Mobile documentation of vital signs
A Participatory Design project at a Swedish hospital
Abstract
We have received a mission from a surgical ward at a hospital in northern Sweden; they want a solution that can be used on portable devices. On these devices the healthcare professionals should be able to document the measured vital signs and the results should automatically be documented in the patient record.
In the context of a Participatory Design project we conducted design sessions which focused on the user interface of the solution but also deliberated possible functionalities that were not mentioned in the original mission description.

The purpose of this study is to describe the situation surrounding the measurement of vital signs of patients. It is currently done manually on a paper form and then registered in the digital patient record. Our aim was to find a design and formulate the functional requirement of a tablet application together with the staff at a hospital in Sweden.

Keywords: mobile, participatory design, healthcare, mHealth, healthcare informatics, vital signs
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Marika & Lisa
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1. Introduction

1.1 The research problem
A regular day at the surgical ward in the North hospital starts with the nursing assistant attending all patients and doing the required tests, e.g. blood pressure, temperature, etc. under the umbrella-term vital signs. This is put down on a piece of paper and then once more in a spreadsheet attached to a writing tablet (spreadsheet is found in ‘Appendix II: Documentation protocol for vital sign’). This information should later be put into the electronic patient records (EPR) on the computer. It happens that the nursing assistant forgets to transfer the results from the notes to the spreadsheet and then leaves for the day, so the results from that day are lost and need to be recorded once again by someone else. It could also be that someone along the process writes the wrong results e.g. temperature 29 instead of 39 and the results are inaccurate. Each vital sign receives a score; these scores are later summed together to a total score which is used as an indication of the patient's clinical status. The calculation of the score is done manually today, which is prone to errors and costs time. The vital signs are measured on a daily basis for all patients, oscillating between 1 - 24 times depending on why the patient has been taken in for care and his clinical condition (Elvira 2015, pers.comm.).

This is just one of the activities within the ward that could be optimized and digitized, and we are concentrating on this particular activity - measurements of vital signs, as the foundation for our thesis. In this research we are gathering requirements for a more mobile solution, an application for tablets. This solution will support the healthcare professionals in their daily work.

1.2 Previous studies
In 2013 an iPad-based ‘early warning’ system for patient monitoring was presented and later rolled out at Oxford University Hospitals (OUH) Trust: System for Electronic Notification and Documentation (SEND). The system was developed by researchers at the University of Oxford’s Institute of Biomedical Engineering and clinical staff from OUH Trust. In this system the clinical staff will put in the information from the vital signs readings and the system will automatically calculate a score that gives an indication of the patient's clinical condition which helps the nurses to decide if medical intervention is needed. The aim with this system is to facilitate nurses to take care of patients more efficiently and effectively (EPSRC, 2013; NIHR Biomedical Research Centre, Oxford, 2013). This solution and its objectives are in many ways similar to the solution we are seeking, but the approach and end result differ (see chapter 1.3).
Stevenson et al. has conducted several studies (2010; 2012; 2014) regarding nurses’ perception and experience of EPR. These studies have highlighted the difficulties in documenting vital signs and pointed out the importance of including future users in the design in order to have a successful implementation.

According to Stevenson et al (2010) and Stevenson et al (2012) are nurses dissatisfied with digital solutions. Darbyshire (2000, 2004) has in several studies shown that the dissatisfaction was due to poorly designed systems rather than resistance to technology. Work tasks like data entry were negatively perceived. The systems used were considered time consuming and the access to the system was considered to be poor due to the lack of terminals (Timmons, 2003).

There is a strong correlation between the documentation quality and patient safety and the way to achieve a high patient safety by having relevant and correct information entered in the systems (Douglas et al., 2010). According to Clark (2007) it is a common problem that systems used by nurses have not been developed together with nurses. The lack of correct people involved in the system design will risk that the system does not support the nurses in their practice and it will therefore fail once it has been implemented.

Considering that 79 % of medical students in the UK owned a smartphone (Robinson et al., 2013) it is strange that healthcare in general is slow in adopting applications that are widely used in other areas (Clark, 2007).

In a Norwegian study conducted by Hasvold and Scholl (2011) it was discovered that by implementing mobile solutions the informal interaction was disrupted and that such disruption could have a negative impact on the workplace and reduce the work satisfaction. It was concluded that these disruptions had to be managed by creation of additional socio-technical mechanisms such as alternative mechanisms for informal group interactions.

1.3 Deficiencies in the previous studies
In the studies that we have looked at (see chapter 1.2), the subjects are often generalized. They are ‘doctors’, ‘nurses’ or ‘patients’ with the implication that subjects within the group are one and the same without individual characteristics. So far we have not seen a study that considers the subjects’ work knowledge and their technical experience. It has been seen in other studies, like Mackintosh et al. comparative case study in 2012, that this type of application lacks a fundamental understanding of the medical capabilities
of a junior nurse, compared to a senior or advanced nurse, and the medical or technical requirements that these personnel expect from a software solution in order to be useful to their roles. It is our opinion that previous experience will have an effect on the individual’s ability to adopt and utilize new technical solutions.

We find it remarkable that few researches consider staff workload as a factor in the usage of eHealth systems. E.g. it is not unusual that the health care staff needs to interrupt what they are doing to attend a patient that is in critical need of attention.

Previous studies that we refer to above in section “1.2 Previous studies” show the importance of including future users in the design of the application and to have a clear understanding on how the workflows will be impacted by the changes. Many of the studies that we have looked at were conducted on implementations that were already done, with the aim of identifying what could have been done differently to achieve a better result. We want to learn from the experience gain in these projects and studies and incorporate this knowledge into our thesis.

Both the SEND project in Oxford and our research have the overarching objective to positively impact the patient care by designing a digital track and trigger system to replace the pen and paper based documenting and reviewing of patients’ vital signs. There are a lot of similar findings in both projects but the design process and end result differ. We believe that the major success factor is involvement of the users in the design process. This contrasts the SEND project in which four clinicians (two doctors and two nurses) acted as “customer” during the specifications process. The SEND solution ended up in a web based application running on a tablet mounted on a stand and interacting with external devices like a barcode reader. Our suggested solution is an unmounted native tablet application that will provide a higher mobility. The SEND project has just recently finished a pilot implementation and the end result has not yet been published. This result will be highly interesting to read once it is available (EPSRC, 2013; Wong et al., 2015).

1.4 The significance of the study

We have chosen to do this study with the aim of looking into the possibilities to support the healthcare professionals in their everyday work. We define healthcare professionals as nurses and nursing assistants. These are also the professionals that we are designing for and also involving in the design process.
We argue that if we are able, with help of this technology solution, to optimize the processes at this particular ward, human factor errors can be reduced and it will in turn have a positive effect on the daily healthcare. If the solution can be implemented and after some months of testing appears to be successful, there is a possibility to implement the solution in other wards in the North hospital and rollout to other hospitals, nationally and internationally.

1.5 The purpose statement and delimitations
Implementing a new solution requires both time and money. Before we started the process of requirements gathering, which should be the foundation for the coming development, we wanted to investigate which attitudes the healthcare professionals possessed towards a new digitized solution instead of the current paper documentation.

We believe that even prior to the implementation of the solution it is possible to indicate if the solution will lead to improvement or not, however the quantity of the improvement is visible first after the implementation and some months of working with the solution fully to evaluate. If there could not be any significant positives improvements predicted in the daily healthcare in this thesis, then it would be a waste of resources to implement a solution.

However the main purpose of the research is to put together functional requirements for a solution that should improve the daily care and to reduce human errors.

We received a clear mission from a surgical ward at a hospital in the north of Sweden; they want a solution that can be used on portable devices. On these devices the staff should be able to document the measured vital signs and the results should automatically be documented in the patient record.

In the context of a Participatory Design (PD) project we held design sessions. We focused on the user interface of the solution, but also deliberated possible functionalities that were not mentioned in the original mission.

In Sweden many daily tasks and processes have already been digitalized to some extent like the use of EPR. There are many processes remaining that could be digitized; however we focused on the one process described in the introduction i.e. the documentation of vital signs. Having complete and correct data is fundamental for a qualitative care and paper based approaches are not feasible in setting with many patients and high workload (Douglas et al., 2010). We analyzed the current work situation and the processes and with this as a background we continued with involving the healthcare
professionals in a PD project to create a first design for a new solution that fit their needs and improves the current ways of doing the documentation.

We have focused on the functional requirements of the system. What does the staff in this ward need from the system? This work do-not include a closer look into the technical integration between the mobile platform and the EPR. This research is an initial study and in which we gathered the first ideas from the staff and created a first design proposal. Before a final solution can be developed there is a need to look into how the mobile solution can fulfill the legislation access control, access auditing and record retention and secure network. We have done an introductory general review of these topics. It is not within the scope of the present study to assure that the solution is included in or fulfills the hospital information security policy.

1.6 Research questions
According to Spinuzzi (2005) PD projects tend to express the object of the research in a purpose statement rather than as a research question. Nevertheless we have decided to form some questions that should give us guidance throughout the research.

Before we start to gather requirements for the planned information system we need to investigate if an information system could improve the daily care in the ward and what impact it could have for different stakeholders, focusing on the healthcare professionals. Thus, first we are doing an explorative study to learn about the healthcare professional’s perception of the work situation and their ideas and attitudes in regards of the planned-for solution. Here we ask:

*What perception does the healthcare professional have of the work situation?*

Together with the results from the first research question and our skills and experience that we bring in, we are in the next step compiling functional requirements together with the healthcare professionals and creating a first design proposal.

*What functional requirements are perceived by the healthcare professionals?*
2. Related literature and theoretical focus

There are different angles that need to be considered for the theoretical focus. Here we have chosen to screen the following areas to get a good foundation for our research; Healthcare and ICT, mHealth, Participatory Design in healthcare, digital patient records and legislation and regulations matters in regards of patient information.

We have selected these areas because they are relevant for the research we have conducted. We have done a PD project within healthcare to design a solution for a tablet, which will have a direct connection to the patient documents. This solutions design will be affected from the legislation and regulations that exist in regards of patient data. The unique constraints surrounding mHealth applications make it worthwhile to learn from other projects in the field so that mistakes can be avoided.

For instance Timmons (2003) discusses the problem with lack of terminals in the ward for nurses to use. In 2003 the use of Smartphones was in its infancy and the option of having mobile applications was not in consideration. However Timmons (2003) finding regarding the importance of having the nurses’ participation of the system design is still valid.

In 2000 Darbyshire was writing about the poorly designed systems. The findings of the importance of well-designed system is still valid, as discussed by Stevenson et al. in 2014, but since 2000 system design, usability and technical possibility have come a long way and the systems that were included in the research have probably been replaced several times.

All the studies must therefore be seen in the spatial and temporal setting they were conducted in.

2.1 Healthcare and Information and Communications Technology

There is a change of demographics with an aging population where we live longer, which entails an increase in chronic diseases (United Nations, 2004; World Health Organization 2003; Fitzpatrick and Ellingsen, 2013). This creates a higher demand on healthcare resources such as money and personnel (Kinsella and He, 2009; Fitzpatrick and Ellingsen, 2013). To use Information and Communications Technology (ICT) is one of many solutions to this new rising challenge (While and Dewsbury, 2011; Fitzpatrick and Ellingsen, 2013).

