a standardized plan of patient's treatment is important to present to the physicians?

> **RQ2:** How can a standardized plan of patient's treatment be visualized for physicians in their working situation?

1.4 Challenges

The challenge for this project was that Task Planning was under development during the project. This caused several changes in the specification's structure. The websites of openEHR Task Planning and Task Planning Visual Modelling Language have been updated since the beginning of this project. As the Task Planning was under development there were no realistic plan prototypes developed causing the need for the creation of a fictive plan for testing purpose. This was challenging, because of the lack of domain knowledge.

1.5 Report outline

In chapter 2, relevant theory, methods and techniques for this project are described. In chapter 3, methods that are utilized in this project are presented. In chapter 4, the results of the research are presented. The results are discussed in chapter 5, containing some recommendations to future work and a conclusion if this project.

CHAPTER 2
THEORY

In this chapter, relevant theory, methods, and techniques are introduced. The section 2.1 describes the Task Planning specification. In section 2.2 state-of-the-art methods and techniques are described.

2.1 Task Planning

2.1.1 EHR

Electronic health records are a digital version of traditional medical records that in the past was written on paper and sorted in folders. All information concerning a patient and patient's treatment is stored in EHR. The Center for Medicare & Medicaid Services (cms.gov, 2019) defines EHR as:

> ”An Electronic Health Record (EHR) is an electronic version of a patients medical history, that is maintained by the provider over time, and may include all of the key administrative clinical data relevant to that persons care under a particular provider, including demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports”

2.1.2 OpenEHR

OpenEHR foundation defines openEHR as “a virtual community working on means of turning health data from the physical form into electronic form and ensuring universal interoperability among all forms of electronic data (www2.openehr.org, 2019). ” OpenEHR provides open source standard specifications in health informatics that describes the management, storage retrieval and exchange of the health data in EHR. OpenEHR are using archetypes to describe real-world tasks as a computational system. Cambridge Dictionary defines *Archetype* as ”the original model or a perfect example of something”, but in openEHR an archetype is the model (or pattern) for the capture of clinical information. An archetype is a machine-readable specification of how to store patient data using the openEHR Reference Model (openehr.atlassian.net, 2019).

2.1.3 OpenEHR Task Planning

OpenEHR have recently extended their EHR information structure with Task Planning, which is a formal specification of information representing planned tasks. Task Planning is a system for structuring and saving time-scheduled clinical tasks. Task Planning is developed to meet requirements from several areas where granular planning of clinical tasks is required. Task Planning makes it possible to create a structured plan, or set of plans, to achieve a goal (e.g. the patient is getting well) (openehr.org, 2018).

A complete plan contains a work plan, task plans, task groups, and tasks. Those are described in sections below.

2.1.3.1 Work Plan

The task planning specification is based around the concept of a *work plan*. The top-level formal concept defined is the work plan, which consists of one or more *task plans*. The work plan is a definition of work to be performed by one or more workers in order to achieve a defined goal with respect to a single subject of care, like a patient. A work plan could describe a complete treatment of a patient, when a work plan is completed the treatment is finished.

Figure 2.1 illustrates the execution of a work plan. The *work plan definition* is a reusable definition of work to be done, a prototype, that is designed based on one or more guidelines. Further, the definition gets instantiated resulting in a *work plan instance*. The performers interacting with the *work plan instance* can be medical staff, machine or software application. The interaction with the *work plan instance* happens through *commands* from the system to the real world actors, *data* presented to the actors from system, and *notifications* from the system to actors.

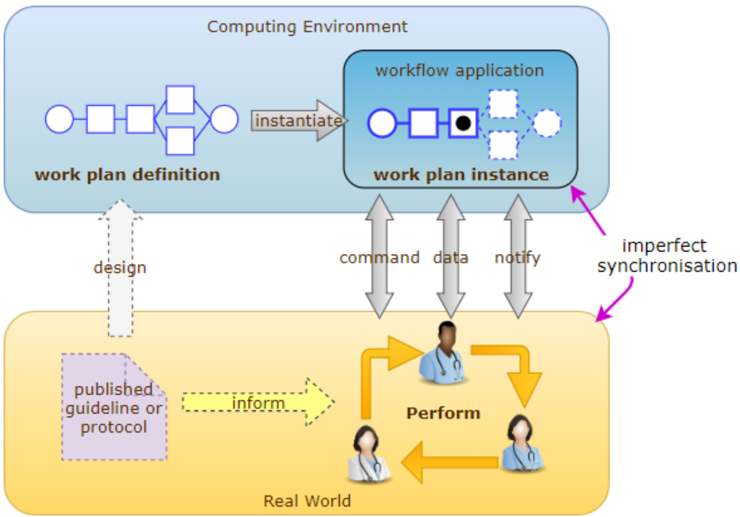

Figure 2.1: Illustration of the execution of the Work Plan (openehr.org, 2018)

2.1.3.2 Task Plan

A task plan is the actual definition of work to be performed by a single performer. Task plan contains a set of tasks or task groups that are planned to achieve a defined result within a larger plan. Task plans can be defined as logical fragments of a treatment that need to be completed at given order to complete the treatment.

2.1.3.3 Task Group

Task group is a group of tasks and/or more task groups within a task plan that are to be executed on either in a sequential or parallel sequence. The conditional group type is a special kind of task group that enables conditional logic structures to be represented in a task plan.

2.1.3.4 Task

A task is a separately performable unit of planned work at any kind of granularity. Tasks may be defined inline or inside a task group, sub-plan or a plan. A task might, for example, be to give medication to a patient or to conduct a laboratory test. Tasks have several lifecycles that are shown in Figure 2.2. A tasks first state is *planned*, then the task can be enabled setting the state to *available* or if not needed the state can be set to *cancelled*. Further the state can be either set to *underway* or *completed* if the task done. The underway state means that the task is active.

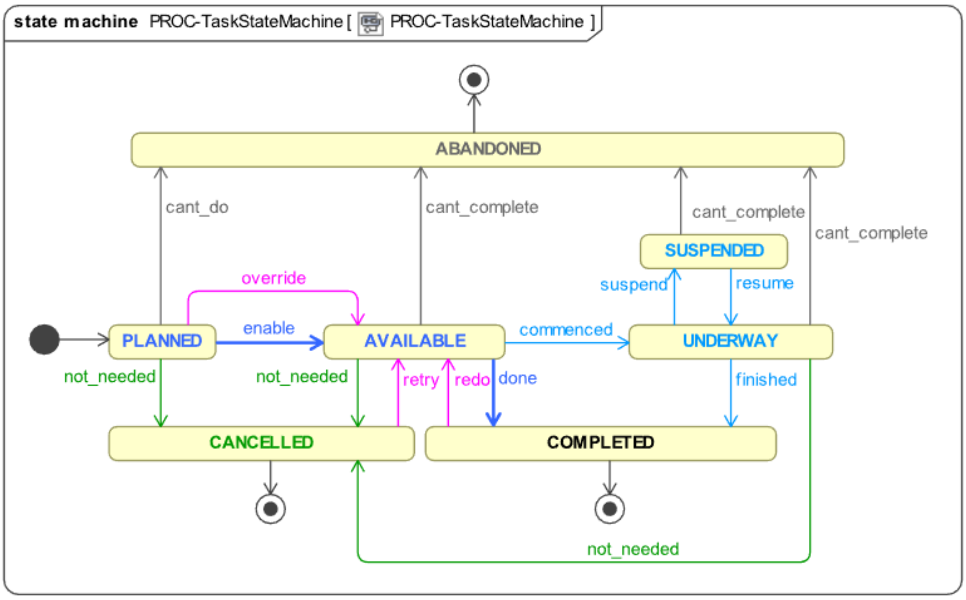

Figure 2.2: Possible lifecycles of a task (openehr.org, 2018)

2.1.4 Creation of task plans

Before being able to start using Task Planning, several prototypes have to be created and saved in a structured way. The prototypes will be created based on clinical guidelines and best practice examples of treating given diagnosis. Clinical guidelines provide a detailed description of how to deal with specific situations within the condition. In openEHR, the prototypes are called care pathways which is another word for clinical pathways, the word clinical pathways will be used further in this paper to lessen confusion. Those prototypes will be the basis of creating a plan of treatment for a given patient. A physician will choose one or multiple clinical pathways and customize them to the patient's condition, creating a plan of treatment for the patient. The lifecycle of Task Planning can be described in the four following stages.

1. **Creation of the prototypes of plans of treatment:** Templates or prototypes of standard plans of treatment is developed and published. The prototypes are structured, generalized, descriptions of care of a condition for a typical patient. The prototypes are created based on one or more clinical guidelines that describe in detail how to deal with specific situations within a condition. This stage will normally be performed by the Directorate of health and medical staff resulting in a set of standardized clinical pathways for several situations.

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4. **Using completed plans for quality assurance and improvement of plans** Completed plans are analyzed and compared in order to quality assurance of pathways and improvement of the prototypes.

2.1.5 Task Planning Visual Modeling Language

OpenEHR designed a visual language to represent the code structure of task plans called task planning visual modeling language (TP-VML). TP-VML is developed to be able to understand the data structure of Task Planning easier and contains descriptions that are one-to-one related to the data structure. TP-VML looks similar to process representation graphical languages like BPMN, YAML, and CMMN but is developed to represent the task planning structure. During the process of developing the task planning specification, those three process representation language was investigated by the openEHR foundation (openehr.org, 2018, specifications.openehr.org, 2019).

2.2 State-of-the-art

This section presents state-of-the-art articles, methods and techniques.

2.2.1 Standardized clinical pathways

In Norway today there are multiple systems for writing and saving patient journals, which does the collaboration within different health departments difficult. Hospitals and medical centers and other medical departments have their own journal systems and communication between those need to be through email. The Norwegian government decided that each patient should only have one patient journal, "Meld. St. 9 (2012-2013) Én innbygger – én journal" regjeringen.no (2019). The government's goals for that initiative are:

(1) Healthcare professionals should have simple and secure access to patients information.

(2) The inhabitants should have access to easy and secure digital services providing information about their personal medical information.

(3) The data should be available for quality improvement, health monitoring, management, and research.

St. Olavs Hospital in Trondheim has researched clinical pathways. They have developed a system for visualizing standardized clinical pathways called electronically standardized patient pathways (eSP). In 2015 a pilot test has been performed where three unique clinical pathways were used in the real setting. Feedback from this pilot was positive. The tool gave a better overview of patient pathways and helped the health professionals to understand the logistics better (onkonytt.no, 2019). Figure 2.3 shows the visualized plan in the eSP tool. The system is visualizing a timeline with icons representing tasks. The tasks are aligned depending on which department will perform the given task. From the image Figure 2.3 it is difficult to see if the system shows past tasks or if it only focuses on the feature tasks that are planned.

