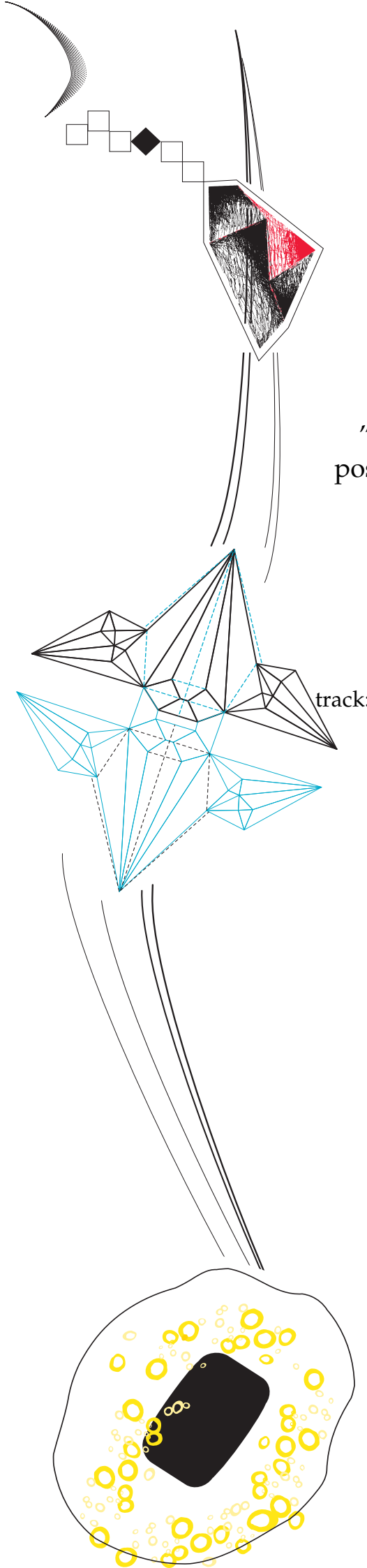

Masterthesis

"Implementation and design of a postoperative follow-up application"

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March 2020

UNIVERSITY OF TWENTE.

Contents

1 Introduction

Surgery and complications
Each surgical intervention poses risks in the form of complications, such as bleeding, infection or pain, even when all protocols are followed and precautions are taken [1, 2, 3]. The type of complication to occur is dependent upon the kind of surgery performed. As all surgical interventions include an incision being made, the most common healthcare-associated infection is surgical site infection (SSI) [2, 4, 5, 6].Prevalent symptoms of SSI are redness, heat, swelling, fever, leakage, an opened wound and pain [2, 3, 7]. Of all patients undergoing surgery 5 to 10% develops an SSI, although the percentages vary for different types of surgery [2, 5, 6, 8, 9, 10]. An SSI can lead to an increased length of stay (LOS), morbidity and mortality for surgical patients and increased costs[11, 12].

Monitoring
Timely discovery and treatment of SSI is essential yet challenging. Health care staff as well as patients may experience barriers which intervene with the timely discovery of an SSI. One of these barriers is the process of monitoring after discharge from the hospital. SSI and other infections may develop days or even weeks after surgery[2, 13]. Nowadays almost half of the SSIs following colorectal surgery develop after patients are discharged from the hospital[2, 6, 8]. Consequently, the greater part of SSI monitoring is shifted to the patients home environment with increased distance from health care professionals. Improvement in surgical techniques and budget cuts are the most important reasons for this development [14, 15]. Secondly, in the Netherlands, outpatient surgeries outnumber inpatient surgeries with a multiple-day admission period [16]. Both the decrease in length of stay and the high amount of outpatient surgeries result in an increase in readmissions for complications [13]. Hospitals try to undercut this problem by providing information folders and reaching out to patients shortly after their discharge. However, patients may still perceive barriers in reaching out to healthcare professionals when possible complications are encountered at home. A lack of medical knowledge and training in symptom assessment may lead to uncertainty and inability to decide on a course of action [17, 18, 19]. Thus, patients need better assistance in SSI monitoring at home.

Technology
Technological developments can help hospitals to support patients during their recovery at home. There are many options: support aimed at education, examples of recovery exercises or monitoring of patients at home. There are several examples of smartphone applications used in postoperative care, some of which contain videos with exercises for follow-up of some types of surgery[20]. Other applications can be used to monitor patients in their recovery process at home after surgery[17, 19, 21]. Most of these contain questionnaires which asks patients about certain symptoms of complications, but the composition of each questionnaire is different. This research project focuses on the development of a smartphone application for postoperative

monitoring.

Integration of data

Integration of applications into the care process varies between the types of applications described above[17, 19, 22, 23]. Any healthcare application can be designed as a standalone tool to be used by a particular group of users. Some applications are designed to be used solely by the patient, and no content or gathered data from this application will be used by health care professionals. Other applications are designed to connect health care staff and patient during the treatment process. These applications can support communication and substitute for the physical presence of the patient in a health care facility or even replace real time interaction. Expectations of patients and health care staff can differ greatly and without attention to these differences the developed application cannot be implemented successfully[18, 19]. Education for both patients and health care staff can help to clarify the functionalities and goals of an application and thereby manage expectations[19]. As far as we know, no one in the Netherlands has developed a surgical monitoring application integrated into their electronic health record (EHR). Such an integration could provide a connection with care processes and improve ease of use for health care staff.

Aim and goal of the research project

This paper describes research into the design of a smartphone application as a monitoring tool for recovering surgical patients after discharge integrated into the EHR. Our aim is to find the most suitable questions to ask a patient to identify an SSI in an early stage. Because of the diversity in questionnaires from existing applications, ranging from a low number of questions and a photograph to long questionnaires with multiple subjective questions, we want to identify the questions suitable to use for Dutch surgical patients. The initial cause for this project lies with the research setting hospital, which is described in Box 1. The major causes that contributed to the aim for this project are described in Box 2. Box 3 contains data on readmitted surgical patients and the unfavorable outcomes for these patients. This underlines the need for an intervention aimed at decreasing the number of readmissions because of SSI. All three boxes can be found below.

1.1 Research Question

Our aim is to develop a mobile application to identify early stage SSI that suits the preferences and requirements of patients, but also supports the different work processes of health care staff. We will develop requirements to reach this goal. To develop and implement the postoperative monitoring application several questions need to be answered to guide our development process. The questions concern the technical, functional and organizational requirements for the application. The questions can be found below.

1.1.1 Main question

What are the requirements for a mobile application aimed at early identification of postoperative complications in the form of infection and/or sepsis for patients who have undergone a high-risk surgery?

1.1.2 Subquestions

1. Which stakeholders are involved in the problems surrounding postoperative monitoring after discharge from the hospital?
2. Which (medical) data are necessary when assessing the occurrence of complications (infection and/or sepsis) according to health care professionals and literature?
3. Which questions have to be asked by who to whom in what way in the application to gather and assess this medical data according to health care professionals, patients and literature?
4. In what way can this data be translated into a (scoring) system to show the likelihood of occurrence of a complication?
5. How should the gathered (medical) data be processed and stored (into the EHR) according to the information specialist and health care professionals in the research setting hospital?
6. What will change in the care process and what do the stakeholders involved want to support them in these new tasks?

Box 1: Research Setting Hospital

The research project has been carried out in a regional hospital in the Netherlands, the Streekziekenhuis Koningin Beatrix (SKB) in Winterswijk in 2017. The SKB has 214 beds, 1100 staff members and servers an area of 150.000 residents in the East of the Netherlands. They work with an electronic health record (EHR) from manufacturer Chipsoft. This EHR offers the possibility to connect external devices or externally generated data into the SKB EHR with a special label. The aim of the project is to develop and build a smartphone application that could be used in the follow-up period after surgery. This application would be used after discharge from the hospital for a 5 day time period by patients at home (the amount of days are selected because of the legal overlap in responsibilities between the hospital and the general practitioner, to prevent disagreement between doctors). The data generated by these patients has to be evaluated through an automated process and only cases presenting with possible complication referred to a medical staff member for further evaluation.

Box 2: Cause for development by the research setting hospital

Management of the hospital had seen some cases of patients who had undergone surgery and showed no signs of complications or other abnormalities during their stay in the hospital. After they were discharged, their physical state began to slowly deteriorate with little signs indicating the seriousness of this decline. After multiple days of deterioration they presented at the Emergency Room (ER) or general practitioner with life threatening symptoms. Only long-term monitoring of SSI-related complaints of these patients, and especially adequate monitoring after discharge, could have prevented the alarming outcome of these cases. The management team of the hospital came up with a solution in the form of a smartphone app. They thought an app would be accessible enough for patients, would fall within budget and would be integrable into existing systems. To save costs, the technical solution would need to be integrated into the EHR and be able to automatically screen patients, as personal review of every case would take up too much time of health care professionals. This research project started after the decision for an app was made, focusing solely on the content and integration within the EHR of the chosen solution. The necessary medical content, the changes in the care process and technical challenges in the development process are reviewed.

Box 3: Readmission data of the research setting hospital

In the Netherlands, hospitals are required to share information on readmissions and surgical outcomes. These are registered at the Landelijke Basisregistratie Ziekenhuiszorg[24]. They collect and process the data of all Dutch hospitals, which can be accessed upon request. The average readmission percentage in the Netherlands in 2015 was 10%[25]. For surgical patients this was 10,2%, where 3% concerned non-acute patients and 7,2% were acute patient readmissions. A regional hospital in the same area as our research setting hospital, with similar characteristics, performed an extensive research project into readmissions and emergency interventions by performing patient file research with 120 patient files of readmitted patients [26]. They found that 46% to 68% of patients at the surgical ward showed signs of an infection. The mean number of days between discharge and readmission was 12 days. In some cases a transfer to the intensive care unit (ICU) was necessary. The readmitted patients performed worse than patients on their first admission, with a longer LOS, a higher number of admissions through the ER and more days at the ICU. The average costs per patient for readmitted patients were almost 1,5 times higher than the referenced group of patients on their first admission. In the research setting hospital, the SKB, the percentage of readmissions was fixed between 6.1% and 8.8% for the years 2015-2017. The LOS for these patients was 4,3 to 6,0 days and the average number of days between discharge and readmission was 10 to 13 days.

2 Methods

2.1 CeHRes Roadmap

The CeHRes Roadmap was applied as a tool for answering the research questions stated in Section 1.1 and is visualized in Figure 1. The CeHRes Roadmap is a widely used research model in eHealth in which a holistic approach is taken for the purpose of integrating technology into an intended care process [27]. The goal of the Roadmap is to guide the whole process of development and take all the necessary steps to create a successful and useful product that is both efficient and effective. The questions under investigation are aimed at the first three steps of the model: the contextual inquiry, the value specification and the design phase. The method reserves an important role for stakeholders. They are consulted and involved in all phases of the project to create a usable and successful end product.

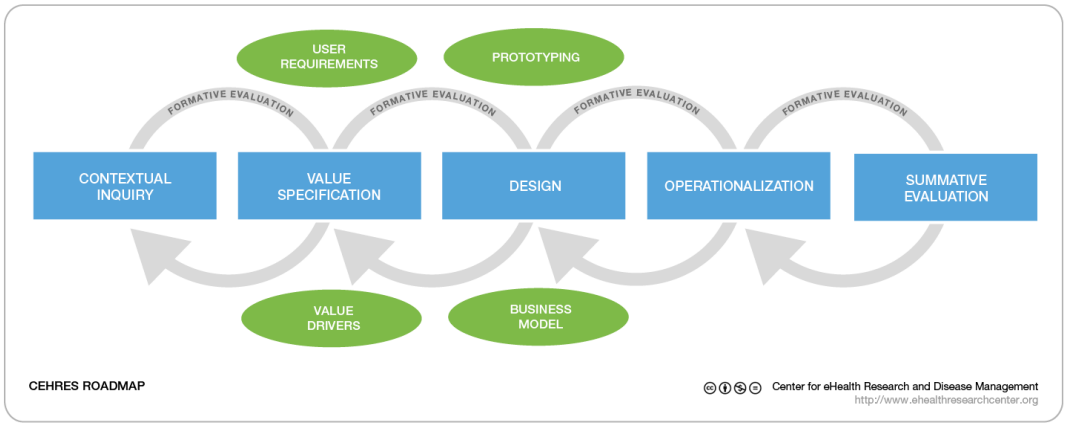

Figure 1: The roadmap of the Center for eHealth, Research and Disease Management[27].

In Figure 1 the phases of the Roadmap (blue) are linked to the research methods (green) used for each phase and the research questions that will be discussed. Formative evaluations (grey) take place between research phases, when results from one phase are used as a base for the next phase. Table 1 links the phases to the methods used and the research questions covered in this phase. A description of each of the applied phases can be found in the section below with an overview of the methods used.

Table 1: An overview of the phases of the CeHRes Roadmap, the methods used in this research project and the research questions.
The numbers relate to the order of the research questions in Section 1.1.

