MASTER

Evaluation of a dynamic clinical checklist support system (DCCSS) in a bariatric environment

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Evaluation of a Dynamic Clinical Checklist Support System (DCCSS) in a bariatric environment

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PREFACE

This report is the result of my graduation project, conducted in partial fulfilment of the requirements for the degree of Master in Operations Management and Logistics at Eindhoven University of Technology.

This master thesis was conducted in cooperation with the Catharina Ziekenhuis Eindhoven. Therefore, I would like to thank Erik Korsten. Although I was too pushy at the beginning (he called me his stalker), we together found the right place for me to do my research. From the bariatrics department I would like to thank the surgeons who took time for me, dr. Nienhuijs and dr. Smulders.

Secondly, I want to thank the people from the university who were involved in my project. Special thanks goes out to my first supervisor Pieter Van Gorp. Many times, when I was pessimistic and out of ideas, Pieter helped me to see things straight again. His enthusiasm was contagious. Also my second supervisor Oktay Türetken was a great help for me. I also want to thank Lonneke Vermeulen and Shan Nan. Lonneke had experience with doing her research in the CZE, therefore, I could always ask questions to her on that manner. Shan was very helpful to me regarding the more technical problems I underwent with Tracebook. Usually problems I was facing for hours, were solved in a moment by Shan.

Then I would like to thank the people who were more indirectly involved. My girlfriend was always a support to me. When I was worried she said the thing that I would always say to her: *everything is going to be alright.* My parents and brother were also important to me; they always supported me. Finally my friends were important in order to get my mind on other things than this master's thesis.

EXECUTIVE SUMMARY

Recently health care organizations are being seen more as Complex Adaptive Systems (CAS), which indicates that their complexity is high with regard to the number of different actors and their mutual relationships (Anderson & McDaniel Jr 2000). Especially in the care for obese people many different disciplines are involved. Therefore optimal coordination between these roles are necessary. Care coordination is also concerned with the interaction between caregiver and patient. Research has showed that here a lack of coordination is being observed (Bodenheimer et al. 2008).

A recent trend in health care is the usage of medical safety checklists. These checklists have as goal to increase patient safety (Levy et al. 2012). Checklists in health care have been carefully researched and their advantage has been shown (de Vries et al. 2010) (Haynes et al. 2009), however checklists are not effectively used by the end-users. Current problems are that checklists are time-consuming, irrelevant or their timing is wrong.

A key factor in the drive to increase the quality of health care is empowering patients to take an active role and be engaged in their health care (Barello et al. 2012). Engaging patients could be done by a number of quality interventions to improve health literacy, clinical decision making, self care and patient safety (Coulter and Ellins, 2007). Patients that underwent bariatric surgery need to conduct physical activities and follow nutritional guidelines to make sure that they reach or maintain their ideal weight (Parkes 2006). Therefore, especially in this discipline it is important that patients play an active role.

This research proposes the Dynamic Clinical Checklist Support System (DCCSS) Tracebook as a solution to the three observed problems. This study is the first to formally evaluate Tracebook. Tracebook is not a standard checklist support system, it distributes the right checklist to the right person at the right time in the care process of the patient. In order to provide a caregiver with the right checklist, Tracebook can communicate with the Hospital Information System (HIS). Checklists are automatically customized to the specifics of patients and their diseases, see Figure 1. Therefore, unlike standard checklists, they are applicable in every situation. In order to provide the checklist at the right time and to the right person, Tracebook has knowledge of the patients care process and its actors involved.

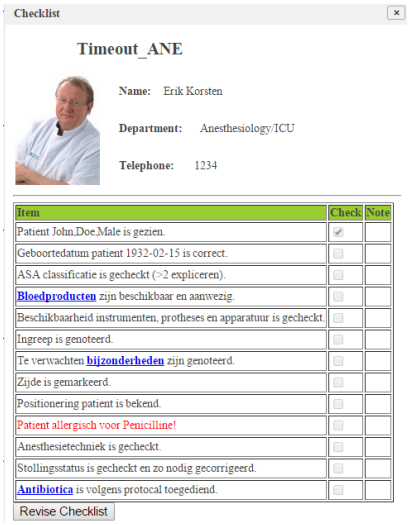

FIGURE 1: CHECKLIST IN TRACEBOOK

To formally evaluate Tracebook a prototype for a specific use case was made. This use case was the *Obesity Centre* of the *Catharina Hospital Eindhoven*. Via acquired documentation a conceptual process model was made, from which a *checklist model* and *flowcharts* were derived. When the prototype was build, it was evaluated by surgeons from the CZE's Obesity Centre.