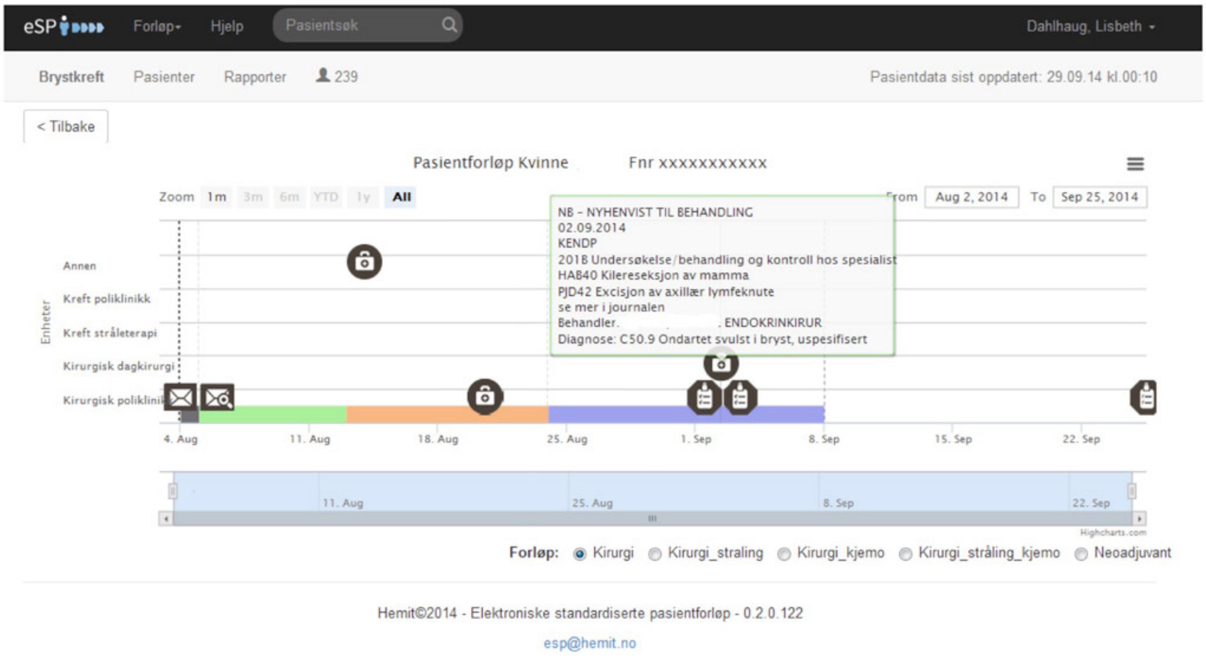


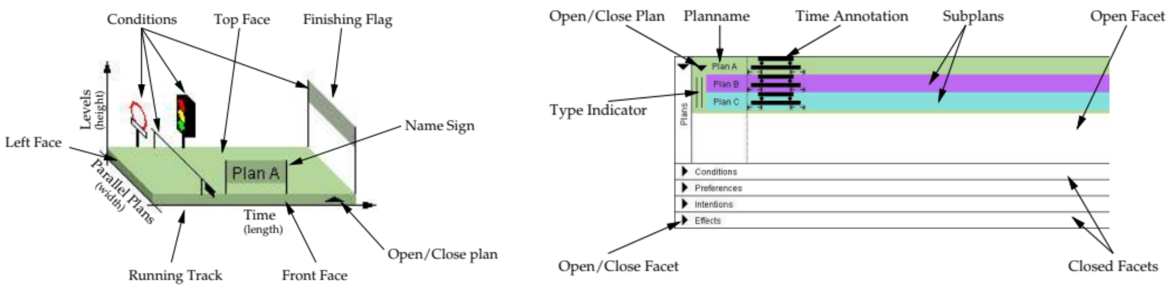
Figure 2.3: Graphical representation of standardized patient plan in the ePS system from (onkonytt.no, 2019)

Standardization of clinical pathways is shown to have positive effects. The study of Zehr et al. (1998) concluded that the introduction of standardized clinical pathways has resulted in a marked reduction of length of stay for all major thoracic surgical procedures. In addition, the total costs were reduced with continued quality of the outcome. Lion et al. (2016), in their research, have implemented multiple evidence-based, standardized clinical pathways. Which they found out, was associated with decreased resource utilization and the overall costs of the treatment without negatively affecting patient physical functioning improvement.

2.2.2 Asbru

Open Clinics describes Asbru as "a task-specific and intention-based plan representation language to embody clinical guidelines and protocols as time-oriented skeletal plans openclinical.org (2019) ”

Asbru is a way of structuring standardized medical records and treatment plans, with similar goals that openEHR have with the Task Planning specification. Kosara (1999) developed AsbruView, an interface for visualizing treatment plans expressed in Asbru. In their research, they developed an interface of visualizing treatment plans and tested its usefulness based on a usability study performed with six physicians. They chose to split the interface into two parts, a Topological View and a Temporal View. The Topological View mainly displayed the relationship between plans, without a precise time scale. Whereas in the Temporal View concentrated on the temporal dimension of plans and conditions. AsbruView utilized metaphors of running track, traffic control and glyphs to depict the complex time annotations used in Asbru and help physicians in decisionmaking. The findings from the usability test showed that physicians regardless of their experience with computers understood the system and considered the program usable. Participants liked the way in which the system handled temporal uncertainty and liked how they can do changes directly into the plan. Five of six physicians said that they could imagine using the program for their daily work.



(a) Temporal view Kosara (1999) (page 23)

(b) Topological view Kosara (1999) (page 28)

Figure 2.4: Figures describes a graphical representation of a treatment plan in AsbruView

CareVis is another proposal of visualizing treatment planning based on Asbru representation language Aigner and Mikish (2005). CareVis contains several simultaneous views to cover the different aspects of a treatment plan. Unlike AsbruView, CareVis based the time-concerning views on the concepts of clinical algorithm maps and LifeLines. The system contains three views to show different aspects of treatment planning: a quick view, a logical view, and a temporal view. Where the quick view provided an overview of the most important patient parameters and plan variables at a distinct position. The logical view represented in-depth details about the treatment plans. The temporal plan focused on the temporal aspects of the treatment plan and measured patient data. The results of evaluation via two user studies showed that physicians found the system easy to use and that the system was easy to understand. Figure 2.5 shows the graphical representation of CareVis.

2.2.3 Graphical Summary of Patient Status

In 1994, Powsner and Tufte addressed the problems of medical records in the paper ”Graphical summary of patient status.” Powsner and Tufte (2001). They stated that traditional medical records were bulky, difficult to file, hard to retrieve, and often illegible. They pointed out that medical records were not designed with patient care in mind. Moreover, physicians and nurses had to sort through ’data dumps’ to see what was happened to their patients. As a solution

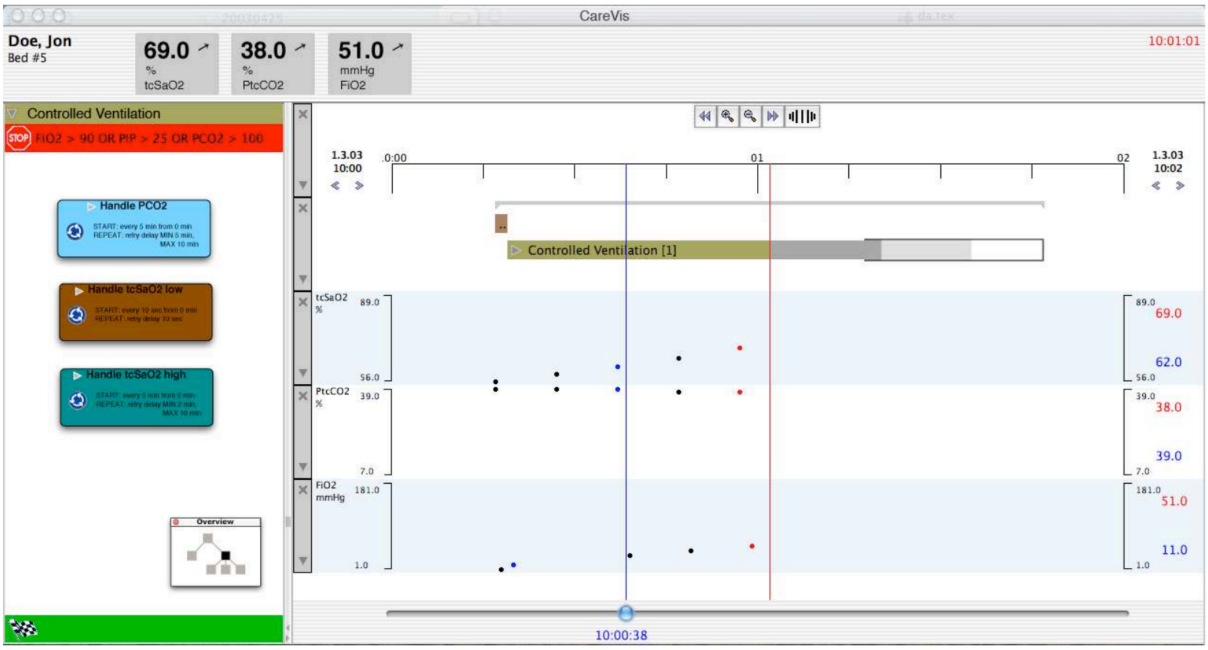


Figure 2.5: Image taken from the paper of (Aigner and Mikish, 2005) (page 209) representing a treatment plan visualized in CareVis

to this, they proposed a graphical summary of patients vital status. The result was a richly detailed, one-page summary of patient status visualized as several graphs describing a different measurement each, shown in figure 2.6.

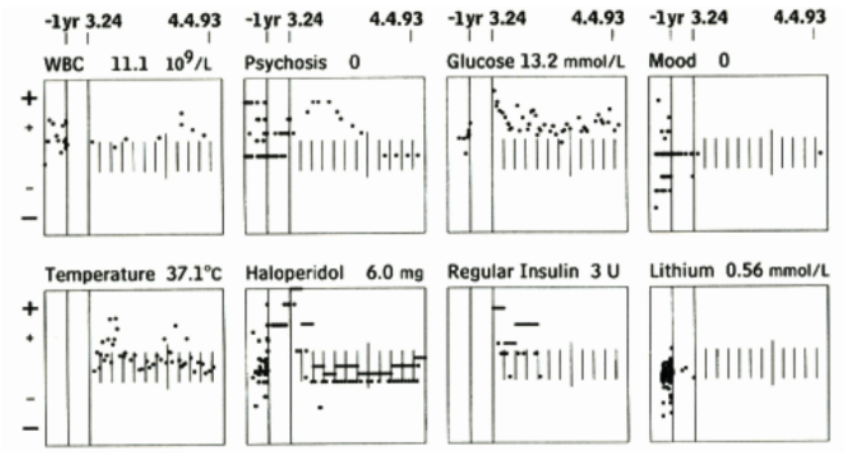


Figure 2.6: Image showing a snapshot of the resulting patient status graphs from the paper (Powsner and Tufte, 2001) (page 388)

Powsner and Tufte concluded that their proposition could invite the viewer to assess the relations between findings and treatment, and allow for consideration of alternative diagnostic and management strategies. They pointed out that their proposition revealed the data of a 5 cm thick record and had a vision that medical computer systems will soon be able to print a fresh summary for each patient every day. The latter would do their solution even more relevant they described.

2.2.4 Information Visualization

Card et al. (1999) defines Information Visualization as ”the use of computer-supported interactive visual representations of abstract data to amplify cognition”

Chittaro (2001) meant that information visualization can be used in the development of medical systems in order to reduce the complexity of understanding complicated data-structured information. He proposed several goals that could be achieved by the use of proper techniques for visual display of data during the development of medical systems. Those goals can be organized into three groups:

- Visually present medical data in more intuitive, easy to understand, easy to learn, easy to recognize, easy to navigate, easy to manage format
- Visually magnify subtle aspects of diagnostic, therapeutic, patient management, and healing process, which otherwise could be difficult to notice.
- Prevent information overload and allow members of the clinical staff to master larger quantities of information.

The most influential proposal for such designing techniques for displaying data is proposed by Shneiderman in the Visual Information Seeking Mantra for designing user interfaces (Shneiderman, 1993). The mantra is described in the following seven steps:

- **Overview:** Gain an overview of the entire collection.
- **Zoom:** Zoom in on items of interest.
- **Filter:** Filter out uninteresting items.
- **Details-on-demand:** Select item or group and get details when needed.
- **Relate:** View relationships among items.
- **History:** Keep a history of actions to support undo, replay and progressive refinement.
- **Extract:** Allow extraction of sub-collections and the query parameters

Faisal et al. (2013) researched the application of information visualization to making sense of personal health. Clinical pathways or treatment planning was one of several research trends that they identified through their literature review. AsbruView and CareVis were described as two examples of information visualization used for visualizing clinical pathways. Additionally, Roque et al. (2010) have looked into six key information visualization systems designed for gaining an overview of electronic health records. Lifelines, Lifelines2, KNAVE-II, CLEF Visual Navigator, Timeline, and AsbuView were described in the paper. All of the six systems used timelines that all were visualized horizontally expanding in the x-axis. In their conclusion, they described that none of the described systems were developed with feedback from the users and that more intimate dialog with clinicians would be beneficial for developing software that will better address the specific needs of the users.

2.2.5 Usability issues in Electronic Medical Records and Electronic Health Records

Zahabi et al. (2015) researched the interface design of electronic medical records (EMR) and related electronic health record (EHR). EMR is a legal record created in hospitals and ambulatory environments and is the source of data for the EHR. In the study, they reviewed research regarding usability issues in EMR and related EHR interface design and the use of safety engineering techniques to identify hazards associated with systems. The literature reviewed in the study focused on physician use of EMRs and their requirements for task performance. Based on the findings, they identified ten usability issues and defined a set of guidelines for promoting usability. They found that EMR and EHR usability problems could be categorized as violations of naturalness, consistency, error prevention, minimization of cognitive load, efficient interaction, feedback, effective use of language, effective information presentation, and customization principles. Table 2.1 shows the relevant usability issues and guidelines for design to prevent these issues.