Roadmap phase	**Methods**	**Main Questions**
Contextual Inquiry	Stakeholder identification	1) Which stakeholders are involved in the problems surrounding postoperative monitoring after discharge from the hospital?
	Field observations	6) What does the current care process look like, what will change in this care process and what do the stakeholders involved want to support them in these new tasks?
Value Specification	Literature review	2) Which (medical) data are necessary when assessing the occurrence of complications (infection and/or sepsis) according to literature? 3) Which questions have to be asked by who to whom in what way in the application to gather and assess this medical data according to literature? 4) In what way can the medical data be translated into a (scoring) system to show the likelihood of occurrence of a complication?
	Interviews	2) Which (medical) data are necessary when assessing the occurrence of complications (infection and/or sepsis) according to healthcare professionals? 3) Which questions have to be asked by who to whom in what way in the application to gather and assess this medical data according to healthcare professionals and patients?
Design	Interviews	5) How should the gathered (medical) data be processed and stored (into the EHR) according to the information specialist and health care professionals in the research setting hospital? 6) What will change in the care process and what do the stakeholders involved want to support them in these new tasks?

2.2 Contextual inquiry phase.

Goal: *Identify stakeholders and acquire an overview of the present setting and the current issues.*
Methods: *Stakeholder identification and field observations.*
Result: *List of stakeholders, flow chart and overview of present setting and current issues.*
During contextual inquiry the stakeholders are identified and the setting is described. A management team needs to be formed to guide the project leader and researcher. Field observations are used to describe the current care processes and the issues that need to be solved. An overview of the present setting is created before any possible changes are designed to make sure these changes fit into, and benefit, the current care processes. Important stakeholder groups have to be identified so that they can be involved in discussing and creating solutions to current issues to integrate into a new care process during the next phase[27].

2.2.1 Stakeholder identification

Aim and method
The aim is to identify the stakeholders involved in the problem and the solution. Involvement of important stakeholders in the process allows for a solution which takes into account all interests, is accessible and applicable in practice. Important stakeholder groups were selected using five criteria published in the Harvard Business Review [28].
Participants
The participants were the management team including the researcher. A list of all participants can be found in Appendix A.
Procedure
The management team held a brainstorm session to create a list of all those (possibly) involved in the problem and the solution. Next, the management team answered five questions related to criteria for important stakeholder groups for each stakeholder on the list. Finally, the researcher selected the important stakeholders that met all five criteria of the Harvard Business Review method[28].

The next five questions were used to identify important stakeholder groups:

- Does the stakeholder have a fundamental impact on your organizations performance?
  important stakeholder: yes
- Can you clearly identify what you want from the stakeholder?
  important stakeholder: Yes
- Is the relationship dynamic (do you want it to grow)?
  important stakeholder: Yes

- Can you exist without or easily replace the stakeholder?
  important stakeholder: No
- Has the stakeholder already been identified through another relationship?
  important stakeholder: No

In case answers were inconclusive it was advised to re-examine if the group of stakeholders could be merged with another group. The newly formed group was evaluated by the identification method again after the merge. All answers were conclusive for all of the identified stakeholders, without merging any stakeholder groups.

Analysis

The management team decided on a final list of stakeholders and important stakeholder groups based on the outcome of the procedure as described above.

2.2.2 Field Observations

Aim and method

Aims to create a clear and correct image of the current care process for surgical patients. Based on the results, the care processes can be transformed into new care processes that include changes needed to support the postoperative application. The method used in this phase is observation.

Participants

The researcher, one nurse from the surgical department performing a virtual discharge procedure and one nurse from the surgical ward performing an actual discharge procedure with a surgical patient.

Procedure

There was a walk-through of procedures with the researcher and a nurse in the nurses lounge taking 45 minutes. The steps of a discharge procedure were discussed, supported by the nurse performing the procedure in the EHR on a test patient. Additional questions were asked to gain insight into the procedure and opinion of the nurse on the process and possible changes, which can be found in Appendix C. Secondly, a real life discharge procedure with a surgical patient was observed in the patient's room. Notes were taken and all items handed out to the patient were listed. The discharge procedure took 15 minutes to complete. Both field observations took place in 2017.

Analysis

Based on the field observations a flowchart was created of the care process surrounding a surgical procedure including the discharge of a patient from the surgical ward and the procedure following possible complications after discharge.

2.3 Value specification phase.

Goal: *To let stakeholders create a detailed overview of the problem and the possible solutions. Decide on the best solution with the use of preferences and requirements.*
Methods: *literature review and interviews.*
Result: *The functional, technical and process requirements to use in development of a prototype.*
During the value specifications phase the preferences and perspectives of stakeholders regarding both the current issues and possible solutions are gathered. They are invited to share their expectations and preferences regarding the new technology. Interviews are conducted with the important stakeholders during this phase. The focus will lie with the new technology to support content and design when interviewing the stakeholders. A literature study will form the basis of these interviews. The combination of results from the interviews and literature study will help shape the application. The requirements formed as a result of this phase will be used to develop a prototype and shape the changes in work processes.

2.3.1 Literature review

Method and aim
The first aim of the literature review is to identify the signs and symptoms of postoperative complications (search 1). The second aim of this literature review is to find information on early warning score system designs, to identify their essential key elements (search 2). The third aim is to find all postoperative monitoring applications to identify their key elements (search 3).
Procedure
The search terms used can be found in Table 2, the search terms for the first two subjects were applied to the Pubmed search engine. The last search term was adapted to search in both Pubmed and Scopus, because it was part of both the medical and the computer science or information science domain. As inclusion criteria the search terms needed to be present in title, abstract or keywords and all articles needed to be in English. Other inclusion criteria used were Human studies and full text available for search 1, full text available in search 2 and the class as article (published or in press), a conference paper or review or a review in Scopus for search 3. All literature reviews were performed in 2017, with results which are collected up to and including 2017.
Analysis
For each of the resulting articles, first the titles and abstracts were reviewed on topic. Articles that were outside the scope were excluded. For the remaining articles the full text was reviewed. All articles that were on topic were included. Two tables with the resulting articles were made for search 1 and search 3 and reasons for exclusion were listed.
For postoperative complications (search 1) all symptoms of SSI described in the articles were registered. If data was available on the amount of patients developing an SSI after discharge or the time between the surgical procedure and the development of

Table 2: The search terms used per search subject.

Subject	**Search term**
Postoperative complications	”Signs and Symptoms”[Mesh] AND ”Surgical Wound Infection”[Mesh] AND (”Mastectomy”[Mesh] OR ”Cholecystectomy, Laparoscopic”[Mesh] OR ”Colectomy”[Mesh])”
Early warning score	”early warning score system”
Mobile applications	”(((monitoring[Title/Abstract] OR follow-up[Title/Abstract])) AND (surgery[Title/Abstract] OR postoperative[Title/Abstract] OR ”post-operative”[Title/Abstract])) AND (”mobile app” [Title/Abstract] OR ”Smartphone”[MESH] OR (”telemedicine”[MESH][Title/Abstract] AND mobile[Title/Abstract]))” ”TITLE-ABS-KEY ((monitoring OR follow-up) AND (surgery OR postoperative OR ”post-operative”) AND (”mobile app” OR ”mobile health” OR smartphone OR ”phone app” OR (telemedicine AND mobile))) AND (LIMIT-TO (DOCTYPE , ”ar”) OR LIMIT-TO (DOCTYPE , ”cp”) OR LIMIT-TO (DOCTYPE , ”cr”) OR LIMIT-TO (DOCTYPE , ”re”) OR LIMIT-TO (DOCTYPE , ”ip”)) AND (LIMIT-TO (LANGUAGE , ”English”))”

an SSI this was included. Furthermore, data was gathered on the incidence of other complications, since some symptoms can overlap between different complications and some complications can impact other complications, the number of readmissions because of complications and the risk factors for developing a complication. The results were split per surgery type. The common findings were combined to be used as general symptoms of SSI. This data can be used as a basis for the questions in the application. The data on readmissions can be used to evaluate the effectiveness of the application.

All articles on early warning scoring systems (search 2) were screened for the type of data the systems used to assess the patients health state and possible decay, what kind of value represented the changes and what actions followed when a patient showed health decay beyond a certain value. If available, effectiveness of the scoring systems and comparisons between different scoring systems were reported. The analysis was made which scoring systems would be suitable to use in the case of a discharged surgical patient to see what form of scoring system would be most effective and also usable in the application.

The articles about the design, development and evaluation of postoperative monitoring applications (search 3) were used to collect data on the prospects of such an application. If possible, the following was described: the name of the application (to combine results of the same application), goal of the study, the gathered (medical)

data, the content of the application questionnaire, the way in which health care professionals could access patient data gathered by the application, if feedback was provided to patients using the application and if a connection was made to the EHR. The collected data was used to analyze the most important (usability) requirements, stakeholder preferences, most used application content, outcome measures used to assess application, the use of photographs and their quality and possibilities of integration into the EHR.

2.3.2 Interviews

Method and aim
The first aim is to identify the most common signs and symptoms, experienced by patients or seen by health care professionals, for complications after surgery. The second aim is to discuss inclusion and exclusion criteria for patients and for types of surgery. The third aim is to create an overview of the current care process after surgery in case of a possible complication.
Participants
Surgeons, nurses and patients. The surgeons were selected based on their area of expertise, which had to include one of the high risk surgeries, and availability. The nurses were selected from the surgical recovery ward, based on availability. All patients undergoing one of the high risk surgeries between June 20th and July 20th 2017 were invited to participate via a letter from the researcher (which is part of the script in Appendix B). If patients wanted to participate the nurses were asked to contact the researcher to plan an appointment.
Procedure
For the interviews, a bundled script was created containing a list of stakeholders to be interviewed, a participation invitation letter, the consent-form, interview scripts and the themes and interview questions per stakeholder group. The script can be found in Appendix B. All patients and nurses will be interviewed at the surgical ward in the hospital. The surgeons will be interviewed at the outpatient clinic in their personal offices. The interviews are planned to last 30-45 minutes. The interviews were recorded, transcribed verbatim and analyzed through coding in an inductive manner. The themes were selected based on the results from the literature review and the selected requirements from the stakeholders.
There were three themes used for both surgeons and nurses, ”complications”, ”patient specific baseline measurements” and ”inclusion and exclusion criteria”. The first theme was ”complications”, where they were asked about the symptoms they encountered during their work with surgical patients that were typical for complications in the form of SSI. Furthermore, they were asked about the time line in which these symptoms developed in their experience, for example the time between the surgery and the first symptoms they saw. They were also asked which questions they would ask their patient if they needed to triage that patient for a possible SSI remotely. The ”patient specific baseline measurement” meant that patients would

have to monitor themselves through the application before their scheduled surgery. These results would then be stored and used to compare to the data they would send the hospital after discharge through the application. In this way, patients with divergent biomedical properties would be processed by the system in the same way an average patient would, but it would entail more work during surgery preparation appointments with the patient. The health care staff were asked about their preferences for the use of patient specific baseline measurements and the reasoning behind their preference. For the theme ”inclusion and exclusion criteria”, the surgeons were asked what types of surgery they thought would be eligible to use the application after discharge and their reasoning behind this choice. The nurses were asked what the inclusion and exclusion criteria should be to select surgical patients to use the application, including their arguments for their choices. For nurses, the theme ”care process changes” included questions about the current care process for patients with complications, such as the dedicated hospital ward receiving these patients and the health care staff that was responsible for their follow-up care from that point. The nurses were asked which changes they thought needed to be implemented in the care process and current protocols to make the integration of the application work and what kind of support they needed to be able to deal with the upcoming changes. All health care professionals were invited to share any other comment they might have on the discussed themes or on the application in general.

For patients the themes ”complication symptoms in past surgeries” and ”patient specific baseline measurement” were used. They were asked about any past surgeries, if they experienced any complications and if so, what symptoms they presented with. The readmitted patient was interviewed about what symptoms he developed, when he developed these symptoms, how interaction with health care staff at the hospital went and when and by whom the decision was made to be readmitted into the hospital. For ”Patient specific baseline measurement” the patients were asked if they would be willing to use the application before the surgery date to collect data to be used as personal reference values after surgery.

Analysis

Recordings were transcribed verbatim using ATLAS.ti software version 8.0.41. The data was analyzed in an inductive manner, where each interview text was divided into separate meaning units and labeled with a code by the researcher following the content of the meaning unit[29]. These codes were later reviewed by the researcher and, if possible, combined into categories. The resulting codes and categories can be found in Section 3.2.2. The category contents were reviewed to show areas of similarities and differences between the participants. These were then reported both for participants of the same group or combined groups of different stakeholders.

2.4 Design phase.

Goal: *Design a product using the requirements from the value specifications phase, and improve and reshape this product through feedback from stakeholders.*
Methods: *interviews.*
Result: *A functioning end product that meets the requirements of all important stakeholder groups.*
The design phase is focused on the functional, technical and process requirements which were the result of the previous phase. This will help shape the application. The preferences and information given by stakeholders are leading. This phase relies heavily on the information gained from the value specification phase[27]. Prototypes can be developed during this phase[27, 30]. These prototypes or mock-ups are then discussed with the stakeholders to improve the design.

