Designing IT Systems to support the Chronic Wound Treatment Process in Healthcare

Julia Benz
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Abstract

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Chronic wounds are both a burden for patients and a major cost factor for a developed country's health budget. This research project investigates into designing IT systems for the treatment of chronic wounds by focusing on sharing, retrieving and entering information. To understand the context and the users, a pre-study was conducted followed by semi-structured interviews. The data gathered through the semi-structured interviews was analysed by applying a thematic analysis which resulted in five major themes. Based on these themes, problems were identified and solutions provided in the form of functional and non-functional requirements for an IT system. The major requirements are that the system should 1) provide fast and easy access to relevant information, 2) be easy to use, 3) adapt to the work environment, 4) reflect on established work processes and 5) focus on the user’s expectations and behaviour. A low-fidelity prototype was created based on the identified requirements and evaluated by conducting a focus group. Overall, the feedback from the focus group was positive.
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# Table of Contents

Acknowledgements 2

1. Introduction 5
   1.1 Research Question 6
   1.2 Individual Contribution 6

2. Delimitations 7

3. Ethics 8

4. Background 9
   4.1 Healthcare Facilities in Region Uppsala 9
   4.2 Patient Records and Electronic Health Records 10
      4.2.1 Usability of Electronic Medical Records 11
   4.4 Chronic Wounds 12
      4.3.1 Wounds. Definition and Classification 12
      4.3.2 Assessment and Documentation 13
      4.3.3 Common Types of Chronic Wounds 14
      4.3.4 Wound Management for Chronic Wounds 14
      4.3.5 The Burden of Chronic Wounds 15
   4.4 Related Work 15

5. Methodology 18

6. Phases 0 and 1 - Understanding the Users and the Context 19
   6.1 Pre-Study 19
      6.1.1 Exploratory Workshop 19
      6.1.2 Training Session with COSMIC 20
      6.1.3 Expert Interview 20
   6.2 Phase 1. Semi-structured Interviews 20
      6.2.1 Description 20
      6.2.2 The Settings of the Interviews 21
   6.3 Thematic Analysis 21
   6.4 Results from Thematic Analysis 22
      6.4.1 Information 22
      6.4.2 The nature of the system 28
      6.4.3 Work environment 29
      6.4.4 Health aspects 31
      6.4.5 User’s Behaviours and Expectations 33
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5 Recommendations</td>
<td>36</td>
</tr>
<tr>
<td>6.5.1 Functional Requirements</td>
<td>36</td>
</tr>
<tr>
<td>6.5.2 Non-functional Requirements</td>
<td>38</td>
</tr>
<tr>
<td>7. Phase 2 - Interface Design</td>
<td>39</td>
</tr>
<tr>
<td>7.1 Pen and Paper Sketches</td>
<td>39</td>
</tr>
<tr>
<td>7.2 Prototype</td>
<td>41</td>
</tr>
<tr>
<td>8. Phase 3 - Evaluation</td>
<td>55</td>
</tr>
<tr>
<td>8.1 Focus Group</td>
<td>55</td>
</tr>
<tr>
<td>8.2 Feedback</td>
<td>55</td>
</tr>
<tr>
<td>8.3 Workshop</td>
<td>56</td>
</tr>
<tr>
<td>9. Discussion</td>
<td>58</td>
</tr>
<tr>
<td>10. Conclusion and Future Work</td>
<td>60</td>
</tr>
<tr>
<td>11. References</td>
<td>62</td>
</tr>
<tr>
<td>12. Appendices</td>
<td>67</td>
</tr>
</tbody>
</table>
1. Introduction

Chronic wounds are becoming a costly and major health problem around the globe (Olsson et al., 2019; Sen et al., 2009). These kinds of wounds are characterized by not presenting progress towards healing in a standard period of time despite being under treatment. Although the causes are multifactorial, the risk increases in the presence of diabetes, arterial diseases and advanced age. With the growing trend of an aging population in addition to the rise of diabetes and obesity, an increasing concern is emerging. Motivated not only for the emotional and physical distress chronic wounds cause to the patients but also for the elevated cost of wound care (Nussbaum et al., 2018). For effective wound care, the collaboration between different healthcare professionals is desired and often required (McDonald & Lesage, 2006). This creates a challenge for monitoring consecutive treatments and assessments addressed by different physicians in long periods of time. Which some institutions are tackling by the implementation of digital records (Gunningberg, Dahm, & Ehrenberg, 2008a).

Digital records, also known as Electronic Health Records (EHRs) are an alternative to paper-based patient records and their popularity has been increasing among healthcare facilities. EHRs are a digital collection of the patient’s medical history and their aim is to enhance the medical treatments a patient is receiving by providing the health care professionals (HCPs) with access to required patient data (Venot, Burgun, & Quantin, 2013). According to a literature review conducted by Nguyen, Bellucci, & Nguyen (2014), HCPs as well as patients, have a rather positive attitude towards EHRs. One aspect that was pointed out is the improvement of the quality of information. It was said that the information provided was up to date and accurate. However, negative aspects were found in both the attitudes of HCPs towards EHRs and the information quality aspect. HCPs perceived that EHRs lead to an increased workload. Moreover, it was found that HCPs struggled with the amount of information that the EHR provides to them (Nguyen et al., 2014). A study conducted by Likourezos et al., 2004 suggests that HCPs are concerned by the amount of time it takes to perform a task using an EHR. The majority of the participants pointed out that EHRs are not enhancing the quality of care the patients are receiving.

With respect to extended use of EHRs in public health, Sweden is a pioneer country. Starting in the 1990s, the nation has experienced a rapid adoption of EHRs on a large scale (Kajbjer K., Nordberg R., Klein G.O., 2011). Being Uppsala, the fourth largest region, one of the first municipalities to implement a local EHR platform able to share information between primary care\(^1\) and secondary care\(^2\) (Tully et al., 2013). Their software, COSMIC, is a healthcare information system provided by the Swedish company Cambio who claims it is suitable for different kinds of healthcare facilities, such as university hospitals and nursing homes (Cambio COSMIC, n.d.). This comprehensive system offers different specialized templates for managing chronic wounds care. However, during an exploratory workshop conducted for this research, it was disclosed that the tools for managing chronic wounds have not been updated since the EHR was implemented in 2004. Furthermore, it was found that other healthcare facilities within Region Uppsala use different EHR systems generating an interoperability issue (How Sweden is giving all citizens access to their electronic health records, n.d.).

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1 Community services (vårdcentral) and general practitioners care.

2 Hospitals and medical specialists care.
The purpose of this thesis project is to investigate how EHR systems could support the process of treating chronic wounds. Aiming to understand HCPs working with chronic wounds, the final goal is to identify the requirements an EHR needs to meet to improve usability. To achieve this, a qualitative study will be conducted among HCPs working with chronic wounds within healthcare facilities in Region Uppsala. The study focuses on sharing information, documentation and retrieving information related to chronic wounds. The found requirements are visualized by low-fidelity wireframes. Finally, the results are evaluated by conducting a focus group.

1.1 Research Question

The main research question is phrased as follows:

How can an IT system aimed for chronic wound treatment be designed to support healthcare professionals on the documentation, retrieval and exchange of information?

In order to answer this question, several areas were analyzed, to further break it down into more specific inquiries, such as:

- How should the system manage information?
- What information of the chronic wounds should be presented and how?
- How should the system support the HCPs tasks?
- What are the qualities the system should have?

To address them, research activities were performed in two main phases. 1) Phase 1, consisting of semi-structured interviews and a thematic analysis, aimed to understand the needs of healthcare professionals when treating a chronic wound in regards of the information they require, document and exchange. This also included the repercussion of their workplace and the common problems they usually struggle with while using the software and retrieving the data to assess a patient. 2) The second phase was a design exploration, built upon the findings in the first one. The goal was to create a design hypotheses of something original that can contribute with better usability than the existing solution. In a further step, the latter was evaluated during a focus group.

1.2 Individual Contribution

This thesis work was carried out by two researchers within the field of Human-Computer Interaction. The workload of the literature review, related work, data gathering and analysis, drawing conclusions, building the prototype, conducting a focus group evaluation, and writing the report was equally shared between the researchers.
2. Delimitations

EHR systems became a large part of the daily work routine of HCPs and therefore have grown to enormous and complex systems. This research project is focusing on EHRs and the treatment of chronic wounds. It was decided to investigate into identifying the requirements a system needs to meet to be able to gain adequate usability. Due to this, the outcome of this work is a list of recommendations on how to design an IT system that supports the treatment of chronic wounds in the best possible way within the context of a healthcare facility. These results will be visualized by wireframes.

While investigating into chronic wounds it became clear that a patient has rarely only a chronic wound. In most cases, a patient would have multiple diagnoses and often they have more than one chronic wound. Moreover, HCPs that treat chronic wounds are likely to also treat other diagnoses. Only HCPs that are specialized in the topic of chronic wounds work exclusively with wounds. Due to this, it was a challenge for the researchers to determine the exact aspects of treating chronic wounds.

In this study, only the perspective of HCPs was taken into account even though the researchers are aware that the design of an EHR system influences the patients too. In that matter, the patient’s perspective should be considered in the possible future design of the system. Moreover, the participants were mainly HCPs who work in the hospital and only a few of them were HCPs who work in other healthcare facilities.

Another limitation of this study is the language barrier between the researchers and the participants. The research was conducted in English. English is neither the native language of the researchers nor of the participants. To keep the influence of the language barrier as small as possible tools such as digital translators were available during the interviews.

Finally, the researchers come from a background of Human-Computer Interaction. Neither of them has a medical background and all relevant knowledge was gathered through literature and the conducted pre-study.
3. Ethics

Before conducting the interviews, all participants received an email including an information sheet (Appendix C). This included information about the topic of the project and explained that the data would be anonymised and that the participation was voluntary and could be withdrawn at any time. Finally, it provided the contact information of the researchers and encouraged to ask questions. Before each session, the participants were educated again, the possibility of asking questions was provided and they were asked to sign a consent form (Appendix D). The researchers conducted semi-structured interviews at the workplaces of the participants. Therefore, it was necessary to sign a “Professional Secrecy” document to protect the patient's data.

Finally, the researchers are aware that patients are an important part in designing systems for healthcare. Those systems are going to affect them as they affect the HCPs that work with the systems. However, due to time constraints, the patient’s perspective was not taken into account in this research project.
4. Background

While the primary objective of this paper is to report the design process, relevant information about three topics is given first in order to establish the necessary context to understand the results. These topics are: Healthcare Facilities in Region Uppsala, Chronic Wounds, and EHRs. In addition, relevant related work regarding IT systems supporting chronic wound treatment will be discussed at the end of this chapter.

4.1 Healthcare Facilities in Region Uppsala

Due to the clinical characteristics, it is very common for chronic wound patients to move back and forth between different healthcare facilities. When a patient is admitted to a hospital, it is very likely that he or she was in a nursery home before and that this patient will get back to that facility after being released from the hospital (Tully et al., 2013). Since different facilities and HCPs treat the same patient, it is important to understand how the patient’s data is shared, or not shared, between the different agents.

In an exploratory workshop conducted for this study, it was discussed that healthcare facilities in Region Uppsala are broadly divided between private and public care. Both of them having inpatient and outpatient care. Each sector uses a different EHR system, as shown in Figure 1, public care uses Cambio COSMIC as their main EHR while the private care might not. An exception are the journals from the municipality, which, even though they belong to Region Uppsala, use a different system and do not report to NPÖ. Additionally, home care uses Siebel, but not exclusively, for documenting wounds.

However, many facilities can have access to the information provided by:

- **National Patient Overview (NPÖ)**. This IT system collects patient records from the different facilities in the private and public care, which can be accessed by most of the Swedish facilities with the consent of the patient (with the exception of municipalities journals). Notes, diagnoses and other relevant patient’s information from other counties can be read through NPÖ.

- **Cohesive journaling**. With this engine, those who have access to private caregivers journal views are able, through an active choice and patients consent, to read notes from other caregivers.

- **1177**. A National Patient Portal for accessing healthcare and health-related information in Sweden, mostly aimed to citizens.

Even if the data is shared across the facilities, HCPs are still supposed to ask for the patient’s permission when they are about to access the data from another healthcare facility. Patients can block or deny data access from the National Patient Portal (1177).

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3 The systems used in private care were not disclosed in this study since it was mainly focused on public care. Nevertheless, they do use Cambio COSMIC to an unknown extent.
4.2 Patient Records and Electronic Health Records

Patient records (PR) are a necessary part of the daily work of HCPs. They provide access to valuable patient data and they have the power to improve the care a patient is retrieving. A PR consists of the medical history of a patient such as the treatments the patient received, his or her diagnoses and the medical state that describes the condition of the patient. A PR evolves from different HCPs contributing by adding data to it. At the same time PR and their content are used by HCPs who retrieve information. Based on the data and information provided to HCPs in a PR they decide on the treatment a patient receives. Besides the focus on one individual patient, PRs provide the opportunity to look at patient’s data from a bigger perspective. The data can be used for research and to draw a picture on health related questions on a collective level. However, designing a PR rises issues and challenges. It is used among different healthcare facilities and from HCPs having different job-roles. This leads to a broad variety of requirements that need to be considered when designing a PR (Venot et al., 2013).

An EHR is a computerized PR (Venot et al., 2013). The International Organisation for Standardization (ISO) defines the EHR as a “repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users” (ISO/TR 20514, 2005).

The patient data consists of the medical history, the current state of the patient and it provides a view on the future development. Aiming to increase the quality of care EHRs are implemented among different healthcare facilities. When comparing EHRs to paper-based PRs one can find two benefits regarding the exchange of health information. The first benefit is that the improvement of the availability of the data. It is easier and faster for a HCP to access required information. The second benefit is that HCPs can share medical information among other HCPs. The data gathered can be exchanged on different levels, such as within one healthcare facility or between different healthcare facilities.
facilities. Moreover, data is accessible from different places and available in real time. Even though EHRs provide major advantages over paper-based PR it is crucial to consider the changes in the workflows and processes of HCPs that are caused by the implementation of an EHR system. Taking the needs of different users with different job-roles into account and meeting their requirements is indispensable when designing an EHR system (Venot et al., 2013).