Additionally, through a literature review, Clarke et al. (2004) indicated four common areas of human-computer interaction issues of EHR during clinical encounters. Poor display of information, cognitive overload, navigation issues, and workflow issues. Cognitive overload is caused when the demand to process information exceeds the capabilities of the cognitive system meaning exceeding the limit of the capacity of the working memory when processing new information. They found out that employing human-centered design by including users' input into the EHR development process, could create a user-friendly system and may assist in reducing the frustration of the physicians and errors caused by cognitive overload. They concluded that human-computer interaction issues in the design of EHR's could have negative impacts on physician-patient interaction in a clinical encounter. Moreover, the provided recommendations included applying human-centered design during the development of new EHR's, simplifying information presentation, analyzing and capturing the relevant information required by physicians, and designing systems that need as few clicks as possible.

2.2.6 Summary of the state-of-the-art

In section 2.1 the structure and usage of openEHR Task Planning specification is described. This is relevant as the project is based on this specification. The positive effects of standardizing clinical pathways are shown in (Lion et al., 2016, Zehr et al., 1998). The idea about one patient plan for each person in Norway decided by the Norwegian government indicates the importance of researching the clinical pathways. St. Olavs Hospital's eSP project, AsbruView, and CareVis are examples of visualization of clinical pathways. AsbruView concentrated on the decision-making process using metaphors of running tracks and traffic for visualizing conditions. CareVis proposed an advanced system, viewing the logistics of a plan in another view and a quick view of planned tasks. The approach of this project is to visualize an instance of a plan structured according to the task planning standard that is customized for a specific patient. The visualization should be understandable and give the physicians a quick overview of the patient's current situation in the treatment. The described systems are based on different data structures for plans and cannot be used directly to visualize a task plan according to openEHR Task Planning specification. However, some techniques and methods from the described systems can be relevant for designing a prototype in this project like the horizontal timeline or use of colors for visualizing different states.

The methods, goals, issues, and guidelines for visualization are relevant for this project during the designing process of the prototype. Despite that the proposed interface design guidelines by Zahabi et al. (2015) focused on the diagnosis process and documentation, some of the usability issues are relevant for this project.

Usability Issue	Guideline	Reference
Naturalness	1. Ensure task or work flow with EHR corresponds to manual clinical process work flow.	Schumacher, Berkowitz, Abramson, & Liebovitz (2010); Zopf-Herling (2011)
	2. Design a “natural” work flow.	Belden, Grayson, & Barnes (2009)
Consistency	1. Use basic but specific color coding and unified form layouts, apply unified design to buttons that have similar functions, and design entry areas based on emphasis and simplification principles.	Nakano & Tohyama (2009)
Efficient interaction	1. Minimize steps to complete a task by providing shortcuts; limit mouse use in accessing information.	Belden et al. (2009); Saitwal, Feng, Walji, Patel, & Zhang (2010); Zopf-Herling (2011); Clarke et al. (2013)
	6. Provide users with system navigation references	Craig & Farrell (2010)
Effective use of language	1. Use clear names of functions and labels.	Walji et al. (2013); Indranoi et al. (2009)
Effective information presentation	2. Provide easy to read displays; ensure visibility of options.	Belden et al. (2009); Walji et al. (2013)
	3. Make meaningful use of colors.	Belden et al. (2009)
	5. Use icons in EMR interface design versus text labels.	Tasa, Ozcan, Yantac, & Unluer (2008); Rodriguez, Borges, Murillo, Ortiz, & Sands (2002)

Table 2.1: Extracted from ’Summary of Usability Guidelines for EMR and EHR Interfaces Based on Literature Review’ (Zahabi et al., 2015) (page 825-827)

CHAPTER 3
METHODS

This chapter describes the methods used in the study.

3.1 General approach: Constructive Design Research

Constructive design research originates from the methodological idea of using design as a central element in research. That is referred to as *research through design*. The term originated in a working paper by Christopher Frayling (Frayling, 1993). Constructive design research is defined by Koskinen et al. (2011) as ”design research in which construction — be it product, system, space, or media — takes center place and becomes the key means in constructing knowledge”. In the book, they describe that Constructive Design Research concerns a study where something is being designed and developed in order to produce knowledge about unexplored terrain, often the designed thing is a prototype. During the design and design process, other research methods can be used. The prototype is used for knowledge generation in the lab, field or in the showroom. Interviews, videos, and observations are research methods described as commonly used for the data collection. Constructive design research focuses on a whole research program instead of individual methods for a single study.

3.2 Overview of research process

The study of this project followed constructive design research (Koskinen et al., 2011). The design process and the evaluation was combined with meetings and semi-structured interviews conducted with physicians.

To understand the research problem, several meetings have been conducted described in section 3.3. In section 3.4, methods used for finding relevant theory and state-of-the-art articles are described. To gain a picture of how the treatment of patients is handled today and understand the research problem from a medical professional’s perspective, interviews with physicians have been conducted, described in section 3.5. In order to initiate discussions and retrieve requirements for a system for visualizing the plan of treatment, a graphical prototype has been developed. In section 3.7, the implementation of the prototype is described. And in section 3.7, the evaluation of the prototype is described.

3.3 Meetings

During the initial phase of the project, several meetings have been conducted with the employees at DIPS. To get a better understanding of the Task Planning specification, there has been conducted conversations with people working with the Task Planning specification. Further, there have been conducted meetings with physicians working at DIPS to get a better understanding of what the requirements for the visualization of task planning are.

3.4 Empirical research

The empirical research was done to obtain information about the clinical pathways and relevant theories and methods in the context of information visualization in the health sector. The empirical research was done by searching through the digital libraries PubMed, Bibsys, and Google Scholar, all of which contain scientific research publications and books. It has also been searched in NTNU's research papers from former students, additionally, Google was used for finding relevant web pages. Those libraries were chosen because of the availability of reading the full text and the number of research reports they contained.

To obtain the theory about the research problem and the domain, concerning research question **RQ1**, the following search strings were used: *openEHR; openEHR Task Planning; clinical pathways; patient care; treatment planning; patient trajectories; pasientforløp; strukturerte pasientforløp;*

To obtain theory about visualization in health care concerning research question **RQ2**, the following search strings were used: *visualization of patient pathway; visualization in health care; information visualization in health; Visualization of a complicated process; process visualization; visualization of clinical pathways;*

The resulting articles have been sorted by relevance, and only articles where the abstract and introduction were relevant for this project to have been saved and read trough. Some of the stored articles have been excluded as they seemed less relevant after more in-depth reading. If articles contained relevant citations, cited articles were reviewed in the same way as described above. In addition, relevant words and phrases from the articles have been used as search strings in order to obtain a broader coverage of relevant theory.

3.5 Interview

User input was necessary to identify the current methods used by physicians to coordinate the treatment of patients and to learn how physicians are gaining the required information during a treatment. That information was gathered by conducting interviews of physicians working both at a hospital and a medical center.

3.5.1 Goal

The main goal of the conducted interview was to understand how patient treatment is done by physicians today. The goal can be divided into four more detailed knowledge questions.

1: How is the treatment of a patient performed today?

2: How do physicians get a necessary overview of the of the patient's current treatment situation?

3: How are the physicians coordinating multiple patients with different physicians?
4: Are there any challenges of the way the treatment of a patient is performed today?

3.5.2 Interview structure

A qualitative interview has been conducted following a semi-structured format. In a semi-structured interview, the questions can be prepared ahead of time, and follow-up questions can be asked during the interview to gather a greater depth of information. The chosen structure allows the interviewees a degree of freedom to explain their thoughts and to highlight areas of particular interest and expertise that they felt they had (Horton et al., 2004).

People are different, and find different things interesting and challenging. The reason for choosing a semi-structured interview was the ability to initiate a deeper discussion with follow-up questions and get information that extends the planned questions.

3.5.2.1 Interview layout

After the creation of all questions for the interview, the questions were divided into relevant themes according to the topic of the questions. The purpose of doing that was to make it easier for the interviewee to follow a given theme during their answer and for the interviewer to ask follow-up questions relevant to the given theme. Splitting the questions into themes was done after a discussion with a researcher.

3.5.2.1.1 Theme 1 - General personal background

The purpose of this theme was to get a picture of who the interviewee was. Questions were general and concentrated on the interviewee. Question about age, about the interviewee's position and the experience, was asked.

3.5.2.1.2 Theme 2 - Technical skills

The purpose of this theme was to know what level of technical skills the interviewees had. Questions were asked about the use of computer in the working situation and about interviewee's thought about using a computer at work. Then a quantitative question about the interviewee's computer skills was asked to map what is the interviewee's computer skill level.

3.5.2.1.3 Theme 3 - Typical workday and coordination of patients

This theme covered the topic about the interviewees workday, the working process and the coordination of patients. The purpose of this theme was to understand how a typical workday of a physician looks. Questions about the number of patients and the maximum amount of patients were asked. Additionally, a question about the responsibility for the treatment of a patient was asked, if it happened to be a shared responsibility or if the physician had the responsibility for each patient's treatment individually.

3.5.2.1.4 Theme 4 - Patient treatment process

This theme addressed the central topic of the interview conducted, the process of treating a patient. The purpose of this theme was to discover challenges and deficiencies in current methods of treating a patient and to help to specify the need for a system for structuring the treatment process. The theme contained several questions about how interviewees are gaining an overview of the patient's condition and it's treatment situation, how do they know which tasks are completed and which tasks remain, and what kind of information about a patient is necessary to perform the treatment. Two questions were formulated with the context of a situation that could have happened on a workday. These questions were asked to obtain a picture of how interviewees usually handle such situations and to learn more about the process of treating a patient. Additionally, questions were asked about whether there are any deficiencies or challenges in current methods of treating patients or if there is information that is difficult to obtain about the patient's condition and it's treatment, and about the importance of seeing the history of completed tasks in current treatment.

3.5.2.1.5 Theme 5 - Digital support tools

This theme helped to obtain a greater understanding of systems that are used daily. The questions in this theme are about the journal system and how the journal system is used.

3.5.2.1.6 Theme 6 - Future

In this theme contained questions about interviewees thoughts on how the process of treating a patient can be improved.

3.5.3 Execution of the interview

Audio recordings were used during the interview to help to remember everything the interviewee said and to let the discussion be less interrupted by writing notes. Before the interview started, it has been given an introduction to the project and the goal of the interview was explained. At the end of the introduction, the interviewees have read and signed a declaration of consent. Where they were informed about the possibility of stopping the interview at any time and about the purpose of the audio recording and that the audio files will be deleted right after the notes were transcribed. The Norwegian Centre for Research Data (NSD) was chosen not to be notified as the participants in the interview cannot be identified and the audio recordings were listened only by the author and deleted after the notes were transcribed.

3.6 Implementation of the prototype

To gather answers for the research questions for this project stated in chapter 1, a graphical prototype has been developed. The prototype was developed as a suggestion of a graphic representation of an instance of a plan of treatment for medical professionals in their working situation. The prototype was used to involve the users to share their opinions and set requirements for a graphical representation of such a tool. The prototype has been developed based on state-of-the-art techniques and methods, the input from DIPS and openEHR employees, and the Visual Information Seeking Mantra was used as guidelines during the designing phase.