2.4.1 Interviews

Method and aim
The first aim is to collect information on preferences from patients and health care professionals about the concept of the application to use during the design process. The second aim is to collect information on preferences on the changing care process from health care professionals. During this phase a mock-up will be presented to the participants.
Participants
See Section 2.3.2 for participant selection.
Procedure
See Section 2.3.2 for general procedure information. A mock-up was presented halfway through the interview. Examples of this mock-up can be found in Figure 2.
The themes for surgeons and nurses were ”functionality and characteristics of the application” and the ”alarm location” within the hospital for patients returning with a possible complication after surgery. For the theme ”functionality and characteristics of the application” they were asked about their impression of the application as described by the interviewer and the functions they would like to be build into the application, for example a photograph function. Subsequently, a mock-up of the application was shown and the health care staff were asked what they thought about the current design, questions included in the application and functionalities within the application. Additionally, they were asked if they would discard or add functionalities, and if so, what their arguments were. For the theme ”alarm location” the health care professionals were asked what they thought should happen to patients selected by the application as possibly having a SSI, which part of the hospital should be allocated to receive and help these patients and which health care staff should be responsible for this category of patients. For all patients, including the readmitted patient, the themes ”impression of application” and ”functionality and characteristics of the application” were used. They were asked about their first impression of the application as described by the interviewer. For the theme ”functionality and

characteristics of the application" the patients were asked about the type of functionalities they would like to be present in the application. Then, the mock-up was showed to provide an example of the application. Subsequently, the patient was asked about the time they would like to spend on the application, the amount of questions they would be willing to answer, the number of times they would be willing to use the application daily and the time of day they would prefer to use the application. Three functions from similar applications were explained, being a photograph function, a feedback function and an information function. Patients were asked what they thought about these functions and if they could see the added value of these functions for their recovery. The focus of the interviews with the patients was on preferences for the usability of the application to maximize the input from this stakeholder group and thereby minimize the risk of non-respondents when the application is in use.

Analysis

See Section 2.3.2 for the methods of analysis.

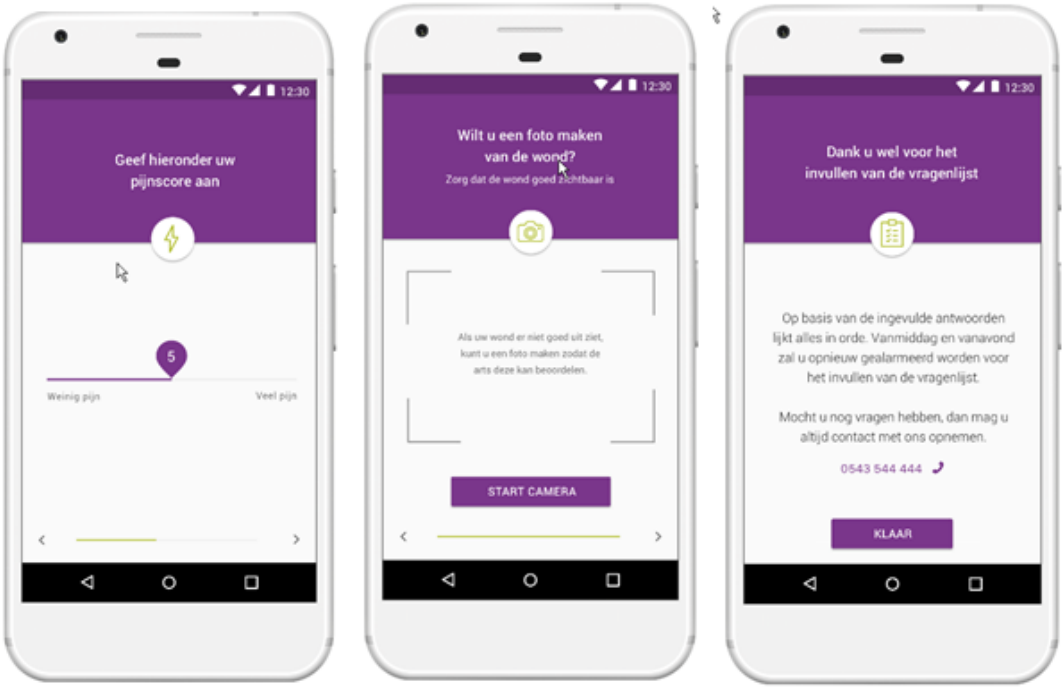

Figure 2: Different screens from the mock up used in the interviews.

3 Results

3.1 Contextual inquiry

3.1.1 Stakeholder identification

The stakeholders identified by the management team are displayed in Table 3. The stakeholders in bold font, the patients, surgeons, nurses and the hospital board, are the important stakeholder groups. The table shows the answer to each of the important stakeholder group identification questions. The original questions can be found in Section 2.2.1. This means all important stakeholder groups should be involved in the following steps of development[27]. Patients undergoing one of the high risk surgeries, nurses from the surgical ward and surgeons performing one of the high risk surgeries were invited to be interviewed and the hospital board was informed through meetings with members of the management team. The last stakeholder, the application developer, was being update through meetings and correspondence by members of the management team.

Table 3: All stakeholders within the research project "postoperative application". The bold answers indicate divergence, excluding these stakeholders from important stakeholder group status.

Stakeholder	Impact	Wishes	Relationship	Replaceable	Representation
Surgical patients	Yes	Yes	Yes	No	No
Doctors (surgeons)	Yes	Yes	Yes	No	No
Nurses	Yes	Yes	Yes	No	No
Hospital board	Yes	Yes	Yes	No	No
Application Developer (Innovatic)	**No**	Yes	Yes	**Yes**	No

3.1.2 Field observation

Both the walk-through and the observed discharge procedure showed the clear discharge protocol for patients from the surgical ward. One of the most important parts in the care process surrounding surgery is the follow-up phone call the day after discharge used as a check-up for possible complications. Contact by telephone is the

most important form of communication for follow-up and contact about possible complications. All nurses emphasized the importance of developing a new protocol before the introduction of the application, to be made in collaboration with one of the nurses, and sufficient training. They also requested extra time in both surgery preparation appointments with patients and during the discharge procedure to discuss the application with patients.

The transcript of the walk-through and the actual observed discharge procedure can be found in Appendix C. A flowchart of the care process from 2017, before introduction of the application, is depicted in Figure 3.

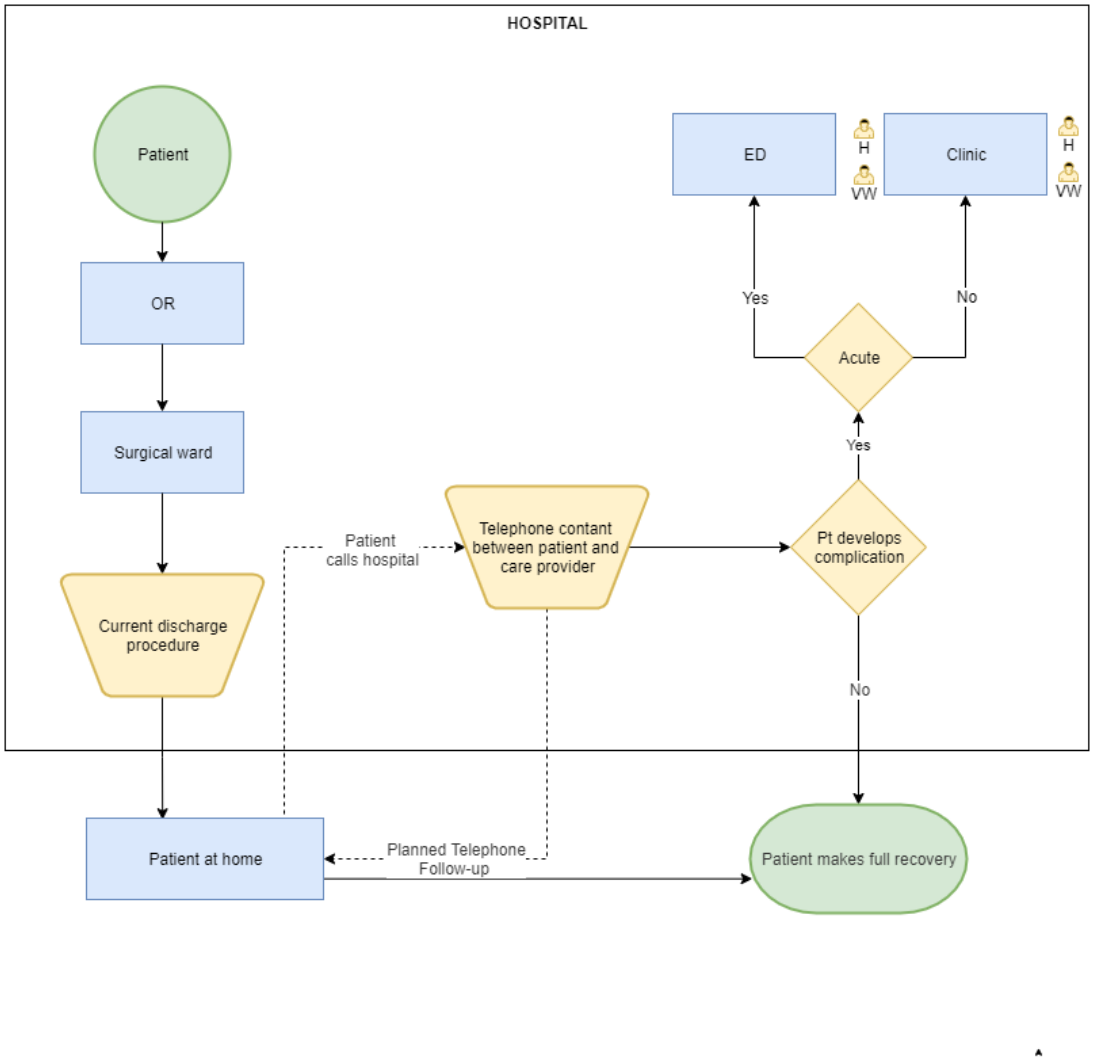

Figure 3: Flowchart of the care process surrounding a surgical procedure (2017).
Abbreviations stand for: operating room (OR), patient (Pt) and emergency department (ED).

3.1.3 Conclusion to use in Value specification phase

The important stakeholder groups surgeons (performing one of the high risk surgeries), nurses (from the surgical ward) and patients (undergoing one of the high risk surgeries) will all be involved in selecting requirements for the application through interviews. The surgeons and nurses will also be involved in the requirements for the changes made in the care process and the flowcharts made of the current care process will serve as a reference. The important stakeholder group the hospital board will be informed and consulted by the management team of the research project.

3.2 Value specifications

3.2.1 Literature review

The results for the literature review are split into three subjects: search 1 is about complications, search 2 contains information on early warning scoring systems and search 3 entails the results on postoperative monitoring applications. Literature was collected up to and including the year 2017.

3.2.1.1 Search 1: Complications

59 articles were found through our search. 30 articles were excluded based on title, 18 based on abstract and 6 based on full text. Reasons for exclusion were specific treatment focus, wrong surgery type, wrong population, off topic, focus on outcome or outdated articles. 5 articles were deemed suitable for review: three about colon surgery and two about breast surgery. No suitable articles could be found about symptoms of infection or sepsis in patiënts who underwent a laparoscopic cholecystectomy. Through the review of references in the selected articles one more article was found about surgical wound infection surveillance in general. All articles can be found in Table 4.

Table 4: The search results of articles about signs and symptoms of infection in patients having undergone breast surgery, colon surgery or a laparoscopic cholecystectomy. For each article the first author, title, year, named symptoms of SSI and other important remarks are registered.

First author	**Title**	**Symptoms of SSI**	**Other remarks**
D. Vilar-Compte[3]	Surveillance, control, and prevention of surgical site infections in breast cancer surgery: a 5-year experience. (2009)	1) Pain or tenderness, 2) local swelling, 3) redness or heat and 4) fever (>38°C)	Hematoma is a risk factor for SSI. Other complications are opened wound, necrosis, hematoma and seroma. Most complications develop within 21 days.
M. Bertin[7]	Determinants of surgical site infection after breast surgery. (1998)	1) Redness, 2) pain, 3) fever(>38°C)	On average, SSI developed within 12,5 days (range 5-30). Readmission rate for an SSI was 33%.
R. Smith[2]	Wound infection after elective colorectal resection. (2004)	1) Pain or tenderness, 2) swelling around the wound, 3) redness or heat and 4) an opened wound	The amount of post discharge SSI diagnosis rise. Half of all infections developed post discharge, which accounted for 13% of SSI's. Median days between surgery and onset of complications were 9 days (IQR 5-19).
B. Tserenpuntsag[8]	Surgical site infection risk factors identified for patients undergoing colon procedures, New York State 2009-2010. (2014)	No specific symptoms named in article.	14,5% of infections developed post discharge. Risk factors for SSI included male sex, obesity, transfusion, type of procedure and prolonged duration of procedure.
J. Scarborough[9]	Associations of Specific Postoperative Complications With Outcomes After Elective Colon Resection: A Procedure-Targeted Approach Toward Surgical Quality Improvement. (2017)	No specific symptoms named in article.	Other complications are ileus, bleeding and anastomotic leaks. If SSI were prevented, there would be 10% less readmissions. 7,0% of patients developed an SSI.
C. Weiss[6]	Six Years of Surgical Wound Infection Surveillance at a Tertiary Care Center (1999)	Diagnosis SSI based on microbial isolates combined with symptoms of infection. No specific symptoms named in article.	53,9% of SSI were identified post discharge. An SSI developed in 2,8-8,6% of surgical cases.