ICT has come to play an important role in healthcare and there has been a transition from manual patient records to electronic records, which facilitates the documentation but at the same time increases the complexity of
documentation (Stevenson et al., 2010). The advances in technology and medicine have had an influence on nurses’ role and the evolution of nursing theory and research has resulted in a change of the processes and documentation of nursing. This, together with the increased ethical and legal awareness, requires accurate and complete patient records (Stevenson et al. 2010).

Forbes and While (2009) urge nurses to become more than data collectors and data analysts, additionally taking on the roles as system managers and designers they should contribute to the shaping of the care system and defining the structural components of the same. The nurses should have more than a passive relationship to the technology merely feeding the system with data for others to interpret or analyzing the information output to meet the health needs.

EPR’s (electronic patient records) aim is to improve quality of care by increasing patient safety through improved documentation quality (Granlien, Hertzum and Gudmundsen, 2008; Douglas et al., 2010). For EPR to achieve these goals the EPR needs to have a format that make sense for the healthcare professionals, be user-friendly and have the relevant and correct information (Curtis, 2007, cited in Stevenson et al., 2010).

Another perceived gain of implementing ERP is possible time-efficiency. According to Poissant et al. (2005) is the time-efficiency mostly measured on a single process, like the documentation of vital signs, and not necessarily on a set of process that is involved in the care delivery.

A study from Moody et al. (2004) found that nurses prefer bedside charting e.g. vital signs. The half of the questioned stated that the need to use duplicate methods for clinical documentation because direct documentation in the EPR was not convenient at the bedside. They often used worksheets or scrap paper etc. for writing information down. Douglas et al. (2010) also recognized the importance of documenting the data at the point-of-care since the monitoring and evaluation of the recorded data are in reality parts of the same process.

According to Stevenson et al. (2014) nurses are often not involved in the design of the EPR, but leaving nurses out of the design process can have a negative influence on the user acceptance and impede the design of a solution that meets the requirements of the everyday practice of documentation.
In the same paper by Stevenson et al. (2014) it is pointed out that it is a responsibility of the system manufacturer to understand the work patterns of the users. It is also the manager’s responsibility to insist that the design will complement the care, assist the clinical staff in their work and secure that it is legally accountable. These responsibilities are consistent with how we interpret our mission with our thesis and what we strive to achieve.

2.2 mHealth
Tablets and smartphones have found their way into healthcare and the usage seems to be limited only by our imagination. Today we can find health application on mobile platforms that can be used for diagnostics, patient education, speech therapy, patient preparation and distraction, reminders, self-management, behavioural prompts, patient monitoring and much more. The possibility to take advantage of the mobile technology to support healthcare has created the interdisciplinary field of mobile health (mHealth) within the field of eHealth (Ben-Zeev et al., 2015). According to United Nation (Vital Wave Consulting, 2009) can eHealth be described as using ICT for health service and communication and mHealth as using portable devices as a way of delivering healthcare or health related services. The digitization of patient records is an example of eHealth where mHealth will act as an access point for entering and reading patient data.

The number of mHealth apps that are published on the two leading platforms, iOS and Android, had reached more than 100,000 apps (Q1 2014) with a market revenue of USD 2.4 billion in 2013. The mHealth market is expected to grow significantly during the next coming years. Although it is predicted to reach USD 26 billion by the end of 2017 is that only representing 0.5 % of the global health market (Research2Guidance, 2014).
The most common type of apps today in the area of mHealth are fitness apps. However are remote monitoring apps and consultation apps the ones with highest expected market potential in the near future. Assuming that mHealth apps will be integrated into healthcare, physicians and hospitals are likely to become the top ranked distribution channel in the coming years. (Research2Guidance, 2014)

Even though the mHealth field holds such a variety of health disciplines there are many advantages and challenges that are shared. In our opinion it is greatly beneficial to follow what is happening in this field in order to learn from other and avoiding mistakes that have already been solved somewhere else.

According to Dunham (2011) the usage of mobile apps can be seen as a part of technology continuum where tablet apps have the same purpose as other tools like books, toys and stimulus cards. The American Speech-Language Association (n.d) can see several advantages with using mobile devices in a therapy setting such as improved communication over distance, data collection, progress monitoring and motivating.

There are also challenges that are unique to mHealth such as a rapid evolving technology, delivery strategies and characteristics of the intended users (Ben-Zeev et al., 2015).
2.3 Participatory Design in Healthcare

According to Cambridge Dictionary (n.d.) ‘motivation’ is defined as "enthusiasm for doing something" and "the need or reason for doing something". One reason for user participation in design is to reduce the resistance to change (Bjørn-Andersen and Hedberg, 1977). Similarly, Helmke, Brinker and Wessoly state that "ohne die Akzeptanz von Veränderungen lassen sich diese oft nur mühsam implementieren und der damit verbundene Nutzen nur schlecht realisieren". This we translate into English as "with a lack of acceptance for the change, the implementation will be difficult and the benefits of the change will not reach its full potential" (Helmke, Brinker and Wessoly (2002, p. 307), our translation from German to English).

Further Lauer states that “Partizipation ist einer der Kernerfolgsfaktoren des Change Managements”, which in English can be translated to “Participation as the classic success factor for change” (2010, p. 125, our translation from German to English). By including as many persons as possible in the change, it will lead to increased motivation and a decrease of resistance. In a study from Timmons (2003) the reasons for resistance were found to be the interface between system design on the one side and on the other side nursing culture and nursing practice. With a PD project we can bring these two together, on the one hand the system design and the other hand the culture and the everyday practice of nurses. This provides the participants a forum to express their concerns and opinions in regards of the change.

In PD the people that are intended to use the system plays a role in the design of the system. PD involves collaborative partnerships and co-construction of knowledge in analysis and co-construction of changes in social practices (Gregory, 2003).

A PD project by Aarhus, Gronvall, and Kyng (2010) found that the contribution from the users add quality to the results and is likely essential for the acceptance toward the design. In a study from Wong, Turner and Yee (2008) they explicitly express the importance of user involvement, and that it can prevent the IT project from failing and create an environment of readiness for change.

The users do not always get the role as co-designers. According to Sanders and Stappers (2008) this depends on different factors such as the level of expertise, passion and creativity of the user. If the user poses a high level of
knowledge and has a passion for the subject it is more likely that the user can become a co-designer.

We are eager to involve the future users in the design process and facilitate them in taking the role of co-designer. These guiding principles from Kensing and Greenbaum (2012, pp. 33 – 34) are concrete advices to strengthen the user's role as co-designers:

- Equalizing power relations – find ways to give a voice for persons that are invisible or weaker within the organization
- Democratic practices – the equality among the stakeholders should be supported.
- Situation-based actions – to understand the actions and technologies in the actual settings one should work directly with people in their workplace.
- Mutual learning – the mutual learning between the different actors should be encouraged and enhanced.
- Tools and techniques – should support the different actors to express their needs and visions.
- Alternative visions about technology – ideas can generate expressions of equality and democratic practices.

The mutual learning that Kensing and Greenbaum (2012) encourages was also identified by Bratteteig (1997) as a key factor for successful implementation of a new system. Bratteteig states that mutual learning is based on the willingness and ability to listening. In the example of the Florence project the PD sessions provided a voice to the tacit knowledge of the nurses and listening to the nurses’ experience resulted in an understanding that would not be possible for the researchers to obtain elsewhere.

2.4 Digital patient records

According to Nilsson and Nilsson (2003) Nils Rosén wrote a doctoral dissertation about medical documentation in 1730 with the title ”De historiis morborum rite consignandis”. In his thesis Rosén wrote that documents are only useful if they are complete. If it is incomplete and missing important circumstances the record would make more damage than good. This created the foundation for medical records in Sweden during the 1700s and 1800s. For a long time the medical records were more of a memory note that was done, owned and died with the doctor. It was first in 1863 when a central directive was issued regarding medical documentation. It was at this point Sweden got a standard form for patient records.
In present time, over 280 years after Nils Rosén wrote his doctoral dissertation, are his findings still valid and stressed as an crucial factor for successful patient care over and over again as in papers from Granlien, Hertzum and Gudmundsen, (2008), Douglas et al. (2010) and Stevenson et al. (2010).

There has been intense work with digitizing the patient records during the last three decades. During the last years the Swedish government has put a national guideline in order to get a common structure and for creating reliability. Nationell patientöversikt (NPÖ) will make it possible for authorized personnel (with the patient consent) to access records that are registered at other healthcare providers. (Inera, n.d)

Over time the medical records went from being handwritten memory notes via typed formulas to become digitalized records. The record in itself is technical neutral: regardless of how they are recorded and stored most of the same laws and rules apply. In the Patientdatalagen (SFS 2008:355, 3§) a medical record is defined as a recording that can be read, listened to or otherwise comprehended only with technical aid. It must also have been made in connection with healthcare of a patient and contains a patient's state of health or planned healthcare measures. Here in its original text:

"Framställning i skrift eller bild samt upptagning som kan läsas, avlyssnas eller på annat sätt uppfattas endast med tekniskt hjälpmedel och som upprättas eller inkommer i samband med vården av en patient och som innehåller uppgifter om patientens hälsotillstånd eller andra personliga förhållanden eller om vidtagna eller planerade vårdåtgärder." (SFS 2008:355, 1 kap 3 §)

When the Patientjournallagen (SFS 1985:562) came into effect in 1986 more professions (currently 21 professions) were required to keep records (Krakau et al., 2008). This lead to a substantial increase in the amount of patient records.

The question is how technical neutral the patient records really are. Does it matter if we use handwritten records or digitalized? What has the change from analog to digital media brought?

In a study conducted by Hertzum and Simonsen in 2008 it was concluded that nurses did experience positive effects of electronic records over paper based
records such as a more complete set of information. It was also concluded that there were some pre-requisites that created this positive experience like speedy access to the information and the possibility to bring the electronic solution to the point-of-care i.e. the patient bedside or at the nurse's office.

We can assume that the information in both analog and digital records are the same and by that assume that any change that occurred with the digitalization could only be due to the new media. Let’s look at some examples:

Readability
An experienced caregiver can get information on a patient from an analog record without even opening and reading the record. The thickness of the records and the colors on the papers within it can suggest the patient’s history. This type of intuitive information is hard to represent on a screen. The analog record chronological structure and the possibility to browse provide a good transparency. According to Palser (2011) this problem is within the design rather than in the technology.

Security
It is possible to add a control on the digitized records to assure that only authorized persons get access to read them. There is even a possibility to classify the information within each record that will provide the information that the reader need and only that part. Another possibility with the digitalized media is to create a log over who has accessed a record. This level of security has never been possible to obtain with the analog records where access control was limited to the archives where the records were physically stored. A problem that could arise is that poorly fitted application could create workarounds that can break this security like a fictive user allowing access to unidentified persons (Balka and Tolar, 2011).

Availability
NPÖ aims to make the health information accessible for the actors who are affiliated, in legislation called ‘Sammanhållen journalföring’ (SFS 2008:355, 5 kap 4 §). Since 2012, Region Skåne has made some information available but the information available is so limited that patients that have been referred from a health center to a specialist may not bring the result from previous examinations and thus have to redo it again. The gain of the NPO arises only when the entire patient history is visible. (Region Skåne, n.d)

One important thing about the record is that it should be available when needed (Christensen and Grimsmo, 2008). The problem with paper records is
that they physically exist and can therefore only be in one location. In 2007 the health center in Vellinge was on fire and the records of the children that were handled by the child care center (BVC) burned and it thereby lost all the information that each child’s medical record contained (Sydsvenskan, 2007). A digitized medical record does not exist physically and can therefore be stored and accessed in multiple locations. A fire would not have the same disastrous effect on this type of records. The accessibility problem for digital records lies rather in the technique. If a system failure or a power outage occurs, the records will not be available.