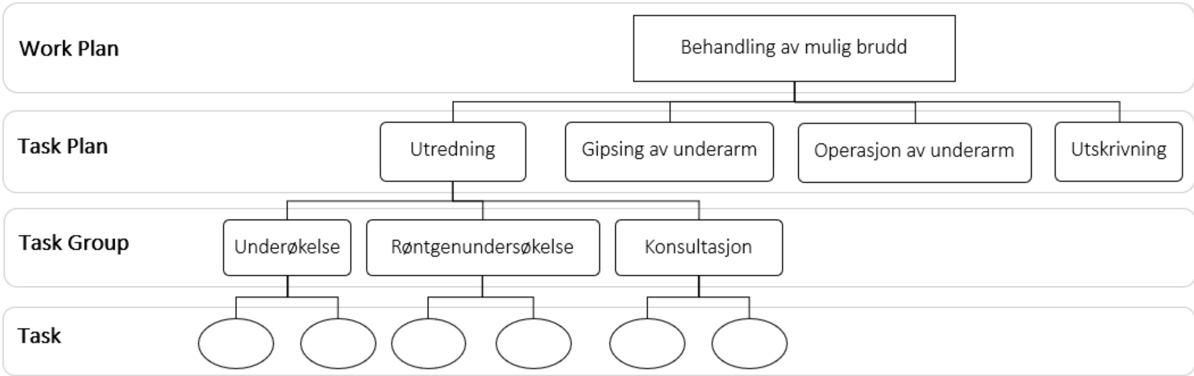


Figure 3.1: Structure of the task plan used for the development of the prototype.

3.6.1 Task plan structure

The prototype was based on a treatment of a fictive patient named Ola Nordmann that fell on ice and had pain in his right underarm. The patient case has been turned into a clinical pathway and saved as a complete plan according to the openEHR Task Planning specification. The tasks were created in a way a similar treatment would be performed in real life. The tasks were created in collaboration with a physician working at DIPS to have a realistic plan as a basis for the development of the prototype.

The final plan was composed of one work plan with the goal of treating patients underarm. The work plan contained four task plans, each with a goal of completing a specific part of the treatment. The three last task plans were inactive because the activation of those task plans was dependent on results from the first task plan. Task plans contained fine-grained tasks to be performed, often the tasks were grouped in task groups by relevance. Task groups contained grouped tasks to be performed in a given sequence. Figure 3.1 shows the idea of the structure of the plan with names used in the prototype. All task plans contained task groups and tasks, the figure shows only the content of the first task plan as showing the whole structure would result in a complex figure.

3.6.2 Functionality

The prototype was chosen to have some functionality in order to show the potential of structured task plans and to open up for further discussions about what is required from a task plan in the given context. The prototype had a level of interactivity allowing to explore the functions in the plan. The level of interactivity implemented was minimal but was implemented in order to let the user explore the prototype on their own initiating discussion about missing interactivity and to gather desired interactivity in the plan that users would desire to have.

3.6.2.1 Overview

The prototype was designed to give a full overview of the patient's current situation in a treatment. The representation of the plan shown in Figure 3.2 was a result of representing a standardized task plan according to Shneiderman's seeking mantra (Shneiderman, 1993). The first

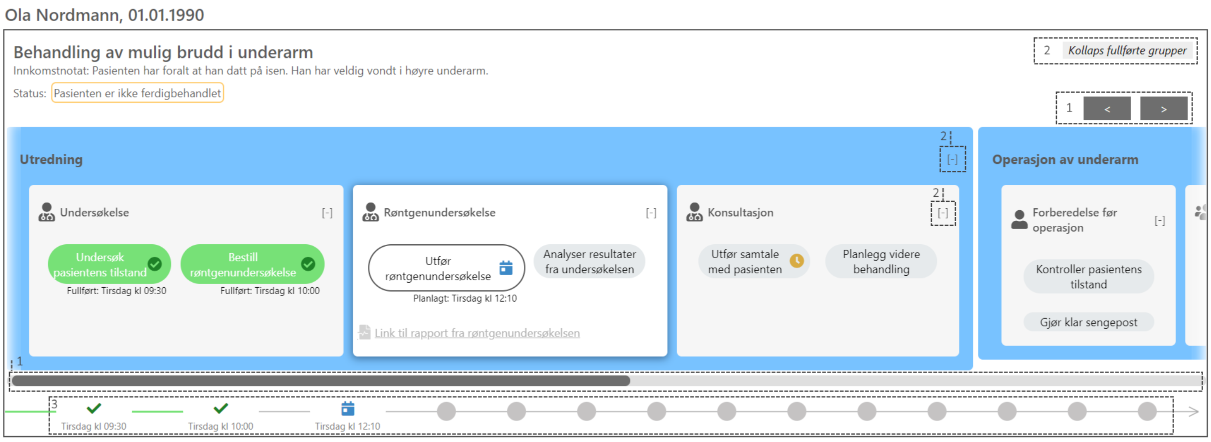


Figure 3.2: Image showing the functionality in the prototype

step, ”Gain an overview of the entire collection”, was interpreted in this study and implemented in order to give an overview of the current situation of a patient’s treatment, including past, current and planned tasks.

3.6.2.2 Timeline

The task plans were represented as a horizontal timeline. The task plans and task groups were visualized as rectangles placed according to the sequence they should be performed. According to the step from Shneiderman’s seeking mantra step ”Relate” (Shneiderman, 1993), showing the user how tasks and plans are related. Horizontally placed tasks meant that the tasks should be performed sequentially, vertically tasks represented the parallel sequence. In the plan of treatment used in this project, all plans and most of the tasks were planned to be performed in sequential order. The timeline can be seen in Figure 3.2, the two tasks to the right show how parallel tasks were represented. The reason for choosing a horizontal view was because the plans and tasks are time-specific and most people think of time as a horizontal timeline. Using horizontal representation of time-concerning events have in addition been used in projects ePS, AsbruView and CareVis with positive feedback from users (Aigner and Mikish, 2005, Kosara, 1999, onkonytt.no, 2019).

3.6.2.3 Navigation

Users were able to navigate through the plan in two ways: by using the scrolling bar below the plans and by using the buttons above the plans. The navigation functionality is marked with ’1’ in Figure 3.2. The navigation was implemented to enable users to explore the whole plan.

3.6.2.4 Collapsing

The functionality of collapsing groups and plans was implemented in the prototype. There were implemented collapsing buttons in the corner of every task plan and task group and a button for collapsing all completed task groups showed in Figure 3.2 marked with ’2’. The functionality of collapsing and expanding task groups and task plans was implemented according to the seeking mantras stage ’Filter’ (Shneiderman, 1993) giving the users a possibility to filter out uninteresting plans and groups. The idea was to enable the possibility to save space if task plans or task groups were uninteresting for the current situation, which might include completed groups or inactive plans. Figure 3.3 shows how collapsed plans and groups were visualized. The functionality of collapsing groups and plans was used automatically in the prototype. The inactive task plans were automatically collapsed in the prototype showing only the name of the task plans. The reason for this was that inactive task plans in the used patient treatment case needed results from the first task plan in order to be activated, and only two of the three possible paths were relevant for the current treatment as two of the inactive task plans were logical contradictions. The idea was to give the physicians a greater focus on the current situation without visualizing details of task plans that might not be relevant.

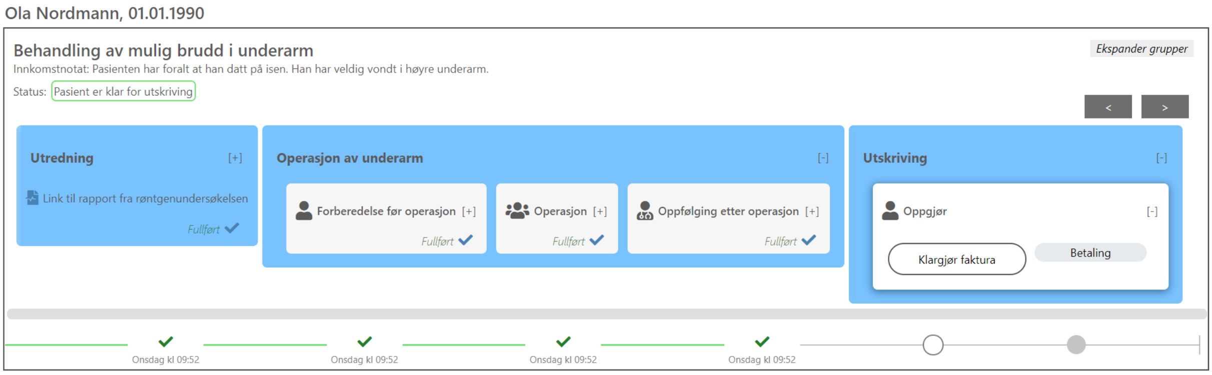


Figure 3.3: The whole plan with the first task plan and all task groups in the second task plan collapsed.

3.6.2.5 Progress view

The prototype had implemented a progress line showing the state of the tasks and the time the state has been changed. The functionality is shown in Figure 3.2 marked with '3'. Users might hover over the state symbol to see the name of the task, shown in Figure 3.4. When the icons describing tasks in the plan were clicked on, the plan was automatically scrolled aligning the clicked task in the center of the screen. The idea of the progress view was to show the user how many tasks there are left to be performed in the treatment and to give a possibility to find relevant tasks in the plan without the need for scrolling.

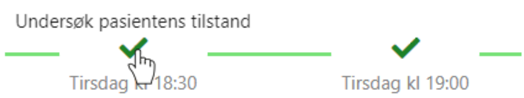


Figure 3.4: The hover functionality in the progress line

3.6.2.6 Lifecycle states

In the prototype, there have been chosen to visualize different states of tasks and plans. This was done by using colors and icons that are familiar to users from other fields. The inactive tasks, task groups, and task plans were visualized using gray color. White was chosen to visualize active task groups and tasks. Additionally, the active plans were chosen to have a blue color, chosen as a neutral color, to create contrast from work plan and task groups. An active plan means that it contains tasks that are remaining to be performed. Tasks had an underway state, visualized white. A completed task was green and had the date for completion printed underneath. Planned tasks had a blue icon representing a calendar and the planned date printed underneath. Icons and text were used to describe the state in addition to the color in regards to color-blind users.

3.6.3 Development

The prototype that has been developed is a partly interactive graphical representation of an instance of a plan for a specific patient. The plan was saved as a JSON file according to the Task Planning specification. The prototype has been developed as a web application using Angular 7 with TypeScript and has been developed in Visual Studio Code.

3.7 Evaluation of the prototype

This section describes the introduction of the prototype to the users. The developed prototype was used to collect qualitative data from users by initiating a discussion about the prototype. Users feedback was used, along with the theory gathered from the interviews, to answer the research questions **RQ1** and **RQ2** presented in chapter 1. The requirements for participants was that they worked daily with patients as a physician at a hospital or medical center.

3.7.1 Structure

In order to retrieve feedback and requirements from users, the evaluation was composed of four stages: 1. An introduction. 2. A set of general questions about the participant. 3. The interaction session that contained three scenarios where users interacted with the prototype. 4. A discussion.

3.7.1.1 Introduction

During the introduction, the project and the goal of the evaluation were presented to the participants. The structure of what is going to happen has been explained and the users were informed that the patient case used in the prototype was fabricated. Additionally, the users and they were encouraged to discuss, ask questions, and think out loud during the interaction with the prototype.

3.7.1.2 General questions

The general questions were asked after the introduction. Questions were asked about the user's age, position, computer skills, the number of patients the user worked with on an average day, and how the required overview of the patient's treatment situation was gathered.

3.7.1.3 Interaction

The interaction with the prototype was divided into three sections. Each section showed a situation from a task plan for the same patient at different periods of time. For each situation, there was a scenario describing the current situation and one open question about the prototype. Additionally, there have been follow-up questions to open the discussion and get broader feedback from the user. The reason for only asking one main question was to get an opportunity to observe what kind of information about the given patient's treatment situation the user found relevant.

3.7.1.3.1 Scenario 1

In the first scenario, users were shown the prototype in a situation where the first two tasks were completed. The situation is shown in Figure 3.5. Before showing the prototype to the user, a scenario was described. The scenario was: 'Given that you get the responsibility of a new patient and open the patient's plan of treatment, this is what you see.'. That led to an open question: 'What does the prototype represent, and what can you read out of the prototype?'.