4.2.1 Usability of Electronic Medical Records

Implementing computer systems in healthcare is challenging and have repeatedly led to negative impact for HCPs. One example is the implementation of a system to order medication, lab tests or similar in a medical center in the US. The new system led to an increased workload among physicians. It was also reported that the system restricted the physicians in their medical assessment and that the system did not tolerate slight misspellings. Due to these factors the users refused to work with the system. Another example for a miscarried implementation of an computer system within a healthcare facility is the implementation of a Clinical Information System (CIS) in the US. The introduction of the system caused a decrease in clinical productivity. HCPs stated that it took them 30 to 75 minutes longer each day to complete their tasks. This prolonged working hours raised because of three reasons. First, the number of steps that needed to be taken to fulfill a simple task was not appropriated. Second, the system was not customized to the requirements of different user groups. Finally, the system was too complex. Problems occurred even after an initial training session. In consequence the system was replaced by another system. In summary the problems that occurred were that physicians spend more time to complete a task, they reported an information overload and a reduction of productivity (Smelcer, Miller-Jacobs, & Kantrovich, 2009).

A study on the perspective of physicians have shown that there are two areas that cause issues. The first one is related to long training times. Systems used in healthcare offer a large amount of functionalities which confuses the users. Typically, the navigation through such a complex system provoke problems. The second area is related to reduced productivity. Among others these issues is caused by three factors that are build around the topic of information. First of all, it was found that HCPs have difficulties to find the information they are looking for. Second of all some screens provide their users with information that is not required but withhold information that is needed. Finally, the information displayed in a screen is not well structured. Too much information is placed in one screen which makes it challenging for HCPs to find what they are looking for (Smelcer et al., 2009). A study in the field of human-computer interaction and the usage of EHRs conducted by (Clarke et al., 2013) identified four the major problems of poor display of information, cognitive overload, workflow issues and navigation issues. Furthermore, the study describes the negative consequences of these problems. Among others one consequence was the causation of errors. Another impact was that the EHR increased the frustration of physicians. As a final consequence HCPs developed a negative attitude towards EHRs and the acceptance towards EHRs declined. A research project that focuses on nurses found five usability issues related to an electronic nursing record system such as "fluency of reporting practices", "accuracy of documentation", "learnability", "exploitation of documented information" and "support for collaborative care". According to the research project the problems are caused by several aspects. Two of them are related to the topic of information and include that it is difficult to search for information and that information is not automatically transferred. Moreover, it was found that nurses are forced to follow complicated interaction sequences and that they even have to perform interactions that are not
needed. The last aspect to be mentioned is that the system is not matching with the mental models of the nurses (Viitanen, Kuusisto, & Nykänen, 2011). In conclusion it can be said that a lot of systems struggle with usability problems (Smelcer et al., 2009).

There are several aspects that should be taken into account when designing an EHR system. While these aspects are important to think of they also contribute to the challenge of designing a useful EHR system. In the following six of these aspects will be described. The first one to be mentioned is the delegation of work. Work can be delegated directly or indirectly, and some HCPs do delegate a lot whereas other do delegate less often. The second aspect is entering data into the system. Different HCPs have different preferences and work flows to do so. Moreover, there are discrepancies when it comes to the pace of work. While one HCP could see one patient within one hour another could see four different patients in the same time. Differences can also be found in the way HCP approach their tasks. They can have different tasks flow and their work get interrupted a lot. The fifth aspect is related to the fact that HCPs are in need of different functionalities, depending on their area of expertise. Finally, some HCPs prefer to enter data right after seeing a patient whereas others start to document when they have seen all patients they had scheduled during their shift (Smelcer et al., 2009).

4.4 Chronic Wounds

4.3.1 Wounds. Definition and Classification

A wound is generally understood as an injury that results in cut or broken skin tissue. For clinical use, Lazarus et al. (1994). (1994) have provided a standard definition and classification:

Wounds result from pathologic processes beginning internally or externally to the involved organ(s). (...) Simply stated, wounds may be classified as those that repair themselves or can be repaired in an orderly and timely process (acute wounds) and those that do not (chronic wounds).

Another definition complements this description adding that chronic wounds do not always behave favorably under treatment. Some chronic wounds can eventually heal, although the process can take from three months up to several years. This is a consequence of an alternative healing pattern that produces recurrences (Enoch & Price, 2004).

Some of the factors that affect wound healing are the appearance of bad circulation, infections, and haematomas, as well as the presence of systemic immune deficiency, diabetes, increased age, obesity, malnutrition, cigarette smoking and corticosteroids (Franz et al., 2008).

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4 Also known as healing wounds and non-healing wounds respectively.
4.3.2 Assessment and Documentation

In order to diagnose, treat or manage a wound, the HCP needs to perform a skin assessment. During this procedure, the wound attributes are identified and evaluated considering the patient’s environment. For this matter, it is vital that the HCP understands the structure and function of the skin tissue.

To execute a skin assessment, Brown and Flanagan (Flanagan, 2013, pp. 52-64) suggest an approach based on existing models, consisting of four steps:

- **Listening.** Inspect into the patient's history by asking the patient the right questions. Focused on the patient's perspective and involvement.
- **Looking.** Evaluate the patient's overall health condition and skin condition. Considering general demeanour, age, illness status, mobility, and body weight.
- **Touching.** Gather information that can't be collected through the first steps, such as skin texture, skin moisture levels, presence of oedema, temperature, pain levels, and skin sensitivity.
- **Smell.** Identify skin condition and hygiene.

A comprehensive assessment would not focus on the skin in isolation but it should take the patient's context into account. While the wound characteristics that need to be evaluated, according to Naylor (2002), are:

- Previous treatments,
- Location,
- Size, depth, and shape,
- Duration,
- Amount and nature of exudate,
- Presence and level of malodour,
- Type of tissue present,
- Signs of infection
- Nature and type of pain
- Surrounding skin,
- Episodes of bleeding
- Wound edges.

The findings obtained through wound assessment contribute to the development of a wound care plan or management plan. This data is constantly collected, documented and compared in order to assess the progress of healing or deterioration. A useful resource for documentation is to include photographs, although they should not be the primary information source. Wound assessment results in long clinical records, therefore the urgency of structuring the documentation process. As Culley suggests:

> **Documentation should be user-friendly, concise, comprehensive, and able to withstand legal scrutiny and assist practitioners to make informed treatment choices based on the data collected.** (2001 cited by Flanagan 2013, p.63)

In addition, Brown and Flanagan (2013) consider that, due to health records being used by several HCPs, effective documentation can be achieved by avoiding confusion when possible, e.g. using the correct terminology or eluding acronyms.
4.3.3 Common Types of Chronic Wounds

Chronic wounds appear by many different causes and each one of them behaves differently. Broadly, they can be categorized into three types:

- **Leg ulcers.** Also identified as vascular or venous ulcers. They are caused by a reduced arterial blood supply to the lower limb or by inadequate venous return. They are classified in venous, arterial or mixed ulcers depending on the affected area. Increased age, immobility, obesity, smoking and varicose veins are few of the risk factors for leg ulcer occurrence.

- **Diabetic foot ulcer.** This kind of chronic wound is a direct consequence of diabetes, caused by neural and vascular complications. With a presence of 15% of the population affected by diabetes. They are classified according to their characteristics as neuropathic, neuroischemic and ischemic. The most critical risks factors are peripheral neuropathy, minor foot trauma, foot deformity, and decreased tissue perfusion.

- **Pressure ulcer.** This is an effect of persistent direct pressure in combination with shear forces and impaired skin conditions. It affects people with low mobility that are bed or chair confined, such as the elderly or people with spinal cord injuries. They are classified in six stages according to its depth and severity: I, II, III, IV, unstageable and suspected deep tissue injury. Some of the risk factors are advanced age, chronic illnesses, immobility, and malnutrition. (Flanagan, 2013; Nunan, Harding, & Martin, 2014).

The treatment for each wound develops progressively into more aggressive ones if the wound does not present positive progress. Each wound is treated differently and not all of them require medication intake, however, they should be tackled with a holistic management approach. If it is impossible to heal, the limb can be amputated (Flanagan, 2013).

4.3.4 Wound Management for Chronic Wounds

Due to the persistence of chronic wounds, a broad treatment should be carried out to support the healing process. An initial step would be prevention, but once a wound is formed a second step would be to reduce the risks of infection and aggravation, followed by the promotion of the development of healthy tissue. Standard procedures include cleansing, debridement, moisture balance, and wound dressing. The treatment for each wound develops progressively into more aggressive ones if the wound does not present positive progress. Every step is more complex and expensive than the previous one. Each wound is treated differently and not all of them require medication intake, however, they should be tackled with a holistic management approach. If it is impossible to heal, the limb can be amputated. (Flanagan, 2013)

The European Wound Management Association (2014) suggests that better results can be achieved with a multidisciplinary team approach, since “no one profession has all the skills required to address the complex needs of individuals with wounds” (p32). Additionally, the HCPs should have the patient at the core of their work, taking into account the overall context of his or her health and well-being.

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5 The removal of dead or infected tissue.
4.3.5 The Burden of Chronic Wounds

Chronic Wounds have serious consequences for patients, which include pain, loss of function, the decrease of quality of life and independence, amputations and even death.

At the same time, wound care implies a major cost to public healthcare that is often underestimated due to be considered as merely nursing practice routine (Flanagan, 2013). Although the economic cost is different in every country, it has a significant impact around the globe, taking up to 3% of the healthcare budget in developed countries (Frykberg & Banks, 2015). The United States spends US$25 billion annually on chronic wound treatment (Sen et al., 2009) while the average cost is up to €1994 in the UK, per person per year, and up to €2585 in Sweden (Tennvall & Hjelmgren, 2005).

While reducing the costs without compromising the quality of care would demand different efforts in every organizational level, a key component is the implementation of a comprehensive data monitoring, clear documentation, training/education program for HCPs and the facilitation of communication between the involved groups (Flanagan, 2013). Therefore, this study aims to make a contribution by exploring these topics within the use of EHRs.

4.4 Related Work

To the best knowledge of the researchers, there is a relatively small body of literature that is concerned with the designing of IT systems for the treatment of chronic wounds. Nevertheless, related work has been done and it will be introduced in this section.

There are different areas related to chronic wound treatment and IT systems. One of them is the usage of machine learning to improve the care of chronic wounds. By applying machine learning algorithms, Kaewprag et al. (2017) were able to improve the identification of risk factors and raised the sensitivity of the prediction of pressure ulcers. Another research project within the field of machine learning used data that was collected in outpatient wound care centers to develop a predictive model for delayed wound healing (Jung et al., 2016).

Likewise, there are also attempts to improve the care of chronic wounds by the usage of a wound measurement devices (WMD). Applying manual methods to determine the size of a wound can lead to less accurate and less reliable results. The use of a WMD can enhance the accuracy and reliability of the measurement data (Nemeth, Sprigle, & Center, 2010). Similarly, Bowling et al. (2009) assessed an optical wound imaging system able to create a 3D image of an ulcer by comparing the results of traditional elliptical wound measurement methods on the same wounds. The results of this research showed the advantages of digital measurement techniques over traditional ones, including the accuracy and the ability of reproduction of the data. Which enhances wound management and improved compliance with care plans by reducing subjective interpretation and inter observer variability.

Some studies were found within the topic of telehealth. In their research, Le Goff-Pronost et al. (2018) aimed to identify the impact telemedicine would have on clinical effects and costs of the treatment of chronic wounds. To reach this aim, they investigated into two groups of patients. The treatment of one group was supported by telemedicine whereas the other group retrieved traditional treatment. The primary outcome was healing. It was found that the time it took to heal a wound was shorter within the group of patients that applied telemedicine. In the same vein, Barrett, Larson, Carville, & Ellis (2009),
trailed a telehealth solution implemented in a rural area and described the systemic barriers encountered during the adoption. The solution consisted of a shared electronic wound imaging and documentation system used for teleconsultation on patients with chronic wounds in different health care facilities. This system aimed to address the problems raised by the implications of different healthcare facilities, the lack of knowledge and training on chronic wound management within the nursing staff, deficient access on expert review, inaccuracy on documentation, and lack of security in data sharing among the different providers. Furthermore, Pak et al. (2018) investigated the accuracy of a smartphone-based teleconsultation system for chronic wound management. The system collected data entered by the patient and the caregiver, and was shared with the physician in addition to an automatic treatment recommendation. The researchers compared the generated recommendations against the primary manual recommendations, having similar outcomes as results. Additional findings highlighted that caregivers improved their medical knowledge after the implementation of this system, patients felt comfortable knowing that their medical records were meticulously monitored, the adoption of mobile technologies was easier, digital measurement tools reduced the subjectivity of that task, and it was identified that HCPs had difficulties assessing wounds with pictures alone and preferred to use videos to undertake this issue.

The literature regarding UCD methodology applied for the design of digital tools for chronic wound care was scarce, but two relevant studies were found. In their case study, Wang et al. (2018) designed and developed a mobile system for chronic wound management that helps managing the flow of the nurse’s tasks as well as met the requirements for the care of each kind of wound in primary and secondary care. Their process consisted of five methods: 1) general clinic requirements for wound management was collected through interviews with nurses, 2) context about the nurse’s task regarding wound care was acquired through contextual inquiry in clinics and wards, 3) a prototype of a smart system solution was built, 4) cognitive walkthrough with nurses helped enriched the prototype iteratively, 5) finally, the system was evaluated by carrying out user satisfaction evaluation and resulted to be effective in a clinical setting. Some of the main functionalities of the smart mobile system are the implementation of a precise wound measurement tool, wound healing monitoring, standard and comprehensive wound assessment and integrated wound case management of the EHR used in the different healthcare facilities. In the same way, in the user trial study of Friesen, Hamel, & McLeod (2013), the researchers developed and evaluated a mobile app for documenting pressure ulcers in the setting of home care which replicated paper-based charting. There was a special focus on data visualization for a user friendly interface, in addition, the features took into account the needs of the caregivers for document pressure ulcers. Nurses were trained on the software and asked to use it for a specific time, afterwards it was evaluated with a survey and a focus group. It was reported to support remote consultation, enhance data organization and analysis, and provide with tutorial information to non-specialized caregivers. In addition, important findings were identified regarding the key role of wound photographs, integrated communication between the involved HCPs, and the advantage of Telehealth capacities.