Colon surgery

The percentage of surgical wound infections after colon surgery is underestimated by most studies due to neglect to collect data from patiënts after discharge [6, 2]. A study from 2004 about surgical wound infections in colon surgeries reported that half of the infections developed after the patiënt had left the hospital [2]. This group accounted for 13% of all surgical wound infections of the studied population (49% of 26% infections)[2]. Another study reported 14,5% of the infections with an onset after discharge [8]. One article names the most common symptoms of infection: pain or tenderness, swelling around the wound, redness or heat and an opened wound [2]. The median number of days between the surgery and onset of the complication was 9 days (interquartile range 5-19 days)[2]. A large American study with 26.682 patiënts undergoing colon surgery studied the most common complications after surgery[9]. They found that ileus (11,8%), bleeding (7,6%), surgical wound infection (7,0%) en anastomotic leaks are most commonly found [9]. Anastomotic leaks have the most severe consequences in the form of organ failure, mortality, re operations and hospital readmissions[9]. Other complications named by this study were urinary track infections (2,6%), pneumonia (1,4%), thrombosis (1,4%) en myocardial infarctions (0,5%), but the occurrence and impact of these complications are limited[9]. Furthermore, 9,4% of patients had to be readmitted within 30 days because of a complication, in most cases because of an anastomotic leak[9]. This study calculated outcome measures if these complications could be prevented. If we look at readmissions there would be a 20,6% decrease for anastomotic leaks, 10,9% for ileus, 10,0% for surgical wound infections, 4,2% for thrombosis, 3.9% for urinary track infections, 2,5% for bleedings, 1,3% for pneumonia and 0,8% for myocardial infarctions[9]. On average between 7,0-26,3 percentage of patients develop an infection [2, 8, 9, 10].

Breast surgery

Most studies about breast surgery focus on risk factors for the development of complications (including infection) after an operation. An article from 2009 names the formation of a hematoma as an important risk factor [3]. Pain or tenderness, local swelling, redness or heat and fever (>38°C) are named as the most important sign of an infection[3]. Other common complications named in the article are an opened wound, necrosis, hematoma and seroma[3]. Most of these complications develop within 21 days after operation[3]. Another study from 1998 names these signs of infection: redness, pain and fever (>38°C) [7]. They found a period of on average 12,5 days (5-30) between the operation and the diagnosis of a surgical wound infection and one third of the patients had to readmitted to get the infection treated properly[7]. Those patients also exhibited more outpatient appointment needs, from 1 to 12 meetings (on average 5,2)[7].

Common findings
The articles showed several risk factors applicable to different types of surgery. Those risk factors include previously diagnosed diseases such as diabetes or obesity, certain parameters registered during surgery such as hypotension or a prolonged procedure and in some cases the initial diagnosis underlying the need for surgery[2, 3, 31, 32]. For example, in colon surgery, there is a difference in outcome for patients undergoing colon surgery for a tumor or for irritable bowel syndrome[31]. With breast surgery radiation and chemotherapy before the operation are registered as possible risk factors [3]. There were no relevant studies into signs and symptoms of infection after laparoscopic cholecystectomy, but the overlap in symptoms between colon surgery and breast surgery suggest that these will possibly be present in different types of operations as well. Complication during the first 30 days after surgery have been named as the most important contributing factor to mortality risk, more than preoperative patient specific risks or circumstances. The common signs of SSI for both colon and breast surgery are pain or tenderness, swelling, redness or heat or fever and an opened wound [2, 3, 7].

3.2.1.2 Search 2: Early Warning Score Systems

For early warning score systems, 17 articles were found, 11 of which were excluded based on title. Reason for exclusion was a focus on pediatric care of all excluded articles. Different types of scoring systems have been developed to objectively assess the physiological state and stability of patients and notice signs of possible decay. Examples are the Therapeutic Intervention Scoring System (TISS-28), Early Warning Score (EWS), Modified Early Warning Score (MEWS) and the Rothman Index (RI). Comparative studies show that the MEWS, a simplified version of the EWS which is easier to use in practice, is better at identifying decay in patients conditions than the TISS-28 [33]. The RI is mainly designed for patients who are admitted into the hospital[34]. This system uses the continuously monitored vital functions measured by medical equipment combined with laboratory results and is not suitable to use for patients in their homes [34]. This is the reason why the MEWS would be best suitable to be implemented, in an adjusted version, in a postoperative monitoring application.
The Early Warning Score is a scoring system used by health care professionals to assess the current physical state of patients in the hospital and quickly notice changes that point to possible decay. In case of divergent physical outcome measures (for example, an elevated body temperature or accelerated heartbeat), points are given according to the magnitude of the change. If a patient presents with too many divergent values, and thus a high number of points, action needs to be taken. This chain of events will also call for more frequent assessments of the patient. After introduction of the guideline containing the first official EWS many different versions have been published and validated to be used in different settings. The original EWS was based on 6 physiological parameters: heart frequency, breathing frequency,

systolic blood pressure, level of consciousness, oxygen saturation and temperature [35, 36].
Any MEWS is a simplified version of the EWS, changing the selected physiological parameters to parameters which fit the clinical setting. There is not one official MEWS version, but rather any adapted version of the EWS can be called a MEWS, as it is a "modified" version of the EWS. The articles found during this literature review contain different types of MEWS, but as most of their parameters overlap, results will presumably be generalizable to different types of MEWS as well.
If the clinical setting is the patients home, the selected parameters need to be eligible to monitoring without hospital equipment. A MEWS is a very suitable instrument to assess patients in the postoperative setting[37, 38, 39, 40, 41]. If the MEWS is combined with opinions of out of hospital staff, such as ambulance personnel or home nurses, more potential vitally endangered patients can be identified [42]. This increases the sensitivity of the instrument and can select more patients with complications who would otherwise not have been identified and treated[43]. Medical conditions which are not the result of a trauma are often misjudged by out of hospital medical staff members and MEWS could support them with this issue[42]. The application developed during this research project needs to identify these kind of non-traumatic medical conditions. An automated MEWS scanning data provided by the patient in the application will therefor probably be more successful than letting this task be performed by, for example, a home nurse.
A validation study needs to be performed for each new MEWS, to legitimize both the selected parameters and the efficacy, efficiency and functionality of the MEWS. It is difficult to choose the right outcome measures when validating a MEWS system. Most studies use mortality and length of stay [35]. Therefor, these would be the outcome measures to use in a validation study for the newly developed MEWS for the postoperative application. There are two tools developed and used specifically for sepsis in patients outside the hospital, the Robson Screening Tool and the BAS 90-30-90[44, 45]. Both of them are not performing as well as the MEWS on specificity or sensitivity in detecting severely deteriorated patients, making them hard to use in practice[46, 44, 45]. The Robson Screening Tool and the BAS 90-30-90 use the same parameters as the MEWS but instead of assigning points to each of the outcomes a patient needs to present with a certain number of divergent parameters to classify as septic[46]. Furthermore, these tools focus on sepsis and the postoperative application is being developed for both sepsis and earlier stages of infection. This means the scoring tool needs to be able to detect both. In the study which compared TISS-28 and MEWS a highly heterogeneous study population was used, where the MEWS performed superior in detecting patients with a high risk of developing an infection [33]. This is important because the group of end users for the postoperative application could consist of a highly heterogeneous population as well.

3.2.1.3 Search 3: Postoperative monitoring applications

There were 33 articles on Pubmed and 128 articles found through Scopus. Of all Pubmed articles 24 were excluded based on title or abstract and for Scopus 109 were excluded based on title or abstract. After reading the full text, an additional 2 articles were excluded for Pubmed and 9 articles were excluded for Scopus. Reasons for exclusion were use of a different technology , wrong study population, articles off topic, articles focused on a specific disorder or protocols for research. Of the remaining 7 articles from Pubmed and 10 articles from Scopus 3 articles overlapped. Therefore the final list contained 14 articles which can be found in Table 5. The table is ordered based on application name as several articles describe the same application.

Table 5: Search results for literature review. For each article the name of the application, first author, year of publication, the goal, the gathered data, patient data access for physicians and the feedback provided to patients who share data through the application is given.

App name	**First author**	**Goal**	**Gathered data**	**Physician access**	**Feedback**
mPOWEr	P.Sanger (2014)[18]	Explore experiences of patients with SSI and their attitude towards a mobile application as a possible solution.	Interviews with following themes: 1) knowledge of self-care, 2) efficacy for self care, 3) surgical site monitoring after discharge, 4) communication with health care providers, 5) Acceptability, 6) perceived benefits and 7) potential limitations of a mobile Health application.	Not applicable.	Not applicable.
mPOWEr	P.Sanger (2016)[19]	Gain insight in conflicts of interest between patients and care providers in post discharge follow-up via a monitoring application.	Interviews with following themes: 1) data capture, 2) data transfer, 3) review/documentation and 4) overall process. Content of application questionnaire: 1) leakage (if so, color of fluids), 2) soak time, 3) pain, 4) redness, 5) warmth, 6) swelling, 7) opened wound, 8) smell and 9) patient concerns. Photograph of wound.	Patient data portal. Notes can be stored in EHR.	Telephone and text message communication. Patient can select communication preferences.

App name	First author	Goal	Gathered data	Physician access	Feedback
QoC Health Inc	J.Semple (2015)[47]	Feasibility study into postoperative monitoring application for the early detections of complications.	Satisfaction and feasibility through questionnaire. Application questionnaire content: anxiety, pain, drainage, feeling of general well begin, support from others, confusion, personal hygiene, voiding, bowel function, breathing easily, headache or backache or muscle pains, nausea or vomiting, pain levels and mobility. Photograph of wound.	Patient data portal.	Telephone communication in case of suspected complication.
QoC Health Inc	K.Armstrong (2014)[22]	Assess the cost efficiency of a postoperative monitoring application.	Costs of surgical follow-up care post discharge.	Not applicable.	Not applicable.
QoC Health Inc	K.Armstrong (2017)[21]	Assess whether mobile follow-up can replace in-person follow-up.	Amount of email and telephone communications and in-person visits. Convenience and satisfaction scores and complication rates.	Patient data portal.	Telephone and email communication.
Wound Check app	J.Wiseman (2015)[48]	Evaluate the willingness and capability of elderly patients to use a smartphone based postoperative monitoring application.	Photograph of wound. Content of application questionnaire not specified.	Not applicable.	Not applicable.
Wound Check app	J.Wiseman (2016)[49]	Evaluate if wound photographs could supplant in-person evaluation of surgical wounds.	Inter-rater agreement for presence of 1) ecchymosis, 2) redness, 3) cellulitis, 4) drainage, 5) wound drain, 6) dehiscence and 7) necrosis.	Photographs provided by clinician.	Not applicable.
Wound Check app	R.Gunter (2016)[50]	Evaluate patient usability of an image-based mobile health platform for postoperative wound monitoring.	1) Mean application completion time, 2) image quality, 3) usability score. Content of application questionnaire: 1) fever or chills, 2) change in medication regime (if so is it related to pain medicine and if so again, increase in pain medicine), 3) redness, 4) swelling, 5) smell, 6) leakage (if so what color and dressing soaking).	Patient data portal.	Not applicable.

App name	First author	Goal	Gathered data	Physician access	Feedback
RAPP	M.Jaensson (2015)[51]	Describe the process of developing a postoperative monitoring application with an interdisciplinary team and focus on usability.	Content of application questionnaire: list of 31 items including pain, nausea, vomiting and shivering or twitching. All items are listed in the text.	Patient data portal.	Telephone communication in case of alert.
RAPP	U.Nilsson (2016)[17]	Protocol for single-blinded randomized controlled trial on systematic e-assessment of postoperative follow-up.	Endpoints are 1) cost-effectiveness, 2) effect on postoperative recovery, 3) health reated quality of life, 4) overall health, 5) assessing the association between differences in postoperative outcomes and patient characteristics and 6) experiences of participanting patients and health care professionals.	Patient data portal.	Telephone communication in case of alert.
Mobile app	B.Debono (2016)[52]	Test a monitoring tool for post discharge surgical follow-up.	Content of application questionnaire: 1) pain, 2) body temperature, 3) painful voiding disorder, 4) motor disorder or 5) a blood stained dressing.	Patient data portal.	Telephone communication in case of alert.
Mobile phone tele-medicine	C.Martinez-Ramos (2009)[23]	Address efficacy of mobile phone-based telemedicine system to improve postoperative follow-up.	Photograph of wound.	Photographs sent via email from phone.	Telephone communication in case of suspected complication based on photo.
Medeo	H. Hwang (2016)[53]	Prevent unscheduled care post surgery using a mobile follow-up application.	Photo accompanied by message on day 1,3,7 and 14 post discharge.	Patient data portal.	Messaging through patient data portal.
Medipal	M. Warren-Stomberg (2016)[54]	Identify technology preferences and test postoperative application for follow-up.	Technology preferences. Content of application questionnaire: 1) pain, 2) post operative nausea and vomiting and 3) feasibility of use.	Patient data portal.	No feedback to patients.