Archiving
The explosive growth of medical records and the legislation that all records shall be stored for at least 10 years (SFS 2008:355, 5 kap 17 §) has resulted in huge archiving needs. This in itself was one of the strongest driving forces to begin digitizing the records.

In Norrbotten a decision was made to start digitizing all the records so that the safety and availability of the patient records will increase, the administrative task load on the health care should be less and the physical storage need reduced. It was calculated that it would take 40 person 3 years to scan the 30,000 shelf meters of records (Norrbottens Läns Landsting, 2006).

2.5 Legislation and regulations
According to the large annual mHealth research conducted by Research2Guidance in 2014 the major obstacle for progress within mHealth is the potential lack of security. One of the most profound laws in Sweden states that the patient integrity must be respected (SFS 2014:821, 4 kap. 1 §). It is the regulatory impact that is seen as one of the main prevention of the market momentum for mobile solutions within healthcare (Research2Guidance, 2014). In our opinion it is of uttermost importance to have one eye on the legislation and regulation when designing a mobile app for health care that will be classified as a ‘medical device’.


Only users that are working with the care of a patient or otherwise needs the information to fulfill their work task can access the patient record. This is
called ‘Inre sekretess’ (SFS 2008:355, 4 kap 1 §). It is the caregiver’s task to handle permissions allocation and access control in order to assure that the user's access is limited to what he/she needs to fulfill the assigned work task (SFS 2008:355, 4 kap 2 §). Although it is the caregivers responsibility to handle access control it is required that the user take an active decision if he or she has a right to access the information (SOSFS 2008:14, 2 kap 7 §). This access shall continually be audited and corrected. It is also required that the caregiver documents all access to patient records and regularly auditing this access to detect any unauthorized access to the information (SFS 2008:355, 4 kap 3 §).

Each caregiver shall keep their own patient records but the Patientdatalag enable caregivers to get direct access to each other's records if they fulfill the demands from the Patientdatalag. This is called ‘Sammanhållen journalföring’ (SFS 2008:355, 5 kap 4 §).

It is stated in the patient record law that any information shall be added into the record as soon as possible (SFS 2008:355, 5 kap 9 §) and there must be routines in place to assure that the information is accessible in a readable way (SOSFS 2008:14, 4 kap 1 §). It is the healthcare staffs responsibility that information about a patient is protected from unauthorized access regardless of what media it has been recorded on (SOSFS 2008:14, 2 kap 20 §). The post in the patient record shall be signed by the person responsible for the information (SFS 2008:355, 5 kap 10 §) and it is the caregiver's responsibility to make sure that there are routines in place for this (SOSFS 2008:14, 4 kap 3 §).

Information in the patient record shall be stored for at least 10 years (SFS 2008:355, 5 kap 17 §).

2.6 Summary of related literature
In the past chapter we have reviewed the literature on areas which we have considered as important for our study. With this literature review we wanted to build a knowledge foundation for us researchers to stand on while planning and conducting this research.

Healthcare and ICT
The increasing need of healthcare puts strains on the documentation of patients. Introducing ICT in the area of healthcare is possibly the only way to handle the high demand and at the same time the introduction has created a change in the nurse's role. Nurses now have to adjust to new processes and
tools for documentation. This leads to a demand on the nurses to rise above the traditional role of nursing and even take part of the system design. It is important for us to have this in mind when working with a new tool that can result in changed working processes for the healthcare professional. At the end of the day it is still the work of taking care of patients that shall be supported by the new application and not vice versa.

mHealth
Using a mobile platform as the method of delivering healthcare related services is still in its infancy. We have just started to see what is predicted to become a virtual boom of business opportunities. This means that over the coming years there will be a difficult path to navigate through the choices of applications that will be offered. Since mHealth has its unique challenges like the characteristics of the intended users and rapid developing functions it can be difficult to find the way through the process of acquiring the tool that is providing the best fit for purpose.
Our thesis will form a foundation of requirements that the healthcare professionals can use as a compass through the process of finding what they need regardless if they choose to buy or build their future tool.

Participatory Design in healthcare
It seems to be an academically well-known truth that using the future users as co-designer is the recipe for success. At the same time it looks like it is very few projects that are actually utilizing the nurses’ experiences when it comes to designing solution for them.
Since we do not have any experience of healthcare, the inherent mutual learning process that comes with PD was a definitive factor when choosing our approach. Having the tacit knowledge that the nurses experience provided is a definitive key factor to succeed in our mission. In addition, the benefit of establishing a sense of participation which brings an openness toward the new application, the selection of PD as our approach was given.

Digital patient records
The importance of correct, complete and timely information in healthcare has been a well proven truth for centuries and the digitalization of the records provides an opportunity to get more use out of the records than ever before but it seems remarkable problematic to start utilizing the possibilities. Working with this thesis it has been our guiding principle to enforce that the documentation of vital signs are correct, complete and instantly available.
**Legislation and regulations**

The new technology is constantly providing new possibilities and only imagination and the legislation is putting limitations on what we can use it for. The legislation and regulation regarding healthcare application are rigorous and it would be impossible to design an application within this field without having a close look at the law. Reading through the Swedish laws that are applicable in this field we have seen several legal demands that we must be fulfilled such as security and documentation retention but also legal demands that actually can be used as promotion for the work we are doing like the demand of the timeliness of information documentation.
3. Empirical settings
In this chapter we are presenting our research objective, the surgical ward at the North hospital and a detailed description of the measurement and the documentation of the vital signs and relevant processes that affects or is affected by a possible digitization of the documentation. This should provide the reader with an understanding of the situation that we want to change but is also a part of our explorative study to answer the first research questions, “What perception does the healthcare professional have of the work situation”. In order to achieve this we have interacted with the staff at the ward, in interviews and by observation. We have also analyzed the documents that are currently used for the documentation.

3.1 The North hospital and the surgical ward
The North hospital is one of two emergency hospitals in an area of approximately 130,000 inhabitants. The hospitals conduct surgical operations within surgery and orthopedics. There are also healthcare within gynecology, obstetrics and specialization within optometry and otorhinolaryngology. Additionally the hospital has wards and clinics for internal medicine. Besides the above mentioned areas there are also activities within child and adult psychiatry, rehabilitation and it has a birthing center and special wards for youth and children (Region Gävleborg, 2014).

The hospital was built in 1828 and expanded gradually over the years. The facilities were quite primitive why they facilities eventually were condemned and a new hospital was opened at its current location in 1895. The hospital was until 1947 undivided, then medical and surgical clinics and radiology was formed. A few years later the eyes and ears wards emerged as well as gynecological and pediatric clinics. Psychiatric ward was opened in 1992. (Region Gävleborg, 2011)

The surgical ward, also called ward 1, has 30 beds approximately 70 % of the beds are emergency care and the remaining 30 % are elective care. They have the following specialist areas: lower gastrointestinal, upper gastrointestinal, otorhinolaryngology and Kava (Surgical emergency department).

Our contact person, Elvira, is a nurse. She is one of two nurses responsible for the care planning and care place coordination. She is also setting up and optimizing processes. She is our main expert in regards to the daily workflows and processes within the ward. She has a four years university education to become a specialist nurse, focusing on surgical care.
Elvira was responsible for selecting the participants for the design project, mainly because it was important that the research did not affect the care in a negative way. Elvira, as responsible for the care planning, holds the information about which time and which persons are best suited to use for the research without influencing the daily work. In addition, she knows everyone from the staff and could so provide us with diversity in regards of experience and position and also with persons willing and motivated to contribute with their ideas.

In our first meeting with Elvira we received information regarding our mission. She described the processes around the measurement and documentation of vital signs and told us that they have wished to have the documentation process digitized and preferably in a mobile. The vital signs are measured once daily for each patient, sometimes more often and are normally documented on paper before it is transferred into the EPR. The following measurements are defined as ‘Vital signs’: respiratory rate, saturation, oxygen supply, temperature, blood, pressure, pulse rate, level of consciousness. To make sure that the patient and documentation matches, all patients have a bracelet with a barcode. The barcode is checked by the nurses before they measure and document the vital signs.

Beside interviewing Elvira at the North hospital we also interviewed Anna, a nurse at the South Hospital. She completed her education in 1991 and has been with the South Hospital for the last eight years, first at the orthopedic ward and then the last three years at the surgical ward. Beside the ordinary nurse duties Anna is also responsible for the coordination of the ward's capacity.

Beside interviews, observations and looking deeper into the ward’s documentation and processes we had a PD session. The participants in the design session consisted of nine persons from the staff, five nursing assistants, three nurses, one of them having the same education as Elvira with the additional one year on the university to become a specialist nurse, and there were also a nurse student in his last year. There were eight women and one man in the group and it was a good diversity in regards of working experience, from students to nurses with 30 years of experience working in healthcare.

To become a nurse in Sweden, in Swedish “sjuksköterska”, a six semester higher education is required. This results in two degrees associate degree (nursing) as well as bachelor's degree. In hospitals, it is the nurse who leads the nursing work and ensures that it is organized in the best way, some of the
practical performance is under the nursing assistant's role. The tasks include management of medication, sampling, examinations and journal entries of the patient's condition from day to day. An important feature is being able to work together in teams with all employees and other professionals. Other key features in the nurse profession are leadership, communication and information. The work also includes a lot of communication with both patients and their families. Also documentation of nursing actions is an important task. (Arbetsförmedlingen, 2012; Falk, 2012; Interview with Elvira, 29. of April 2015)

The title nursing assistant is not regulated in Sweden however the high school's three-year nursing program or assistant nurse in adult education, or through distance learning, is usually a requirement in order to receive the title of nursing assistant. These are in Swedish called “undersköterska”, there are also the title “vårdbiträden”, they do not have the required education. The profession nurse and nursing assistant are differently defined depending on each country, there are differences in the education and also in the tasks and responsibility. Assistant nurses often work close to the patient. The tasks vary to some extent depending on where you work. In a hospital ward, the work can sometimes include task such as controlling patients' temperature, pulse and blood pressure, take samples, put on wounds and, when necessary help the patients to wash and dress. Both nurses and nursing assistants work closely to the patients. (Svensk Vård & Kompetensutveckling, n.d.; Interview with Elvira, 29. of April 2015)

The PD session was conducted during working hours at the ward with the staff that were currently on duty. Our contact person Elvira chose one day in which the fitting staff were working so that we would get a good diversity of the participants but also with participants that were motivated to be a part of the study and contribute with their thoughts and ideas. We also had to make sure that the care at the ward did not suffer.

Here we have presented the setting of our study: the hospital, the participants and their profession. We have chosen to work with the two professions, nurses and nursing assistants because they are the future users of the technology solution that we are designing. We conducted this study in spring 2015.
4. Methodology

In this chapter we present our chosen design approach (PD), paradigm, data collection and data analysis methods, validity and reliability and the ethical consideration in context of this research.