Finally, a study conducted by Gunningberg, Dahm, & Ehrenberg (2008) investigated into the accuracy of the recording of pressure ulcer prevalence and prevention. They compared data that was gathered before and after the implementation of an EHR, including templates specialized for pressure ulcers. Before the implementation of the EHR, paper-based records were used. It was found that the accuracy in recording enhanced after the implementation when compare it with the data from the paper-based records. Nevertheless, there is still room for improvement, since the information that can be found in the EHR is still not reliable.
Together these studies provide important insights into the importance of IT systems regarding chronic wounds care.
5. Methodology

A user-centered approach was applied in this study by conducting several methods. These methods were executed in four phases (see Figure 2):

- Phase 0: Pre-study. Understanding the context.
- Phase 1: Semi-structured interviews and thematic analysis. Understanding the users.
- Phase 2: Prototype. Interface Design.
- Phase 3: Focus group. Evaluation.

The methods will be described in detail within the next three chapters.

Figure 2. Methods overview
6. Phases 0 and 1 - Understanding the Users and the Context

6.1 Pre-Study

In order to get familiar with the topic, an exploratory approach was used to acquire an understanding on chronic wounds and the Swedish healthcare system. A general overview was presented by the representatives of Region Uppsala during the initial meeting. Furthermore, previous knowledge was gained during a student project for the course of Medical Informatics on EHRs, which was carried out on behalf of the same institution.

Data for this pre-study were collected using a workshop with two IT coordinators from the hospital, a training session with their EHR software, COSMIC, and an expert interview with a pressure ulcers expert. These activities took place in the hospital offices. The results were used, in addition to the background findings, to design the study.

6.1.1 Exploratory Workshop

An exploratory workshop was arranged by two IT coordinators from the hospital. The aim of the session was to introduce the researchers to the Swedish healthcare system and give an overview on its IT systems and facilities. It was realized within the Elektronisk Patientjournal offices at Uppsala University Hospital and took 90 minutes.

It consisted of a preliminary presentation regarding the different healthcare facilities in Sweden and how they operate through Region Uppsala. Followed by a collaborative construction of a patient journey by the coordinators.

For the patient journey, the coordinators created a scenario surrounding a fictional patient with attributes they considered added enough realism and complexity to example. The case consisted of an elder woman with several pressure ulcers due to lack of mobility, with an additional heart disease. Her journey starts at the nursing home, where she has a heart attack and go to the ER with the help of an ambulance, from there she is transferred to the cardiology ward and eventually she is canalized to the geriatric ward. Once she is stabilized she returns to the nursing home. During this process, the patient records are documented and retrieved in different systems. Additionally to COSMIC, the main EHR at Uppsala University Hospital, other systems play an important role, such as NPÖ, Sibet, Prator and Mobi Med.

For illustrating this process, the coordinators used sticky notes, markers and a whiteboard. The researchers contributed by asking questions while identifying the information flow and the artifacts that supports it. The information resulted from this session was analysed and concentrated in a diagram, which can be consulted in appendix H - patient journey, and helped the researchers to understand the context and plan the study.
6.1.2 Training Session with COSMIC

The training session was effectuated in a training lab and lasted one hour. It was instructed by the IT Administrator, which part of her duties is to express the hospital’s needs to the EHR provider. It was held in English, although the interface was in Swedish, for which the instructor translated the main subjects.

The aim of the session was to acquire familiarity with the interface used by the medical staff for assessing and treating chronic wounds. The session focused on the templates for pressure ulcers, which are standardized forms that allows the HCPs to describe a wound.

After the session, some of the screens were provided by the Elektronisk Patientjournal staff, as well as documentation regarding the prevention and treatment in inpatient care for pressure ulcers, which are part of the health care manual followed by the system.

6.1.3 Expert Interview

After the researchers informed themselves on the topic of chronic wounds, a healthcare developer specialized on pressure ulcer prevention was reached in order to overcome uncertainty on the subject. The approach of the interview was informal and it was performed in the hospital’s library, lasting one hour.

Preliminary questions were addressed resulting in following inquiries. The interview was focused on the process of acquiring a wound, the job roles who take care of wounds and what they take into account for deciding on a treatment, how the templates are used in the hospital, how the treatment is followed through the template and how the skin assessment is carried out. In addition, the expert disclosed official protocols and procedures surrounding pressure ulcers.

The resulting information was crucial for the design of the semi-structured interview questionnaire.

6.2 Phase 1. Semi-structured Interviews

6.2.1 Description

After familiarizing with the currently used software, the topic of chronic wounds and the workflows within healthcare facilities in the pre-study the next step was taken. Semi-structured interviews were carried out among the target audience of HCPs working with wounds and wound treatment. The aim of the semi-structured interviews was to gain insights into the working environment of the participants and understand their needs and requirements. The focus was on retrieving information, sharing information and documenting information. To be able to describe these needs and requirements the focus during the interviews was on three different parts. The first part was focusing on the information the users need to create, evaluate and update a care plan and a status. Within the second part it was crucial to find out how the information was shared between other users in the hospital as well as outside the hospital. Finally, the interviews included investigating into problems that currently occur as well as suggestions and requests the participants have towards a system.
6.2.2 The Settings of the Interviews

To understand the issues and challenges of the user's eight semi-structured interviews with HCPs were conducted. In addition to this, a pilot interview was performed to identify potential problems and flaws within the prepared interview protocol. The results of the pilot interview were used to improve the protocol for the semi-structured interviews. The participants were recruited with the help of the E-health Project Manager at Region Uppsala, since working with public officers required the recruiting process to be handled from a higher hierarchy. They worked in different health care facilities in Region Uppsala and had different roles and tasks:

- Nurses at the vascular ward of the Uppsala Academic Hospital
- Nurses at the geriatric ward of the Uppsala Academic Hospital
- Nurses assistant at the geriatric ward of the Uppsala Academic Hospital
- Foot therapist at the diabetic ward of the Uppsala Academic Hospital
- Care developer at the journal documentation department of the Uppsala Academic Hospital
- Nurse at a private municipal home care.

All participants were related to treating chronic wounds and the process of documenting and sharing information regarding chronic wounds. The interviews were held in English and occasionally, a dictionary was used. However, one interview was held in Swedish. A native Swedish speaker was asked to conduct the interview. This person was a fellow HCI student and experienced in conducting interviews. Moreover, she was briefed by the researchers on the topic of the project and the aim of the interviews. Each interview took place in the working environment of the participant and lasted for 40 to 60 minutes. All interviews were audio recorded. When the researchers first contacted the participants, they were provided with an information sheet containing a summary of the project and the most important information regarding the interviews including the contact information of the researchers to be able to ask questions. Before starting the interviews the participants were educated on their right to withdraw their participation at any time, they were informed that the sessions will be audio recorded and they had a chance to ask questions. Finally, they got a consent form to sign. After the interviews the recorded sessions were transcribed by the researchers. The one interview that was held in Swedish was transcribed and translated to English by the same person that held the interview. The questions and the consent form of the interviews can be found in appendix A and D.

6.3 Thematic Analysis

After conducting the semi-structured interviews the gathered data needed to be analyzed in order to identify meaningful findings. To do so, a thematic analysis was applied aiming to find patterns and themes. A thematic analysis includes six steps (Mortensen, n.d.):

1. In the first step the researches got familiar with the gathered data. This process already started when the interviews got transcribed.
2. Within the second step relevant data was marked and summarized to codes. These codes were written on post its to be able to further process them. In this stage the data was only marked as being relevant and not interpreted.
3. The third step consisted of interpreting the data and identifying themes. For this purpose the post its were spread out and sorted, one by one, into themes using a whiteboard. After this step 16 themes were identified.
4. Within step four the identified themes were reviewed, rearranged, merged and split.
5. In the fifth step the themes were named and grouped into five major themes. Each of these five themes contained several sub-themes.
6. The last step was to describe the findings of this thematic analysis.

The general aim of this research project is to determine the requirements an EHR has to meet to gain usability regarding sharing, entering and retrieving information when treating chronic wounds. The data gathered within the semi-structured interviews was looked at with respect to this aim. Patterns and topics that reappear were found and grouped applying a bottom-up approach. The thematic analysis resulted in five major themes. Each theme shed light into the goal of understanding the users, their behavior, workflows and tasks and the current issues they face. Moreover, the themes provide insights into the work environment the users and the system are part of. The themes are connected to each other and they do overlap. Each of the five themes contains at least one sub-theme. The results of the thematic analysis were processed in two steps. In the first step, problems and issues were formulated for each of the themes and sub-themes. In the second step, solutions for each problem and issue were identified.

6.4 Results from Thematic Analysis

This chapter includes the results and findings of the semi-structured interviews and thematic analysis. Moreover, the outcome of the pre-study is applied in this chapter. After describing the results in detail, a summary will be provided in the end of this chapter. The following list of five major themes were identified:

1. **Information**: Describes how information is gathered, shared and retrieved.
2. **The nature of the system**: Describes the complexity of the system.
3. **Work environment**: Describes the characteristics of the environment.
4. **Health aspects**: Describes the characteristics of the procedures and medical implications.
5. **User’s behaviours and expectations**: Describes how the users are working with the system, which expectations are not met by the system and what they are wishing for.

6.4.1 Information

The theme **information** covers the areas of sharing, entering and reading information. Within the interviews, it was found that sharing information can be done among colleagues, that work within the same healthcare facility or it can be done with HCPs that work within another healthcare facility. The shared and entered information can be of two different kinds. First, it can be information regarding the status of a wound, this kind of information describes the characteristics of a wound such as size and location. Second, it can be instructions regarding how to treat the wound. In total this theme consists of four sub-themes, which are Retrieving information, Information flow (inside and outside the hospital) and Instructions and Documentation.
General Description and Purpose of Retrieving Information

Retrieving information is one of the core functionalities an EHR should provide its users with. According to the interviewees, HCPs are in need of information before seeing a patient to know the current status of the wound and to be able to prepare accordingly. It is also important to get information on the occasions and measures of the previous shift. Also, the HCPs might be interested in the patient’s history. It can be crucial to know for how long the wound existed and how other HCPs treated the wound. Moreover, the participants stated that, retrieved information is also the basis for the daily tasks of a HCP. The interviews have shown that HCPs would read the information in the system and then decide on what their tasks are during their shift. However, the EHR is not the only information source the HCPs are accessing. Other sources, besides the EHR are consulting other HCPs, the patients themselves, their own memory of the HCPs and observations on the patients.

Problems found in Retrieving Information

After analysing the interviews, four issues within the process of retrieving information occurred:

1. First of all, it turned out that the information is distributed in a decentral way. According to the participants, information can be found inside and outside of the system. Moreover, the information a HCP is looking for can be stored in different places within one system, but it could also be distributed among other systems. Information sources outside the system are the patients themselves and other HCPs. HCPs retrieve information from the patients not only by assessing them but also by talking to them. The interviewees reported that talking to the patient can be the only information source a HCP have to know where information about this patient is stored. In this matter there is no way to be sure that one has found all relevant information regarding a patient.

2. The second issue within this sub-theme is that the information is not provided in a useful way. According to the participants, there is no overview of one patient, no timeline and no list of tasks. Instead the HCP is asked to read a lot of information in different places in one system and also in other systems without knowing where the information will be found. On top of this, the participants criticized, that the information is mainly text based and it takes a long time for the user to go through it and extract the needed information. There is no visual support provided to present the development of the wound over time or to visualize where the wounds are located on the body. As a consequence the HCPs are confronted with an information overload. The provided information is not precis but rather elaborately.

3. Moreover, the interviewees stated, that the information is not structured according to what the users are looking for. Thus, the users need to read through everything regardless if they are looking for instructions on how to treat a wound, for a list of tasks, or for information on how the wound was treated in a previous facility.

4. Finally, the participants said, that not all information is accessible for all users. Patients are visiting different healthcare facilities and the information gathered there is not necessarily accessible for every HCP, even though they treat the same patient. This problem is caused by two factors: First, there are different systems used that do not communicate with each other and, second, the accessibility of the sensitive information is restricted by law.
General Description and Purpose of Information Flow

According to the participants, patients move back and forth in between different healthcare facilities, and the information regarding one patient is supposed to be transferable between those facilities. The information flows inside and outside the hospital, and also within one entity of a healthcare facility such as a ward within the hospital. The interviewees reported that the kind of information that is transferred can differ. It can be a treatment plan or it can be a description of the evolution of the patient during his or her stay in the facility. Within one entity of a facility it would be of interest to know what has happened during the previous shift. The participants stated that there are several information channels involved. The information can be transferred within an EHR among different wards in the hospital, and for certain healthcare facilities outside the hospital. However, not all healthcare facilities are able to exchange information using EHRs. There has been four communication channels identified besides EHRs during the interviews:

1. First, the patients themselves are an important information source. An HCP can provide oral information regarding the treatment plan of a wound to a patient. In a next step, the patient would pass on this information to another HCP working in another facility or entity.
2. According to the participants, another communication channel is a paper based treatment plan. It is filled in and printed by an HCP when the patient is about to be sent to another healthcare facility. The printed treatment plan is given to the patient who is then in charge of passing it on to the next HCP.
3. Whenever a patient is released from the hospital, an HCP is asked to write an “Epicrisis”. This is a summary of the status of the patient when he or she was hospitalized, what kind of treatments were applied during the stay in the hospital and, finally, the condition of the patient when he or she was released. The “Epicrisis” can be used as an information source by other healthcare facilities.
4. Finally, the last information channel to be mentioned is oral communication between different HCPs. The oral communication happens in person but also on the phone.

Problems found in Information Flow

Within the sub-theme of information flow, six problems were identified.