Smartphone monitoring requirements

In 2009, one of the first mobile phone based follow-up systems was introduced[23]. A total of 96 patients received a mobile phone and some training to take pictures of their surgical wound and email these to their physicians[23]. Possible complications were reported by 31,3% of participants, though only one patient was invited for follow-up treatment at the hospital[23]. Since then, multiple smartphone based monitoring applications for postoperative follow-up at home have been developed[19, 47, 50, 51, 52, 53, 54]. They can contain a photograph function, a message option or a questionnaire[23, 53, 52, 47]. The usability requirements of both patient and health care providers are important to take into account during the development process [19, 47, 48]. Patients identified three major challenges for postoperative monitoring of their wound at home, which were required knowledge for wound monitoring, self-efficacy for surgical site monitoring and accessible communication with health care staff about concerns for their wound[18]. Perceived benefits named by patients were more frequent, thorough and convenient follow-up[18]. Concerns named by patients were lack of a timely response, coordination with health care providers and inaccessibility due to technological difficulties[18]. Health care providers were concerned on the time efficiency of implementing a monitoring application into the follow-up care process[19, 47]. Their perceived benefits were the ease-of-use of the system and the opportunity to monitor patients in a non-clinical setting[47]. Patients and health care providers agreed on the importance of ”providing contextual meta data”, ”accessible and actionable data presentation”, ”building on existing socio technical systems”, and ”process transparency”[19]. There were six areas of conflict, where patients expectations diverged from those of care providers. Patients expressed their need for: ”more flexibility in data input, frequent data transfers, text-based communication, patient input in provider response prioritization, timely and reliable provider responses, and definitive diagnoses”[19]. Health care providers were concerned this would inflict on their currently busy schedules and not meet the needs for reliable triage[19, 47].

Usability and patient preferences

The overall attitude of patients towards mobile postoperative monitoring applications was favorable[18, 48]. Patient satisfaction scores vary between 93-95%, with a usability score of 83,3%[47, 50]. The convenience score for patients using an application was 1.39 compared to the in-person follow-up[21]. For patients that used an application, 95% thought e-monitoring improved their care[53]. During usability testing, only minor adjustments were suggested by patients and care providers[51]. Although overall attitude of patients is positive and one study found a 92% willingness of elderly patients to use a smartphone in postoperative monitoring, another study found 46% non-responding application users, with fewer responses from elderly patients[18, 48, 54].

Application content and outcome

The content of the application questionnaires differed amongst applications but most used parameters were: pain (5), fever or chills (3), nausea or vomiting (3), soaking time of dressing (3), anxiety or patient concerns (3), voiding problems (3), bowel function (2), breathing easily (2), headache, backache or muscle pains (2), leakage (2), redness (2), Swelling (2), smell (2), feeling of general well being (2), personal hygiene (2) and mobility (2)[19, 47, 50, 51, 52, 54]. Other parameters used were: warmth or heat, opened wound, drainage, support from others, confusion, pain levels, change in medication regime, dizziness, feasibility of patient using the application, sleeping well, enjoy food, feeling well rested, feeling in control, feeling relaxed, normal speech, normal handwriting, return to work, feeling restless, feeling too cold, nightmares, depressed, feeling lonely, difficulty sleeping, sore throat and concentration problems [19, 47, 50, 51, 52, 54]. On average, the questionnaires contained 12 parameters (range 3-31). A study showed that 8% of patients is willing to answer no more than 3 questions, 12% is willing to answer a maximum of 4-6 questions and 80% of patients is willing to answer between 7 and 9 questions, meaning the amount of parameters used in the application may influence the number of non-respondents[48]. Out of the 8 applications, 5 contained a photograph function, 6 contained a questionnaire and 2 offered messaging free text[19, 21, 50, 17, 52, 23, 53, 54]. The mean number of logins was 21,6 for a 30 day study and the mean time spent during each session 5.0 minutes[47, 50]. Most logins took place in the first 14 days and most alarms were triggered in the first 2 days post discharge[47, 52]. The symptoms triggering most alarms regarded pain and fever[52]. Unscheduled care was prevented in 29-55,2% of cases[23, 53]. When the amount of in-person visits is compared between application users and patients receiving standard follow-up care, the mobile app group has 0.4 less in-person visits[21]. There is no difference between complication rates of patients using a mobile application for follow-up or patients receiving standard follow-up care[21].

Photograph quality

The assessment of photographs taken by patients can be challenging, since important parameters such as temperature or smell cannot be assessed using an image. Some applications therefor provide patients with questionnaires which contain questions on (body) temperature, leakage and smell [50, 47]. Other applications offer the option of including a text message [53, 21]. In some cases, the application contained only a questionnaire[50, 52, 54]. The quality of the photographs sent by participants did not affect the ability of physicians to identify possible complications when compared to in-person assessment[49]. Also, course of treatment had a high inter-rater agreement, with agreement coefficients between 0.72 and 0.92, compared to 0.82 and 0.90 for in-person assessments. Furthermore, between 81.8% and 95% of photographs were deemed as quality sufficient for diagnosis by physicians [23, 50]. Although patients felt overall comfortable taking pictures, this was also named as the most challenging part of a monitorings application as opposed to writing messages or answering

questions[18, 50, 48]. The follow-up post discharge of surgical patients using a smartphone based monitoring application is cost effective when compared to standard in-person follow-up care[22].

Integration into EHR
Health care providers would prefer an application which is connected to the EHR[19]. All of the reviewed applications used either a separate (web-based) patient portal to review patient data or received photos through email[19, 21, 50, 17, 52, 23, 53, 54]. One application offered the option of copy-pasting a note from the patient portal into the EHR[19].

Implementation focus points
Although overall attitude towards postoperative monitoring applications is favorable for both patients and health care professionals some important remarks were made by both groups[18, 48]. Patients perceived technological difficulties as an important barrier[18]. Health care staff named both time efficiency and reliable triage of patients as their most important concerns[19, 47]. The provision of adequate information and training for both groups is eminent for application success, as some studies found high amounts of non-respondents, especially amongst elderly patients[18, 48, 54]. As there are multiple areas of conflict between patients and health care professionals with regards to the design and implementation in follow-up processes both groups should be involved in, and informed on, application development [19].

3.2.2 Interviews

The interviews were conducted in 2017 with 3 surgeons, 2 nurses and 4 patients (including one readmitted patient). The major themes were ”complications”, ”patient specific baseline measurements”, ”inclusion and exclusion criteria”, ”care process changes” and ”complications in past surgeries”. Table 6 shows the code scheme that was a result of the assigned codes and categories. The conclusions will be described in the form of similarities and differences amongst the participants per theme.

Table 6: The code scheme result with the codes and the categories these were assigned to. The results for each category, split for surgeons, nurses and patients (number of respondents in parentheses). An example of each result is shown in the form of a quote from a respondent.

Category	**Codes**	**Results**	**Example**
Complications	General symptoms of complication	Surgeons named: pain (3), fever (3), tachycardia (2), overall discomfort(2), bowel function (2), nausea (1), blood pressure (1), shortness of breath (1) and appearance of the wound (redness (3), swelling(2), bleeding (2), hematoma (1) and leakage (1))	”Do patients exhibit tachycardia and pain.”
		Nurses named: fever (2), tachycardia (1), blood pressure (1), bowel function (1) and appearance of the wound (redness (1) and stiffness of wound tissue (1))	”Mainly wound infection accompanied by fever.”
		Patients named: Nausea (1), palpitations (1) and appearance of the wound (discoloration (1))	”Yes, I felt really nauseous then.”
	Symptoms for SSI	Surgeons named: fever (3), pain (3), feeling of wellbeing (3), tachycardia (1), voiding disorders (1) and appearance of the wound (redness (2), swelling (2), leakage (2) and hematoma (1))	”Infection? Well, redness and swelling.”
		Nurses named: fever (2), pain (2), feeling of wellbeing (2), tachycardia (1), voiding disorders (1), low blood pressure (1), nausea (1) and appearance of the wound (redness (1), stiffness of wound tissue (1), swelling (1) and hematoma (1))	”Well of course there is fever and tachycardia.”
	Time line for development	All surgeons (3) and nurses (2) claim the time frame for the development of SSI is very wide, even for patients with similar characteristics or the same type of surgery.	”That varies greatly. Some will be back within a day, or lets say in 24 hours. And others return after a week or even a month.”

Category	Codes	Results	Example
Inclusion and exclusion criteria	Type op surgery	Surgeons named: breast surgery (2), cholecystectomy (2), appendectomy (1), abdominal surgery (1) and orthopedic surgery (1)	"appendectomy because that is a common one."
		Nurses named: breast surgery (2), cholecystectomy (2), orthopedic surgery (2), urology (2), appendectomy (1), abdominal surgery (1) and plastic surgery (1)	"It is also eligable for orthopedics. A lot return with hip infections, knee infections."
	Patient characteristics	Nurses would exclude unscheduled abdominal surgeries as those already entail a large amount of focus points for patients. Breast and abdominal surgery have a large amount of check-ups and guidance, which decreases the chance of missed SSI. Focus point is the ability of elderly patients to use a smartphone application (1).	"We would be trained but for elderly patients well, it might be difficult (to use the application)."
Patient specific baseline measurements	Patient specific baseline preference arguments	All surgeons (3) and nurses (2) prefer the use of patient specific baseline measurements over the use of standard references values. One surgeon and one nurse voiced concern over correct temperature measurements in a home setting.	"It sounds silly, but there are a lot that don't understand how a thermometer works."
		All patients (4) do not object to using the application before surgery, as long as this is supported by sufficient arguments.	"I think I would choose the option that started before the operation."
Care process changes	Care process changes support	Both nurses (2) named the monthly clinical seminar as a training opportunity before implementation of the application. Development of a cue card about the application is suggested (1). Nurse involvement in protocol development before implementation is essential for success(2).	"Yes, optionally a short clinical lesson idea"

Complications

There was a general consensus between the care providers about SSI symptoms to look for and type of questions to ask patients. Multiple care providers named temperature (fever), pain, feeling of wellbeing, tachycardia, voiding disorders and physical appearance of the wound. For this appearance they were looking for redness, swelling, leakage of fluid, blood or pus and possible hematomas. The time line for the development of an SSI was difficult to predict according to all health care professionals, even for patients with similar characteristics or who had undergone the same type of surgery. Sometimes a complication is diagnosed within days, while others insist on longer terms for different complications. The range lies between a day and multiple weeks. The questions to ask patients in the application were all centered around the symptoms of SSI. Multiple questions were focused on the appearance of the wound, and many health care professional therefore revered to the possibility of a photograph, even before they saw the mock-up (which contained a photograph function).

Inclusion and exclusion criteria

When asked about the type of surgeries suitable for use of the postoperative application all care providers named different types. Only breast surgery, cholecystectomy and orthopedic surgery were mentioned by at least 3 care providers. Some doctors would say that patient who had a simple type of surgery were more suitable while others thought patients with an operation with severe impact would be best to use the application.

An argument to include only severe category surgeries:

"And I think the larger abdominal operations in general with all colleagues, so extensive abdominal surgery." ... "Look, with abdominal surgery you off course have the most complications. That is general knowledge, it is a part of it. So yes, off course you want to select these."

An argument to include only simple type surgeries:

"Care with low complexity. Say the bulk, the gallbladder, the inguinal hernia, the removal of the swellings in the OR. "" ... "" The colons, that group I find too heterogeneous. That difference between someone who has a very quick and uncomplicated recovery and someone who has longer uh that uh that difference is too large, I think you cannot properly capture it under one denominator."

One of the doctors claims that the more severe abdominal surgeries experience a high complication rate and are therefore more suited for use of the application. Another doctor says that only simple surgery should be included, because the group of abdominal surgery patients is too heterogenous and that is why they are not suitable for the application.

The nurses were concerned for patients who underwent unscheduled abdominal surgery, as these types of surgeries are accompanied by a large amount of information and protocols for the patient to follow when discharged. Adding the application would bring too much pressure for some of these patients. One of the nurses also

explained that for patients undergoing breast surgery and some types of abdominal surgery there are large support teams and multiple check-ups scheduled, which decreases the possibility for a complication to remain unnoticed. Another comment made by the nurses regarded elderly patients. The use of a smartphone can be quite challenging and this category of patients might need additional training and guidance if they are to be included in the patient group using the application.

Patient specific baseline measurements
The health care professionals all have a preference for use of patient specific baseline measurements, meaning the patient will use the application days before the surgery to collect data on their normal temperature, heart rate or other selected parameters through the application. This data will serve as reference values for the data patients sent in through the application after discharge. Non of the patients have objections to use the application before their surgery, as they perceive this will benefit their care.

Care process changes
Both nurses named clinical training to work with the application as necessary before the pilot started. For all surgical ward nurses a monthly seminar is organized, which would be suitable to host training and information workshops before the application is launched. Nurses carry a range of cue cards, designed for special tasks or check-ups. One nurse suggested a cue card could be designed with information about the application, making it easier to inform patients and answer questions patients might have. Both nurses emphasized the importance of involving both nurses and patients in the proceeding development steps of the application.

3.2.3 Conclusion to use in Design phase

There is some overlap between results of the literature review, the characteristics of existing postoperative monitoring applications and our interviews with health care staff and patients. The most important alarm symptoms for an SSI are increased temperature or fever, pain, feeling of wellbeing and divergent appearance of the wound (redness, swelling, leakage and hematoma) [19, 47, 50, 51, 52, 54]. The most used additional functionality of monitoring applications are feedback by telephone or text message and options to send photographs of the wound [19, 21, 50, 17, 52, 23, 53, 54]. These functions are therefore discussed during the interviews with stakeholders to assess the value of these additional functions in the application according to important stakeholder groups patients, nurses and surgeons. Both health care staff and literature have shown different surgery types to be suitable for this application[23, 52, 53]. Breast surgery and colon surgery are found in literature as high-risk surgeries for SSI and named by the surgeons as suitable types of surgery for the application[2, 3, 7]. Cholecystectomy was also mentioned by the health care

professionals, but susceptibility for SSI could not be found in literature. During the walk-through of discharge of patients with the nurses and the interviews the need for clear protocols and adequate training were both mentioned as important factors of support and this can also be found in literature[19, 54]. The nurses should be involved in the development of new protocols, in which the new care process will be formed, to be used after introduction of the application. The interviews in the design phase will therefore focus on the responsible health care professional for patients showing alarm symptoms through the application.