The prototype needed to be evaluated on two viewpoints; the specific aspects for the use case (e.g. right content and position of checklists) and the general aspects of Tracebook (i.e. usability). The evaluation of the first viewpoint resulted in changes that needed to be made to the prototype of Tracebook. The experiences from this step were the basis for modelling guidelines and a more technical methodology that should be used in future implementation projects of Tracebook. The evaluation of the second viewpoint resulted in a list of recommendations for further development of Tracebook. The main barrier the interviewees had was the increase of workload Tracebook brings along. Also the cumbersome way of adapting a process in Tracebook was found as a disadvantage. Although it should be stressed this is already quite an improvement with the current situation.

Up to this point, this research only tackled aspects of care coordination and inefficient use of checklists. The lack of patient involvement was the third observed problem. Therefore, a scenario was sketched in which Tracebook is used as a health engagement tool for in-hospital patients. With the use of *patient terminals*, patients can access detailed information about their care process. It provides information on the clinicians who are directly involved in the patient's care as well as which activities will be conducted in the future. A similar research by Vawdrey et al. (2011) showed that in-hospital patients are eager to use a tablet computer for accessing health information, including photographs and background stories of involved caregivers. Besides tacking the patient involvement problem, our *redesign* also marked other important areas of Tracebook that should be further developed. The workload was a main obstacle, to diminish this, Tracebook should be optimally integrated into the working processes of the caregiver. Therefore the checklists should pop-up on the caregiver's screen as soon as it should be filled in. The *pop-up checklist* can be achieved by tracking the patient throughout the hospital via scanning devices. When the caregiver is in his (her) office and scans the patients id, the corresponding checklist will automatically pop-up. Tracking the patient also makes sure the patient's process is being real-time monitored and Tracebook will always be up-to-date. It is however important to take into account the willingness of clinicians to share information from Tracebook with the patients. This subject was also researched and the results show that disclosing the care process of the patient is acceptable, but notes and checklists should not be shared.

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CHAPTER 1: INTRODUCTION

This thesis focuses on solving the problems observed in the healthcare environment and especially in the care for obesity. We try to find a solution for these problems by introducing a dynamic clinical checklist support system (DCCSS) called Tracebook that has as main goal to improve patient safety (Nan et al. 2015). It provides situation-specific checklists to healthcare professionals at appropriate times. Since Tracebook is a newly developed system, the goal of this research is therefore to evaluate which aspects need to be focused on during further development. Therefore, Tracebook will be configured for a specific care process, namely the bariatrics care process. This chapter first describes the problem context, where the problem is explained and the different stakeholders are introduced.

1.1 PROBLEM CONTEXT

Care coordination

Recently health care organizations are being seen more as Complex Adaptive Systems (CAS), which indicates that their complexity is high with regard to the number of different actors and their mutual relationships (Anderson & McDaniel Jr 2000). Especially in the care for obesity patients, healthcare professionals from multiple different disciplines are involved, such as surgeons, anaesthetists, psychologists, physiotherapists and dieticians. Most of the time bariatric patients also have comorbidities; a study among 193 patients by Ramaswamy et al. showed that more than half of the bariatric patients also had hypertension, a third obstructive sleep apnea (OSA) and a quart diabetes (Ramaswamy et al. 2004). This means that efficient cooperation between different departments is needed, to provide patients the best possible care. Therefore an optimal coordination between these disciplines, departments and other stakeholders is essential.

Care coordination is the function that helps ensure that the patient's needs for health care and information sharing across people, functions and locations are met over time, so that the patient receives maximal value of health care services (Bodenheimer et al. 2008). Coordination of care is not only concerned with the interaction and collaboration between different healthcare providers, but also between providers and patients (including their families) (Bodenheimer et al. 2008). The lack of coordination is a recurring issue, many articles have been devoted to this problem. Research findings include a lack of awareness among patients about their disease and medication and a lack of communication and information sharing between care providers. Due to the multi-disciplinary environment in the care for obesity, coordination of care is of extra importance. Patients with chronic conditions, like obesity, come in contact with the health care system multiple times, and are therefore, in combination with its multi-disciplinary character, the ideal group to profit from improvements in care coordination (Hofmarcher et al. 2007).