1. First of all, the participants criticized that there is no common terminology used. This problem applies for both settings, information that is passed on among different healthcare facilities and information that is shared within one facility. The participants stated that instead of using a common language a different terminology can be used for the same diagnosis or condition as patient has. Due to this, the information created from one HCP can be interpreted and understood in different ways from other HCPs. This leads to misunderstandings between the HCPs.

“(..) we can't use too many words for the same things, like for example when you have care plans about someone's cognitive abilities, that's so many words like psychosocial problems or cognitive problems or you say that someone is not adequate, it's so many words. But what is it? Is it for real like, a disease? Alzheimer? Or is it just, like you're down because of your infection (..)” P3.
2. A second problem that was found based on the interviews is the number of different information channels and places information can be found. As described above, information can be within different places in one system, it can be spread out in different systems, it can come on paper, or the patients themselves are used as a communication channel. These circumstances cause two problems that were pointed out by the participants. First, it takes a long time for a HCP to find the required information, since they need to go through all the different information sources. Second, they cannot be sure if they found all relevant information that is existing regarding one patient. The amount of sources is unclear and it depends on the facilities the patient has visited before. If the patient is able to tell where he or she was treated before, the HCP has a lead to follow, but still no guarantee to find everything. If the patient is not able to communicate the facilities he or she visited previously, it becomes even more difficult to know where the information is stored.

3. The last problem leads to the third one, the patients are a relevant part of the communication between healthcare facilities and HCPs. They are asked to pass on information and even supervise their treatment, give instructions on how to treat a wound and report how the wound was treated towards a HCP that developed a treatment plan for a wound. The latter is due to the fact that an HCP that is specialised within the area of wounds is giving out a recommended treatment plan on how to treat wounds but has no possibility to see if other HCPs have followed this treatment plan or not.

4. According to the interviewees, this problem is strengthened by a missing communication channel between healthcare facilities, which is the fourth problem within the sub-theme. During the interviews, it was criticized by the participants that it is hard for HCPs to further inquiry on a subject. Finding the right contact person, which could be the HCP that treated the patient last or a wound expert, can be difficult and time consuming. This is true for both directions, for the HCP that receives a treatment plan and has questions about it and for the HCP that received the treatment plan and sees that the wound was not treated the right way and want to further investigate.

5. As mentioned above, information is distributed, and it is hard to find the information one is looking for. On top of this, is not necessarily possible for all HCPs to access all information. There are two different scenarios that describe this problem. The first one is that the information can be stored in systems that are not accessible for HCPs that do not work with the same system. The second reason why information cannot be retrieved are legal restrictions.

6. Finally, information is shared using paper and it is the patient’s responsibility to make sure that this paper is transferred between healthcare facilities and HCPs.

**General Description and Purpose of Instructions**

According to the interviews, it was found that instructions or treatment plans can be created by all HCPs that are treating wounds. However, for treating wounds, the instructions and treatment plans are mostly created by nurses and, in this particular case, it is not mandatory for any other HCP to follow them. They are understood as recommendations. Treatment plans are shared by HCPs within one entity, within different wards of the hospital and between different healthcare facilities. The participants said that besides instructions on how to treat the wound - such as how to clean the wound, how often to change the bandage and so on-, the treatment plan includes the material that should be used and the medication that should be provided to the patient. When the wound hurts, medication such as painkiller needs to be dispensed a certain timespan before treating the wound. It is crucial to use the right material depending
on the kind of wound, using the wrong material can lead to serious damage on the patient. The treatment plan is shared among HCPs within the hospital using the EHR. However, when sharing a treatment plan outside the hospital, the treatment plan is printed and given to the patient.

Problems found in Instructions

This theme consists of five sub-categories. All of them are built around the major problem that was found in this theme, the fact that instructions are not followed.

1. First of all, wounds are mostly treated by nurses and not by doctors. Nurses, however, are not authorized to prescribe a treatment. Due to this, there is no mandatory treatment plan for most chronic wounds.

2. Another problem found based on the interviews is that different healthcare facilities have different healing material to work with. The material recommended in a treatment plan might not be available and therefore replaced. Some healthcare facilities do not have the financial background to afford more expensive materials and, even if the facility is ordering the material, it is not immediately available. As mentioned above, replacing recommended material can lead to serious harm on the patient depending on the kind of wound.

   "(...) some of the dressings are very expensive, they (other healthcare facilities) will not buy it because it's too expensive and they (...) use a cheaper dressing and because of that they will not follow my recommendation." P1.

3. Another problem that was reported by the participants is related to education and knowledge. According to them, there is a knowledge gap between different kinds of HCP-roles and there is only little focus on wounds within the education of nurses. The latter leads to different levels of knowledge regarding wounds, since some nurses get a special education on wounds later on but most do not. Different HCP-roles receive different medical education which leads to different levels of knowledge about medical procedures and the human body. As a HCP creating treatment plans, one can never know what knowledge level the HCP that is going to receive the treatment plan has. This leads to uncertainty and insecurity on both sides. The HCP that is writing the instruction needs to invest a lot of time to explain everything in detail. Therefore, in case a well-trained HCP is receiving the instructions it will contain a lot of unnecessary information and both of them would lose valuable time. In particular, the HCPs who are creating the instruction consider and review the words they are using very thorough. However, this exact information will be needed in case an HCP that has a lower knowledge level is receiving the instructions. These HCPs can feel insecure in how to treat a wound even if they have instructions to follow.

   "Some assistant nurses do not dare to write down the dressing they are using, because they are scared that they do wrong." Participant during the focus group.

4. As mentioned in the previous section, it is hard to find the right contact person to ask questions due to the lack of a communication channel.

5. Finally, the participants criticized that since the HCP receiving instructions feel insecure on how to follow them, it is uncertain for the one who created them if the instructions are followed and understood in the right way. In some cases, the only possibility to see if the wound was
treated as wished is to wait for the patient to come back for a follow-up and look at how the wound has developed and what material is currently used.

**General Description and Purpose of Documentation**

The interviews made clear, that documentation is a major part of the interaction between a HCP and an EHR system. The participants reported, that it is part of the daily work of an HCP to document information regarding the patient’s status, the measures that has been taken and the recommended treatment plans. These three aspects need to be covered for each diagnosis the patient has. Documentation is crucial to let the next shift know what has happened and how the patient was treated. It is also necessary to be able to receive information on the patient’s medical history and finally, the documented data can be used in research. During the interviews it was found, that HCPs in different healthcare facilities use different EHR systems for documentation. While most HCPs document on their own some of them dictate the information using a record device. In these cases, the documentation within the system is done by assistants. When it comes to workflows within documentation it was found that some HCPs document after each patient whereas others document after seeing all patients. Moreover, most of the participants take notes on paper as memory support between seeing a patient and being at the computer to document. This can be a blank paper but also paper with the shape of a human body printed on to mark the location of the wound. To support the determination of the pressure ulcer category some HCPs have a card with them that shows pictures of the different categories. This pictures can be compared with the pressure ulcer a patient has and help to decide on a category.

**Problems found in Documentation**

1. During the interviews six problems regarding documentation were identified. The first two problems are related to each other and are concerning the emotions HCPs have when it comes to documentation. While the participants described documentation as absolutely necessary for their work, they have rather negative feelings towards it. One of the participants said that he feels like the time he spends documenting is time he cannot, but should, spend with the patients. To him, documentation takes away too much of what he sees as his actual work.

   “The main thing is like you collect all this information and scrabble it down in your paper, and then you have to sit down and do documentation. I think that is not fun. I want to be with the patient, it (documentation) takes time away from doing what I'm supposed to be doing, I think.” P8

2. Closely related to the negative emotions HCPs have regarding documentation is the second problem that was found. The interviewees described documentation as too time consuming. To them, the time they spend documenting is not adequate.

3. The third problem is that documentation of the same content is often done more than once. According to the participants, this is happening on two levels. The first one is that most HCPs take notes on paper as memory support as they go from patient to patient. In this matter, they document twice, first on the paper and later taking the paper notes to the computer. The second level is that the same content can be documented by different job-roles in different places within the system. In this scenario, time is not only over spend to document, but also the amount of information is unnecessarily increased and HCPs already suffer from an information overload.
4. The problems four and five can also be seen as related. The participants reported that the current systems do not offer visual support. Instead, the status of a wound - including, among other factors, location, size and smell - are described using words. However, the participants argued that it is difficult and time-consuming to describe a wound using words only.

5. Problem four leads to the fifth problem. The words used to describe a wound can be interpreted differently by different HCPs, which leads to misunderstandings. Furthermore, it takes more time to read texts when compared to visual supported information.

6. Finally, the last identified problem is that the documented data is not reused in an efficient and effective way. Instead of providing the HCPs with a list of his or her tasks, the HCPs are asked to read through all the information themselves, identifying the tasks they need to perform and putting them in order.

6.4.2 The nature of the system

This theme describes the system itself and how it is perceived by its users. It investigates into the expectations of the users towards the system and how the users cope with it. Moreover, it reveals how satisfied the users are with the system. The theme includes two sub-themes, the first one is called the complexity of the system and the second one tackles the topic of standards within the system.

General Description and Purpose of the complexity of the system

Due to the fact that a majority of the participants work or are familiar with COSMIC, the focus of this section will be on this system. COSMIC is used as an EHR system at the Uppsala University Hospital. It is used by a number of different HCPs and it is placed in a complex work environment. It is constantly improved and expanded, resulting in constant updates. During the interviews it was found that HCPs use COSMIC for documentation, retrieving information and sharing information. It is so integrated into their daily work life that some of the participants have never worked with a different EHR system before.

Problems found in the complexity of the system

A total of five problems were found when looking into the sub-theme of the complexity of the system.

1. First of all, as the name of the sub-theme already indicates, COSMIC is a complex and huge system. It is used in a complex environment and provides a large amount of templates and features to its users. As a result, COSMIC is not easy to learn. According to the participants, it takes time and training to get familiar with the system and even experienced users might not be aware of the variety of features the system offers.

“(...) it's (COSMIC) not like a computer program that you have at home where you just can look at it and understand how it works. Someone has to teach you how it works, so it's not like user friendly in that way. See, if you buy a program for your computer you kind of get the feeling of it on your own, but not this one, here you have to take classes to learn.” P8
2. The second problem that was identified is related to the first one and to the constant updates of COSMIC. After each update the user interface of COSMIC is different. Workflows and processes that were learned by the HCPs need to be relearned. The attitudes of the participants towards these updates were in conflict with each other. Whereas a part of the HCPs appreciated updates other stated that they were confused by the updates and that they preferred the previous versions of the system.

3. The third problem is about how information is entered into the system. As mentioned before, COSMIC is used by different HCPs that own different job-roles. Depending on these job-roles, COSMIC offers different templates and areas to enter information. In this matter, the participants reported that the same information finds its way into the system and is stored in different places. The participants said that, as a result, information is entered multiple times and the amount of information to read is increasing.

4. The fourth identified problem is about the mental models of the users that do not match to the appearance of the system. It was found from the interviews that COSMIC was perceived as unmodern. Also, the information architecture is not fitting to what the HCPs expect. During the interviews it was mentioned that COSMIC is lacking a patient overview that specifically meets the requirements of nurses. Regarding the overall satisfaction with the system, all participants agreed that an EHR system is an absolutely necessary tool. However, the majority of the participants were rather not satisfied with COSMIC.

5. Finally, the participants criticized, that the data that is entered in COSMIC is not accessible to all HCPs treating one patient. This problem can occur among different wards within the hospital but it mainly occurs when patients move between different healthcare facilities.

General Description and Purpose of Standards

Standards are already implemented within COSMIC. There are different standardized formulas for different kinds of wounds to begin with. COSMIC also provides different job-roles with different standardized formulas. Standards are needed to reduce complexity for the HCPs and to be able to process the gathered data.

Problems found in Standards

Even though COSMIC provides certain standards to its users, a problem identified during the interviews was the lack of standardization. According to the participants a lot of text is entered and later on read by HCPs during documentation. Entering free text leads to a large amount of information. Moreover, interviewees reported that the information entered is not distinct but can be interpreted. A certain condition a patient is in can be described using many different words that have different meanings for each individual.

6.4.3 Work environment

This theme describes the nature of the working environment the HCPs work in and the system is used in. It provides insights into the structure the HCPs work in and the kind of relations between different HCPs. Moreover, it investigates into the working processes and habits of HCPs and how patients move
between different healthcare facilities. The theme consists of three sub-themes which are related to the hierarchy of the different users, the workflows and finally the patient’s journey.

**General Description and Purpose of Hierarchy among HCPs**

HCPs are working together having the common aim of improving the patient's condition or healing the patient. However, a hierarchy is applied within healthcare facilities. During the interviews it became clear that there are defined lines between different HCPs, as so as for their responsibilities and authorities. Whereas some participants described themselves as working as a team, most of them perceive this hierarchy as significant. Each job-role is related to a certain level within the hierarchy and these levels are connected to specific expectations regarding the tasks and responsibilities. Even though they treat the same patient and have the same goals, they might not equally value the work and pay attention to the work of each other. They rather look at the patient from their perspective only.

**Problems found in Hierarchy among HCPs**

Within this sub-theme, three problems have been identified. The first one to mention is that physicians and nurses do not perceive themselves as working in a team. This becomes not only clear through how they work with each other but also through the way the system facilitates their work. According to the participants, they write and read within different areas in COSMIC. This is why they document the same content more than once, but they also need to check out different places to find information or might even never notice relevant information. The second identified problem is that there is a lack of understanding between nurses that work in different healthcare facilities. Nurses that work in one facility might have different tasks and work routines than nurses in another facility. Due to that, they perceive instructions and information differently which can lead to misunderstandings and frustration. Finally, it was described by the participants, that treating wounds is seen as a nurse’s responsibility. Physicians check wounds only on critical occasions, and chronic wounds are not an exception. This results in a lack of an official diagnosis and therefore also in a lack of mandatory instructions to follow. On top of this, there was a deficit of knowledge found among nurses.