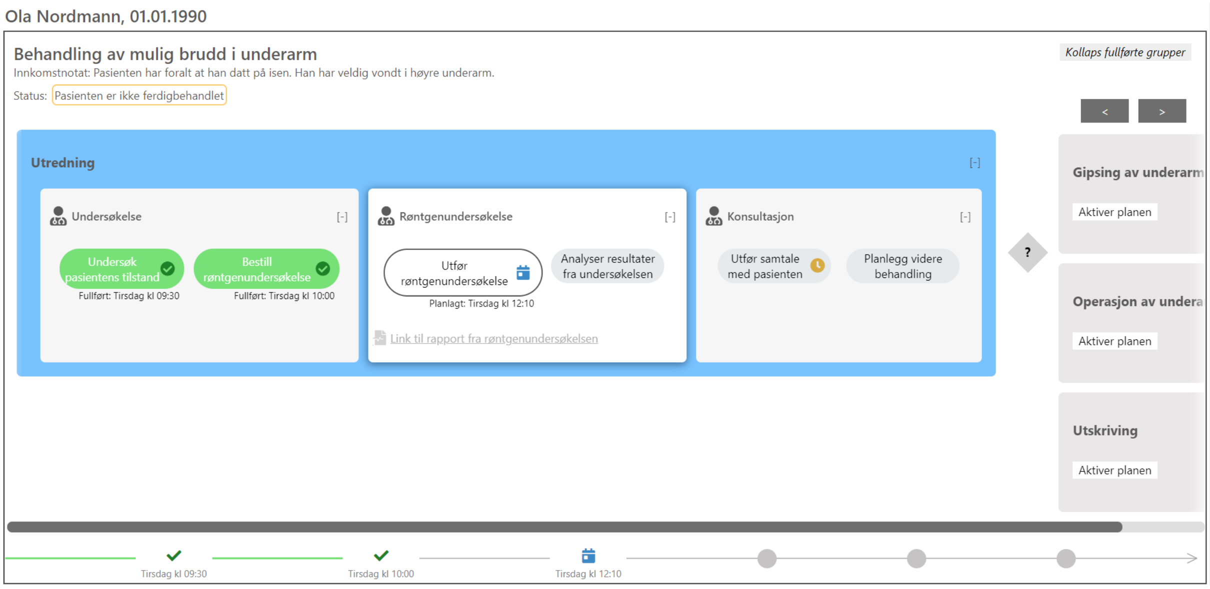


Figure 3.5: The situation that was shown to the participants during the first scenario.

3.7.1.3.2 Scenario 2

In the second scenario, users were shown the prototype in a situation where the first five tasks in the first task plan were completed, leaving the last task active. The last task was about a decision that had to be made for further treatment and was chosen to let the user discuss further decision in the treatment. The situation is shown in the Figure 3.6. The scenario was: 'You open pathway plan for the same patient at a later time and see this.'. That led to an open question: 'What can you read out of the plan at this point?'.

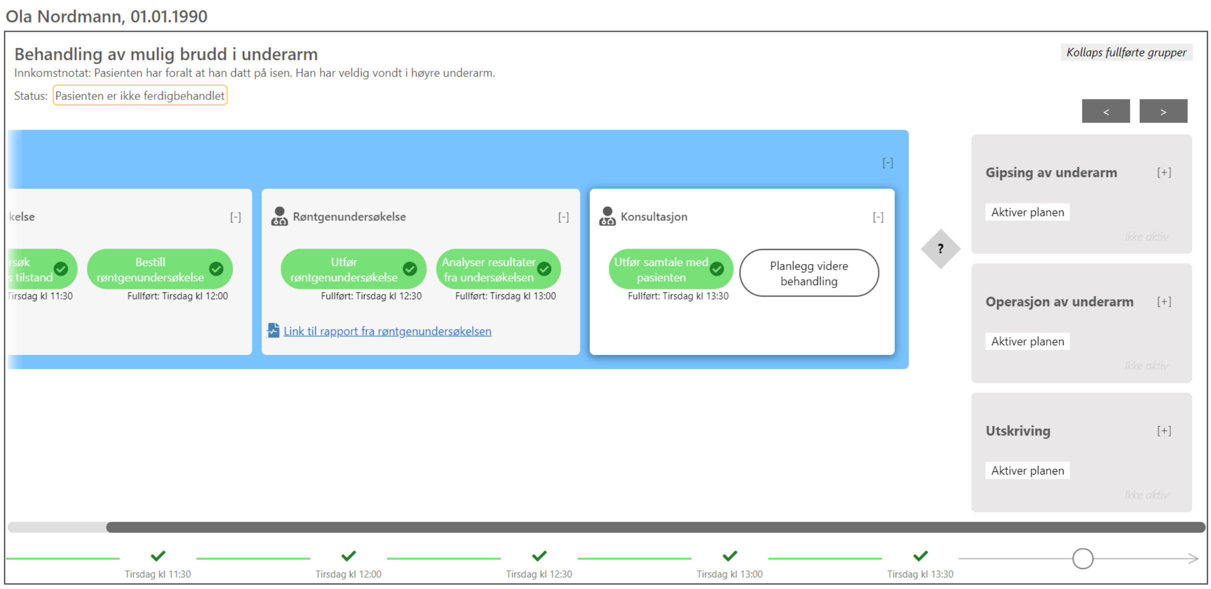


Figure 3.6: The situation that was shown to the participants during the second scenario.

3.7.1.3.3 Scenario 3

In the last scenario, users were shown the prototype in a situation where all the tasks in the first task group and the first task in the group 'Operasjon av underarm' was completed shown in Figure 3.7. This situation was chosen to extend the length of the plan and be able to examine if the scrolling and navigation functionality will be used. The purpose was to initiate a discussion about the length of the plans. The scenario was similar to the second scenario and led to this open question: 'Can you tell something about the progress in the treatment?'.

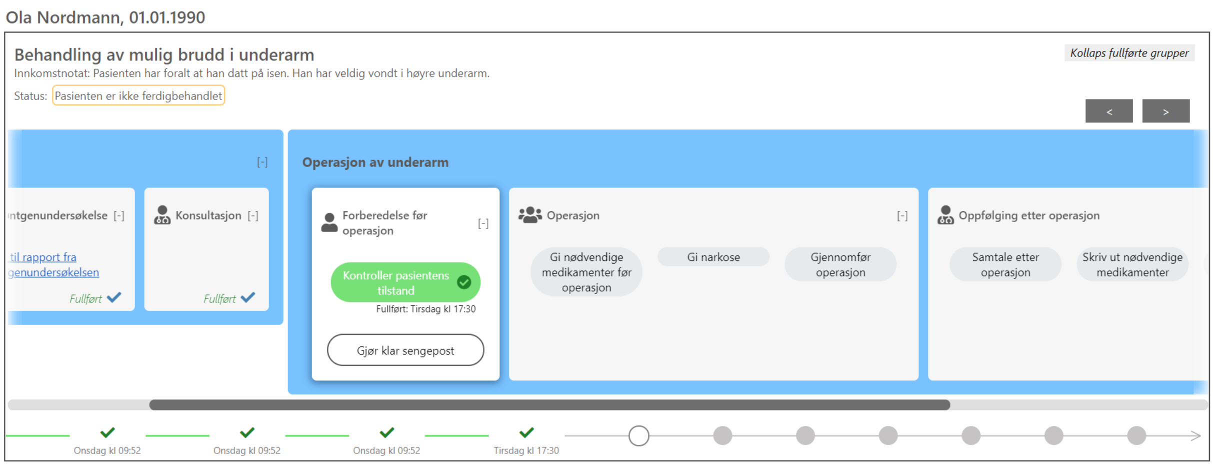


Figure 3.7: The situation that was shown to the participants during the third scenario.

3.7.1.4 Discussion

After the interaction session, a discussion with the user has been conducted. The discussion followed a semi-structured interview format. The discussion was split into two parts. The first part concentrated on the functionality of the prototype. Questions were asked about how it was to gain an overview of the patient's condition and it's treatment progress, if anything was incomprehensible or unclear, and what kind of information was missing that was desired to be presented in the plan, and if the user would like to use such a tool in the future.

The second part contained general questions about the prototype, users thoughts, input, and feedback. Questions were asked about the user's thoughts of the prototype in general and about the visualization, and if the user had any suggestions for improvement. In addition, questions were asked about the user's impression after using the prototype, if the user had some additional input or feedback to the prototype

3.7.1.5 Execution

The visualization in the prototype was based on a plan of treatment for a specific patient, structured according to the openEHR task planning specification. The data in the plan structure was modified during each scenario to simulate real-life progress in the treatment. The visualization of information corresponded to the up-to-date data in the plan structure focusing on giving information regarding the current situation in the treatment. The timeline view of task plans was automatically scrolled to show the current task that was underway in a visible position on the screen. Inactive task plans were automatically collapsed in the first two scenarios. In the third scenario, the task groups of the completed task plan were collapsed showing only the names of the task groups within the task plan.

During the interaction with the prototype, three scenarios were given to the users. The desired topics that users should discuss during the scenarios were the reason why the patient is treated, past and future tasks, the next task to be done, and the functionality of the prototype. If the topics were not mentioned, follow-up questions were asked to get a more in-depth discussion about the prototype in the given situation. Additionally, follow-up questions were asked if the user mentioned something relevant for the project.

Video recording was used during the interaction with the prototype. The camera recorded only what happened on the screen in order to capture how users interacted with the prototype. At the end of the introduction, the participants have read and signed a declaration of consent. Where they were informed about the possibility of stopping the test at any time and about the purpose of the video recording and that the video will be deleted right after the notes were transcribed. The Norwegian Centre for Research Data (NSD) was chosen not to be notified as there only was recorded the screen while the user interacted with the prototype. Participants in the evaluation cannot be identified and the recordings were reviewed only by the author and deleted after the notes were transcribed.

CHAPTER 4
RESULTS

In this chapter, the results from the conducted interview and the evaluation of the prototype are presented.

4.1 Interview

In this section, results from interviews are presented. The interview was conducted in order to understand how patient treatment is done by physicians today. Three interviews have been conducted in total. Two of the interviews were conducted in person and one over the internet. All of the interviewees were men. Results are presented in six themes according to the structure of the interview conducted.

4.1.1 Theme 1 - General personal background

Age and profession varied among interviewees; a regular general practitioner, a consultant, and a foundation doctor was interviewed. Two were working at a hospital, and one was working at a medical center. All interviewees worked in different organizations. The age of the participants was 27, 35, and 61 years.

4.1.2 Theme 2 - Technical skills

All of the interviewees used a computer in their workday, and they all liked working on a computer in their working situation. A computer is the main resource we have as physicians were stated by one of the interviewees. In total the computer skill level was intermediate and above.

4.1.3 Theme 3 - Typical workday and coordination of patients

The average number of patients the physicians worked with typically was 18. The answers varied due to the profession of the participants and the different workspaces of participants working at a hospital. In the hospital, the number of patients ranged from 8, in an outpatient clinic, up to 25 when working on a bedpost. In the medical center, there were usually between

15 to 20 patients every day. The interviewee that was working at the medical center had all the responsibility to follow-up and complete a patient's treatment. Whereas at the hospital, the interviewees said that in many cases the responsibilities for one patient's treatment and planning thereof were distributed across several physicians. In the medical center, most of the patients were known to the physician while at the hospital new patient's arrived constantly.

4.1.4 Theme 4 - Patient treatment process

To gain an overview of patients treatment was described as a similar process by all interviewees. When the situation was that a new patient arrived, the approach was as follows. The physicians would start by looking in the journal system and read through the patient's journal and the history of the patient's earlier treatments. The physician would talk with the patient as physicians often obtain useful information about the situation from the patient. Additionally, physicians would look at earlier results from laboratory or x-ray if that was found relevant. For all interviewees, the patient's journal was the primary source of information about the patient's treatment. They all admitted that one challenge about the patient journal was that the notes in the journal varied based on who was writing them. Some physicians wrote long notes while others wrote too short notes, which made the journal inconsistent. Another challenge of the way patient treatment is done today was the communication between the medical center and the hospital.

The physician that was working at the medical center pointed out that more information about what happens with the patients that were sent to a specialist at a hospital was desired. The user desired to have a quick overview of planned appointments and a summary of what happens with the patients at all times. The functionality should be used only on demand without too many disturbing notifications that are irrelevant. All three interviewees agreed that to find the information about the patient needed for planning the treatment happens to be a time-consuming process. The two physicians working at a hospital described that when working at bedpost, physicians need to be familiar with all patients and their treatment situation in the morning before going to the patients. This procedure could take over one hour, they described. The procedure was time-consuming because the physicians had to read through all notes and results in the patient journal regarding the current and past treatments for each patient. Two of the interviewees pointed out that the required documentation in the health sector takes longer and longer time, leading to less time with a patient which both was against. They both pointed out that human interaction with the patient is an essential stage of the treatment, and was skeptical of several new time-consuming systems for documentation. All interviewees said that the records about what has been done in current treatment were relevant for knowing what to be done next, but the previous treatments and previous test results often provided important information for planning and deciding what kind of treatment the patient needs.