Checklists

A recent trend in health care to increase patient safety is the introduction of medical checklists. A checklist contains a list of items or criteria, which are arranged in a consistent manner, allowing the user to check whether items listed are considered or completed (Hales & Pronovost 2006). Medical

checklists have as main goal to improve patient safety (Levy et al. 2012). Checklists are useful for clinicians since they support decision making under stressful conditions (Hales et al. 2008). They increase standardization of medical processes and decrease the chances of human error. The use of checklists in medical environments have been shown to be advantageous in multiple studies. The SURgical PAtient Safety System (SURPASS) (de Vries et al. 2010) is a frequently studied checklist, as well as the World Health Organization Surgical Safety Checklist (WHO SSC) (Haynes et al. 2009). The implementation of the SURPASS in eleven hospitals in the Netherlands resulted in a reduction of mortality from 1.5% to 0.8% and a reduction of comorbidity from 15.4% to 10.6% (de Vries et al. 2010).

Although, due to its multi-disciplinary character, the bariatric environment is ideal for the usage of checklists we have not found any prove in the current state of research on the usage of checklists in bariatric environments. There do exist multiple sources of guidelines, for example the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) provided guidelines for safety, quality and excellence in bariatric surgery (Melissas 2008). The National Heart, Lung and Blood Institute (NHLBI) also provided a practical guide containing guidelines for the identification, evaluation and treatment of obesity (Panel et al. 1998).

The previously mentioned papers contain guidelines that are possibly relevant enough to add to a checklist. However, there is still a problem with the use of checklists; in many cases clinicians are not effectively using them. Multiple studies show a high checklist completion rate among the clinicians, but a low to moderate level of accuracy (Fourcade et al. 2012, Levy et al. 2012, Sparks et al. 2013). Fourcade et al. (2012) examined the problems clinicians had with checklists and why they were not efficiently used. Frequently mentioned barriers are duplication with existing checks, time consuming and ambiguity in its content.

Patient involvement

The after-care is an important step in the care for bariatric patients. Patients that underwent bariatric surgery need to conduct physical activities and need to follow nutritional guidelines to make sure that they reach or maintain their ideal weight (Parkes 2006). Since severe obesity is a chronic clinical condition, long-term nutritional and psychosocial counselling is believed to be important. The paper by Ziegler et al. specifies the latest guidelines for the follow-up of patients that underwent bariatric surgery (Ziegler et al. 2009). They state that the mental health of postoperative patients needs to be controlled. Research has showed that bariatric weight loss surgery increases the chance of substance use (drug use, alcohol use and cigarette smoking) by the patient (Conason et al. 2013). It does get even worse; two studies show that the suicide rate increases among post-bariatric surgery patients (Omalu et al. 2007, Tindle et al. 2010).

For post-surgical patients to achieve or maintain their ideal weight they should adopt a healthful lifestyle, by participating in exercises and improving their eating habits (Mechanick et al. 2009). According to multiple clinicians a lack of patient motivation to lose weight is a barrier to address obesity (Leverence et al. 2007, Story et al. 2002). This requires that patients play an active role in their care trajectory. It has been shown that patients who perceive they have played active roles in their own care recover more quickly from their illness than patients who perceive they have played a more passive role (Brody et al. 1989).

The increase in overweight in most countries is notable and is leading to significantly higher risks of impaired health and chronic health conditions (Hofmarcher et al. 2007). Due to the complex nature of care for obesity patients, coordination of care is of high importance to increase the quality of care. A healthcare wide initiative is the introduction of checklists to increase patient safety. The checklists however are currently insufficiently supported. Besides that, the involvement of patients in checklists is not taken into account, although this would be beneficial in motivating them for playing an active role in their own care. This research will focus on these observed problems.

1.2 PROBLEM SCOPE

The scope of this thesis is limited to one country and one hospital, the Catharina Hospital Eindhoven (in Dutch: Catharina Ziekenhuis Eindhoven (CZE)) in the Netherlands. The CZE is a large teaching hospital with 696 beds and employs more than 3,600 members of staff. There are 39 different specialist areas with 211 medical specialists (Catharinaziekenhuis, 2015). The *Obesity Centre* is the department of concern for this research. In October 2013 the Dutch healthcare insurance company CZ recommended the Obesity Centre of the CZE as the best for bariatric surgery, it scored maximal on the five criteria (Zorgverzekeraar CZ: 2013). The CZE's Obesity Centre has five bariatric surgeons recruited, who together perform more than 900 operations a year, therefore they belong to the top five of largest obesitas centres of The Netherlands. They mainly conduct two operations, the gastric bypass and the gastric sleeve. The gastric band is a technique they are less willing to conduct, the long term effects of this procedure are not as positive as for the other procedures. Furthermore the Obesity centre is specialized in 'recover surgery', which are procedures to convert a previously done surgical action to another surgical approach. According to the CZ the Obesity Centre of the CZE stands out for their good after-care. The after-care of the CZE is over a period of five year, where the patient comes into contact with different healthcare professionals, such as the psychologist, the dietician, the surgeon and the physiotherapist.