“(...) doctors are not really interested in wounds, and they have some in their education -but very, very few- and so have we (nurses). I had four hours of education on my ‘Basic Education’” P1

Some nurses have a special education in wound treatment. However, most of them only have little education on wounds and wound treatment. According to the participants, there is only very little time spend to provide knowledge on wounds during their education. This problem gets intensified when one considers that wounds are not exclusively treated by educated nurses but also by less trained HCPs. The above mentioned leads to the impression that the hierarchy goes beyond different job-roles and also applies on diseases and chronic wounds seems to have a rather low position within the hierarchy.

**General Description and Purpose of Workflows**

The interviews have shown that different HCPs have different workflows and approaches to complete their tasks. This was identified within different HCPs in different healthcare facilities but also among
HCPs that have the same job-role and work in the same facility. One example is that some participants said they would document after each visit, whereas others prefer to see all patients first and document afterwards.

Problems found in Workflows

The problem that occurs in this sub-theme is the challenge of making the system fit to the many different workflows and approaches the HCPs have. The system needs to provide adequate support for each of these approaches. At the same time, complexity should not be increased but decreased.

General Description and Purpose of the patient’s journey

The participants reported that a patient is rarely only treated in one healthcare facility. Rather the patients do move from one facility to another. They move back and forth, been treated by many different HCPs resulting in their medical history been entered into different systems. According to the participants, these systems -and, therefore, also the information they contain- is not accessible for all HCPs treating the same patient.

Problems found in the patient’s journey.

The patient’s journey through the different healthcare facilities is unpredictable. The fact that their data is entered in different systems and retrieved by HCPs having different backgrounds is adding complexity to the process of treating the patient. The interviews have shown that the system is not supporting communication between HCPs that work in different facilities. Therefore, there is a clear cut between those HCPs and it is hard to contact each other in case questions occur. Currently, the communication and exchange of patient's medical information is not matching to the way the patients are moving between the healthcare facilities.

6.4.4 Health aspects

This theme takes the perspective on different characteristics and aspects of wounds. It describes the nature of wounds and other medical and health related aspects that are related to wounds and their influence on how HCPs treat them. These factors imply how the system should be designed in order to support the treatment in the best possible way. The theme includes three sub-themes. The first two are focusing on wounds and are named “Different kind of wounds” and “Development of the wound”. The last sub-theme is focusing on the patient as a whole and how wounds are connected to other diagnoses and conditions. It is called “The patient looked from a holistic view.”

General Description and Purpose of Different kind of Wounds

During the pre-study and the interviews, it was found that there are many different kinds of wounds. Even though this research was narrowed down to chronic wounds there are still different kinds of
chronic wounds to consider. This is done within this sub-theme which is investigating the differences and how they affect the work of HCPs.

**Problems found in Different kinds of Wounds**

According to the participants, different kinds of wounds do require different kinds treatments. The healing material used to dress the wound, the timeframe that sets how often the dressing should be changed and the medication used, are just some examples of the factors that are determined by the exact diagnosis of the wound. A system that supports taking care of wounds should offer standardized templates for the different wounds. It should be flexible to offer what is needed for each wound and, at the same time, it should provide its user with a fixed and standardized framework to follow. Besides the treatment, the system should also provide support to determine what kind of wound a patient has. The participants reported that they have visual support in the form of a paper card, showing pictures of the six pressure ulcer categories to be able to define the right category. Within the different healthcare facilities and job-roles, there are HCPs that treat the whole range of different wounds whereas other HCPs are specialized in one particular kind of wound. The interviews have shown that the HCPs that treat different wounds are likely to not only focus on wounds but on the patient as a whole. The system should adjust to the varied workflows and requirements that occur from these circumstances.

**General Description and Purpose of Development of the Wound**

During the interviews, the participants explained that a wound is developing over time. Chronic wounds can persist for a long period of time and in this period, they can develop in both directions. They can get better, but they can also become worse. The interviewees stated that according to their development the treatment plan and status of the wound need to be adjusted and in case the wound keeps getting worse an expert needs to be consulted. Furthermore, the HCPs are asked to document the development to be able to go back in the wound’s history.

**Problems found in Development of the Wound**

According to the participants chronic wounds can last for a long period of time. HCPs do document the development and there can be a lot of data stored regarding one wound. The participants criticized, that this makes it hard for them to get a fast overview on the current state of the wound and its development. The situation aggravates due to the fact that there is no visual support to show the wounds development. Visuals would make it easier to compare a past state of the wound with the current state. Instead it requires a lot of reading to get to know the wound’s history. Considering that it is common that patients have more than one wound it becomes clear how time consuming it is for HCPs to retrieve the required information. However, the participant pointed out, that it is crucial for HCPs to know how the wound is developing since changes in the development might require a change of the treatment plan. In some cases, the development also demands the opinion of a wound expert. In this case the HCPs might be asked to find another HCP outside his or her own healthcare facility which can be hindered by the lack of a communication channel between the healthcare facilities as described in 6.4.1 Information “Problems found in Information Flow”.

32
General Description and Purpose of the Patient looked from a holistic View

A majority of patients that suffer from chronic wounds do have other diagnosis in addition. They have different kinds of struggles and some HCPs do treat several of the diagnosis a patient has while other are specialized into a certain area.

Problems found the Patient looked from a holistic View

According to the participants, the patient is mostly not looked at as a whole entity but only from a certain perspective. This is related to the hierarchy and the different job-roles which are described in 6.4.3 Work environment “Problems found in Hierarchy among HCPs”. However, interviewees suggested that the patient should be seen as a whole. For instance, it is important to know how mobile a patient is and if the patient has any nutrition issues to be able to treat a wound. This illustrates that looking at the wound only is not enough and isolating the wound from the person is not recommended.

6.4.5 User’s Behaviours and Expectations

The fifth theme is investigating into the user’s behaviour and the expectations the users have towards the system. It describes how the users deal with situations in which the system is not providing the required support. Moreover, it offers insights into what the users are wishing for and how the system is involved in the process of decision making. The theme consists of the two sub-themes “Wishes” and “Workarounds”.

General Description and Purpose of Wishes

The second part of the semi-structured interviews was about asking the participants what they would wish for. The researchers pointed out that no technical or legal restrictions should be considered. Rather the participants should envision a perfect system that supports their work in any matter. Whereas most of the participants had clear ideas and suggestions some of them struggled in imagining a different system. However, some suggestions were mentioned by almost all participants. Due to this a clear picture of five features the participants are missing was identified.

Wishes found

Among the seven identified wishes, the first three were outstanding due to the fact that they were mentioned by a majority of the participants.

1. The first one is related to the amount of different systems that are used among the healthcare facilities and the legal restrictions. Both factors are contributing to the fact that not every HCP can access all the information stored about a patient. The participants argued that they cannot access required data. On top of this, they said that they cannot be sure if HCPs that are going to treat a patient in the future can access that data they enter. They stated that they would appreciate it if it was certain that all HCPs treating one patient could access all data regarding this patient. In the matter of accessing data a majority of the participants said that they would
wish for a quick access on the right data. The system should only provide them with relevant information. One of the wishes related to this one was that the participants asked for a common terminology. They argued that this would reduce misunderstandings but also the amount of text entered in the system.

“(...) my wish is that everybody could read what I have written down. Then, we don’t need to use this paper because all the information is in the computer. So, that would be my best wish in the world, that everybody could read it.” P2

2. The second wish which was mentioned by all participants was the use of visual support to document the wounds. The participants asked for pictures they could take, upload in the system and share with other HCPs across different facilities. Besides pictures the HCPs also asked for interactive visual support such as sketches of the human body to mark the location of a wound. Visuals would offer the possibility of grasping the status and development of a wound on one glance. Sharing pictures with other HCPs could support consulting sessions. Finally, the participants argued that it was faster to mark the location of a wound and further to see where the wounds are located using visual support when compare it to write and read text.

3. The third wish the majority of the participants had was related to improvements regarding the documentation of wounds. Different suggestions on how to improve the documentation process were made. Currently, there is a lot of paper notes involved in documenting. Most of the participants document on paper, while they see the patients and later on they put the information from the paper into the computer. In that matter the participants suggested a mobile version they can take with them when seeing the patient. Another suggestions to improve the documentation process was to reduce free text by preset options. Connected to this was a wish for templates and standardization. It was asked for templates which provide standards and preset options and at the same time offer room for customization to improve documentation. One participant mentioned a speech-to-text feature to reduce the amount of time spent on documentation.

4. The fourth wish was mentioned by one participant and is also related to documentation. The participant argued that HCPs do document the mental state of a patient or the perceived level of pain. This information is interpreted first by the HCP that talked to the patient and entered the information and in a next step from the HCP that reads the information. Through these two steps the actual statement of the patient can get biased. To avoid this the HCPs stated that the patient should be able to enter data him or herself using a mobile version of the system that is available at each bed.

5. Another wish mentioned was that the system should provide a list of tasks the HCP needs to complete during a shift. This list should be interactive to be able to mark what was done and it should be shared with other HCPs working the same shift.

6. The sixth wish that was mentioned by the participants is to avoid having treatment plans shared on paper. As already mentioned treatment plans are printed and given to the patient. The patient is then responsible to pass on the treatment plan to the next HCP. The participants would like to be able to share those treatment plans in a way that does not include the patient being responsible. Furthermore, a printed treatment plan offers no opportunity for any kind of interaction.

7. Finally, the last wish, that was mentioned by one participant is to have the option of video-calls with patients. Some patients travel for having a follow up on a wound. This could be avoided by a video-call. During the video-call the patient should be accompanied by a nurse working in
a healthcare facility. This would enable a direct communication between nurses working in different facilities and the wound expert.

General Description and Purpose of Workarounds

When the system is not supporting the workflows and processes of its users workarounds accrue. This sub-theme describes two workarounds that were identified. The first workaround is regarding paper notes the participants use and the second is related to the lack of visual support.

Workarounds found

Based on what the participants said during the interviews it was found that they use paper notes in addition to the system. The interviewees mentioned that they first read through the information in the system and then create lists on what they need to accomplish during their shift using paper. Furthermore, paper notes are also used as memory support between seeing a patient and documenting. The second workaround that was found arises from the lack of visual support. The participants mentioned that they upload pictures in the system even though they are not supposed to. Moreover, one participant said that she uses her private phone to share pictures of wounds with other HCPs. She stated that this is her only way to provide a HCP she wants consultancy from with visual support.

Summary of the most important Results

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1.</td>
<td>The patient is not in the center of the system</td>
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<tr>
<td>2.</td>
<td>Information can be in different places</td>
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<tr>
<td>3.</td>
<td>There is an information overload</td>
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<td>4.</td>
<td>It is difficult to gain a quick overview of the patient’s history</td>
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<tr>
<td>5.</td>
<td>Communication between different facilities is not supported</td>
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<tr>
<td>6.</td>
<td>There is no or only little visual support</td>
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<tr>
<td>7.</td>
<td>Documenting wounds using words is challenging</td>
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<tr>
<td>8.</td>
<td>There is a knowledge gap across different HCPs that treat wounds</td>
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6.5 Recommendations

As reviewed in previous chapters, a system which aims to facilitate the documentation and tracking of chronic wounds across different healthcare facilities would need to tackle several challenges. Firstly, it should guarantee the prompt and easy access of relevant information, which can be easy to retrieve, analyze and use. Secondly, it should be understandable and easy to use in spite of its complexity. Thirdly, it should work attending the characteristics of the workplace practices while supporting overcoming obstacles. Fourthly, it should reflect the clinical procedures that are carried out by the users outside the system. Fifthly, it should take into account the users behaviours and expectations.

Above this, the approach of the system should focus on the patient well-being. This criterion would prioritize those functions that help the HCPs to provide the best medical attention without requiring a lot of cognitive load that can interfere with their performance.

Considering all of the previous statements, a set of product requirements are proposed as a complement of an EHR system. The following requirements were classified into functional and non-functional (Robertson & Robertson, 2012).

6.5.1 Functional Requirements

Functional requirements consist of what the product should do and provide. For this matter, they were arranged in three categories: Information architecture, Visual interface and Features.

<table>
<thead>
<tr>
<th>A. Information architecture</th>
<th>1. Entered data should be classified in order to be reused when necessary. Some of the benefits could be avoiding different users entering the same information multiple times, using the data as source for an automated to-do list and running statistics.</th>
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<tr>
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<td>2. A clear information structure should be provided thus improving findability. This includes, but not exclusively, navigation, information hierarchy and labels. As long as allowing information to be easily filtered and sorted.</td>
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<td>3. The system should provide standardized templates as long as conferring a certain range of flexibility and customization</td>
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<td></td>
<td>4. Even though users are consulting information regarding a wound, complementary reports regarding the overall patient’s health should be presented at hand for informed opinions.</td>
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<td></td>
<td>5. Relevant information regarding a patient should be available for any of the HCPs treating him or her regardless of their workplace. As long as it is aligned to the patient data privacy, collaboration and</td>
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</table>
communication between the users, as well as transparency in the information, must be supported.

6. As an extension of the last point, it should be clear what healthcare facilities the patient has visited, when and what procedures were carried out there.