4.1.5 Theme 5 - Digital support tools

All of the interviewees used different internal medical record systems. The patient journal was included in all the systems. The patient journal was the primary source of information for treatment planning and conducting treatment of a patient. A patient journal was described as a chronological list of records that in total gives a detailed description of what has been done with a patient during the treatment. It included records from all medical sectors that have been in contact with a given patient. Nurses, specialists, physicians, and other health professionals wrote their notes into the same journal. Typical usage of the medical record system for a physician included a need for filtering out the irrelevant notes. Often the relevant records for physicians were written by other physicians. The journal is used to: gather an overview of the history of patient's earlier treatments, to obtain needed information about current treatment and understand what is to be done next, and to report what has been done in the treatment of a patient. By law, everything that was performed with a patient had to be documented in the patient's journal.

4.1.6 Theme 6 - Future

One of the interviewees wanted a better filtering mechanism for the patient journal to be able to faster filter out the irrelevant information. Another interviewee talked about a solution where other physicians should be taught how to write precise and short notes. Such a solution should make the final journal of a patient shorter and more straightforward to read, the user explained. The one physician working as a general practitioner described a system showing scheduled appointments of the patients referred to hospital. The interviewee mentioned that more information about what is happening with the patients during treatment at a hospital would be useful as the poor communication between hospitals and medical centers could occasionally lead to difficulties.

4.2 Evaluation of the prototype

This section presents the results of the conducted evaluations. In total, it has been conducted four individual evaluations. One woman and two men participated in individual conversations that lasted between 45-60 minutes. Because of the distance of one of the participants, one evaluation has been conducted through video conversation over the internet where the participant was able to control the prototype remotely. The remaining evaluations were conducted in person.

4.2.1 Initial questions

The age and profession varied among the participants. The average age of the participants was 40 years. The professions of the participants were: regular general practitioner, consultant, and foundation doctor. All of the participants were using a journal system for obtaining an overview of a patient's condition and a patient's treatment.

4.2.2 Findings from the interaction session

All of the participants understood what the prototype showed quickly. All of them started by looking at the top left and were describing the patient's situation and status of the patient's treatment. Further, all participants started to look at the tasks and described which tasks have been completed and which task was the next to perform. All of the participants found the next task to do with the patient. The definition of a task varied among two of the participants. One user referred to the next task that needs to be done from a perspective of the user's profession. Another user referred to a task group as a task. Two of the participants pointed out some errors in the plan regarding the chosen language in some tasks and the order of how some tasks would be performed in a real situation. Three of the participants started to click on tasks and desired to have more information about the tasks including what has been done in the completed tasks and what should be done in the planned tasks. Two of them wanted additionally to activate further plans.

During the second scenario, all participants discussed that they need to know what the results of the x-ray were and clicked on the button with the link to see results from x-ray. That function was not implemented in the prototype. They pointed out that a decision for future treatment needed to be done in this scenario, and that the next plan should be activated based on the results from the x-ray. All participants reported that they would like to have the possibility to access such results directly from the plan. One of the users stated that the result could be one short sentence inside of the plan, with a possibility to open more information and see the x-ray image.

None of the users did use collapsing functionality. In the third scenario, three of the four participants mentioned concerns about the length of the visualized plan. The amount of scrolling needed in case of more complicated plans was mentioned. After showing them how they can collapse task plans and task groups, they all were positive to the functionality. The problem of long plans would be reduced by the ability to collapse plans was said by one of them. The participant working as the general practitioner liked the way plans could be collapsed and mentioned that the compression of collapsed plans could be visualized smaller than proposed in the prototype, taking less screen space. The user described that the essential information to know about the past tasks was that they have been completed, with the possibility to see more details on demand, and being able to see the results from different tests that were performed in the collapsed task plan. Remaining participants liked the way the active task was visualized showing both the past and future tasks. They described that seeing what has currently been done in a plan was as important as to see future planned tasks. This was especially important for new physicians taking over the treatment of a patient, giving the possibility to gather required information in order to know what is the next thing to do.

All of the participants understood the symbols and use of colors of planned, completed and awaiting tasks. The use of colors and icons was described as clear, understandable and intuitive. The timeline at the bottom was mentioned by three of the participants. None of the participants clicked on the icons, only the hovering functionality was used. While one said that it is a good tool for gaining an overview of the whole plan without the need for scrolling, another said that it was not needed to be presented.

4.2.3 Findings from the discussion

In total, the feedback was positive after the interaction session. All participants reported that the graphical representation of the plan was good and that it made it easy to get an overview of the patient's current treatment situation. The visualization was reported to be understandable and intuitive. Two of them said that it was a logical visualized plan and liked that a horizontal timeline was used to visualize the plan, it made the plan intuitive and clear. Three of the participants were concerned about the details of the planned tasks, they pointed out the importance of finding a balance in the creation of the plans so the plans will not become too detailed and still gives sufficient value for physicians. There has been pointed out that the plan used in the prototype was straight forward, and that there are more complicated plans in real life that can be challenging to standardize and visualize in such a way.

It was reported by all of the participants that more information about the patient would be useful to have in the plan, such as the patient's medicines, allergies, if the patient needed a sick leave, the patient's civil status, a contact person and other essential information. The information was described as important for simplifying further treatment decisions. Comments were suggested as additional information in the plan. There have been described two different forms of comments. Comments connected to each task, and one general comment for the whole treatment. The comments would be used for communication with other physicians in the treatment plan. Another desired functionality that was described by one of the participants was a way of showing essential findings in the plan that would be important for further treatment. It was described as an option for a task, that when enabled the findings from that task would be displayed on top of the plan.

Communication with other systems was a topic raised by three of the participants. If the final solution will communicate with other systems, then the value of it will increase, was stated by one of them. Another pointed out that the communication of current systems is really bad, so communication with other systems was a requirement for new systems for health professionals. It has been mentioned by three of the participants that the documentation takes too long time already, so a new system should shorten the time used on a computer instead of extending it. Two of the participants described that most of the tasks should be completed automatically by the system. For the tasks that needed to be completed manually, by the physician, there was requested a quick way of completing tasks using as few clicks as possible and a possibility of undoing accidental activities. One of them would prefer using a keyboard to complete tasks instead of the mouse. That user mentioned that the usage of a mouse to navigate and complete tasks can be messy and proposed to use the keyboard. Three out of four participants said that they would use such visualization in their work. Whereas, the participant working as a general practitioner desired a list of all patients with planned activities on a timeline that would give more useful information than detailed information about one of the patients like the prototype showed. The user described that such a list would give more valuable information and that displaying a detailed plan of one patient, like the prototype, could be done from that list.

One participant was positive to the standardized plans and stated that the implementation of standardized treatment plans in health will increase patient safety by giving all patients the same treatment and lowering the possibility of forgetting tasks in treatment. Another user said that a solution like the prototype could help to shorten down the process of writing an epicrisis after the treatment is completed. Epicrisis was described as a summary of what has been done in the treatment. The user described that today, to write epicrisis, physicians need to read through all notes concerning current treatment in the patient journal and summarize them. In contrast to reading many pages of patient's journal, the user stated, a solution like this prototype could shorten down the time it takes to write an epicrisis and give a simple overview of the complete treatment that can help to detect eventually tasks that have been overlooked. This was described in contrast to the possibility of seeing the whole plan and being able to scroll back in a treatment.

CHAPTER 5

DISCUSSION AND CONCLUSION

In this chapter, the results presented in the previous chapter are discussed. First, in section 5.1 the research questions presented in chapter 1 are answered. Then, the limitations of the study are discussed in section 5.2. Further work is outlined in section 5.3, and in the section 5.4, the project is concluded.

5.1 Answering the Research Questions

In the project, the knowledge was gathered in two phases. In the first phase, the knowledge was gathered through meetings with employees at DIPS as well as people working from openEHR foundation, empirical research, and interviews with three physicians. The knowledge in the second phase was gathered through a developed prototype that was presented to four physicians in order to retrieve their feedback and the requirements they had for a system for visualization of standardized plans of treatment.

The results from the interviews and the feedback from evaluations presented in chapter 4 provided knowledge that will now be used to answer the research questions stated in chapter 1. The results from the evaluations cannot be used as proof. However, the results can indicate requirements for future research and development based on opinions from working physicians.

5.1.1 Required information to present in a visualization of a plan of treatment RQ1

RQ1: What kind of information about a standardized plan of patient's treatment is important to present to the physicians?

The results from the evaluation indicate that the chosen level of information about the plan of treatment that was presented in the prototype was informative and gave a helpful overview of the patient's current situation in the treatment. However, through the feedback, the participants shared ideas about more information that they would like to have presented in the plan. Participants requested to have more information about the patient presented in the prototype. Accessing different test results directly from the plan was desired by the participants. Three of the four participants desired to see more detailed information about each task. Additionally, the possibility to share relevant findings and comments directly in the plan was requested to be presented in the plan.

5.1.1.1 Patient information

In the prototype, the task plan structure was expanded with additional information describing the treatment cause and patient status presented in the top left corner of the plan together with patient name, treatment name and the reason for treatment. All physicians interacting with the prototype started by reading that information before looking at the task plans below. The information added, seemed to be relevant and important as all participants understood what the visualization represented and no questions were asked about the reason why the patient was treated during the interaction session. Additionally, the participants desired more information about the patient treated including medicines, allergies, if the patient needed a sick leave, the patient's civil status, a contact person and other essential information. The reason for including such information, described by the participants, was to help to make decisions during the treatment. Knowing what medicines and allergies the patient has can, for example, be useful when prescribing new medications. By applying such information about the patient, the plan could be more valuable and informative and could decrease the need for finding patient information in separate systems. However, further research should be done on what information about the patient is important to present and how often the information would be accessed directly from the plan as presenting patient information that will not be used often will make the plan more complex taking up the space on the screen and might lead to cognitive overload.

5.1.1.2 Test results

The possibility to access results from different tests relevant in a given treatment directly from the plan was desired by all of the participants. One of the participants described an idea where one short sentence summarizing the results should be presented inside the plan with a link to show more detailed results. This solution can spare the physician time of opening the detailed test result, given that the sentence of summary contains enough relevant information.

The communication of the future solution with other systems was described as a requirement by the participants during the prototype evaluation. The information flow in current systems used today was described as bad by one of the participants. Another participant said that the value of the future solution will increase if it communicates with other systems that are currently used. Additionally, the issue of poor communication between hospitals and medical centers was addressed in the interview by the physician working as a general practitioner. The poor communication that was described between both the intern systems in one organization and between the medical centers and hospitals in the current solutions seemed like a big issue for the physicians indicating a requirement for future systems to support better information flow across different systems. The standards from openEHR provide broad information structures and Task Planning is only an extension of those structures that gives the additional possibility to save time-specific tasks. DIPS is currently using several structures in their product supporting different sectors in the health organizations. Information about the patient is already used in their system, therefore to fulfill the requirements of participants, existing information about the patient and the results of tests could be considered to be presented in the plan. However, despite the amount of clinical information that already is implemented in DIPS further research should be performed defining what information should be presented in the plan and what information should be found in other places in the system. The visualization tool should focus on giving the best overview and not being a complex all-in-one tool that is a portal to all of the clinical information available in DIPS. Therefore a balance between information that is required versus information that is nice to have should be found.

5.1.1.3 Further functionality

The feedback from the interaction session indicated that more detailed information about tasks should be provided. Three of the participants wanted to see a detailed description of past and future tasks. This requirement corresponds to the *detail-on-demand* stage from the information visualization seeking mantra (Shneiderman, 1993) as the participants wanted more detailed information about each task by clicking on the task. This kind of information could be stored in the data structure of task planning indicating a requirement for expanding the data structure. Additional information that was desired to be presented in the plan by the participants, was information gathered during the treatment. A desire for comments was described. The information shown in the comment will be written by the physicians during a treatment and presented in the plan in order to communicate essential findings with other physicians in the treatment.

5.1.2 Visualization of a plan of treatment RQ2

RQ2: How can a standardized plan of patient's treatment be visualized for physicians in their working situation?