3.3 Design

3.3.1 Interviews

The interviews were conducted in 2017 with 3 surgeons, 2 nurses and 4 patients (including one readmitted patient). The major themes were ”impression of the application”, ”Functionality and characteristics of the application” and ”alarm location”. Table 7 shows the code scheme that was a result of the assigned codes and categories. The conclusions will be described in the form of similarities and differences amongst the participants per theme.

Table 7: The codescheme result with the codes and the categories these were assigned to. The results for each category, split for surgeons, nurses and patients (number of respondents in parentheses). An example of each result is shown in the form of a quote from a respondent.

Category	**Codes**	**Results**	**Example**
Impression of application	First impression of application idea	Surgeons were overall positive about the application (2), but concerned about additional workload(3). All patients (4) responded positive to the idea of such an application. One patient questioned the burden it would impose on patients having undergone major surgery. Another patient named the application clear and thought it would lower the threshold to contact the hospital.	”I think that’s a very good idea, yes.”

Category	Codes	Results	Example
Functionality and characteristics of application	Intended use	Patients are willing to use the app 1 time a day (2) to 3 times a day (1), for 5 (1), 10 (1) or 15 (1) minutes and a maximum of 10 questions (3). The preferred time for a reminder differs, from a preference for the morning (1) or midday (2) and no preference (1).	"Well, in that case I think ten minutes or so is long enough."
	Functionalities	All surgeons (3) named the photo function as a preferable function to add to assess the wound. Patients would like to see a photo function (4) and a function that provides basic information on wound care and complications (3).	"A photograph function is really a great idea."
	Additional comments about application	One surgeon suggested to provide the reminder in the morning, as more health care providers are present during daytime to assess and treat patients. One nurse commented that both health care providers and patients should be included during all stages of the development process of the application. A patient voiced some concerns about privacy and security issues regarding the app (1).	
Alarm location	Acute	All surgeons (3) and nurses (2) do not think they should be responsible for patients using the application and named the emergency department as suitable location, with accessibility(2), easy communication between doctors and nurses (2) and focus on triage (2) as most important arguments.	"Yes, that would be at the emergency room."
	Non-Acute	Surgeons (3) named the emergency department (1), outpatient clinic(1) and surgical ward nurses (1) for non-acute patients. Both nurses (2) named the emergency department, because nurses are not qualified to decide on a course of treatment and would always have to consult a physician.	"For a surgical case at the surgical ward." "We can't decide on a course of treatment, so we would have to call a doctor so I think the ED is more convenient."

First impression of the application

All participating patients responded positive to the application concept. Both health care professionals and patients were positive about the technology and its goal, although all care professionals directly expressed their concerns for extra workload. One doctor answered to the question who should be responsible for taking in the patients from the application:

"Not with me" ... "Yes, I can't really imagine I will receive a message about it in the middle of the night to be honest."

Patients on the other hand found it hard to grasp the automated idea of the application, where not all of the data send by them will be reviewed by a health care professional, most of it will only be assessed by a computer. One patient expressed:

"yes, but behind every computer is a human being, right?"

This depicts the conflict between health care professionals being swamped in work and patients wanting attention and reassurance from their doctors.

Intended use

When patients are asked about the intended use of the application they give similar answers. The patients want to spend a maximum of 5-15 minutes per session and each session can have a maximum of 10 questions. The number of times patients want to fill out the questionnaire is 1 to 3 times a day. One patients says:

"And yes, if it is a simple surgery, then I also think well, it will be fine. One time is enough. Yes. Yes, that works both ways huh? Whether you are doing well and if you have had a major surgery, then you can only take one time, but this is ... and I ... I think would think never mind, I feel good. So it actually works both ways."

This suggests that patients who have undergone a simple surgical procedure will recover so quickly they will not feel the need to use the application more than once a day. For patients who have undergone major surgery, their recovery can be quite difficult, which means using the application once a day can be a burden.

The patients prefer different moments during the day with one patient mentioning the morning, and three naming the afternoon or evening after they have had some exercise. The exercise will help them assess how they are doing:

"Yes, well there are the mornings, then you have rested the night before and you will be doing much better." ... "And at night, you would have been busy all day."

"Maybe provide a pop-up in the morning. So you, uh, when you weren't doing well the night before you can act upon it immediately. Otherwise, uhm, yes if you have used up some energy during the day so you, uhm, feel a little worse. Because that could also lead to complications. Yes."

All but one of the health care professionals did not prefer a specific moment during the day for the application to be used. One of the surgeons named the mornings as suitable because if the patient would present with a possible complication the hospital had more time to act upon it, having more staff scheduled to work during daytime. There was no preference found in literature supporting a certain moment during the day to use the application, therefore we would suggest presenting a pop-up reminder

in the morning, but giving patients the option to use the application at any time.

Application functionalities

The functions that are suggested as possibilities are a photograph function, feedback function and background information function. All patients like the photo function idea, because it can be hard to assess whether the wound is healing properly. One patient says:

"Yes, I think, I think it is a very good idea. Especially since I am yes, I would not know how yes, I could feel something but a picture would be much more clear. If it is already a little red and I would say "yes not too bad" but they would say well, just come because uh .... Then you already have a photo."

The care providers were especially interested in the photo function, as all of them named this function when asked about extra information that would help them assess a patient. This was before they were showed the mock-up, which contained photograph functionality.

The functions for providing feedback on the patients answers in the application and background information both got mixed responses. Some patients did express a positive attitude towards background information on, for example, wound care instructions. Other notes from patients were that the feedback function would be specific to their personal situation and therefore more valuable:

"Uh, the feedback function I think is...a good, a good idea yes a good idea. That you get a pop-up saying, keep this in mind or this will happen, something like that, yes."

"Well, then with (other condition) first I sat behind the computer to search. But it didn't give me much to go on and eventually I went to the hospital."

One patient also responds to the background information, saying she never uses those type of functions:

" And background information, I would never look at it. If there is one of those "I"s (used as an icon for "information") behind it I would think "yeah, whatever"."

Additional comments about application

One patient voiced concerns over the security and privacy of the application:

Well, I was thinking. I work in an inpatient institution, how would you uhm. Because of the sensitivity of the privacy. A lot of people work with their phone and uh, some clients could steal that phone. So a lot can happen then.

This should addressed when introducing the application and patient privacy and data security should be guaranteed at all times.

Alarm responsibility and location

As for the responsibility for the group of patients using the application, all care providers thought the acute cases should be handled at the emergency department. For the non-acute group the surgeons named different locations, such as the outpatient clinic, the surgical ward and the emergency department. Both nurses

named the emergency department for these patients, as they were unsure whether care for these patients could be assigned to them. Nurses are not certified to decide on a course of treatment and would have to consult with a physician in all cases. All of the care providers thought that care for patients using the application should be centralized. Division of responsibilities and tasks can lead to miscommunication or a lengthy discussion about the course of treatment that should be avoided. As the emergency department is used to short communication channels between nurses and physicians, is open 24 hours a day and is specialized in triaging patients remotely this is the most suitable alarm location according to the health care providers.

4 Discussion

This research project was aimed at the first phases of development of a postoperative monitoring application in collaboration with the stakeholder surgeons, nurses and patients. There is a consensus between health care providers and literature to ask for pain, fever and feeling of wellbeing ,and either include a photograph of the surgical site or add questions about redness, swelling, leakage and hematoma[2, 3, 7]. Troubled breathing and voiding disorder were named by both literature and some interviewed stakeholders and troubled breathing is included on nurses cue cards to indicate patient health state decay[47, 51, 52, 55]. Literature underwrites the importance of photo functions in monitoring applications[18, 21, 23, 49]. Although "feeling of wellbeing" can be hard to quantify, both literature and the interviewed health care providers included it in their assessment of the patient. A study about patient scoring systems for nurses included the parameter "feeling of worry" and found it contributed to indicate patients at risk for complications [55]. It can be argued this is equal to "feeling of wellbeing" in the home setting and should therefor be included in the application. The collected patient data needs to be scored to assess the possibly presence of an SSI. A modified early warning score has been developed, the App Scoring Card, based on the result of this research project and can be found in Figure 4. MEWS is the preferred scoring system as it can be used in a home setting and can successfully be applied to highly heterogeneous patient populations[33, 42].

App Scoring card						
parameter	2	1	0	1	2	3
temperature	-1°	-0,5°	Reference value patient	+1°	+2°	
pain			Reference value at discharge	+1	+2	+3 or more
Feeling of wellbeing	Absent	Decreased	No change			
Additional parameters						
Appearance of wound	0,5 per parameter	redness, swelling, leakage, hematoma				
Troubled breathing	1					
Voiding disorder	1					
>2 points: potential complication, non-acute. Put patient on telephone list, contact within 24 hours **>4 points:** potential severe complication, acute. Put patient on ED-alert list, contact within 1 hour.						

Figure 4: The MEWS concept "App Scoring Card" using points per symptom and cut-off values to assess the possibility of a complication.

The interviews revealed an important conflict of interest between health care providers and patients. The health care providers want to rely on an automated system to assess patient data and worry about overloading their schedule with false alerts of patients suspected of having a complication. Patients on the other hand assume all of their application data will be reviewed and responded to by physicians. A similar result was found in literature[18]. This highlights the importance of information provision and training for both groups before and during implementation. Recently, a deep learning algorithm has been developed that is able to assess photographs of surgical wounds for the presence of possible complications [56]. This technique does need to be assessed and researched further before being implemented in practice. Consequently, the questionnaire outcome could be assessed by an algorithm but if a photograph function is included in the application, assessment will have to be done by physicians manually. For validation purposes, all decisions made by the algorithm will also have to be checked by physicians manually in the first stage of implementation.
To highlight changes in the care process, a new flow chart has been developed in collaboration with the nurses. This flowchart can be found in Figure 5.

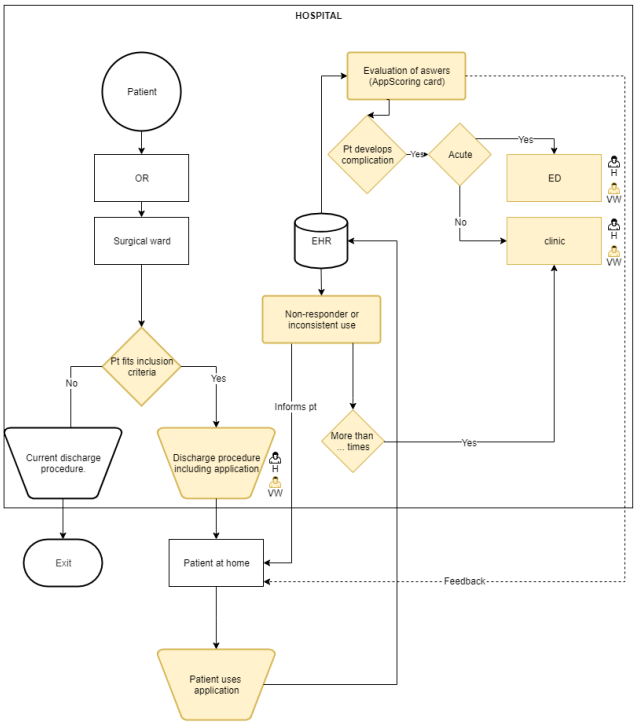

Figure 5: Concept flowchart of the new care process surrounding the post operative complication SSI. The yellow components indicate a conceptual status and these should be addressed in future research before implementation of the application.
Abbreviations stand for: operating room (OR), patient (Pt), electronic health record (EHR) and emergency department (ED).

Both literature and the results of the interviews depicted a divers group of surgeries in which postoperative monitoring applications were used. All health care providers named different types of surgeries for different reasons. In some cases the simple procedures were suggested, because these patients are discharged at an early stage and might need more thorough follow-up at home. Others suggested the complicated surgeries were more suitable, as these patients presented with more infections post discharge. The applications described in the literature review were all designed for different types of surgeries. Although literature showed MEWS can sufficiently assess heterogeneous patient populations, caution is important in selecting the surgery types to include in the first stage of implementation. It is advised to only include the high-risk surgeries, being breast surgery, colon surgery and cholecystectomies.

Limitations

One of the limitations of this study is the literature review results on symptoms of SSI. No results could be found on cholecystectomy surgeries. Because of the overlap in symptoms between the articles on breast surgery and colon surgery, it is expected that these will also apply to cholecystectomies. For the interviews there was a small pool of respondents, which could affect generalizability in the results. This could also be the case for the small number of field observations, although the observed strict use of protocols should generalize these procedures for different nurses and circumstances. All data collection for this study, including field observations, literature review and interviews were performed in 2017 and no data from recent years are included in the results. As most implementation or change in processes in health care can take a lot of time, it is not expected to impact the outcome of this research project.