7. The system should be robust enough to handle the documentation of pictures, to support basic image edition. Since it was found that users need them for comparison and for determining the development of a wound in retrospective.

| B. Visual interface | 1. Recognize the information which is better to present visually, such as in diagrams, rather than plain text in order to increase the effectivity of the information retrievalment. For example, the visualization of the wounds location and the presentation of a summary of the patient’s health. |
| B. Visual interface | 2. Considering documentation is a time-consuming task, it is essential to optimize information input and avoid free-text when necessary. For example, using checkboxes or dropdowns when selecting an existing option. This can also help for the classification and reuse of the data. |
| B. Visual interface | 3. Information should be presented according to relevance, this principle should apply to the note’s layout. To avoid long reading times, the design should allow that important data can easily be extracted by the user. |

| C. Features | 1. List of the different HCPs that are treating the patient with contact information, specifying to what healthcare facility they belong. In addition, they should be able to communicate and share documents. |
| C. Features | 2. Timeline with relevant information of the records. |
| C. Features | 3. To-do list with the daily tasks of the users, available for printing. |
| C. Features | 4. Clear and comprehensive support section. |
| C. Features | 5. Adaptation for mobile devices. |
| C. Features | 6. The patient could also be an active user of the system, being able to read the data, fill information by him or herself, and to allow permission to access the information. |
| C. Features | 7. Specify in treatment notes what material and procedure should not be replaceable and show equivalences when allowed. |
| C. Features | 8. Compare treatment note’s material list to the healthcare facility’s inventory and identify when a material is ran out. |
6.5.2 Non-functional Requirements

On the contrary, non-functional requirements refer to the desirable qualities the product should offer, including characteristics outside the product itself. In this sense, the seek aspects for the present system are:

1. Information should be presented with a focus on human perception.
2. The use of a common or standardized language should be incentivated through the information input when possible. It should help to prevent misinterpretations.
3. Facilitate the understanding and following of care plan notes for the HCPs that need to carry out the treatment.
4. Simplify data entering.
5. Reflect users mental models in the system.
6. Provide an easy and quick way for evaluating the progress of a wound in retrospective.
7. The system should work within the legal constraints and be transparent in case of a deviation.
8. Offer an interactive and smooth alternative for communication in healthcare facilities and between them.
10. In addition, the system could be enforced with practices inside the hospital. It is suggested to have an expert figure in wounds who can be consulted in case of doubts.
11. Provide training to the users.
7. Phase 2 - Interface Design

The design process derived in pen and paper sketches, which lead to a low fidelity interactive prototype that could be evaluated with users in a further step. The interface was built around the context of use in the geriatric ward, due to being the ward with patient records comprehending the full range of chronic wounds and where patients with numerous and long-time records can be found. This approach would facilitate the adaptation of the design in less challenging contexts.

The interface intended to help the users to facilitate the tracking of wounds through patient records and is not constrained to the capacities and limitations of any of the software used by the users at their different healthcare facilities. Although it was envisioned as an extension of an EHR and it is supposed to be embedded in a more complex system.

7.1 Pen and Paper Sketches

The results from the thematic analysis were used as inputs for the sketching phase. The aim was to define the user flow, the overall structure of the interface, and the disposition of the different functionalities.

Navigation Flow

Prior the sketching, an outline of the different screens and their functions, along with their connections, were defined according to the users tasks and principles of information architecture.

The interface was built around one screen containing the most relevant information of the patient, called Patient Overview, from where the users could check the patient record, create a new note, communicate with other HCPs treating the patient, or go to a new screen, the Wound Tracker, to see in detail the development of a particular wound. From an upper level menu, the users could select one of their patient from a list, explore the Support section, and review their tasks. This menu would also integrate the interface within a more robust EHR system (see Figure 3).
Iterative Sketching

For each screen, every functionality was designed individually as a module before organizing them all together on a compound page (see Figure 4). This flexibility allowed the proposal of different versions of the modules without having to affect the rest, as long as to work in detail on the interactions of every module. The modules and screens were evaluated based on how well they were meeting the requirements and discarded through short design critique sessions ran by the researches.
Some of the screens, like ‘All my tasks’ and ‘Support’, were left aside due to time constraints and low relation between complexity and value proposition for the purpose of the project.

### 7.2 Prototype

Using the previous sketches, the three main screens with internal interactions plus the patients menu were designed on Balsamiq. These wireframes focused on the functionality and did not prioritize the visual design, in addition, dummy text was used for the examples and did not always use the right medical term. Basic interaction was implemented to connect the screens with each other.

The subsequent presentation of the wireframes follows a user scenario where the user looks for a patient, informs herself about the patient, looks for a specific wound and analyze its development, checks the recommended treatment for the wound and finally updates its status and change the treatment.

**Navigation Menu**

The navigation menu is located at the top. The navigation icon, at the left, would be the connection to the system in which this interface is embedded. At the right, the name of the user, her role and her workplace would be displayed, since it is common to share a computer at the healthcare facilities it should be easy to identify who is logged in. Next to it, a logout icon would allow the user to sign off the session. In the middle, it is possible to reach other sections of the system through buttons; for this version only three sections are available: ‘My patients’, ‘All my tasks’ and ‘Support’.

‘My patients’ is where all the information about the patients can be found. In ‘My tasks’ the users can get a to-do list with all the tasks they need to accomplish at the end of their shift. Finally, ‘Support’ is a section where tutorials, advices and medical procedures regarding wound treatment are disclosed. This is intended to help HCPs with less experience as well as to provide a tool for the experienced ones to point at for exemplification.

This menu is present through the rest of the screens and the prototype will be mainly located on ‘My Patients’ section.

![Figure 5. Navigation menu](image-url)
‘My Patients’ Menu

From this menu it is possible to find all the patients treated by the user. Since the number of patients a HCP can treat is extensive, this list shows by default only those who the user is going to take care of on her shift, but the rest of patients can be found with the search function. The patients can be filtered by name, time spans, diagnosis or other keywords, like release date.

The list displays the names of each patient next to how many notes have been added to their record since the last time the user checked. A mark is activated if the patient is in a critical state, represented by a red dot on the wireframe.

Patient Overview

This screen presents the most relevant information regarding a selected patient (see Figure 7). It is divided into seven sections: 1) General information, 2) My tasks, 3) Upcoming events, 4) Timeline, 5) Illness locator, 6) Notes and 7) Communication, plus one floating button for adding notes.
1. General Information

This module gives a summary of the basic data of the patient, such as name, age, gender, national identification number, height and weight. Including important alerts as allergies or the emotional state of the patient, marked in red and blue respectively on Figure 7. It can be expanded to show complementary information, which could be diet restrictions, living conditions, medications, or others; although this is not comprehended in the prototype.

2. My Tasks

This is a to-do list extracted from ‘All my task’ but focused on the selected patient. It displays the task and the time, as well as a checklist to mark when the task has been completed. This list can be printed. Moreover, a visual aid helps to identify which task have high priority and should not be skipped or rescheduled, marked in red on Figure 7.

3. Upcoming Events

This table gives an overview of the events this patient is expecting, which could be a test, an appointment with a physician or the release date from the healthcare facility, for example. These events are not constrained to the user’s duties, they can involve other HCPs if relevant. It shows the description of the event, the date and the time.

4. Timeline

This graphic allows the user to locate the record notes in relation to the time the patient has been in the system. The horizontal axis represents the time while the vertical one designates the number of notes, from zero to an average number (which was not calculated in this study but it is presented as 100 in the example). This disposition makes it easier to the user to identify critique periods in the patient health as long to reach old notes. As default, the current year is chosen, but other time spans can be selected, it could be a year, a month, a week, etcetera. Other tools for filtering are included, which can help to find notes by job role or diagnosis, for example. This filters can be used in combination, allowing the user to look for ‘pressure ulcer’ notes created in ‘2018’ by a ‘nurse’.
5. Illness Locator

This module is designed to visually show the illnesses diagnosed on the patient and where they are located in the body. In the bottom part there are buttons that correspond to the category of the illness. In this example, the patient has illnesses on four categories: heart diseases, skin issues, psychological problems and nutritional issues. These categories were not developed in detail for this study due to be out of scope, but it is suggested that these categories cover the physiological and psychological wellbeing of the patient in a reduce catalogue, which can include but not exclusively the eleven systems of the human body (circulatory, respiratory, etcetera). Each category can have subsections, in the example the skin category has selected the ‘wound’ subcategory, but it can also include diabetic wounds, melanoma, skin cancer, and other skin diseases. Only the categories that are affected would appear, in order to present only the relevant information. As default, only the active diagnosis would be show. For example, if one of the wounds get better and is reported as healed for a period of time, it would stop appearing. This setting can be adjusted to show past illnesses in this view.

In addition, the image can be zoom in and out for issues located in concentrated areas. Besides, each issue displays the number of notes it has reported. In this way, it is easy to the user to overview the gravity and the duration of an illness. In the example, four wounds can be found under the skin category and correspond to the part of the body where the wound is presented on the patient’s body. If the cursor is put over a wound a pop-up with a summarized information appears (see Figure 8). This pop-up contains a miniature of the most recent picture of the wound, the kind of wound, when was the picture
taken, since when the wound was diagnosed and an icon indicating if the wound has been improving or not. In the example, the selected wound is a pressure ulcer, category 2, which has a timespan of four months and it is detrimentally developing.

On the contrary, if the wound is clicked the Wound Tracker section (explained later) would appear containing all the information available on that wound. The same result happens if the pop-up is expanded.

Finally, the representation of the body corresponds to the patient’s gender and age. In the example the body depicts an adult man.

![Figure 8. Illness locator’s pop up](image)

6. Notes

At the very right a place for the notes and the communication channel can be found, it can be switched by pressing the toggle. When the notes are selected, it displays a chronological list of all the notes regarding the selected patient, with the most recent one appearing at the top. In the upper part of this module there are two tools that can help the user to retrieve a specific note: the search and filter functions. The first one uses the text entered by the user while the second one has different categories, such as timespan, diagnosis, job role, type of facility, kind of note, what kind of attachment they have, during what shift the note was written, among others, which can facilitate sorting the notes.
Each note has three main parts. The first one contains the information of creation: ID, kind of note, date, the name and job role of the user who created it, and a label for those which are new notes. The second one shows the headline of the note and the beginning of the content. Lastly, the third one displays the number of comments and attachments this note has, if there are any available. If the note is clicked, it will be expanded to show the full information. Moreover, if one note is restricted due to privacy, it will be shown in a different color and could not be expanded unless the access is requested and granted.

For this study, the researchers suggest to classify the notes in three kinds. These classifications were constructed around chronic wound treatment and can differ or expand to other affections. The three kinds are:

- **Diagnosis.** The disease or condition that was identified by a HCP according to a series of symptoms.
- **Treatment.** The care plan and instructions suggested by a HCP to treat the diagnosed illness.
- **Status.** Informs the last assessment of the patient to identify if the treatment is working or not.

On top of all, a floating button is popping out in this area for adding a new note.

When the user clicks the Add Note button a form to fill would appear, each of the previously described kind of notes would have a different form according to the required information they must have. But regardless the kind, all of them would contain the same information in the upper part:

- **Patient’s details** (name, age, gender and personnummer),
- **Kind of note,** with a drop down allowing the user to change it from here,
- **Location,** this information would be automatically filled with the selection on the illness locator but can be changed with a drop down menu containing a list of predetermined body parts, next to it there is a body icon which opens the illness locator to point out where the issue is placed. Both ways would let the user know the locations that are currently affected,
- **Headline,** offering a free text space to the user to meaningful explain what this note is about.

A diagnosis selector would also appear on status and treatment notes, which can be a type of chronic wound such as pressure ulcer.

For status notes (see Figure 9), the first section includes all the necessary criteria to describe the wound (category, size, appearance, smell, etcetera). Each criterion has a series of options which can be selected using radio buttons to facilitate the filling. Below, an area to upload pictures is available, they can be edited with freehand lines to give emphasis to certain areas. This is followed by a free text section for further comments. At the bottom of the form one can find the users related to the note and who would get a notification in case of an update. The default setting would be the other HCP currently treating the same wound, but the user can also add other contact at her discretion. Finally, to publish the note there is a button to save it but also another button allows the user to save it and create another status note for another wound, given that many patients usually present more than one wound.
Regarding treatment notes (see Figure 10), the researchers suggest to divide the instructions in steps, “cleaning” or “dressing” for example, that can be connected to the Support section in case the reader needs more information on how to carry out the procedures. The user who writes the notes can select the kind of steps they need to describe the treatment and each step would have a series of details, such as material or frequency, with predetermined options to be chosen by the user or even customized. She can also mark when something needs to be followed as stated, indicating to the reader that a material cannot be replaced or a procedure cannot be done in a different way since it can compromise the patient health. This is displayed as a lock in the example. In addition, a free text field is available to add comments on each step. In the bottom of the form the user can see what users are going to be notified about this treatment or select them herself. Finally, the user can save the note to publish and also print the instructions.
Similarly, a treatment note in read mode (see Figure 11) would present the previous information in a way that facilitates following the steps and where it is easy to identify the different elements of the instruction. The header shows the patient information along with the note’s ID, kind of note, date of creation, who wrote it (name, job role and facility), the headline and subtitle, which is a summary of keywords automatically retrieved from the note. In the steps, the mandatory materials and procedures are highlighted to avoid interpretations. There would be a shortcut on each step to the Support section, but if the reader has any doubt or needs clarification she can reply on the comment section at the bottom of the note, with the possibility of uploading a picture too. A printing option is also available.
7. Communication Channel

When the toggle is selected on the Communication Channel this section presents a list of the HCPs that are treating the selected patient. This list is displayed according to the last time the user was in touch with the contact. The search and filter options are also included here to facilitate reaching another HCP, the contacts can be sorted for job role, facility where they work, the last time they treated the patient, and other relevant filters.

The contact information includes a picture of the user, the full name, the job role and the facility they work in. The first words of the last conversation are also shown if available. A shortcut to start a call or video call are visible at the right. If the contact is not available, due to holidays or sick leave, a warning appears next to the name, making available the information of who to contact instead. To start a conversation the user only needs to click the contact card or the message icon, which would open a chat window. In addition, the users are allowed to share files in the chat window.

While right now nurses have to search for the other HCPs on their own and share pictures of the wounds on unauthorized mediums, this communication channel would facilitate conversations and offer a safe place for disclosing sensitive information.
Wound Tracker

The wound tracker appears whenever a user selects a wound on the Patient overview screen and shows detailed information on the wound’s record. It contains four sections: 1) Wound locator, 2) Last notes, 3) Wound development and 4) Image archive.

1. Wound Locator

This module works exactly as the Illness locator, with the exception of being focused on skin issues. Similarly, only the wounds that are affecting the patient would appear in the representation of the body unless the user adjusts that setting to see past ones. The wound that is selected would affect all the information on the surrounding modules, showing always what belongs to that wound. In the example, the subcategory of pressure ulcer is active, and the sacrum wound is selected (see Figure 13). Other categories of skin issues can be chosen with the bottom menu, like diabetic wounds (see Figure 14), and the representation of the body can adapt to fit the best, focusing on the feet for example.
2. Last Notes

Located at the top right, this module shows a short version of the last documented note for each kind of note (diagnosis, treatment and status) and works similarly as the Notes module in the Patient overview (see Figure 7).