Despite there was no, or minimal, instructions given to the physicians before they were presented with the visualization. It seemed that the visualization was easily understood and gave physicians a good overview of the patient's treating situation. All participants were positive about the way the plan was visualized in the prototype. Words like 'Intuitive', 'Clear' and 'Understandable' was used to describe the visualization. The choice of visualizing plans as a horizontal timeline was described as a good decision, making the plan clear and logically structured. The positive feedback from the evaluation of the prototype indicates that the proposed visualization of the task planning in the prototype can be used to visualize an up-to-date instance of a plan for physicians. However, the feedback indicated that the proposed prototype should be more interactive including a possibility of completing tasks and a possibility of writing comments directly in the plan. Furthermore, the results from the interaction session indicated that the functionality of collapsing task groups and task plans in the plan should be improved.

5.1.2.1 Horizontal timeline and progress view

Visualizing task plans in a horizontal timeline inside the work plan resulted in positive feedback from the participants. This matches the state-of-the-art propositions of visualizing time-specific clinical pathway tasks from Asbru, CareVis and eSP (Aigner and Mikish, 2005, onkonytt.no, 2019, openclinical.org, 2019). Indicating that the future solution could visualize the time-specific tasks in a similar way.

From the results, it is difficult to prove or disprove the importance of visualizing the progress view in the plan. One participant stated that the progress view was a good tool for gaining an overview of the whole plan without the need for scrolling, another said that it is not needed to be visualized. The remaining participants did not mention the progress line. The positive feedback about the whole visualization might suggest that although the two participants did not mention the progress view explicitly they might like the way it was presented in the plan and express it as a part of the general feedback about the whole visualization. However, they did not seem to use the functionality actively. Additionally, the functionality of clicking on the tasks in the progress view was not used by any of the participants during the evaluation. The progress view should be considered implementing in further development and researching with more complicated plans as the functionality might help to navigate in the plan without the need for scrolling and in addition give an abstracted overview of all the tasks and the task states in a treatment.

5.1.2.2 Interactivity

Findings from the evaluation indicate that the future solution should be interactive. Besides the minimal interaction that was added to the prototype, participants wanted more interaction with the visualized plan. Three of the participants clicked on the tasks with a desire to retrieve more information about the clicked tasks. Another form of interaction with the plan requested was the possibility to complete tasks. Two of the participants pointed out that the completion of tasks should need as few steps as possible and that most of the tasks should be completed by the system if possible. Additionally, support for undoing the activity if done by accident was described. The completion of tasks by the system is included in the idea of task planning specification described by the openEHR that performer performing and completing tasks should be a human, a system or a machine. (openehr.org, 2018). The simple completion of the tasks corresponds to the guideline of minimizing the steps to complete a task by including shortcuts; limit mouse use in accessing information presented by Zahabi et al. (2015) proposed to improve the issue of effective interaction.

The possibility to write comments was desired by the participants. Two ideas were described for the implementation of the comments. One idea that was described was to implement one general comment for the whole treatment where physicians could communicate and write essential findings that would be relevant for further treatment. Another idea was to implement comments for each task. The general comment idea might result in repetitions when, for example, the essential information in a specific task needs to be described as the task and the general comment will be separated on in the visualization. The idea of comments for each task could provide more consistent comments than the idea of one general comment as the comments would be connected directly to the tasks. However, implementing the comments for each task visualized in a logical place according to the tasks may cause the information to disappear from the viewing space as the treatment progress and tasks get completed. Which comment idea to apply should be researched in order to find how physicians would use the comments and which idea is most suitable for their requirements. Another solution would be to implement both ideas where the general comment would be used to communicate with other physicians and a possibility to write one comment directly connected to each task.

5.1.2.3 Collapsing functionality

Despite the functionality of collapsing task plans and task groups was not discovered by the participants at first, after showing the function to the participants, the functionality seemed to be useful and important giving the possibility of filter out uninteresting groups and plans. There might be two reasons the users did not use the functionality, either the functionality was not needed by the users because of the simplicity of the visualized plan or that the chosen visualization of the buttons was not clear. The feedback after showing the users the functionality might indicate that the graphical representation of the buttons was not clear enough and should be improved in further development.

Results from the evaluation indicate that seeing the details of the completed tasks is more relevant and important for the physicians working at the hospital than for the physicians working at the medical center. The way the plan was visualized in the prototype showing the completed tasks and the planned tasks at once was described as useful by the physicians working at the hospital. The information about past tasks was described to be as important as the information about future tasks. On the other hand, the physician working at the medical center described the most essential information about past tasks was to know that they were completed with the possibility to open details on demand and view the results of the performed tests in the collapsed plan. That feedback might strengthen the importance of the collapsing functionality. The contradictory answers concerning the information about the past tasks can be explained based on the results from the interview that showed that the patients at the medical center were often known to the physician and that the physician often had the total responsibility of treating a patient. In contrast to the situation in the hospital, where the physicians worked with constantly new patients and where the responsibility for treating a patient was often shared among several physicians. What might indicate a higher need for supporting coordination at the hospital than at the medical center where the physicians alone plan and treat their patients.

5.1.2.4 Design

According to Shneiderman, to give an overview of the entire collection was the first and most important step followed by zoom, filter, details-on-demand, relate, history and extract (Shneiderman, 1993). During the design and development process of the prototype *overview*, *filter* and *relate* were used as guidelines and implemented. The visualization showed an *overview* of the entire current situation in the patient's treatment. The collapsing functionality was implemented to give the user the ability to *filter* out uninteresting task groups and task plans. The task plans were presented in a horizontal timeline showing how the task plans were *related*. More information was desired by the participants to be presented in the plan concerning two more steps *details-on-demand* and *history* of the information visualization seeking mantra. Participants desired to see more information for each task concerning *details-on-demand*. Additionally, the participants desired to have support for undoing the action if made by mistake. The results indicate that the seeking mantra should be used as a guideline when designing the future solution as it showed to be a relevant through the evaluation of the prototype in this study.

The results correspond to the guidelines presented by (Zahabi et al., 2015). Indicating that some issues observed in their paper also apply for visualization of patient's treatment to the physicians that were studied in this project. Based on the positive feedback from the participants, the goals presented by Chittaro (2001) might be treated as achieved by the techniques used in the prototype. Strengthening the choices made during designing and developing the prototype.

5.2 Limitations

This chapter discusses the limitations of the project and methods used in the project.

5.2.1 Limitations of the project

During the project, the project's problem has been changed several times. This was due to several changes in the openEHR Task Planning specification. The project's original goal was to redesign the Task Planning Visual Modelling Language with a collaboration with the openEHR foundation. This collaboration did not work as planned and a new problem was defined after a discussion with DIPS. The new problem was to investigate the visualization of task planning from the health professional's perspective, that is the problem described and studied in this report. The change of the problem caused time limitation as the users were working physicians and involving users in the study was a challenging and time-consuming task.

Because the task planning specification was under development during this project, there were none existing plan prototypes structured according to the specification that could be used in the study. Additionally, the detailed information about how plans were meant to be used in a real setting was not existing. This led to the need for the development of a treatment plan by the author without the domain knowledge and without the knowledge needed to find a correct balance in the level of detail in the created plan of treatment.

5.2.2 Limitations of the first phase of data gathering

The meetings conducted with employees at DIPS and openEHR foundation provided some general information about the task planning. However, as the task planning was still under development when the meetings were conducted, concrete information about how to use the specification was not known by any of the contacted persons from the openEHR foundation. A limitation of empirical research was that relevant state-of-the-art articles and technologies could have been overseen. However, theories and methods provided relevant information that was useful during the study. During the research, three interviews have been conducted with physicians. The purpose of the interviews was to understand how the treatment of a patient is performed by physicians today. Given three physicians with different professions and working in three different organizations, the results provided sufficient information despite only three interviews conducted. However, more interviews could be performed and questions asked in the interview should reveal more detailed information about the exact information that is needed during the treatment.

Better results of the developed prototype could be achieved if an observational study would have been conducted in addition to the interviews. Such a study would provide actual insights into how the physicians work with patients and some requirements could be defined before creating the prototype. Using those requirements would result in a prototype more concentrated on physicians needs which might result in more concrete feedback. This was however not possible in practice due to privacy laws and time limitations.

5.2.3 Limitations of the prototype

The patient treatment case was created in collaboration with a physician working at DIPS based on a fictive patient situation. This provided a more realistic treatment plan that the author would produce individually. The resulting patient treatment was turned into a complete plan structured according to the openEHR Task Planning specification. The lack of information about how the task planning specification should be implemented and used might lead to wrong interpretation of the specification resulting in a plan that is not implemented in the correct way.

The resulting plan was simple and described as straight forward by the participants of the evaluation. The simplicity of the plan might have affected the results in this study causing the users to understand the visualization easier, in addition, it might limit the need for using implemented functions for collapsing and navigating. The plan used in the prototype should represent a more complicated treatment with more realistic data. However, due to the limitation of the information about the usage of the task planning specification, and the time limit, this would be difficult to accomplish in this study.

The functionality in the prototype was limited, limiting the possibility to interact with the prototype. The interactivity implemented in the prototype helped to engage the participants to explore the prototype on their own giving the opportunity to observe what kind of information and further interactivity the users required from such a solution. This provided feedback on what interactivity the participants desired to be implemented in the plan. However, this might have confused the participants during the interaction session as many of the things they wanted to click on were chosen not to be interactive. That could lead the users to stop exploring and the users might assume that there is no more interaction added to the plan.

The prototype was developed as a stand-alone application and was not implemented in DIPS. The reason for that was that the task planning extension is not fully implemented in DIPS and implementing the prototype in DIPS would be unnecessary and time-consuming and would not lead to better results. However, if the task planning structure would had been supported in DIPS the prototype could be implemented using real data. This would give a more realistic prototype and more value for DIPS as the prototype could have been used for future development.

5.2.4 Limitations of the evaluation of the prototype

The evaluation conducted with four physicians resulted in valuable discussions and feedback. The three scenarios with open questions worked well. However, the follow-up questions should be more structured to retrieve similar feedback from the participants. The evaluations have been conducted with a long period of time between each as they needed to be coordinated with participants' time schedule. This lead to varied time for preparations before each evaluation that caused inconsistent follow-up questions. The follow-up questions should be written down by the author and the author should be better prepared for each evaluation in order to gather broader feedback.

More evaluations could be useful to conduct giving broader feedback and strengthen the requirements extracted from the evaluation. However, that would need more time which already was limited in this study.

5.3 Future work

The implementation of standardized task plans in DIPS is a demanding process. First, the data structure needs to be implemented giving the possibility to store and manage planned tasks in DIPS' systems. Further, clinical pathways or plan prototypes structured according to the specification have to be designed and saved in the system. The clinical pathways will be the basis for creating an actual plan of treatment for a specific patient that will be created by customizing one or more clinical pathways to the specific patient's condition. When a plan of treatment is created and activated, the data structure creates the possibility to create different applications that help different actors to interact with the structure. The proposed prototype in this study focused on showing the up-to-date plan of treatment for physicians, giving the physicians an ability to gain an overview of the current situation of a specific patient's treatment.

The four evaluations conducted in this study provided feedback and presented requirements the physicians had for a tool visualizing the task planning in their working situation. However, further research should include observational studies to learn how the treatment process actually is performed by the physicians and what kind of information is required by the physicians during treating a patient. By following a physician during a working day, knowledge about how complicated a treatment could be in real life and how such complex treatment is handled by physicians could be gathered. Such a study could reveal new requirements that could prove or disprove the requirements presented in this study, resulting in a list of requirements for the further development of the future tool. The further solution developed will then address the needs of the actual users. The evaluation was conducted in a lab-like situation with fictive data and limited functionality of the prototype. Further research should evaluate the solution in the field with the use of a more realistic and complex plan of treatment. That could be done by a prototype implemented in DIPS when the task planning structure is implemented.