Recommendations

The expectations of patients and doctors regarding the amount of supervision by medical staff differed greatly. Patients expect all of their data to be reviewed by physicians, while care providers rely on algorithms to assess and select patients. Therefor, providing information, sufficient training, flexible scheduling and managing expectations is important during implementation. For outcome measures used in the validation study for the MEWS mortality, length of stay and readmission rates should be collected. Patient satisfaction and convenience scores and care provider satisfaction scores should be assessed.

5 Conclusion

For this research project important stakeholder groups were identified to support the development of a postoperative application. The important stakeholder groups in this research project consisted of the different actors in a hospital: patients, surgeons, nurses and the hospital board. During interviews with these stakeholders and literature review the conclusive symptoms for SSI are indentified as pain, fever, diminished feeling of wellbeing and changed wound appearance, including redness, swelling, leakage and hematoma. This information can be gathered by mobile application using a questionnaire with addition of photograph of the wound. A modified early warning score containing the symptoms will be used to assess the possible presence of an SSI. The monitored patients will be directed towards the emergency department for assessment and decision on course of treatment. The changes in surgical care processes should be designed in collaboration with the nurses and sufficient training needs to be provided to successfully implement the application. Future research should include a validation study into the newly developed App Score Card and the types of surgery to include for use of the application. A study into the most suitable set of symptoms to include in the questionnaire could improve sensitivity and specificity of the resulting application.

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Appendices

A Supervision

A.1 Management team

Stuurgroep in het SKB:

- Wilco Kleine - Specialist Integraal Risicomanagement (dagelijks begeleider)
- Bert Bartelink - Zorggroepmanager
- Erik de Groot - Teammanager Informatisering & Automatisering
- Antoinette Arink - Teammanager Kliniek D1 (contactpersoon medische staf)

A.2 Supervision University of Twente

Begeleiding UT:

- Lisette van Gemert-Pijnen - Hoogleraar eHealth
- Floor Sieverink - promovenda vakgroep Psychologie, Gezondheid & Technologie

B Interview Script

Op de volgende 12 pagina's staat het complete draaiboek zoals gebruikt tijdens het onderzoek. Dit draaiboek bevat een algemeen overzicht, een deelnemersbrief voor patiënten, twee scripts voor de introductie tijdens de interviews (1 voor patiënten en 1 voor zorgverleners), een toestemmingsformulier en de vragen die in elke van de 4 interviewversies worden gesteld (artsen, verpleegkundigen, patiënten (eerste opname) en patiënten (heropname)).

Draaiboek interviews

project postoperatieve app

Anouk Veldhuis
1625624

28 juni 2017

UNIVERSITEIT TWENTE.

Streekziekenhuis
Koningin
Beatrix

1 Introductie

Dit draaiboek is bedoeld voor de interviews in het kader van het project postoperatieve app in het Streekziekenhuis Koningin Beatrix (SKB). Hiervoor zullen een aantal stakeholders worden geïnterviewd. Dit draaiboek bevat zodoende een lijst met die stakeholders (sectie 1.1), een deelnemersbrief (sectie 2), een formulier voor informed consent (sectie 3.2), een script voor tijdens het interview (sectie 3) en de thema's en vragen die in de interviews aan bod komen (sectie 4).

1.1 Stakeholders

De stakeholders die worden geïnterviewd:

- Patiënt, hoogrisico operatie (mammachirurgie, cholecystectomie of colonresectie)
- Patiënt, Heropgenomen na hoogrisico operatie met infectie
- Arts, chirurg die hoogrisico operaties uitvoert
- Verpleegkundige, afdeling chirurgie

1.2 Agenda

De agenda voor de interviews zijn als volgt:

- Introductie d.m.v. deelnemersbrief
- Voorstellen + onderzoek en verloop interview uitleggen
- Formulier informed consent tekenen
- Interview afnemen
- Afsluiting (eventuele vragen beantwoorden)

2 Deelnemersbrief patiënten

Deelnemers krijgen onderstaande brief als informatie over het project en hun deelname. Naast de geschreven informatie worden ze daarnaast mondeling geïnformeerd en zal hen een informed consent formulier worden aangeboden om deelname aan het onderzoek mogelijk te maken.

Beste meneer/mevrouw,

Onlangs ben u opgenomen in het SKB voor een operatie of opnieuw opgenomen na een operatie eerder. Met deze brief wil ik u graag informeren over het onderzoek waar ik mee bezig ben. Voor dit onderzoek zou ik graag een aantal patiënten van de afdeling chirurgie interviewen en ik hoop dat u er daar een van bent.

Mijn naam is Anouk Veldhuis en ik doe een master-opleiding gezondheidswetenschappen bij de Universiteit Twente.Voor mijn afstudeeronderzoek ben ik hier in het SKB bezig met het project "postoperatieve app". Dit project gaat over een speciale SKB app die gebouwd gaat worden voor patiënten van de afdeling chirurgie. Deze app is bedoeld om complicaties na een operatie sneller op te sporen als u als patiënt thuis aan het herstellen bent. De app vraagt elke dag aan de patiënt om een een paar vragen te beantwoorden op zijn of haar mobiele telefoon. De antwoorden van deze vragen worden naar een computer in het SKB gestuurd die nakijkt of er tekenen zijn van een complicatie. Het gaat dus om een extra controle naast bijvoorbeeld de belronde en de informatiefolders die u als patiënt nu meekrijgt bij ontslag.

De app moet nog gebouwd worden. Omdat we de app zo goed mogelijk willen laten werken voor zowel patiënten als zorgverleners wil ik u van harte uitnodigen voor een interview over deze app. Als u bent heropgenomen na een eerdere operatie wil ik daarnaast ook weten waaraan u zelf merkte dat het herstel niet goed ging. Het interview zal ongeveer 30 tot 45 minuten duren. Ik zou het interview ook graag opnemen met een geluidsrecorder. Het onderzoek is volledig anoniem en heeft geen gevolgen voor uw verdere behandeling. Ook is het op elk moment mogelijk te stoppen met het interview of uzelf terug te trekken uit het onderzoek. Als u vragen heeft of twijfelt over deelname kom ik graag langs om al uw vragen te beantwoorden. U kunt uw verpleegkundige vragen dit nummer te bellen: 06-36157499.

Als u mee wilt doen kunt u dit doorgeven aan de verpleegkundige die u verzorgt. Ik maak dan samen met uw verpleegkundige een afspraak wanneer ik naar de afdeling kom voor het interview. Als u alleen op de kamer ligt kan het interview daar plaatsvinden, als u kamergenoten heeft zoek ik samen met de verpleegkundige een geschikte ruimte op de afdeling. U zou mij en toekomstige patinten op uw afdeling enorm helpen met uw deelneming aan het onderzoek.

Ik hoor het ook graag als u ideëen of op- en aanmerkingen heeft die ik mee kan nemen in het ontwerp proces. Als u vragen heeft naar aanleiding van deze brief of tijdens het interview kunt u die op elk moment stellen.

Alvast bedankt voor uw tijd en medewerking!

Anouk Veldhuis (t.a.veldhuis@student.utwente.nl of 06-36157499)

3 Script

3.1 Script Patiënten

- **Voorstellen (Anouk Veldhuis, UT GZW master, afstuderen SKB)**
  Mijn naam is Anouk Veldhuis en ik doe een master gezondheidswetenschappen bij de universiteit Twente. Namens het SKB voer ik als afstudeeropdracht een onderzoek uit naar een postoperatieve mobiele applicatie voor patiënten van de afdeling chirurgie.

- **Onderzoek (project postoperatieve app, complicatie monitoring na ontslag, extra veiligheid)**
  Het project postoperatieve app gaat over een mobiele applicatie die gebouwd gaat worden. Het idee is dat mensen deze app bij ontslag uit het ziekenhuis op hun mobiel installeren. In de dagen die volgen stelt de app elke dag een paar vragen over hoe u zich voelt en of u bepaalde symptomen heeft. De antwoorden die u geeft worden naar een computer in het SKB gestuurd en deze computer kijkt of er aanwijzingen zijn voor een complicatie. Als dat zo is wordt u door het ziekenhuis gebeld om terug te komen. De app is extra, want hij komt naast de belronde en de lijst met symptomen waar u zelf op moet letten, en dient dus niet als vervanging hiervan. In feite biedt de app extra bescherming voor u als patiënt tijdens uw herstel.

- **Interview (Integreren in zorgproces, mening van patiënt meenemen, vormgeving — vrij antwoorden op vragen)**
  De app moet op dit moment nog gebouwd worden. Om een app te maken die makkelijk te gebruiken is en fijn werkt voor patiënten willen we interviews houden met patiënten van de afdeling chirugie, waaronder u. Uw mening wordt dus gebruikt om de app straks vorm te geven en in te richten. Wat we willen bereiken is een app die voor elke patiënt geschikt is en die echt helemaal bij de behandeling gaat horen. Ik zal straks een aantal vragen stellen om een zo goed mogelijk beeld te schetsen van uw mening over de app, u bent vrij om te antwoorden op de vragen. Als u liever geen antwoord geeft op een vraag kunt u dat ook gewoon aangeven.

- **Geluidsopnames (uittypen, coderen, geen namen of herkenbare teksten in rapport)**
  Ik zou het interview graag opnemen met een geluidsrecorder. Als het interview is afgelopen zal ik daarna met de geluidsrecorder het interview uittypen. Ik zorg er hierbij voor dat het interview en de antwoorden volledig anoniem blijven en er geen enkele informatie in komt die aan u te linken is. Er zullen ook geen namen in het rapport genoemd worden. U blijft dus altijd anoniem.

- **Deelname stoppen (elk moment stoppen, pauzeren of terugtrekken)**
  Ik zet de geluidsrecorder bij het begin van het interview aan en zal dat dan ook

duidelijk zeggen. Op elk moment kun u aangeven dat u wilt pauzeren of niet meer wil deelnemen aan het onderzoek. Dat is geen enkel probleem.

- **Vragen, Opmerkingen?**
  Als u nog vragen (of opmerkingen) heeft kunt u die nu stellen, maar ook tijdens het interview. Dat kan op elk moment. Is alles duidelijk?

- **IC formulier**

3.2 Script Zorgverleners

- **Voorstellen (Anouk Veldhuis, UT GZW master, afstuderen SKB)**
  Mijn naam is Anouk Veldhuis en ik doe een master gezondheidswetenschappen bij de universiteit Twente. Namens het SKB voer ik als afstudeeropdracht een onderzoek uit naar een postoperatieve mobiele applicatie voor patiënten van de afdeling chirurgie.

- **Onderzoek (project postoperatieve app, complicatie monitoring na ontslag, extra veiligheid)**
  Het project postoperatieve app gaat over een mobiele applicatie die gebouwd gaat worden. Het idee is dat mensen deze app bij ontslag uit het ziekenhuis op hun mobiel installeren. In de dagen na hun ontslag verschijnt er elke dag een pop-up die vraagt om een aantal vragen in de app te beantwoorden. De antwoorden worden in Chipsoft verwerkt om tot een score vergelijkbaar met de EWS-score te komen. Op het moment dat de score zodanig hoog is dat we een complicatie vermoeden wordt er een order aangemaakt in Chipsoft om contact op te nemen met de patiënt. De app komt bovenop de belronde en de informatie die patiënten meekrijgen als extra veiligheid.

- **Interview (Integreren in zorgproces, mening van patiënt meenemen, vormgeving — vrij antwoorden op vragen)**
  De app moet op dit moment nog gebouwd worden. We willen graag van artsen en verpleegkundigen weten hoe we met de app het beste op zoek kunnen gaan naar complicaties. De inhoudelijke vragen die gesteld worden moeten namelijk nog vastgesteld worden. Hierbij is dus uw hulp nodig. Ik zal straks een aantal vragen stellen om een zo goed mogelijk beeld te schetsen van uw mening over de app, u bent vrij om te antwoorden op de vragen. Als u liever geen antwoord geeft op een vraag kunt u dat ook gewoon aangeven.

- **Geluidsopnames (uittypen, coderen, geen namen of herkenbare teksten in rapport)**
  Ik zou het interview graag opnemen met een geluidsrecorder. Als het interview is afgelopen zal ik daarna met de geluidsrecorder het interview uittypen. Ik zorg er hierbij voor dat het interview en de antwoorden volledig anoniem blijven en er

geen enkele informatie in komt die aan u te linken is. Er zullen ook geen namen in het rapport genoemd worden. U blijft dus altijd anoniem.

- **Deelname stoppen (elk moment stoppen, pauzeren of terugtrekken)**
  Ik zet de geluidsrecorder bij het begin van het interview aan en zal dat dan ook duidelijk zeggen. Op elk moment kun u aangeven dat u wilt pauzeren of niet meer wil deelnemen aan het onderzoek. Dat is geen enkel probleem.
- **Vragen, Opmerkingen?**
  Als u nog vragen (of opmerkingen) heeft kunt u die nu stellen, maar ook tijdens het interview. Dat kan op elk moment. Is alles duidelijk?
- **IC formulier**

Op de volgende pagina is het officiële formulier voor informed consent te vinden. Alle deelnemers moeten dit formulier ondertekenen voordat zij deel kunnen nemen aan het onderzoek.

Toestemmingsverklaringformulier (informed consent)

Titel onderzoek: Project implementatie postoperatieve app
Verantwoordelijke onderzoeker: Anouk Veldhuis (Masterstudent Universiteit Twente)

In te vullen door de deelnemer

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode, doel en [indien aanwezig] de risico's en belasting van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord.