Figure 13. Wound tracker
3. Wound development

This timeline supports the visualization of the wound development over time, giving clarity on if it has been improving and for how long it has been affecting the patient, while illustrating it with intervals of the documented pictures.

The horizontal axis represents the time while the vertical one corresponds to the gravity of the wound. As default, the timespan appears from when the wound appeared to the current moment, but it can be adjusted on settings. Whereas the gravity of the wound goes from critical (top) to healed (the base).

This graphic is automatically calculated with the information that is currently entered in the status notes. The criteria for assessment (color, size, smell, etcetera) are already containing information about the gravity of the wound, so this data can be analysed and evaluated.

If one of the vertex or the pictures is clicked, a pop-up with the corresponding status note is shown. If more than one picture were taken, they can all be navigated from here. This pop-up can be expanded to read the full note (See Figure 15).
Lastly, in the bottom part of the screen there is a gallery presenting the documented pictures of the wound in chronological order, which can be navigated with a horizontal scroll bar. The user can adjust the filter setting to find pictures in a specific period of time.

If clicked, the pictures can be viewed in full screen, but they can also be dragged to the right corner to select those pictures that the user wants to compare with each other. This feature opens a modal with the selected pictures (see Figure 16), where the number of pictures can be adjusted (in the example there are four) and some configurations are also provided in the settings to common comparisons, which can be “first and last picture” or “show all wounds” as an example.
Figure 16. Wound tracker’s pictures comparison
8. Phase 3 - Evaluation

The evaluation took place in the hospital and had a duration of 100 minutes. Five participants attended, from which two were former nurses currently working as IT coordinators, one a recently retired nurse from the vascular surgery ward, one healthcare developer specialized on pressure ulcer prevention, and the last one was a nurse at the geriatric ward. With the exception of one participant, all of them were familiar with the research since they contributed on previous stages of the project.

The session consisted of two parts, the first one was a focus group where the prototype was presented and discussed while the second one was a workshop where the participants intervened the screens. Overall, the prototype received good comments and the participants showed good disposition to collaborate and create. The results from the discussion were divided into four sections: positive comments, negative comments, unclear elements and suggestions. The outcome of the workshop was a list of suggestions.

8.1 Focus Group

The prototype was presented on a projector and each screen was described in detail, explaining the concepts behind each element. The exposition lasted 40 minutes and was carried following a user journey example where a nurse at the geriatric ward needed to take care of the sacrum wound of a patient, followed by updating the status and recommending a new treatment. In general, they expressed that the prototype offers a more compounding way to follow the development of a wound than their current system, as one of them said "It's basic but still much better than what we have."

During the presentation the participants asked questions whenever they needed clarification on a function and expressed their thoughts afterwards. The researches gave further explanation but questions regarding the technical feasibility for storing the images were left aside. Moreover, the content received comments on not matching the real medical terms or procedures and there were no comments on the Support section, possibly due to the absence of screens.

8.2 Feedback

<table>
<thead>
<tr>
<th>Positive comments</th>
<th>The timeline and the illness locator were appreciated. One participant indicated that in this way &quot;it is easy to follow the wound wherever you are instead of reading through notes&quot;.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regarding the wound tracker, one said “it is good that you know what wound belongs to which notes. It's good to see what care plan and status belongs to what wound.”</td>
</tr>
<tr>
<td></td>
<td>Being able to communicate and discuss notes with other HCPs regardless the facility was very appreciated, as some mentioned “it would be easier to communicate from COSMIC to Prator, in particular pictures”, &quot;I like the idea</td>
</tr>
</tbody>
</table>

55
of being able to communicate with someone directly, send a picture and ask questions”.

Giving tools to ask for opinions to other HCPs was valued highly, since "some assistant nurses do not dare to write down the dressing they are using, because they are scared that they are doing it wrong. So it's good to have advice”.

<table>
<thead>
<tr>
<th>Negative comments</th>
<th>The body figure was perceived as unprecised, it should be anatomically correct and contain genitalia, since wounds are presented in that area too. The wound tracker without the patient information available can lead to confusion, it should always be included.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclear elements</td>
<td>The Support screen was confused with a customer support section instead of being a database with extended material on wound treatment. Using same iconography helped to the confusion. The participants could not identify which sections would be filled automatically and which needed the user input. It was not clear to the participant where to click to create a new note.</td>
</tr>
<tr>
<td>Suggestions</td>
<td>The participants said that the communication channel can be extended to connect with experienced HCPs that can offer immediate advice or clinical opinions on unclear cases, stating &quot;I need to contact somebody that can help me and I need it now not in two months&quot; and “it would be nice to have someone on the chat who you can consult”. The nurses revealed that it is important to see when a wound has been dressed and by whom. Some added that this information can be displayed in the timeline linked to the correspondent notes.</td>
</tr>
</tbody>
</table>

### 8.3 Workshop

A workshop was conducted after the presentation where the participants were asked to improve the interface with the tools or information they thought could be useful. It lasted 55 minutes and they were divided into two groups, one with two members and the other with three. Pens, markers, sticky notes and the printed screens were used as materials for sketching. The groups worked by themselves and presented their projects at the end, the sketches can be found in appendix F.
Suggestions

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Add a “no change” function that copies the last information on new status notes.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wounds can have an ID that can be retrieved on follow ups.</td>
</tr>
<tr>
<td></td>
<td>Wound history can be analysed and present statistics.</td>
</tr>
<tr>
<td></td>
<td>Add an option on status notes to state that the treatment was carried out accordingly to the instructions.</td>
</tr>
<tr>
<td></td>
<td>Add a view in the wound locator with the last status and treatment notes for all the wounds.</td>
</tr>
<tr>
<td></td>
<td>Add a view on the wound tracker’s timeline where all the wounds can be compared, including dressing notes. It should be clear who wrote the note and when it was created, so the nurse easily see if the patient has his or her wounds treated promptly. Include filters to show different kind of notes, pictures, or all of them together.</td>
</tr>
<tr>
<td></td>
<td>Allow the patients to upload pictures of their wounds.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th>In the wound locator, the dots can be colored according to the gravity or category of the wound.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Add dressing updates in the wound tracker’s timeline, connected with the corresponding notes.</td>
</tr>
<tr>
<td></td>
<td>Add skin assessment as a new kind of note, complementary to status.</td>
</tr>
<tr>
<td></td>
<td>For default, notes can be checked for other HCPs who treat the patient without having to ask for request, having a checkbox for when the patient explicitly express the privacy of his or her information. In this case, the user would be able to access to the information in case of emergency.</td>
</tr>
<tr>
<td></td>
<td>Adapt the interface for tablets. In the wards, every patient could have an ipad at bed where the nurses can see the plan for each patient and document right away.</td>
</tr>
</tbody>
</table>

To a great extent, the participants, even though they were allowed to remove features in the interface, they tended to add more instead. Expressing that the prototype seemed functional but needed some complementary functions.
9. Discussion

The aim of this study was to answer the research question: How can an IT system aimed for chronic wound treatment be designed to support healthcare professionals on the documentation, retrieval and exchange of information? Based on the research conducted, non-functional and functional requirements were identified. The functional requirements can be divided into three categories: information architecture, visual interface and features. Furthermore, the identified requirements were visualised through a prototype which got evaluated in a focus group. The focus group resulted in feedback and recommendations for improvement.

The following paragraph is answering the first subquestion which was: How should the system manage information? The category information architecture is related to the need of a clear information structure, since it was found that it takes too much time for HCPs to find the information they are looking for. Moreover, the entered data should be reused in a meaningful way. Further, the importance of the availability of all relevant information for every HCP involved within the care process was pointed out by the participants. This results from the fact that chronic wounds are treated by different HCPs working in different facilities. The lack of information that was documented was criticized by a large majority of the participants as one of the most severe issues. Finally, entering the data should be supported by standardized templates. The findings in this paragraph are supported by the study of (Viitanen et al., 2011) that found usability problems related to the topic of collaborative work and searching for information.

The second category is the visual interface and it is related to the second subquestion: What information of the chronic wounds should be presented and how? A system should offer visual support to its users instead of plain text only. Visualization using diagrams or taking pictures of wounds would increase the process of retrieving information when compare it with plain text. During the semi-structured interviews it was found that the current systems do not support visuals. At the same time visual support was requested by all of the participants. Moreover, the study of Friesen, Hamel, & McLeod (2013) suggests that pictures are useful in the documentation of wounds. Besides the visualization the interface should support the way data gets entered by the user. It should move from free text options to pre-set options such as checkboxes. This would accelerate the process of documentation and retrieving information. Finally, when presenting the information the job-role of the user should be taken into account and relevant information should be displayed accordingly to the job-role and more important information should be clearly marked. The importance of adapting the interface to the special needs of different job-roles is also pointed out by (Venot et al., 2013). Moreover, (Smelcer et al., 2009) suggests that the information that is displayed needs to be carefully chosen to avoid an information overload or a lack of relevant information.

Finally, the last category is features and it is aiming to answer the third subquestion: How should the system support the HCPs tasks? The features aim to provide support for different problems that have been identified. A list of HCPs that have been treating the same patient, the support area and the tutorials and information on how to treat wounds are aiming to remove the insecurity some HCP have when treating a wound. Furthermore, the purpose of these features is to cope with the challenge of having a knowledge gaps across the HCPs that treat wounds. The knowledge gap was mentioned by participants along with the issue of having only very little time spend on chronic wounds within the education of a nurse. It gets also supported by literature as Barrett et al. (2009) state that there is a lack of knowledge.
among HCPs regarding the treatment of chronic wounds. In this matter, the system should clearly point out what material to use for the treatment of a chronic wound and if it is critical to use the recommended material or if it can be replaced. A mobile version of the system could support the HCPs documenting.

It was found that a majority of the HCPs document on paper first and later they enter the information from the paper into the system. Further on it was mentioned by one participant that the patients themselves should be involved within the process of documentation. The participant argued, that information the patient is providing gets interpreted twice, first by the HCP that was in direct contact with the patient and then by the HCP that reads the entered data. This is potentially leading to misunderstandings. To be able to follow a patient’s development the system should provide a timeline. This could also be used to provide an overview of the patient’s condition which was reported to be missing by the participants. Finally, the system should provide a “To Do” list to its users. Currently, it takes a lot of time to read the information and extract the tasks one has during the shift.

To answer the fourth and final sub-question, What are the qualities the system should have? Several characteristics were identified based on the problematics the participant stated to have with the current system. These non-functional requirements can be broadly grouped in four qualities. Firstly, the system should be designed according to usability standards attending to human perception, cognition and human factors. This is to facilitate the understanding, usage and input of the information. This strategy can also help to overcome some of the problems identified during this study, such as low learnability and satisfaction, according to the studies of Clarke et al. (2013) and Viitanen et al. (2011). Second, it should assist in the prevention of miscommunication while supporting adequate communication between the HCPs involved. The usage of common terminology and the evasion of acronyms are a key element for adequate communication, as stated by Brown and Flanagan (2013), and this can be encouraged by the system. Thirdly, it should reflect and work within the legal policies around information privacy law, which is reinforced by Culley’s recommendation upon how documentation should be structured. Finally, it is necessary to acknowledge that the system cannot work successfully without the support of the healthcare facility. Supported by Flanagan (2013), hospitals and health centres can improve the user experience by providing training, on the software and on the medical practice. As long as to allow experts advice through the software, which was demonstrated to have positive outcomes in the research by Friesen et al. (2013).
10. Conclusion and Future Work

Chronic wounds are a major health problem around the world. The trend of an aging society and the rise of chronic diseases such as diabetes point out the need of action. EHRs are replacing paper-based records and have been proven to provide benefits. However, several studies have shown that there are usability problems when it comes to EHRs. Moreover, only little research has been conducted regarding a comprehensive approach on the design of IT systems supporting the treatment of chronic wounds. However, it was found that the system should adapt to the needs of chronic wound treatment, which has the challenges of documenting big amounts of information through long periods of time under the supervision of several HCPs.

This study is investigating into the research question: How can an IT system aimed for chronic wound treatment be designed to support healthcare professionals on the documentation, retrieving and exchange of information? Aiming to answer this question, a pre-study has been conducted, followed by semi-structured interviews, an interface design phase and, finally, a focus group evaluation. The semi-structured interviews resulted in a list of functional and non-functional requirements that were visualised by wireframes. The functional requirements are represented in three categories: information architecture, visual interface and features. Within the category information architecture the importance of a clear information structure is pointed out. The category visual interface is about the need of visual support and the need of customization of the displayed information. The last category is related to features the system should offer to support HCPs performing their tasks. The features should enable communication, provide the option to ask questions and obtain support when required and facilitate patient involvement. The focus group provided the researchers with feedback and recommendations. As for the non-functional requirements, the study indicates certain qualities the system should have in order to facilitate its use and support the users on their tasks. The system should be designed attending to usability standards, to overcome the issues of low learnability, high cognitive load and poor acceptance. It should also facilitate the distribution of information among the team involved while attending to the patient privacy. Additionally, better results can be expected when the healthcare facility promotes complementary strategies such as constant training on the software and on chronic wound treatment methods, as well as to facilitate consultation with experts for advising.

The next steps taken in the future are divided into two lines, the first one is related to the improvement and extension of the prototype, and the second one to the addition of complementary technologies.

Regarding the first line, an initial step would be the insertion of the feedback from the focus group. Based on this, a second iteration could be performed and evaluated. In a third iteration, a high fidelity prototype could be built to get more detailed feedback. Additionally, as chronic wounds are established as skin diseases, the recommendations in this work can be extended and adjusted to other skin related diseases. Moreover, chronic wounds are mostly treated together with other diagnoses and rarely looked at isolated. For the future it would be necessary to put the research done in this project into a greater picture and propose how to integrate it within an EHR.