4.1 Research design
The setting for our research is a surgical ward on a hospital in the northern of Sweden, (referred to as the North hospital in this thesis). The ward is a surgical emergency ward with 30 care places. During past years they have been working on process optimization specific for their ward. In the previous chapter ‘Empirical setting’ we have described the hospital, the ward and the participants involved in our study in more detail.

In order to get an understanding of the work situation, that is in focus for this thesis, and if it is isolated to the surgical ward at this particular hospital (North) or something that is experienced elsewhere we were also doing a reference study at a surgical ward at another hospital in Sweden (South). The same situation was discussed during an interview that was conducted with one nurse. Depending on the situation at South hospital, this reference study could provide us with ideas for solution or/and a second opinion on how to solve our mission at the North hospital.

In the following we introduce the design of our research and relate it to the two stages of our study, the explorative part and the design part. We first start with describing PD as a method and then continue with how we gathered and analyzed our data.

4.1.1 Participatory design
According to Mirel (1998) PD’s paradigm is constructivist. Constructivist sees knowledge making occurring through the interaction among people, practices, and objects (Spinuzzi, 2005). The interpretivist/constructivist researcher tends to rely upon the participants views of the situation being studied" (Creswell, 2003).

Introducing an electronic track and trigger system can result making data less accessible if the implementation is badly done (Mackintosh et al., 2012). We have chosen to conduct a PD project, because we want to encourage involvement from the users on an early stage in the process and by that avoiding the pitfalls with inadequate designed systems discussed by Darbyshire (2000, 2004) (see section “1.2 Previous studies).
PD is a way to evaluate the problematic context, where co-research and co-design will lead to conclusions in conjunctions with the users (Spinuzzi, 2005). The principal is that the suggested solution would work best if users are involved in its creation. The participatory ideas allow for a multidisciplinary take on the research where participants with different knowledge will work together to achieve a common goal.

One approach for PD is the Scandinavian tradition, with the central issue of the users’ involvement in the computer based system design (Elovaara, Igira and Mörterberg, 2006). This is the approach that we aspire.

According to Bjørn-Andersen and Hedberg (1977) user participation in design have different motivations; it improves the knowledge on which systems are built, it reduces the resistance to change and enables people to have realistic expectations. Finally it gives the members of an organization the right to participate in decisions, which affect their work – this by turn should increase workplace democracy.

With this in mind we consider PD as the best method to conduct our research and to achieve our objectives.

PD strives to involve future users in all parts of the development process (Gregory, 2003):

- Determine design objects on social and technical bases
- Analyze the current situation and co-construct the problem formulation; conceptualization of design, designing and evaluating possible design solutions
- Implementing changes and training people for new practices
- Evaluate, maintain and ongoing improvements
- Iterative design

This research deals with the first two described parts of the development process. The first two bullet points are related to our research questions. With the exploratory study we determined design objects with help of interview and observation, providing us with an understanding for what is needed from the solution. It also help us to analyze the current situation and together with Elvira to formulate the problem and conceptualization of design. In the design session we were together with the users designing the solution and at the same time we received a first evaluation of the design suggestion.

We have only used qualitative research methods, starting with interviews and observations on site to examine the current situation and process. This provided us with an overview and we got a first impression if the daily work tasks could be improved with support of a new technology solution. In the next stage we conducted a design session with different individuals and
examined if processes had the possibility to be optimized and digitized and we gathered the requirements for the new solution.

We were planning to divide our work in three major blocks, creating the theoretical framework, gathering data and analyzing the data. In figure 2 the time planned timeframe is shown graphically (in larger scale in ‘Appendices I: Timeframe’). After the data analyzing, which we assumed to be very time consuming, we started writing up our thesis. We expected that data gathering and data analyzing would be carried out in some parts parallel. We used the outcome from the exploratory part to plan the design session and to create a Mock-up that was used during the design session. After the design session we did an analyze of the new data we had collected such as suggested design, input and ideas from the participants

4.2 Role of the researcher
Information technology design consists of three types of tasks, developing an information technology system, performing systems design and managing the process (Bratteteig et al., 2012).

Our task was to involve the future users and hear their thoughts and ideas about the planned solution and we also had the function as requirement gatherers. Additionally we had the role as interviewers and observers.

4.3 Units of analysis
We analyzed the healthcare professionals’ staff, nurses and nursing assistants, in the conduction of one of their tasks, because they are the future users of this solution and one of their daily tasks are the one that we strive to set up in the new solution.
We divide the professionals in two groups: nursing assistants and nurses, with the preconception that not only the education differs but also the responsibilities within the ward and the different work tasks.

The patients were not observed or interviewed however they are automatically included in the study as an object on which the work tasks of the professionals are carried out.

We also reviewed the documents that are currently used for the documentation of the vital signs measurement and other processes around the measurements of vital signs.

4.4 Data collection methods
For our research we used four methods: observation, interviews, document reviews and the design sessions that also functioned as data collection method. In the exploratory study we observed, interviewed and did process and documentation reviews to answer our first research questions. After the exploratory study we conducted a PD to answer our second research question. The exploratory study was important for us to understand our mission and to plan the design session. It was of great importance that we not only got information about the processes that will be displayed in the system but also to understand our future users’ way of working.

Documentation
For documentation review we gathered documents used in the daily work, e.g. the excel sheet they have attached to the writing tablet, see Appendix II: Documentation protocol for vital sign. Due to patient privacy we were not able to take photos during all of the data collection; we were however taking notes during the observation and additional use a voice recorder for the interviews.

Interviews
During the initial dialog with Elvira, in which we received information about our mission, she described several situations that indicated problems with the current routine of gathering vital signs. Based on this information we developed a set of questions that we used during semi-structured interviews.

We conducted interviews, in particular with the specialist nurse. All interviews were either semi-structured or unstructured interviews. We had
some predefined questions for the interviews with our experts, but in the design session we asked some unplanned questions as well (unstructured).

For semi-structured interviews the interviewer has some predefined topics or questions, but opens up for the interviewee to elaborate answers and discuss topics more widely. In unstructured interviews, the interviewer introduces a topic and let the interviewee steer the interview (Denscombe, 2010). Semi-structured interviews enables the researcher to deviate from the planned questions and so collect as much information as possible from the interviewee (Lazar, Feng and Hochheiser, 2010).

The first interview was with our contact person, Elvira; in this interview we asked questions regarding our mission with the aim to in detail define our task. The everyday flow was described and the measurement of the vital signs was explained, e.g. what is measured, why it measured and what happens with the results of the measurement. The predefined questions are listed in the Appendix VI: Interview guide under Interview 1.

Our second interview was also with Elvira, our intention was to get information about her professional background and special knowledge but also get her ideas and thoughts for the planned solution. Because she is the one that had the idea about this application and who initiated this project it was interesting to learn more about her expectations. In Appendix VI: Interview guide we have listed the questions that we prepared before the interview to collected the needed information. However the most questions were spontaneously asked during the interview depending on the answers we received from Elvira.

We wanted to have an understanding if the situation and the perception of the situation among the healthcare professionals were local and unique to the ward in the North hospital or if this was something that could be seen at other hospitals as well. It could also be that issues experienced in the northern hospital was solved somewhere else and that this solution could be used at the northern hospital or at least give valuable input to our research. For this purpose we conducted an interview with Anna, a nurse at a surgical ward on a hospital in southern Sweden. This interview was semi-structured and included questions from our first and second interview with Elvira.
Observation
Observation is a way for the researcher to gain understanding through watching or participating in the particular situations. The researcher should keep notes from the observation (Crang and Cook, 2007). Observations will show how someone is acting in a real situation, and does not only correspond to the personal perceived acting. To refer to Plato, a person can only view the shadows of their own experience, whereas an external observation can reveal hidden elements (Plato, 380 bc).

We needed to observe the healthcare professionals in their daily work to get an understanding for the processes that we wanted to digitalize and to detect the potentials of processes optimization. We observed the healthcare professionals while they were measuring and documenting the vital signs in the morning. This is the particular process that should be transformed into a table application, and therefore we consider it important to understand this process. We observed a female nurse with approximately ten years of working experience while she measured the vital signs of four different patients.

Design session
We see design session, with different healthcare professionals such as nurses and nursing assistance etc., as a good way to gather requirements for the intended solution.

The purpose of the design session was to gather data with means of the participants’ interactions. As researchers, we provided guidance in the regards of the topics that were discussed. At the same time we avoided to use leading questions. It was from advantage to form the research questions in advance to make sure that the right data was collected.

For the design sessions we provided a predesigned Mock-up. In the early stage of the process the objects that the participants interact with are called props and mock-ups. In later stages they are called prototypes (Brandt, Binder and Sanders, 2012). A Mock-up is a low-fidelity design model that can be used for demonstrating, evaluation and getting feedback early in the design process (Interaction Design Foundation, n.d). We use Mock-ups as a way to get feedback and ideas from the staff on functionality and design needed for a successful future application.

The Mock-up was created in three steps; first we got the required elements from the interviews with Elvira. Secondly with our previous skills and
experience in system development, usability architecture, graphical design and eye-tracking-analysis, we drew up a first draft. Finally Elvira evaluated this draft and came with suggestions and ideas for changes which we modified to get the final Mock-up (see Appendix VII: Pre-designed Mock-up). The Mock-up served as a basis for discussion in the design session.

In the design session each participant received a tablet and different elements in paper form, such as data fields, buttons or functionalities that were listed as required objects in the initial conversation with Elvira. The first task for the participants was to create one's own user interface on the table, using the required functionalities but also with the possibility to add other elements or functionalities that were not originally planned in the beginning. We took photos of each Mock-up for the later analysis. The second task was to create just one Mock-up together as a group, for this all participants had to agree on the final proposal of the user interface. We presumed that this would lead to interesting discussion that will facilitate us to answer our research questions.

We did the design session in two steps, first task individually and the second task as a group, this way we first of all got an impression how the different participants want the solution to look and act like; this can vary depending on the nature of the professional role but also be individual preference. The second task was planned to provide us with a requirement list of the solution and with a first draft of the user interface that will be accepted from all kinds of professionals that will use the solution.

4.5 Data analysis methods
The qualitative data, that has been gathered must be analyzed, interpreted and described in ways that explains the spatial and temporal settings the data was collected in. We used a content analysis method to bring order to the information. Content analysis is a flexible method to analyze text (Hsieh and Shannon, 2005) that has been derived from the data collection methods that we will work with such as observation, interviews, workshops and previous studies (Kondracki, Wellman and Amundson, 2002).

The techniques for content analysis include several steps (Hsieh and Shannon, 2005):

**Knowing the data** — The researcher starts with reading through the material repeatedly to get a sense of it.

**Focus the analyses** — As previously stated (see chapter 1.6) is it not necessary to use research questions in PD but we have chosen to start up with
two research questions (see chapter 1.6). In this section of the data analysis will those be used to see how the each subject has responded them. During this phase is it possible that new research questions will emerge and be used in the same way.

Categorize information — This is a time consuming part that is the center of qualitative analysis. It is about identifying themes or patterns such as observed behaviors and incidents or expressed ideas and phrases. We worked with both present and emergent categories. This combination allowed us to have some predefined categories (like input validation, clear navigation, terminology and accessibility) as a start point but at the same time make room for categorizes that emerge during the analysis. This process is iterative and will continue until no new categories emerge.

Identify patterns and connection within and between categories.