An implementation of the standardized task planning structure in DIPS opens up for further ideas of creating applications on top of the underlying structure. The underlying structure can be presented to different actors in different situations. An example could be presenting plans about a given condition for similar patients that could be used for quality assurance and improvement of the clinical pathways. Another example could be to present an abstracted version of the plan to the patient presenting a timeline with important tests that the patient has to attend to. When a plan is created, and for example, an x-ray examination is planned, the time for the examination could be displayed for the patient. This could give a better understanding of the whole treatment and could help the patient remember when to attend to different examinations and consultations. However, to be able to develop and test further ideas, the structure has to be implemented and used by the physicians so there is real data stored in the system. In real life, planning a full treatment for a patient from the beginning would be impossible, often the diagnosis is not known before several examinations are performed. The plan needs to be updated and customized according to the new diagnosis and test results that are gathered during a treatment. The clinical procedures are rarely straight forward. Therefore an easy way to add and edit plans directly from the visualization would be needed during the execution of a plan. This tool will be used by physicians in their working situation, as the visualization of the plan, therefore some requirements might be similar to the requirements presented in this study. Such tool should be easily accessed from the visualization of the plan of treatment.

The findings from the interview show that the patient journal that is used today contains chronologically records about the patient's treatment and is used both as the primary source of information when treating a patient and for the required documentation of the treatment. If the idea of having the possibility to write comments for each task would be implemented in the future solution, it could open a possibility for converting completed tasks and task plans directly into the patient journal for faster documentation of what has been done in the treatment. The information from a completed task plan would then contain detailed tasks with comments describing additional information about the task, the time tasks were completed and who completed the tasks. The idea of saving plans directly in the patient journal could spare the physicians to use two separate systems, one for coordination and another for documentation, as the task would automatically be documented in the patient plan. This could do the visualization tool more relevant for the users as there was mentioned during the interview that the documentation takes already a long time and that users were skeptical of tools that would extend the time used for documentation.

5.4 Conclusion

This study has investigated, through a concept of a graphical prototype, the requirements health professionals have for visualization of an instance of a standardized plan of treatment that is structured according to the openEHR Task Planning specification. Through the development of a graphical prototype and confronting physicians with the prototype, requirements have been retrieved for further development of such a tool.

The positive feedback from the evaluation of the prototype might indicate that information presented in the prototype and the methods for visualization of that information could be used for further development of a tool for physicians in their working situation that visualize a plan of treatment for a specific patient. In addition to the information presented in the prototype, users desired to see more information about the patient, access the test results, see more information about each task and desired a possibility to share comments in the plan. The requirements for additional information in the plan created a need for the visualization to be more interactive.

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Appendix

This section presents appendix. **Appendix A** shows the declaration of consent for used in the interview. **Appendix B** contains questions that were used in the interview. **Appendix C** shows the declaration of consent for the evaluation. **Appendix D** shows the structure of the evaluation conducted containing introduction, questions that were asked and the scenarios.

Appendix A

Samtykkeerklæring for intervju

Beskrivelse av oppgaven

Jeg skriver masteroppgave ved institutt for datateknologi og informatikk, NTNU i Trondheim. Oppgaven går ut på å lage en prototype av en visualisering av en elektronisk forløpsplan. For å få en best mulig prototype trenger jeg bakgrunnsinformasjon fra sluttbrukere om hvordan pasientforløp håndteres.

Jeg ønsker å intervjue deg om temaet pasientforløp. Formålet med intervjuet er å lære mer om hvordan pasientforløp håndteres av leger i dag og hvordan leger får oversikt over pasientforløpet til pasienter. Notater fra intervjuet samt en beskrivelse av disse refleksjonene vil bli analysert, brukt som en pekepinn for utvikling av en prototype og beskrevet som en del av masteroppgaven.

Frivillig deltakelse og lydopptak

All deltagelse er frivillig, og du kan trekke deg når som helst. Det vil bli tatt lydopptak under intervjuet. Lydopptaket skal kun brukes som et hjelpemiddel for å huske hva som ble sagt og skal slettes umiddelbart etter at notatene har blitt skrevet. Lydopptaket vil bli slettet inntil 6 måneder etter at intervjuet er gjennomført. Ingen andre enn meg, Maciek Adamczyk, skal få tilgang til og-/eller få høre opptakene. Du kan når som helst avslutte intervjuet eller trekke tilbake informasjon som er gitt under intervjuet.

Anonymitet

Notatene og innleveringsoppgaven vil bli anonymisert. Det vil si at ingen andre enn meg vil vite hvem som har blitt intervjuet, og informasjonen vil ikke kunne tilbakeføres til deg. Før intervjuet begynner ber jeg deg om å samtykke i deltagelsen ved å undertegne på at du har lest og forstått informasjonen på dette arket og ønsker å delta.

Samtykke

Jeg har lest og forstått informasjonen over og gir mitt samtykke til å delta i intervjuet

___________________________________	___________________________________
Sted og dato	Signatur

Appendix B

Samtykkeerklæring for intervju

Tema 1: Bakgrunn

1. Hvor gammel er du?
2. Hva er stillingen din?
3. Hvor lenge har du jobbet som i denne stillingen?

Tema 2: Tekniske ferdigheter

4. Bruker du et datasystem på en datamaskin i hverdagen din? Hva synes du om det? Liker du å bruke en datamaskin på jobb?
5. Hva er dine datakunnskaper? Du kan gjerne svare på en skala fra 1-10.

Tema 3: Arbeidshverdag og arbeidsprosess

6. Hvor mange pasienter jobber du med i gjennomsnitt på en dag? Hvor mange pasienter jobber du med på en travel dag?
7. Hvordan er det når det gjelder ansvar for hele behandlingen av pasienten, er det kun en lege som har ansvaret for at behandlingen blir utført eller kan det hende at det er flere leger som deler på ansvaret?

Tema 4: Pasientforløp

8. Hvordan får du oversikt over pasientens tilstand og forløp? Hva som har blitt gjort av behandlingen og hva er det neste som skal skje?
9. Hvordan får du oversikt over handlinger som må utføres for å behandle pasienten?

10. La oss si at du får inn en ny pasient, pasienten sier at han har vondt i armen. Hva er fremgangsmåten for å behandle pasienten?

11. Hva slags oversikt om en pasient mener du er viktig for å planlegge videre behandling og å fullføre behandlingen?

12. Er det noe form for oversikt som er vanskelig å få tak i, eller mangler i din hverdagslige arbeidsdag? Hva slags oversikt er det?

13. Hender det at du må ta over en pasient som har påbegynt sin behandling? La oss si at en annen lege ble syk og du må ta over en pasient som har startet å bli behandlet men det er flere ting som gjenstår for å fullføre behandlingen. Hvordan håndterer du dette? Hva er fremgangsmåten for å få oversikt over hva som har blitt gjort og hva som er det neste som skal gjøres?

14. Opplever du utfordringer i dagens måte å håndtere pasientens forløp og behandling? Hva slags utfordringer er det?

15. Har du noen andre tanker eller noe å tilføye om pasientforløpet?

16. Hvor viktig er det for deg å kunne se historikken av behandlingen for en pasient? Hvis ja, kan du gi eksempler på når historikken av behandlingen kan være til nytte? Og eksempler på hva slags historikk som er relevant.

Tema 4: Digitale støtteverktøy i arbeidsprosessen

17. Hvordan bruker du journalsystemet, er det et primært verktøy for behandlingsforløpet?

18. Kan du beskrive vanlig bruk av journalsystemet?

Tema 5: Framtiden

19. Hva slags tiltak ville gjort at du hadde fått bedre oversikt over et pasientforløp?

20. Har du noen tanker om hvordan et it-system kan gi bedre oversikt over et pasientforløp?

Appendix C

Samtykkeerklæring for evaluering av prototype

Beskrivelse av oppgaven

Jeg skriver masteroppgave ved institutt for datateknologi og informatikk, NTNU i Trondheim. Oppgaven går ut på å komme med et forslag for visualisering av et elektronisk standardisert pasientforløp. Etter å ha utviklet en prototype, trenger jeg din hjelp for å få høre om dette er brukbart eller ikke samt få tilbakemeldinger om prototypen.

Jeg ønsker å la deg teste mitt forslag for visualisering av pasientforløp. Formålet med evalueringen er å få tilbakemeldinger på prototypen jeg har laget. Det er prototypen og ikke deg som blir testet. Resultatet av evalueringen blir deretter analysert og beskrevet i min oppgave.

Frivillig deltakelse og opptak

All deltagelse er frivillig, og du kan trekke deg når som helst. Det vil bli tatt opptak av video under evalueringen. Det vil bare bli tatt opptak av hva som skjer på skjermen, du vil ikke bli filmet. Film skal kun brukes som et hjelpemiddel for å huske hva som har blitt gjort og sagt og for å kunne få med hvordan prototypen har blitt brukt. Opptakene slettes umiddelbart etter at resultatene har blitt skrevet ned og analysert. Opptakene vil bli slettet inntil 6 måneder etter at evalueringen er gjennomført. Ingen andre enn meg, Maciek Adamczyk skal få tilgang til og-/eller få se opptakene. Du kan når som helst avslutte evalueringen eller trekke tilbake informasjon som er gitt under testingen eller diskusjonen.

Anonymitet

Notatene og innleveringsoppgaven vil bli anonymisert. Det vil si at ingen andre enn meg vil vite hvem som har deltatt på evalueringen, og informasjonen vil ikke kunne tilbakeføres til deg. Før evalueringen begynner ber jeg deg om å samtykke i deltagelsen ved å undertegne på at du har lest og forstått informasjonen på dette arket og ønsker å delta.

Samtykke

Jeg har lest og forstått informasjonen over og gir mitt samtykke til å delta på evalueringen

______________________________	______________________________
Sted og dato	Signatur

Appendix D

Evaluering av prototype

Introduksjon

Du er med på en evaluering av en prototype jeg har laget i forbindelse med min masteroppgave. Data i helsesektoren blir mer strukturert med tilsvarende muligheter for ny funksjonalitet. Min oppgave handler om å komme med et forslag for visualisering av pasientforløp basert på slike data.

Du skal få teste prototypen jeg har laget. Målet for denne testen er å få dine tilbakemeldinger for å kunne utvikle et fremtidig system som dekker behov og ønsker leger har for et slikt system.

Det er kjempefint om du "tenker høyt" i forhold til oppgavene jeg gir deg, og sier ifra om det er ting du lurer på, hva du leter etter mm. Jeg kommer først til å stille deg noen innledende spørsmål, deretter skal du få se litt på noen scenarioer visualisert ved hjelp av min prototype, og så har vi noen oppsummeringsspørsmål til slutt.

Prototypen skal vise en ferdig satt opp plan for en gitt pasient som også er tilpasset til pasientens diagnose. Data brukt i prototypen har blitt fabrikkert og er ikke et forsøk på å gjenskape en problemstilling fra din hverdag.

Er det noe du lurer på før vi begynner?

Del 1 - Innledende generelle spørsmål

1. Hvor gammel er du?
2. Hva er stillingen din?
3. Hvor mange pasienter jobber du med daglig?
4. Hvordan får du oversikt over pasientens forløp?

Del 2 - Test

Scenario 1

"Gitt at du får ansvar for en ny pasient og åpner pasientens forløpsplan, dette er det du ser."

Kan du forklare hva prototypen representerer og hva du kan lese ut av prototypen?

Scenario 2

"Du åpner forløpsplan for den samme på et senere tidspunkt, dette er det du ser."

Hva kan du lese ut av planen på dette punktet?

Scenario 3

"Du åpner forløpsplan for den samme på et senere tidspunkt, dette er det du ser."

Kan du si noe om fremdriften i behandlingen?

Del 3 - Oppsummeringsspørsmål

Del 3.1 - Bruken av systemet

- Hvordan var det å få oversikt over pasientens forløp?
- Var det noe informasjon som manglet? Hva slags informasjon tror du ville gjort planen bedre?
- Var det noe som var uforståelig? Forklar hva det var og eventuelt hva som ville gjort det enklere for deg å forstå?
- Kunne du tenkt deg å bruke noe lignende på din arbeidsplass i fremtiden? Begrunn svaret. Hvis ikke dette er relevant, kan du se for deg at dette kan være relevant for andre spesialiseringer?
- Hvor ofte ser du for deg et sånt system ville blitt åpnet og brukt under en behandling?

Del 3.2 - Om systemet

- Hva synes du om systemet generelt?
- Hva synes du om måten jeg valgte å visualisere planen på? Var dette oversiktlig? Var dette forståelig? Har du noen forbedringsforslag?
- Hva er inntrykket du sitter igjen med etter å ha sett systemet?
- Har du noen andre innspill eller tilbakemeldinger?

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