For the second line, it would be beneficial to study technologies that can enhance the users tasks as revised, such as automatic measurement tools or the implementation of algorithms for statistics.
The results and findings of this research project will be provided to the vendor of the EHR system used at the Uppsala University Hospital with prospect to inspire the future work of the vendor. The design provided in this research was elaborated to support medical staff on the treatment of chronic wounds. It is the researchers hope that the recommendations found in this thesis can be applied in medical IT systems used in broader environments.
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Appendix A - Interview Questions

The goal of the interview is to know:
- what information the users need to create, evaluate and update a care plan
- what information the users need to create, evaluate and update a status
- how they share information between other users treating the same patient
- what are the problems they currently find
- what they would like to have on the system

Introduction

- What is your job-role?
- For how long have you worked here?
- How old are you?
- What are your main tasks?
- What do you like the most about your job?

Care Plan

- Do you usually create care plans?
  - Who does that?
  - Can you go through the process
- When was the last time you created a care plan?
  - What information do you need to create a care plan?
  - Where do you get the information from?
    - How many sources did you consult to get the information?
      - Ex. COSMIC, the Patient, a colleague, …
- Do you follow a “protocol” for the creation of a care plan?
  - If so, what does it include?
  - Have you memorized it or do you eventually consult it?

- Have you changed an existing care plan?
  - If so, what was the reason?
  - How do you know that you need to change it?
  - Can you tell us how you changed the care plan step by step
  - What information did you need to change the care plan?
    - Where do you get the information from?
- Did you use the existing care plan or did you create a new one?
- Tell us what you do when you take care of a wound.
When was the last time you followed the instructions you found in a care plan on how to treat a wound?
- If you do not use the care plan, how do you know what to do?
- Did you find all the information you need to treat the wound?

Did you treated patients with more than one wound?
- Do the system provide tools to handle more than one wound?

How do you know what is required to do during your shift?

Do you give instructions or hand over information to other nurses?
- If so, how?

How do you know when you should perform a certain task
- Eg. change the dressing
- In case of special indications. Ex. in case of a pressure ulcer: how do you know when you need to move the patient?

Status
- What information/observations are relevant to document about the status?
- When do you enter the information?
  - Right after the assessment of the patient?
- Where do you enter the information?
  - At the office? or right next to the patient?
- Do you have enough ‘fields’ to add the information you need for documentation?
  - Is it easy to describe and consult the wound evolution on the system?
  - Why?
- Is it easy to find information within the status?

In what situations do you update the status?
- How do you know when to update the status?
- Can you tell us what you do when you update a status?
- Do you create a new status or do you copy an old one?

Information Sharing
- How many roles are involved in the following of a care plan?
- How many roles are involved in the creation of the status?
- How many roles are involved in the following of the status?
- Is it usual to misunderstand documentation related to care plan and status?
  - If so, what are the things that you see are mostly misunderstood by you or your peers?
- Do you always use the EHR to communicate relevant information regarding care plan and status?
  - If not, what other mediums do you use? Ex. physical notes, oral instructions...
  - In what cases do you use them?
- Is it easy to understand what your peers wrote on the status?
Is it easy to consult?

Assessment

- How do you know if the plan care is working or not?
  - Is it easy to notice?
- How do you know the status is being updated properly and on time?
  - Is it easy to notice?
- Is it easy to have an overview of the patient’s evolution?

Envision

- Would you like to keep features COSMIC offers?
  - Which ones and why?
- Would you like to remove features from COSMIC?
  - Which ones and why?
- How would you improve your current system?
  - Which features would you like to add to COSMIC
  - For what purpose?
- How difficult would you say is to manage the care plan and status? Why?
- Do you think the time you spend on the documentation and consultation regarding the care plan and status is adequate? Why?
- How much do you like using the current tools for the described tasks?
- How useful do you think your documentation and processes are for the patient’s health?

Closure

- Do you think that COSMIC is helping you in taking care of wounds? Why?
- Do you have anything else that you would like to add or discuss?
Appendix B - Interview Protocol

| Welcome the participant | - thank you for supporting us  
|                         | - introduce ourselves briefly  
|                         |   - names  
|                         |   - study field  
|                         | - introduce our topic briefly  
|                         |   - designing systems for care plan management  
|                         |   - focus on chronic wounds  
|                         |   - from a user-centered perspective  
|                         |   - these interviews would help us to understand how the health care staff deals with the management of wound care plan and how they use technology for that matter  
| educate the participant | - what we need from them  
|                         |   - this is just an interview  
|                         |   - we want to know your perspective  
|                         |   - we won’t be sharing your identity or what you say  
|                         |   - we need your honesty  
|                         | - you can withdraw your participation at any time without naming reasons  
|                         | - if you want to feel free to us the dictionary in your phone for translation  
|                         | - before we start we would ask you to sign the consent form  
|                         | - do you have any further questions before we start now?  
|                         |   - feel free to let us know if a question is not clear  
| Start the interview     | - inform the participant that we start to record now  
|                         |   - no one but us will ever listen to the recording  
|                         | - ask the participants’  
|                         |   - age  
|                         |   - job role  
| End the interview:      | - end it always by asking: is there anything else you want to tell us?  
| First Step              |   - stop the recording, name the file according to the participants number  
| End the interview:      | - thank you for your time  
| Second Step             |   - contact us if you have any further questions  
| Thank the participant   |   - contact us if you have any further questions  

Designing IT Systems in Healthcare to support the Wound Treatment Process

Information for the Research Project

You are invited to be part of a research project regarding the design of IT Systems in Healthcare. The focus of this project is on the process of wound treatment and how it can be supported by an IT System.

What is the purpose of the research?
The aim of the interviews is to understand the users and their perspectives, to identify their requirements and their needs. The outcome of the research project will be a list of recommendations of what the user interface should include, and look like, to support the user in performing a certain task. This outcome will be visually supported by a basic prototype.

Who is conducting this research?
This research is conducted by the master students Kutzi Romero and Julia Benz, from Uppsala University. It is part of the Master Thesis course within the program of Human-Computer Interaction. The study is performed under the supervision of Lisa Larsson, Handläggare IT at Region Uppsala, and reviewed by Åsa Cajander, Professor at the department of Information Technology at Uppsala University.

How specifically do I participate?
You are invited to take part in an interview that will take at your workplace. The interview will take approximately 45 minutes. The questions will concern your experience of working within the process of wound treatment and the usage of the electronic health record system. Your answers will be audio recorded.

What will happen to the information you collect about me?
Only the researchers will have access to the collected raw data. All the information will be anonymised and treated confidential. You will not be identified by your name, face or any other information. The anonymised data and resulting analysis may be used in academic and non-academic publications and presentations.

What if I change my mind or have questions?
Please note that you can ask questions, stop your participation, or withdraw completely from the research project at any time. If so, the collected data will not be used and will be destroyed.
In case you decide to participate in this research project you will be asked to complete and sign a consent form in the beginning of your interview.

If you have any questions, please don’t hesitate to contact:

Julia Benz
Julia.Benz.7334@student.uu.se

Kutzi Romero
Kutziyolanda.Romeroherrera.0561@student.uu.se
Appendix D - Consent Form

Consent form for Focus Group as Part of the Master Thesis Project
A study carried out by Kutzi Romero and Julia Benz
“Designing IT Systems in Healthcare to support the Wound Treatment Process”

I, the undersigned, confirm that (please tick box as appropriate):

☑ I have been given the opportunity to ask questions about the project and my participation in it.

☑ I voluntarily agree to my participation.

☑ I understand I can withdraw my participation for at any time without giving reasons and that I will not be penalised for withdrawing nor will I be questioned on why I have withdrawn. I understand that other researchers from Uppsala University, who are part of the project team, may have access to the anonymised information collected.

☑ I understand that I will be interviewed for the study and that this session will be audio recorded and that the data will be stored securely.

☑ I understand that anonymised direct and indirect quotes from this session may be used in written academic and non-academic publications and conference presentations about the Research project.

Name (please print):

Signature:

Date:
Appendix E - Protocol for the Focus Group

1:30 hr
1. Information (5)
   - Give consent form
   - Welcome and thank you
   - we are Kutzi and Julia, we are Master students in HCI (what is HCI?)
   - explain the project
   - this project is very different from the last one, the research was done much more thorough this time, the focus was on truly understand issues and processes
   - aim of the focus group
     - what we’re expecting from them
     - critics on our design and recommendation
     - be honest
   - Give the schedule
   - Questions

2. Breaking the ice (5)
   - Presentation (name and job role, what do you like)

3. Showing the wireframes (20)
   - Present the main problems:
     - Decentralized (lack of communication)
     - Hard to document/describe wounds
     - Lack of picture support
     - Hard to get an overview
     - Hard to evaluate the development of the wound with text
   - Explain the workflow with the projector
     - Have laptops with the wireframes

4. Getting critique (10)
   - Q & A

5. Break (5)

6. Working together (30)
   - explain what is going to happen. Split into 3/3
   - hand-out the material

7. Wrap-up (10)

Hand-in
   - What works? What doesn’t? What is confusing? What can be improved? what do you like the most / what do you like the least? / why? Discussion
Appendix F - Results from the Focus Group

Results from group 1
Description:

Wound Category:
- Category 1
- Category 2
- Category 3
- Category 4
- Non-classifiable
- Necrotic tissue
- Exposed deep skin
- Eschar
- Infection
- Birthmark
- Acute wound
- Chronic wound
- Wound with slough
- Wound with granulation
- Wound with epithelialization
- Partial wound
- Border necrosis

Size:
- 5 x 20 mm

Appearance:
- Fresh red granulation
- Hypertrophied
- Epithelialization
- Partial wound
- Border necrosis

Pictures:

Comments:

5 x 20 mm. 48 hr.

Add another wound

Save
Results from group 2
+ note for dressing the wound.
Appendix G - Prototype
Diabetes wound in right inner arch
Due to bed confinement.

Diabetes wound in right inner arch
Treatment diabetes wound in right inner arch
This is a very short summary of this note, including the most important information. This is a very short summary of this note.

Diabetes wound in right inner arch, increased size
This is a very short summary of this note, including the most important information. This is a very short summary of this note.
Appendix H - Patient Journey

<table>
<thead>
<tr>
<th>System</th>
<th>Nursing Home (NH)</th>
<th>Ambulance</th>
<th>ER</th>
<th>Ward 1</th>
<th>Ward 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPÖ</td>
<td>Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COSMIC</td>
<td>- nurse / nurse assistant calls an ambulance</td>
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<tr>
<td>Prator</td>
<td>- Take care of the wound</td>
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<tr>
<td>Siebel</td>
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<tr>
<td>Mobi Med</td>
<td>Task</td>
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<tr>
<td></td>
<td>- take the patient from the NH to the ER</td>
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<td></td>
<td>Information</td>
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<tr>
<td></td>
<td>- get info from the NH:</td>
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<tr>
<td></td>
<td>- oral info</td>
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<td></td>
<td>- printed paper</td>
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<tr>
<td></td>
<td>- no info</td>
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<tr>
<td>COSMIC</td>
<td>Task</td>
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<td></td>
<td>- treat the &quot;emergency&quot; that brought the patient</td>
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<td></td>
<td>into the hospital</td>
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<td></td>
<td>- not so much focus in wounds</td>
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<td></td>
<td>- supossed to assess the skin</td>
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<td></td>
<td>Information</td>
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<tr>
<td></td>
<td>- get info from Ambulance:</td>
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<td></td>
<td>- orally</td>
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<td>- printed paper</td>
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<td></td>
<td>- no info</td>
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<td></td>
<td>- (get info through a Fax from the NH)</td>
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<tr>
<td>COSMIC Prator, used to communicate with other facilities regarding managing the patient</td>
<td>Ward 1</td>
<td>Task</td>
<td>Information</td>
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<tr>
<td>communicates to NH</td>
<td>- could call the NH for information</td>
<td>- do a diagnosis</td>
<td>- get infos from the ER</td>
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<tr>
<td>- informs the NH via Prator about discharge date</td>
<td>- create a care plan</td>
<td>- orally</td>
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<tr>
<td></td>
<td>- treat the wound</td>
<td>- through COSMIC</td>
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<tr>
<td></td>
<td>- might change the care plan</td>
<td>- call the NH</td>
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<td></td>
<td>- keep track on the wound: status</td>
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<td>- update the status as the wound changes</td>
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<td></td>
<td>- documentation</td>
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<td></td>
<td>- instruct the patients</td>
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<td></td>
<td>- identify risks to get a pressure ulcer</td>
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<td>- set a goal:</td>
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<td></td>
<td>- heal the wound, or</td>
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<tr>
<td></td>
<td>- not make the wound worse</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>COSMIC Prator, to communicate with other facilities regarding managing the patient</th>
<th>Ward 2</th>
<th>Task</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>communicates to NH</td>
<td>- could call the NH for information</td>
<td>- do a diagnosis</td>
<td>- get some infos from the previous ward</td>
</tr>
<tr>
<td>- informs the NH via Prator about discharge date</td>
<td>- create a care plan</td>
<td>- receive a summary</td>
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<tr>
<td></td>
<td>- treat the wound</td>
<td>- through COSMIC</td>
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<td>- might change the care plan</td>
<td>- call the NH</td>
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<td></td>
<td>- not make the wound worse</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Users / Roles</th>
<th>Nurses, responsible for wounds</th>
<th>- nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nurses assistants, do the basic treatment</td>
<td>- nurses assistants</td>
</tr>
<tr>
<td></td>
<td>Doctors, they do not so much (only COSMIC users)</td>
<td>- doctors</td>
</tr>
<tr>
<td></td>
<td>can reach out the specialists</td>
<td>- can reach out the specialists:</td>
</tr>
<tr>
<td></td>
<td>dermatologist, vascular surgeon, plastic surgeon</td>
<td>dermatologist, vascular surgeon, plastic surgeon</td>
</tr>
<tr>
<td></td>
<td>- nurses</td>
<td>- nurses</td>
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<tr>
<td></td>
<td>- nurses assistants</td>
<td>- nurses assistants</td>
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<tr>
<td></td>
<td>- doctors</td>
<td>- doctors</td>
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<tr>
<td></td>
<td>can reach out the specialists:</td>
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