This includes:

- Summarizing the categories.
- Combine categories into clusters.
- Understand the relative importance between the categorize.
- Recognize relationship between categories such as concurrency and consequences. According to Schutt (2012) this will move the research from a simple description to an explanation why things have happened.
- Authenticating the information. It is important to consider the validity of the information. This deals with the informant credibility: Is the information spontaneous or a response to a question? How is the researcher or subjects’ present/absence influencing the statements from others? (Schutt, 2012)

From our initial interview with Elvira we identified some initial categories to work with such as input validation, accessibility and terminology. When we continued with analyzing data from published texts, laws, interviews and notes from design sessions more categorize emerged.

The first interview with Elvira gave us a direction to go ahead with. We started exploring the literature to create a knowledge frame as a foundation for our research. We were looking into PD but also other areas within healthcare and informatics connected to the solution we were working with. Subsequently we started planning and constructing our research. Our first step was the interviews, observations, documentation and process analysis. This first step provided us with data that we converted into knowledge about the situation and the tasks of the healthcare professionals. We used this knowledge to plan the design session, e.g. creating a Mock-up, a work package. The design session provided with new data, for one the very
concrete design proposal that we are presenting in the next chapter but also with a deeper understanding of the nurses perception which enable us to answer our first research question.

4.6 Validity and reliability
If the data collection is not reliable it is also invalid, however even if the data collection is reliable it does not mean that it is automatically valid.

It will be a challenge to secure the reliability of the study, because of the qualitative methods we have chosen, especially in regards of the unstructured interviews and the observation. The findings can differ depending on the researcher and his perception of the situation doing observations or if the researcher controls and leads the interview in one direction and not following the lead of the respondent. It is our belief that it is important that we as researchers are aware of our role and that we are taking detailed notes to be able to analyze the situations afterwards. Since we were two researchers we were able to counteract the personal perception, with both of us observing the same situations and taking notes. This allowed us to compare findings afterwards and remove any false interpretations.

Because we have little prior experience in the healthcare we have been having problems with the validity. It was hard for us to judge if we gained all required knowledge and data to answer our research questions. We were dependent on our contact person to give us access to all the knowledge and data that we needed. To be able to detect any gaps in the data collection we did pre-studies on the daily healthcare and did detailed walkthroughs in the ward before we start analyzing the everyday tasks.

Many studies that have been published over the years have been so in journals such as: Health Informatics Journal, Journal of Clinical Nursing and Health Informatics Journal. A vast majority of the studies are qualitative case studies where a specific context has been analyzed. The validity of the study is for that specific context in that specific time. The outcome of these studies could still be valid and of interest but the problem was unique in that specific time and place.

4.7 Ethical considerations
This paper has not conducted any medical research that involves patients. This project has however required that we analyzed the work that the personnel at the clinic are doing and by doing that we came in contact with patients at the clinic. This required that we considered the ethical issues for
both the participants in the study (personnel at the clinic) as well as the patients. Precaution was taken to respect the patients’ and personnel’s integrity.

This research does not include any patient information and all data has been anonymized. We have renamed all places, persons and also censored certain references to prevent identification.

It was important that the subjects for our study understood that the material we gathered is for a research purpose and that their participation was voluntary. We asked all potential research subjects for informed consent (see Appendix V: Informed consent) as a way to address any ethical concerns that might arise due to our study (Denscombe, 2010; Robertson and Wagner, 2012). Any dissent was respected. If the subject’s physical condition prevented giving informed consent the subject was not included unless informed consent was given from legally authorized representative.

This study is dependent on the participation of the future users and it is important that they are acknowledging for the expertise they possess. Mutual respect and trust for all the participants are fundamental. (Robertson & Wagner, 2012)

In order to protect the individual and to secure the respect for human dignity in researches a new law was created in January 2004 ‘Lag (2003:460) om etikprövning av forskning som avser människor’. This law states that research involving human beings requires an ethical review. However this law is not applicable on this thesis since it excludes work that is carried out at higher education nor did we handle personal information (SFS 2003:460). We did not need to seek approval from the Regional Ethical Review Board.
5. Results and discussion

In this chapter we present the results of our exploratory study and our design session and in direct connection we discuss our results. First we are presenting the explorative study in which we learned about the healthcare professionals perception of the work situation and their ideas and attitudes in regards of the planned solution, this was done with interviews, observations and analyzing the processes and documents connected with the technology solution. This provided us with the answer to our first research question, “What perception does the healthcare professional have of the work situation?”. Consequently with the result from the explorative study we wanted to find out which requirements users have for this solution which should enable us to deliver a suggestion for a design for this new table application and answer our second research question, “What functional requirements are perceived by the healthcare professionals?”. This study was done in the context of the design session.

We have chosen to have results and discussion in the same chapter because of the type of study that we have conducted, we consider it important to have the results and discussion in close connection to each other, similar to the development we had in the design session with a mixture of results and discussion simultaneously.

We have already described the empirical setting and in this chapter we are involving the healthcare professionals in the design process, starting with interviews to learn more about their ideas and thoughts on the planned solution. We proceed with a design session in which the staff created their own designs with help of a pre-designed Mock-up. If the solution is implemented and successful in the specific surgical ward, this solution could possibly be adapted to other wards within the hospital and even in other hospitals as well, nationally or internationally.

5.1 Exploratory research

When we present the data from this phase it is important to notice how the vital signs are currently measured and documented. This is the current way of working and we would like to understand how and why it is done. The knowledge that we won in this phase was used to plan the design session and to create the Mock-up and working package that were used in the design session which we present in chapter 5.2.

5.1.1 Documentation and processes

The presented information in this chapter is gathered during the interviews (Interview with Elvira via Skype, 8. of April 2015; Interview with Elvira, 29.
of April 2015.) that we conducted, (see Appendix VI: Interview guide). The interviews were conducted in Swedish, they were recorded and notes were taken. In addition to interview we also got information, which we use here, during observation of the healthcare staff while they were measuring the vital signs.

The working day for the day staffs at the surgical ward in the North hospital starts with a hand-over meeting together with the night staff. Following the hand-over the nurse attends all patients in the ward. The nurse normally starts to hand out medicine, this could be pills, injections etc. The patients are asked how the night was and the vital signs are measured.

The vital signs are documented on a protocol that is attached to a writing table in the corridor. After all patients have been seen to by the nurses or the nursing assistants, they have the responsibility to add the values into the EPR. Figure 3 shows the document for all the measured vital signs with comments from our contact person. The columns marked with a red cross are not foreseen for the new solution.

![Figure 3 Documentation of vital signs with comments](image)
Table 1 contains a translation of the different columns from the Documentation of vital signs.

<table>
<thead>
<tr>
<th>Column:</th>
<th>Swedish:</th>
<th>English:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sal, pat</td>
<td>sal, patientens initialer</td>
<td>room, patient initials</td>
</tr>
<tr>
<td>AF</td>
<td>andningsfrekvens</td>
<td>respiratory rate</td>
</tr>
<tr>
<td>Sat</td>
<td>saturation</td>
<td>saturation</td>
</tr>
<tr>
<td>O₂</td>
<td>syrgastillförsel</td>
<td>oxygen supply</td>
</tr>
<tr>
<td>Temp</td>
<td>temperatur</td>
<td>temperature</td>
</tr>
<tr>
<td>Bl.tr.</td>
<td>blodtryck</td>
<td>blood pressure</td>
</tr>
<tr>
<td>Puls</td>
<td>puls</td>
<td>pulse rate</td>
</tr>
<tr>
<td>AVPU</td>
<td>medvetandegrad (Alert/Voice/Pain/Unconscious)</td>
<td>level of consciousness</td>
</tr>
<tr>
<td>NEWS</td>
<td>National early warning score</td>
<td>National early warning score</td>
</tr>
</tbody>
</table>

Table 1 Translation of vital parameters

All values of the measured vital signs are summed up to a National Early Warning Score (NEWS), this is done to identify patients that are sick or at risk of getting sicker. These patients could possible need extra attention or immediate actions need to be taken to improve the state of health.

NEWS is a scoring system that is used to monitor patients in the hospital. Six physiological parameters are the basis for the scoring system, see table 1. NEWS system is used as a surveillance system for the patients, tracking their clinical condition, alerting the clinical team to any deteriorations and triggers timely clinical actions to changes in the clinical condition. (Royal College of Physicians, 2012)

The surgical ward at the North hospital has been working with NEWS for almost two years and was one of the first wards in Sweden to do so.

“The vital signs are measured once daily on all patients. And depending on the score the time intervals for future measurements are determined” (Interview with Elvira via skype, 8. of April 2015. Our translation from Swedish)

Each patient in the ward should be “NEWS:ed” once daily between 6 and 12 o'clock. Depending on which NEWS score the patient gets the measurement
interval can vary between once daily or continuous monitoring (Appendix IV: Hur vi arbetar med NEWS).

Figure 4 shows the customized NEWS protocol for the surgery ward where we conduct our research, based on the international document for NEWS.

![Figure 4 NEWS list (North hospital)](image-url)
In principle, the vital signs are measured once daily, however depending on which score the NEWS algorithms delivers this could be done more frequently. E.g. five points would mean that the vital signs should be monitored every sixth hours, at the most the vital signs are monitored once an hour. For severely ill patients, the healthcare staff does not leave the bedside of the patient. The interval of the monitoring is normally set-up the key provided for the NEWS algorithms, however sometimes the patient's responsible nurse or doctor will decide on the time interval.

The values from the vital signs document are later transmitted in the EPR from a nurse or a nursing assistant. This can be done on any computer in the ward, there are several laptops spread across the ward and some stationary PC in the ward reception. The tests results in the EPR are later discussed in the ward round, the healthcare professionals’ daily routine check of all patients in a ward.

As already mentioned, depending on the score the team decides on which actions should be taken for each patient. However if some of the vital parameters are crucial at the time of the measurement there can be a need for immediate actions. In this case normally the patient responsible nurse is called and/or the responsible doctor.

Summarizing the process it consists from two documents, the vital sign document and the NEWS list. The NEWS list is used to receive the total score for NEWS that should be documented on the vital sign document. In this first step only a digitization of the vital sign document is intended.

The ward has routines in place however this is an emergency ward which means that staff may be forced to drop everything and attend to critical patients. This means that it can take hours before the results from the vital signs document can be transmitted into the EPR. This is done whenever the staff finds the time for it.

5.1.2 Interviews
In this chapter we present the results of our semi-structured interviews with Elvira and Anna. In the first interview we formulated the mission together with Elvira and started with initial conception of the design. In the second interview we received the first answers to our first research questions and learned more about Elvira's perception on the work situation. We continued with the first research question in the third interview with Anna from the South Hospital in which we received her perception on her work situation at a different ward and hospital as our setting.
In connection to the design session we were also asking the participant questions, the results of these questions are handled in chapter 5.3, design session as a part of the results.

**Interview 1 Definition of the mission**
Elvira guided us through the normal daily routine and the processes around the measurement of the vital signs. She provided us the documents that are currently used and explained these in detail. The Mock-up for the design session was discussed and with her remarks, e.g. of the order of the values, we finalized the Mock-up. (Interview with Elvira via Skype, 8. of April 2015)

The outcome of the interview has also been used for the description of the empirical settings in chapter 3 and for the understanding of the documentation and processes.