[indien van toepassing] Ik begrijp dat film-, foto, en videomateriaal of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Naam deelnemer: ……

Datum: …… Handtekening deelnemer: ……

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Naam onderzoeker: ……..

Datum: …… Handtekening onderzoeker: ……

4 Interviewvragen

4.1 Artsen

Thema's: complicaties, medische baseline

1. Wat zijn de meest voorkomende voorspellers van een complicatie?
2. Welke van deze voorspellers zijn geschikt om uit te vragen aan de patiënt?
3. Wat zijn de voorspellende symptomen van een infectie of sepsis?
4. Hoe ziet het tijdsbeloop van een complicatie eruit?
5. Als je een patiënt 5 vragen mag stellen om te beoordelen of hij of zij een complicatie heeft, welke 5 vragen zouden dit dan zijn?
6. Als je dit uit mag breiden tot 10, welke 5 zou je dan nog meer stellen?
7. Zou je nog meer informatie nodig hebben om goed te kunnen beoordelen of iemand een complicatie heeft?
8. Welke operaties zijn het beste geschikt voor de app?
9. Welke van deze twee opties heeft uw voorkeur en waarom: gebruik van vaste waardes om antwoorden aan te meten of gebruik van patiëntspecifieke baseline?
10. Wie moet verantwoordelijk zijn voor het opvangen van potentieel vitaal bedreigde patiënten die de app identificeert?
11. Heeft u zelf nog ideeen over de app of toevoegingen die u wilt delen?

4.2 Verpleegkundigen

Thema's: complicaties, medische baseline, geschiktheid patiëntengroep, verandering zorgproces

1. Wat zijn de meest voorkomende voorspellers van een complicatie?
2. Wat zijn de voorspellende symptomen van een infectie of sepsis?
3. Hoe ziet het tijdsbeloop van een complicatie eruit?
4. Welke van deze twee opties heeft uw voorkeur en waarom: gebruik van vaste waardes om antwoorden aan te meten of gebruik van patiëntspecifieke baseline?
5. Welke patiënten zouden volgens u het beste in aanmerking komen voor gebruik van de app?

6. Wat zou er volgens u veranderen in de ontslagprocedure en wat heeft u daarvoor nodig (toevoeging bij onduidelijkheid: ondersteuning)?
7. Wie moet verantwoordelijk zijn voor het opvangen van potentieel vitaal bedreigde patiënten die de app identificeert?

4.3 Patiënten (eerste opname)

Thema's: indruk app, frequentie vragenlijstoproep, lengte vragenlijst, extra functies, gebruiksduur

1. Is dit uw eerste operatie of bent u vaker geopereerd?
2. Kunt u mij vertellen hoe dat verlopen is, welke dingen gingen er goed en welke minder goed?
3. Als u straks ontslagen wordt, welke dingen vindt u dan belangrijk? Welke informatie is voor u het belangrijkst om mee te krijgen?

   Ik heb net al even kort wat vertelt over het project en de app. Straks laat ik u een voorbeeld van de app zien op mijn computer dan kunt u zien hoe deze eruit ziet.
4. Wat is uw eerste idee bij de app zoals ik deze omschreven heb?

   U zou de app dus installeren als u ontslagen wordt en thuis nog een dag of 5 in moeten voelen. Met deze vragen beoordeelt een computer in het ziekenhuis of u misschien complicaties heeft. Op dit moment wordt dat alleen gecontroleerd tijdens de belronde de dag na uw ontslag en door een informatiefolder. Hierin staan symptomen van complicaties en aan u wordt gevraagd om te bellen als u hier last van krijgt. De app komt hier als extra veiligheid bij. Ik zal u eerst een voobeeld van de app op mijn computer laten zien zodat u er een beeld bij heeft, daarna wil ik graag wat vragen over de app stellen.
5. Hoeveel tijd zou u per invulmoment maximaal kwijt willen zijn? En hoeveel vragen zou u maximaal per keer in willen vullen?
6. Hoe vaak zou u de vragenlijst willen invullen?
7. Welke moment van de dag zou u dit het liefst doen?

   De volgende functies zijn al bekend in soortgelijke apps in het buitenland: feedback , fotofunctie, achtergrondinformatie. Feedback wil zeggen dat u van het ziekenhuis krijgt te horen dat uw antwoorden goed zijn aangekomen en geen tekenen geven voor complicaties. Het kan ook dat u met de feedback tips krijgt van het ziekenhuis om een complicatie te voorkomen. Achtergrondinformatie

kan gegeven worden bij de vragen, bijvoorbeeld uitleg over de manier waarop u uw temperatuur het beste kunt meten. De fotofunctie is speciaal voor de operatiewond. Als de app merkt dat het niet goed gaat kan deze vragen om een foto van de wond te maken. Deze stuurt de app dan ook naar het ziekenhuis en wordt bekeken door een arts of verpleegkundige die beoordeeld of de wond goed heelt of dat u extra behandeling nodig heeft.

8. Wat vindt u zelf van deze drie functies? Waar ziet u wel en niet meerwaarde in??

   Het kan zijn dat in sommige gevallen de arts een medische baselinewil. Dat is een meting van de waarde zoals ze normaal zijn bij u. Om een voorbeeld te geven: sommige mensen hebben een wat hogere lichaamstemperatuur van zichzelf. De app zou dit als koorts kunnen zien en dus denken aan een complicatie terwijl dit eigenlijk niet het geval is. Om deze informatie te krijgen is het dan nodig om een paar dagen voor de operatie al te beginnen met het invullen van de app.

9. Stel dat uw zorgverlener u zou vragen om de dagen voor de operatie de app al in te vullen. Wat vindt u daarvan?

4.4 Patiënten (Heropgenomen met complicatie)

Thema's: indruk app, extra functies, gebruiksduur, verloop heropname

1. Welke symptomen ontwikkelde u na de operatie?
2. Hoe verliep de tijd tussen uw ontslag uit het ziekenhuis en de heropname?
3. Hoe verliep het contact met zorgverleners tussen de eerste symptomen en uw heropname?
4. Hoeveel tijd zat er tussen de eerste symptomen en de uiteindelijke heropname?
   Ik heb net al even kort wat vertelt over het project en de app. Straks laat ik u een voorbeeld van de app zien op mijn computer dan kunt u zien hoe deze eruit ziet.
5. Wat is uw eerste idee bij de app zoals ik deze omschreven heb?

   U zou de app dus installeren als u ontslagen wordt en thuis nog een dag of 5 in moeten voelen. Met deze vragen beoordeelt een computer in het ziekenhuis of u misschien complicaties heeft. Op dit moment wordt dat alleen gecontroleerd tijdens de belronde de dag na uw ontslag en door een informatiefolder. Hierin staan symptomen van complicaties en aan u wordt gevraagd om te bellen als u hier last van krijgt. De app komt hier als extra veiligheid bij. Ik zal u eerst een voobeeld van de app op mijn computer laten zien zodat u er een beeld bij heeft, daarna wil ik graag wat vragen over de app stellen.

6. Hoeveel tijd zou u per invulmoment maximaal kwijt willen zijn? En hoeveel vragen zou u maximaal per keer in willen vullen?
7. Hoe vaak zou u de vragenlijst willen invullen?
8. Welke moment van de dag zou u dit het liefst doen?

   De volgende functies zijn al bekend in soortgelijke apps in het buitenland: feedback , fotofunctie, achtergrondinformatie. Feedback wil zeggen dat u van het ziekenhuis krijgt te horen dat uw antwoorden goed zijn aangekomen en geen tekenen geven voor complicaties. Het kan ook dat u met de feedback tips krijgt van het ziekenhuis om een complicatie te voorkomen. Achtergrondinformatie kan gegeven worden bij de vragen, bijvoorbeeld uitleg over de manier waarop u uw temperatuur het beste kunt meten. De fotofunctie is speciaal voor de operatiewond. Als de app merkt dat het niet goed gaat kan deze vragen om een foto van de wond te maken. Deze stuurt de app dan ook naar het ziekenhuis en wordt bekeken door een arts of verpleegkundige die beoordeeld of de wond goed heelt of dat u extra behandeling nodig heeft.
9. Wat vindt u zelf van deze drie functies? Waar ziet u wel en niet meerwaarde in??

   Het kan zijn dat in sommige gevallen de arts een medische baselinewil. Dat is een meting van de waarde zoals ze normaal zijn bij u. Om een voorbeeld te geven: sommige mensen hebben een wat hogere lichaamstemperatuur van zichzelf. De app zou dit als koorts kunnen zien en dus denken aan een complicatie terwijl dit eigenlijk niet het geval is. Om deze informatie te krijgen is het dan nodig om een paar dagen voor de operatie al te beginnen met het invullen van de app.
10. Stel dat uw zorgverlener u zou vragen om de dagen voor de operatie de app al in te vullen. Wat vindt u daarvan?

C Field observations

Part 1: Walk-through discharge procedure
Op 16-05-2017 is met een verpleegkundige van de afdeling D1 (chirurgie) van het SKB de ontslagprocedure besproken en de bijbehorende protocols in het EPD doorgenomen. Hieronder staat het verslag van deze veldobservatie. Voor dit gesprek heb ik kort uitgelegd wat het project postoperatieve app inhoudt en waar de app voor dient.

Onderzoeker: Kun je mij meenemen door de ontslagprocedure zoals jullie die hier op de afdeling doen?

Ontslagprocedure doorgenomen via de formulieren in het EPD. Er worden hiervoor checklists gebruikt waarin onderin aangevinkt kan worden dat iemand gewezen en ingepland is voor de belronde een dag later. (hier kan later ook het vinkje voor de app ingevuld worden)

Onderzoeker: Hoe werkt de belronde?

In deze belronde worden vragen gesteld over hoe mensen zich voelen (is net vernieuwd in het EPD, zijn nu open vragen/tekstvelden). Daarnaast worden er vaak adviezen gegeven bij eventuele problemen. Als er echt problemen zijn wordt er overlegd met de arts en eventueel beleid afgesproken.

Onderzoeker: Het kan zijn dat er ook wat dingen over de app uitgelegd moeten worden door jullie als verpleging. Daarvoor willen we jullie ondersteunen met een goede training. Hoe zou je het liefst training ontvangen en wanneer?

Uitleg over app het beste bij "thema van de maand" (maandelijkse bijeenkomst waarop verschillende onderwerpen besproken worden en trainingen plaatsvinden). Iedereen is dan bijeen en krijgt dezelfde uitleg.

Onderzoeker: Er zullen wat dingen in de ontslagprocedure als de app in gebruik wordt genomen. Hier zal dus een nieuw protocol voor gemaakt moeten worden. Hoe kan het nieuwe protocol het beste ontwikkeld worden? Heb je hier ideëen over?

protocol schrijven samen met senior verpleegkundige (dit is al besproken en akkoord met de senior verpleegkundige die assisteert bij het project) en dit publiceren op iPortal. Dan kan iedereen erbij. Daarnaast een informatiefolder voor patienten maken over de app om mee naar huis te nemen.

Onderzoeker: Zijn er verder nog op- of aanmerkingen of misschien tips die je mee wil geven voor dit project?

Adviezen gegeven door verpleegkundige:

Het liefst een centrale beoordeling van alle gegevens inclusief foto. Niet naar meerdere plekken sturen, dat schept verwarring. Uitleg tijdens ontslag moet een paar min duren en niet stap voor stap de app doornemen zijn. Het liefst ook al eerder uitleggen, dus bijvoorbeeld tijdens POSgesprek of poli-afspraak vooraf of al op de afdeling. Train iedereen, niet een paar mensen. De voordelen zijn dat iedereen dat gewoon zelf in het ontslag mee kan nemen en dat het geen ramp is als deze mensen er niet zijn omdat ze vrij zijn bijvoorbeeld. Daarnaast hebben deze mensen ook andere taken en dan niet altijd tijd om iets uit te leggen.

Part 2: Observation live discharge procedure
Op 24 mei is een ontslagprocedure met een patient van de afdeling chirurgie bijgewoond. De uitgedeelde documenten zijn genoteerd en van alle stappen en besproken punten zijn aantekeningen gemaakt.

Documenten voor de patient:

- afsprakenkaart met afspraken en patientenpasje/identificatie
- medicijnen overzicht + recepten voor apotheek
- fysiotherapieverwijzing (alleen in geval van orthopedische ingreep)
- leeflijst met leefregels (waaronder de dingen waarvoor patienten terug moeten bellen)
- tevredenheidsonderzoek

Doorgenomen met patient:
Er is een belafspraak met de chirurg gepland (dit staat op de afsprakenkaart). medicijnenoverzicht wordt genoemd, plus recepten die beneden bij de apotheek opgehaald kunnen worden. Er zit een tevredenheidsonderzoek bij dat ingevuld kan worden. Als er iets is (bijvoorbeeld: merkt u misselijkheid/braken) dan even contact opnemen met SEH of HA of de behandelend arts. Adviezen gegeven over drooghouden wond en rustig aandoen. Let op de leefregels. Pleisters worden meegegeven en moeten nog een aantal dagen blijven zitten. Het bandje wordt doorgeknipt. De belronde wordt genoemd, de dag erna (hemelvaartsdag) wordt gebeld door de afdeling. Gewoon bellen als er iets is! Dat wordt als afsluiter meegegeven.