**Interview 2 Perception on the work situation and first requirements gathering**
Elvira has had an idea about mobile solution for quite some time; however it has not been a possibility to make the idea concrete and presentable for the decision makers. In a previous conversation with us the idea came up and Elvira saw an opportunity to start the process of designing a new solution. She sees the high workload, especially in the mornings, as one of the main problems in the ward that needs to be addressed. She believes that this mobile application will save the staff time because the multiple documentation of the same information that is currently required can be replaced with a few clicks on a tablet. Elvira sees this as a valuable benefit to change the current way of the documentation:

“To get the measured values directly into the data log via a plate would be extremely valuable, it would reduce the double documentation and ease our workload” (Interview with Elvira, 29. of April 2015. Our translation from Swedish)

Each step that can be optimized or removed will release time for other tasks and activities. Another benefit would be the reduction of errors, for each time that something needs to be transferred the risk of errors in the documentation increases.

“By removing steps from the documentation process, elements in which mistakes can occur can be avoided”
One of the risks that she sees with the new solution is that until now there is a document in the corridor, which is visible for the whole staff. If the tablet solution is put to use, this document will no longer be available in the corridor. This leads to the need to change the way of working. Until now the responsible nurse, e.g., could easily check the new results in the corridor; however, with this new solution the nurse would need the access EPR to be able to see the patient’s current clinical status. This could be a problem if there is e.g. a new student measuring the vital signs and is just putting the results onto the tablet without reflecting over the results, e.g. informing the responsible nurse if the clinical status rapidly has gotten worse. Some results can be critical and need immediate actions. It is important that the routine adapts and changes to the new solution, making sure that the one’s measuring is alerting the right persons in case of need of immediate actions. It is also to consider that new or temporary staff would need access to the solution to be able to document the measurements, unlike the current process with the paper documentation.

Another risk that she brought up is also one of the benefits; the multiple time of documentation can also work as self-control.

“Howver this can also have a downside, because the multiple steps could also work as self-control.” (Interview with Elvira, 29. of April 2015. Our translation from Swedish.)

Be transferring the information from a piece of paper into the EPR the results are automatically viewed a second time.

When she is asked to predict possible impacts on the daily work she has a positive attitude towards a mobile solution. As already mentioned, the mornings are especially busy and this application would make the process smoother. This could possibly free up time for other things. She also predicts that the EPRs will have a constant update of the patient information in another way than currently; this would be of advantage in e.g. the ward round.

Elvira had some concrete ideas for the design of the new solution, e.g., she recommended us to use the same order and colors for the tablet as on the
existing documents. This will make it easier for the staff to learn and work with the new solution.
If there is a possibility to set-up limits for the values this could prevent the staff from writing the wrong value, e.g. temperature 59 instead of 39. (Interview with Elvira, 29. of April 2015)

**Interview 3 Reference interview at the South Hospital**

As a reference, an interview was conducted with a nurse, Anna, on a surgical ward at a hospital in southern Sweden. This was based on the same questionnaire that was used for the interviews in the northern hospital. She has been a nurse on this ward for three years and before those five years at another ward. The surgical ward at the southern hospital has 22 patient divided into groups with approximately 6 patients.

Anna starts at 6:45 in the morning with reading up on what has happened with the patients in her group. If necessary she can discuss the events with the night shift before they leave. When she has read up on the events she collects the fluid balance report for each patient and measures the vital signs. She will then calculate the score and register them in the EPR.

The frequency of the vital signs measurement depends on the clinical condition of the patient but all patients are measurement once in the morning. If the scoring is abnormal a specialist team is called in to evaluate the patient and decide on future actions. Minor discrepancies will be discussed on the ward round.

The South Hospital had just implemented a new form for doing the documenting of the vital signs. Anna considers the new form as an improvement since all the patient in her group are now documented on a single form which makes the reading in the morning much easier. When she hears about the initiative from the northern hospital she can see the benefits of not doing the double documentation with first entering the vitals manually on a form and then put the same values into the computer. (Interview with Anna, 12. of May 2015)

**5.1.3 Observation**

The main target for our observation was the healthcare professionals when they measured and documented the vital signs. This was done on one single occasion at which vital sign measurement processes were observed on four different patients. However the procedure was the same at each patient, and therefore we only describe a single situation. We were not interested to
observe how the vital signs were measured but much more the workflows surrounding the measurements.

The nurse entered the room with the machine that measures the vital signs. She disinfects her hands and goes to the bedside from the patient. First of all she asks the patient how he is and how the night was. She then attached the machine to the patient and wrote down the results on a piece of paper. After she finished the measurements she returned to the hall and transferred the data from the paper to the spreadsheet attached on the writing tablet. The nurse continued to the next room and the same procedure was repeated with the next patient.

We were not able to observe the transfer of the data to the EPR because the nurses were always occupied with new arising tasks.

We have chosen not to describe the time or place to secure that there is no possibility to identify the patients.

5.1.4 Comparison between two surgical wards in different hospitals
We wanted to see if the problem scenario that the northern hospital wanted to solve, is isolated to this specific ward or hospital. It is possible that the issue at hand could have been solved elsewhere and that in this case an existing solution could be re-used at the northern hospital.

We got in contact with a surgical ward at a hospital in southern Sweden. This hospital had just changed to a new routine regarding documenting measurements of vital sign. The new routine was a new form where the nurses recorded the vital signs for all patients in the group.
The form that just got implemented at the South Hospital has the same thought as the one that the North Hospital is using, with some minor differences. The routine of double documenting with first filling in this form and then transfer the information to the computer is also looking the same at both hospitals.
In both hospitals there is also a separate form used if a patient is in need of more frequent monitoring.

![Documentation with frequent measuring of vital signs at the South Hospital](image)

The new routine has just been in place for a few weeks at the time we conducted the interview so it was premature to see if any of the issues that was described at the North Hospital also was present at the South Hospital.

However is it worth noting that the North Hospital was using the NEWS measuring system and was one of the first in Sweden using this already two years ago. At the South Hospital the MEWS system is still used but it is planned to move over to NEWS at the end of this year.

The difference between NEWS and MEWS is if the patient receives oxygen supply this has a negative influence on the total score, while in MEWS the oxygen supply has no impact on the score (Elvira 2015, pers.comm.).

It seems that the North Hospital is working with improvement and innovation more actively than the South Hospital. There is nothing that says that the issue identified in the North Hospital will emerge in the South Hospital even though the new system implemented in the South Hospital is looking a lot like the system that the North Hospital wants to improve. But the solution that the North Hospital eventually will implement would most likely be useful in the South Hospital as well. At the very least we could assume that
the result from the work in this thesis could be re-used at the South Hospital as well.

5.1.5 Review of the exploratory research
We learned a lot during the exploratory research, we received a deeper understanding of the healthcare professions and the tasks it involves. We learned that even though the care is similar in different hospitals the processes and documents that they are using are not the same. This gave us the insight that it would be of advantage to create a solution that fits the need of this particular ward.

The observation showed us that the measurement and the input in the EPR does not always happen in connection to each other. If the solution is implemented this will lead to that the data is faster entered into the EPR than before and that it saves the staff steps in the documentation.

We have also learned that the ward at the North Hospital is open to change and continuous improvement of the processes and they are positive to a technology solution that would spare them the double documentation. Another concrete outcome of the exploratory research is the Mock-up that we used in the design session. In the interview with Elvira we received the information about what should actually be a part of the solution. We used our previous experience and education, media design and programming, to come up with a draft for the Mock-up. Elvira then delivered her ideas and thoughts on how the icons and symbols should look like, this was important input for us because we did not know if they were already using a certain symbolic on the ward. She also recommended us to use the same order and colors for the tablet as on the existing documents, because this would facilitate the learning and understanding of the solution.

5.2 Design session
The design session was carried out at the ward with 9 persons from the staff. As already mention this is an emergency ward, which means that staffs have to might have to leave everything to attend a patient whose condition deteriorates. This leads to some difficulties finding a time slot for the design sessions during working hours. On the other hand it is hard to find volunteers who are prepared to invest time in their leisure hours. Our contact person suggested that we conducted the design session in the breakfast break and this was ok for all the participants. Doing the design session during this break made the atmosphere good, also, we assume, it led to more energy among the participants.
Each person received a work package, see figure 7, to start with. This contained the current document, the NEWS list, an empty tablet, icons, text descriptions of the fields and the pre-designed Mock-up and other things like pen and papers.

The participants in the design session consisted of nine persons from the staff, five nursing assistants and three nurses with a diversity in terms of working experience.

5.2.1 Mock-up
The pre-designed Mock-up (see figure 8) consist of a tablet and all the vital signs that should be documented as both icons and text objects. In addition there are two different types of symbols for the early warning function that we want to transpose. One icon looks like traffic lights in which different values received either; green, yellow or red light. The second early warning function consists only of two warning triangles, yellow and red.

There is a field for the patient’s personal code number which works as a unique key for matching the data from the mobile solution with the patient’s EPR. All patients have a bracelet with a barcode. This would also be in line
with the legalization demand that each patient should be identified (SOSFS 2008:14, 3 kap 4 §). We suggest a solution in which the barcode is scanned with the tablet camera.
Naturally there is also a field for the measured value.

![Mock-up Image]

**Figure 8 Pre-designed Mock-up**

In the design session all fields and icons were provided as loose parts and there was also possible to draw their own icons that the participants rather preferred. The orientation and order of the fields will be divided on from the participants.

**5.2.2 Individual designs**

We planned to start the design session with each participant doing their individual design, with the purpose that each participant had the possibility to express themselves. Because depending on each individual and the group dynamic there will be persons that easier will be heard in a group and there
will be others that do not have the same ability to express themselves in a group.

Nonetheless the participants started to pair up and discuss with each other during the individual design session. We did not want to reverse the creative process so we decided to let it be. In figure 9 we see one of the “groups within the groups” discussion and building their design.

![Interaction during design session](image)

**Figure 9 Interaction during design session**

After the first part of the design session the participants had created four different drafts for the design. Below we have summarized the different designs and all designs are available in the appendices:

- **Design 1** (Appendix VIII: Design 1) was very basic, there was only the field for the personal code number and the suggested fields and in the same order as in the Mock-up, the icons were left out and only the text descriptions were used. For the warning signs the triangles were preferred instead of traffic lights. The “ok” button was forgotten on this design.

- **Design 2**, unlike Design 1, used both icons and text descriptions, see Appendix IX: Design 2. The removed the icon for the NEWS result and added only the description for this field. The discussed the color of the warning triangles and brought to our attention that the color of the warning triangles should correspond the colors on the NEWS list.
There was also the idea to make the icon for oxygen supply more colorful.

- Design 3 also used both icons and text descriptions for the fields. Three symbols replaced from the Mock-up, the respiratory rate icon was changed to a picture of a man that exhales, the saturation icon exchanged with a picture of a device that they are using, and the symbol for the NEWS score should be an animation of a thumb going up or down depending on the result. There is also a suggestion to add a field for blood glucose level. Design 3 is found in Appendix X: Design 3.

- Design 4 was the most detailed design, seen in Appendix XI: Design 4. Here the symbols for respiratory rate, saturation and oxygen supply have been replaced. For respiratory rate there were a man exhaling, just like Design 3. The same saturation icon was also the same as Design 3. Additionally the icons for oxygen supply were changed to an icon in blue. The text description for level of consciousness extended to “Medvetande (A/V/P/U)”. Just as the three other designs the warning triangles were preferred, however with the alternative solution in which the input values changes colors according to the color scale on the NEWS list. Next to the input fields the measuring units had been added, e.g. °C after temperature. Finally the NEWS score was moved to the right side of the table and the changed the “ok” button to “send”.

All participants preferred the triangles instead of the traffic lights (see figure 10 triangles vs. traffic lights), because this follows a similar procedure as the NEWS list. In the NEWS list the colors yellow and red are used and green does not mean ok but this could be assumed if the traffic light lights up in green. Another benefit of the triangles would be that they only emerge if the values are out of the normal range, in opposite to the traffic lights icon that would always show with lights off. This would rather attract the attention of the user.

Another useful idea that we did not consider was the displaying of the measuring units.
Some of the participants wished to add a field for the blood glucose level even though this is not one of the vital parameters. They explained that for ca. 25 % of all the patients the blood glucose level is measured at the same time as the vital signs. Having this in the application as well would be useful otherwise they would still be forced to go to a computer to add this additional information to the EPR.

To have the NEWS score to be calculated automatically with reference to the vital sign results was another idea to save time, not being forced to sum all scores together, but also to avoid mistakes. The reason why some of them wanted the NEWS field to be right-align was to distinguish this from the other fields.

5.2.3 Group design
In the group design session the same persons participated as the ones who created their individual design. The group design was mostly a summary of the four different designs and an agreeing on what and how should be on the final design.

Figure 11 displays the group design that the participants agreed on.
In the group design the participants decided on the new suggested icons for respiratory rate, saturation and oxygen supply, which were suggested during the individual design session. And a new icon for level of consciousness was introduced as a “jumping jack”. The group agreed on adding a field for blood glucose level and the measuring units after the input fields. The participants could not however agree on if the warning triangles, with the same colors as in the NEWS list, should be used and/or the input values also should change color according to the NEWS list.
The NEWS score field and the “ok” button were placed right-aligned.

5.2.4 Suggested solution
With the outcome from the design session and with our experience in system development we are suggesting an application for a tablet, just like wished for in the mission from the North Hospital.

We see the following functional requirements as essential after the initial design session:
- All vital signs should be available in the application and additionally the blood glucose level. So that all values, which are measured simultaneously available for direct documentation in the EPR.
- There needs to be value limits set in the fields, this will prevent mistakes from occurring.
- There should also be warning signs for values, which are show that the patient is in a critical condition. E.g. the warning triangles or the text changing color according to the NEWS status.
- There should be integration between the application and the EPR, the information added in the application needs to be written into the EPR. In best case there should also be a possibility to check previous measurements, this is however a questions foreseen for security and needs to be looked at in detail in future research.
- Another benefit would be if the previous measurements are displayed in the application to facilitate decision in regards of the medical treatment.

5.2.5.1 Advantages & disadvantages with tablet solution
Using a new device at the hospital will require some time and efforts in implementing and learning. For a staff that is already under a lot of pressure and stress could this be a daunting task even if it promises a better situation in the long run. One of the issues was mentioned by Elvira when she suspected that a mobile solution will force some changes in their work routines.

Elvira also mentioned that the easy access that an analog solution, such as the paper chart, provides today will be more complicated when, for instance, new/temporary staff first needs to get the proper access to the digitalized system.

It can also be a possibility that the new/temporary staff blindly trust the system and sees their task as fulfilled after putting the information into the solution, when they should have notified the responsible nurse about a patient’s deterioration.
Anna was also mentioning one of the strong points in having a paper based system where all patients are recorded gives them a good overview over several patients at the same time. If not all current usages are considered while developing or choosing a mobile solution could there be a risk that some function is lost in the translation.

The work conducted by healthcare professionals requires them to be highly mobile. The work in itself is also mobile and thus needs to have the information mobile. Consider a ward round where each patient is discussed. During this time is it vitally important that the correct and updated information is present. Mobile ICT should therefore seem naturally fitting as a tool supporting the work tasks. The business case for introducing tablets within healthcare would prove well worth doing.

5.2.5 Summary of design session
It was an inspiring design session with a lot of great ideas that rose to the surface. All participants were actively involved with design and everyone was positive to the thought of a new solution. No one was questioning why this solution is needed or showed reluctant of using the new solution once it is in place.

Viewing the designs made by the participants, see Appendix VIII-XII, we could determine that all designs principally followed the Mock-up in terms of the order and also the symbols for the warning signs.

It is our opinion that the design session achieved its objectives, to gather ideas and thoughts from the future users, but also involve them in the design process. With the design session we could answer the second research question and could list essential requirements in chapter 5.2.4.

In the empirical setting we described the nurses’ profession, one important ability was to be able to work in team. It was interesting to observe that the ignored our plan to first work individual with the design before starting the teamwork. They directly started to discuss and working together, we believe this is in the nature of the nurses and nursing assistant. They are daily working together in team and it is crucial that they discuss and inform each other on the patient's status to secure the quality of the care. We see this as an important conclusion that should be considered planning and conduction PDs within healthcare.
5.6 Future research
This thesis set out to investigate what needs the future users could have on a mobile application for documenting vital signs. The limitation on this thesis opens for some future research.

Before going into a buy or design phase with an application the non-functional requirements must be ironed out. This includes questions like:

- **Interoperability** - the information exchange between the mobile application and the ERP needs to be defined. Is there any requirement put on an application to fit into the hospital target IT landscape.
- **Security** - assuring that the mobile application is compliant to the security legislation. In this area are there huge legal demands on the data integrity.
- **Performance** - such as response time
- **Capacity** - how many concurrent users will be using the application and how much data will be transferred over the network.
- **Availability** - how shall this mobile work of there is a system outage of the ERP system.
- **Hygiene** - how can it be secured that the mobile devices are aseptic so that they are not presenting another health risk to the patient.
- **Archiving** - The documented vital signs could be stored in the EPR and the retention of the information will mainly be a consideration in the management for the ERP. However could the answer to questions related to availability and response time be solved by locally stored data which requires archiving.

The Mock-ups that were designed together with the staff has its limitation in design experience. A suggestion is to push the design future and look into how it could be possible to use visualization to get more information into the application in a form that is easy to comprehend and digest.

It is important to involve the users in the future steps as well and collect feedback on developed designs. This can be done with quantitative research tools e.g. evaluation forms.

A future project should also look into what is available in the market today. It could be that there are developed applications in the market that fit the requirements (see chapter 5.5), e.g. similar to the roll-out in Oxford.
We were planning to do an interview with the IT-responsible at the hospital but we did not manage it timely. This would have been an interesting aspect because this new solutions needs to be compatible with the hospital's technological infrastructure and fit into the hospital's IT strategy.

5.7 Reflections of the results and discussion
We are pleased with the choice of method, to conduct a PD project; this was a good experience not only for us but also for the participants. Elvira, our contact person, has expressed her satisfaction with the final outcome. However this being the first time we are responsible for planning a PD project we are well aware of the fact that there is room for improvement in the execution. Looking back at the study there are things that we could have done differently, e.g. it would have been interesting to have the group to create a design without looking at the Mock-up before and see how the results would have been if the participants were not influenced in advance. This was however not possible because of lack of time. None of us are from healthcare so we were forced to invest a lot of time to understand the processes that we were analyzing. This is not necessary negative, it can be a benefit that someone from the outside observes and analyses the situation with a fresh mind.

In chapter 2.3 we presented some guiding principles from Kensing and Greenbaum (2012) that were concrete advices to strengthen the user’s roles as co-designers. We used these principles in the construction and execution of the design session. We argue that we succeeded in making the users to co-designers in which the:

- The design session with both nurses and nursing assistance was equalizing the power relations, in which also the nursing assistants and even a student were participating in the design session. Giving a voice to persons that because of their position are weaker or invisible within the organization.
- Had a democratic practice, thus each participant’s opinion, regardless of his or her position, had the same value.
- The design session was carried out on their workplace making it a situation-based action.
- The mutual learning (also brought forward by Bratteteig in 1997) was also facilitated with discussion during the design session. But also between us as non-healthcare professionals with experience within information systems and the participants.
- The working package gave the users a tool to express their needs and vision.
Stevenson et al. (2014) argues that the lack of involvement of the nurses in the design of EPRs can have a negative influence on the user acceptance. In our opinion this is also true for the kind of mobile solution that we are designing and we see that the design session had a positive impact on the attitude of the users toward the intended solution.

Further Stevenson et al. (2014) argues that the absence of the involvement of the nurses can impede the design in which a solution is designed that does not meet the requirements of the everyday practice. We advocate that with our research design, first learning about the processes and the daily tasks to get an understanding for the requirements before going into the design phase, we were able, together with the users, to come up with a design proposal that in fact meets the requirements of the everyday practice. It is our perception that is important that we as researchers not only focus on the conduction of a PD project but also understands the processes behind the design and in which setting it will be used, to be able to get the most out of the project and avoid mistakes caused from lack knowledge about the everyday practices. We saw it our role to guide the participants through the design session, for this we needed the knowledge, e.g. about the NEWS- system.

Aarhus, Gronvall and Kyng (2010) state that the contribution from the users adds quality to the results, this is something that we experienced during our research, the participants did not only come with additional valuable ideas to the Mock-up but they were also pointing out things that we have done wrongly or missed in the construction of the Mock-up. These were important information that otherwise could have led to a failure of the system after the implementation which results in need for extra resources and time to correct the system later on.

Just as Douglas et al. (2010) and Moody et al. (2004) we found that nurses prefer documentation of vital signs at the point-of-care i.e. at the patient's bedside in order to support having the documentation and evaluation in the same process. In addition to this confirmation can we also see other values of bedside documentation. Because of the high workload of the nurses it is not unusual that the documentation is interrupted, as seen in the observations, with this system it would be possible to measure and document the vital signs in direct connection and also to receive a first evaluation with help of different features within in solution, e.g. the warning triangles. Removing the step of double-documentation, paper and digital, would also obey to the patient record law that states that any information shall be added into the record as soon as possible (SFS 2008:355, 5 kap 9 §).
In chapter 2.4 we presented some areas of non-functional requirements that is necessary to consider when building a mHealth application. Some of the non-functional requirements have intentionally been left out for future research (see chapter 5.6 Future research). The remaining non-functional requirements were forming the foundation during the design phase.

Palser (2011) and Balka and Tolan (2011) showed in their research how important it is with a design that is thought through in order to support both readability and security. By doing an initial observation of the work process and by involving the future users in the design process we got an understanding of the situation and tapped into the tacit knowledge that the nurses have. This knowledge was then used so that the design was supporting the users’ readability and preventing a need for workarounds.

By digitizing a pen and paper based solution we have also considered the availability. The documentation is no longer a physical entity that only can exist in one place. Instead the information will be available on demand from any tablet connected to this system.

We do not have an answer to if this solution will be successful or not and if there will be a positive or negative influence on the everyday tasks. We saw it as our assignment to create a foundation for future implementation. If it is decided that this solution should not be implemented or it fails in its success, we have wasted resources in going ahead and gather requirements in context of a PD project. This research can however be used to explain and convince the decision makers of investing in this idea, because the benefits have been made visible.

We, researcher in this project, had never met face to face before we started working on this thesis and that could have been a disadvantage if we had not worked together on other assignments before. During the previous assignments we have come to learn each other’s strength and habits and we had already established a way of working. This previous experience was a necessity in order to do most of this thesis at a distance from each other.

We have completely different backgrounds, computer science and business administration and previous experiences. One of us has a lot of experience in programming and the other within media design, for us this was valuable in terms of the conception of the design, because these discipline focusing on different things. One was always thinking if the ideas were technically feasible and the other focusing on the users to design a pedagogical solution that is appealing to the users. This has only been of benefit and we have
complemented each other very well and provided feedback to one another from different point of views.

It has been a great experience working with this thesis, not only collecting the first experience with PD but also working together.
6. Conclusion

We took on this mission not only seeing it as an interesting research subject but also with a personal motivation. This year one of us was a patient in a hospital and in a critical condition with everything that comes with it, fear and frustration. At one point the staff was discussing if there was a need to increase the medication and one of the staff answered “I do not know I have lost her journal”. This was not connected to this specific ward but with this experience we were glad to take on this mission from Elvira when we were asked. We could see from a personal point of view a need for improvement of documentation. So with these digitizing the vital signs documentation we are doing a first effort in this direction.

This problem was presented to us from our contact persons and she was asking if we could, in the context of our thesis, investigate if there is a possibility to improve some processes at her ward. This was an interesting topic for us, which gave us an opportunity to work with a practical problem and contribute with a suggestion for a solution. With and for the future users. We started off wanting to not only gather requirements for the new solution but as well planning, developing and implementing the solution. We established that this could not all be done in such short time so we redefined our assignment to first of all understanding the current situation and process and in the next step to gather requirements.

Viewing our formulated research questions, we draw the conclusion that we have reached our objectives with this thesis:

What perception does the healthcare professional have of the work situation?
In the explorative part we were able to learn more about the perception of the healthcare professionals. We learned that they are open for a new solution and that they see problems with the current way of vital signs documentation. In the design session the conclusion that we draw from the exploratory study were confirmed from the participants in the session, showing us that this is not only one person's perception but a more general one.

The answer to the first question also help with the design session, making it possible for us to answer our second research question.

What functional requirements are perceived by the healthcare professionals?
In this research we have gathered the first functional requirements, they are listed in chapter 5.2.4 and we were able to make a first design proposal, this was done with a combination of our experience and skills and the participants
contributions during the interviews and design session. However in scope of this thesis we are not able to provide a full list of requirements, especially the non-functional requirements needs further attention.

When looking at previous research in the area of creating a solution to the issues of documenting vital signs we have seen the consequences of badly designed applications (Balka and Tolar, 2011). In our opinion is this due to that the projects often generalizing the subjects too much and the future users are not involved in the design process. This is by no means the first attempt to digitalize the documentation of vital signs. However we cannot find any previous research that has done the design together with the future users. Our theoretical contribution with this thesis is to avoid implementation problems by using PD. In our opinion a representative group of PD members is the best way to secure that the new application holds for the range of needs a differentiated user group has. PD as a design method will also be an important tool for a successful deployment by overcoming hurdles like resistance for change or organizational culture.

In the work of this thesis ‘time’ has been a concept of great importance. In our contact with the staff and reading other studies time has, in different contexts, been highlighted. The future application shall have a positive impact on the time it takes for new data to be available in the EPR as well as it should contribute to time-efficiency in the data gathering sequences to free up the staff for other tasks.

It could have been possible for the ward to simply buy the solution, e.g. the one developed in Oxford, without involving the users in the design. However doing so the benefits that Participatory Design brings would have been lost and the solution may not meet the needs of this particular ward.
References

Law and regulations


Literature and journals


Mackintosh, N., Rainey, H. and Sandall, J., 2012. Understanding how rapid response systems may improve safety for the acutely ill patient: learning from the frontline. BMJ Quality & Safty, [online] Available at: http://qualitysafety.bmj.com/content/21/2.toc [Accessed 02 August 2015]


Appendices

Appendix I: *Timeframe*
<table>
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<th>Bl.tr.</th>
<th>Puls</th>
<th>AVPU</th>
<th>News</th>
<th>Tand</th>
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Vid upprepade News-kontroller a 4 ggr/dgn används lista på sal.
Vid blodtryckskontroller x flera används blodtryckslista.
Vid B-glukos x flera skrivs värden i Mellor.

Appendix II: Documentation protocol for vital sign.
Appendix III: *Documentation protocol for vital sign - with comments*
Appendix IV: Hur vi arbetar med NEWS

Hur vi arbetar med NEWS & MIG...

Vilka patienter ska NEWS:as?

- Alla patienter ska NEWS:as vid ankomst till avdelningen och alla måtbåarden ska denna gång registreras i Meller.
- Alla patienter ska NEWS:as varje dag mellan kl. 08 och kl. 12.
- Temp-kontroll på alla kl. 14 liksom tidigare.
- För patienter i livets slutskede kan läkaren på ordern distansera patienten om behöver NEWS:as. Detta dokumenteras under röntgenteckning i Meller och rutten för NEWS kan läsas på listen för dagliga kontroller för att synliggöra detta.

Vem gör vad?

- Nattpersonalen får gärna i den mån de hinner kontrollera andra parameter och antacknar i så fall detta på listen för dagliga kontrollerna så att dagpersonalen ser vad som är gjort.
- Lägg upp jobbet vid morgonrapporteringen och bekräfta vem som är ansvslig för vad (data upp patienternas inom arbetsdag och gör allt på de nätvärken eller data upp parametrarna t.ex. sjukvårdsplan mäten saturation på alla vid vårdmeddelning...)

Dokumentation

- NEWS:as pågår dokumenteras under mättiden i Meller (någon gång NEWS:as, kommer att ändras till NEWS). Vid NEWS 0 behöver inte vården för enskilda parametrar skrivas in (förutom temp 3g/dygn och NEWS vid ankomst till avdelningen).
- Vid NEWS:as pågår 2:1 dokumenteras under mättiden i Meller för den/dessa parametrarna som avvikar. Skriv även i kommentarrutaen för NEWS:as pågår vilket vilka vården som avvikar.
- NEWS och vitalparametrarna dokumenteras under mättiden i Meller eller på NEWS övervakningslista. Lämpligt med övervakningslista på salen vid kontroller. Skulle övervakningslisten på salen noteras detta i avsedd ruta på listen för dagliga kontroller. NEWS övervakningslista är en journalhandling.
vilket innebär att den ska följa med patientens övriga papper vid utskrivning för att
sannat i journalen av påkortsare.
• Vid MIG-behandling har VIK-patienten med sig en MIG-journal. Efter avslutat
konsultation lämnar de en kopia (hej fotokopia) av vårldsjurnell denna placeras i
pärmen så länge det är aktuellt och kan sedan flyttas till facket där patientens övriga
papper förvaras.

Dessa är inte en rutin utan ett levande dokument som vi med stor sannolikhet kommer att
överlåta flera gånger. Ställ upp dina aktier i kanett! Vi måste tillsammans komma fram till
 hur vi bättre kan arbeta med MIG & NEDS.

Handläggningsplan

<table>
<thead>
<tr>
<th>NEVS-poäng</th>
<th>Övervakningsintervall</th>
<th>Minst läggning:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 poäng</td>
<td>Minst en gång per dygn</td>
<td>Fortsättningsmässiga läggningar enligt NEDS</td>
</tr>
</tbody>
</table>
| 1-4 poäng  | Minst var 4-6:e timme | Informera patientansvarig sjukhusledare (PAS) som
|            |                      | 
| 5 poäng    | Tätare intervall   | Informera patientansvarig
| eller mer än 3 | till minst 1 gång | sjuksköterska (PAS) som
| i en vecka  | i timmen           | skall undersöka patienten |
|            |                     | PAS avgör om övervaknings-
|            |                     | intervallet skall utföras. |
|            |                     | PAS skall skydda med informera
|            |                     | patientansvariga sjuksköterska
|            |                     | på avvikelser med möjlighet
|            |                     | till övervakning |
|            |                     | kontinuerligt övervakning av
|            |                     | och övervakning av
|            |                     | vitalparametrier |
|            |                     | Patientansvarig sjuksköterska
|            |                     | skall omgående informera PAL
|            |                     | möjlighet att konsultera MIG |

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Appendix V: *Informed consent*

**Till personal som jobbar på avdelning 1, X sjukhus!**

**Förfrågan om deltagande i en studie**

Ett forskningsprojekt har påbörjats i samarbete mellan avdelning 1 på xx sjukhus och Linneuniversitetet med syfte att undersöka möjligheten att inför ett nytt mobilt informations system för att underlätta den dagliga vården. Personalens egna upplevelser och synpunkter är viktiga att beakta för att kunna utveckla och förbättra processer på avdelningen.

Medverkan är frivillig och kan avslutas när som helst, men ditt bidrag är viktigt för att få tillförlitliga och användbara resultat som underlag för utarbetningen av det nya systemet. Vi kommer att observera det dagliga arbetet samt föra en eller flera intervjuer med Dig. Vi kommer dessutom att användas oss av en kamera för vår dokumentation, alla bilder användas dock enbart och ses enbart av författarna av arbetet.

De uppgifter du lämnar hanteras konfidentiell och vid redovisning av resultaten kommer Du inte att kunna identifieras.

Ansvariga för studierna är Marika René och Lisa Knutsson Fröjd. Lisa kommer att kontakta Dig på avdelningen och tillfråga Dig om medverkan och kan då också ge ytterligare information kring studien.

April 2015

Forskningshandledare: Sisse Finken

**Mail:** sisse.finken@lnu.se
Appendix VI: *Interview guide*

Inform about:
- Is it OK to record the interview?
- See informed consent for additional information.

<table>
<thead>
<tr>
<th>Interview 1</th>
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<tbody>
<tr>
<td><strong>Analyzing the situation</strong></td>
<td>Tell us about the typical working day for nurses?</td>
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<tr>
<td></td>
<td>Which vital signs are measured?</td>
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<td></td>
<td>Why are they measured?</td>
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<td></td>
<td>How often are the vital signs measured?</td>
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<td></td>
<td>What is done with the collected (measurements) values?</td>
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<tr>
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<td>If one or more values are abnormal, which actions do you take?</td>
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<td>Who decides which actions are initiated?</td>
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</table>

<table>
<thead>
<tr>
<th>Interview 2</th>
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<tbody>
<tr>
<td><strong>Background information on interviewee</strong></td>
<td>Tell us about your education?</td>
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<td>What is your professional role and which tasks does it include?</td>
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<tr>
<td><strong>Analyzing the mission</strong></td>
<td>What are the main problems that need to be addressed in the ward/ the hospital?</td>
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<td>Why are you thinking about investing in a new solution?</td>
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<tr>
<td>Question</td>
<td>Answer</td>
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<tr>
<td>Why hasn’t this been done before? (investing in a new system)</td>
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<td>Which benefits/risks/concerns do you see with this solution?</td>
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<td>Where do you see limitations?</td>
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<td>Which affect do you think this solution will have on the daily work?</td>
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<tr>
<td>Will it have any impact on the care and its quality?</td>
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</table>
Appendix VII: *Pre-designed Mock-up*
Appendix VIII: Design 1
Appendix IX: Design 2
Appendix X: Design 3
Appendix XI: Design 4
Appendix XII: Group design