Since the bariatric department is one of the largest of the Netherlands and is highly valued it is most likely representable for other bariatric departments as well.

The system of focus in this research is the dynamic clinical checklist support system Tracebook (Nan et al. 2015, Nan et al. 2014). Tracebook is a newly developed system by a PhD-student and is meant to improve patient safety and quality of care. This is enabled by a number of advantages Tracebook incorporates opposed to traditional checklist support systems. First of all, the checklists it provides are dynamic, in the sense that they are created depending on the situation. Secondly, Tracebook takes the patient's care process into account and therefore provides the checklists to the right person at the right step in that care process. Currently various departments of the CZE are already cooperating to discover the benefits Tracebook could provide for them. Tracebook started as part of the collaboration program BrainBridge between the Zhejiang University (China), the Technical University of Eindhoven (the Netherlands) and Philips Research. Chapter 3 will elaborate more on the features, benefits and drawbacks of Tracebook.

CHAPTER 2: RESEARCH DESIGN

This part forms the basis of this project. First the previously introduced problems will be summarized in the problem definition. Next the research method will be discussed, as well as its relation to the research questions. This research aims to answer these research questions and thereby to solve the research problem mentioned in the problem definition.

2.1 PROBLEM DEFINITION

There might be different solutions available for solving the observed problems, but we choose to introduce Tracebook as a solution. By implementing Tracebook we aim to increase patient safety and quality of care by 1) improving care coordination, 2) increasing the efficiency of checklist usage and 3) increasing patient participation.

The problem definition can therefore be summarized by the following question:

How can Tracebook facilitate process coordination, checklist usage and patient participation in the bariatrics domain?

Since this question is still quite global, it needs to be broken up in multiple research questions, so that we can get to an answer to this question step by step.

2.2 RESEARCH METHOD AND QUESTIONS

The stages of this research and how they are connected with the deliverables are shown in Figure 1.

The introduction already suggested Tracebook as a solution and Chapter 3 will go deeper in the features and benefits of Tracebook. The next step is to test Tracebook in practice. Therefore an use case in the bariatrics discipline will be chosen and a prototype of Tracebook will be made, which is specifically modelled for this use case. Therefore the first research question is:

RQ1: How can a prototype of Tracebook be developed?

The first stage forms the basis for the prototype of Tracebook. In this stage the requisites for a Tracebook prototype are specified. This requires a solid understanding of Tracebook, including its different engines. Secondly, the requisites have to be collected. The methods developed in different studies will be discussed, after which a method will be selected/created and applied to the use case. Since the prototype is made for a specific use case, a solid examination of the use case is needed. This includes a stakeholder analysis as well as an analysis of the guidelines, documentation and information systems. In the second stage, when the requisites are collected, a prototype of Tracebook will be made.

The next step is to formally evaluate the prototype, therefore the second research question is:

RQ2: How can a prototype of Tracebook be evaluated?

To answer RQ2 an evaluation method needs to be developed and used in practice, which is the final stage. This evaluation method will be used for the evaluation of two viewpoints on the prototype;

Viewpoint 1: *The specific aspects of the prototype regarding the use case. Most likely, the actual working process are slightly different than the processes from the documentation we used;*

Viewpoint 2: *The general aspects of Tracebook.*

When the prototype for the use case is evaluated on its specific aspects related to the use case, most likely changes have to be made to the prototype. These experiences can be translated into a methodology for future projects concerning the modelling of Tracebook.

The evaluation of the general aspects will result in a list of recommendations. These recommendations address aspects of Tracebook which need further attention in Tracebook's development.

Since Tracebook currently is focused on in-hospital support, this research needs to be extended to also involve finding a solution for the third observed problem, lack of patient involvement.

RQ3: How can Tracebook be extended to also involve patients?

To answer this research question we will make a scenario sketch in which Tracebook would be used by patients to increase their awareness of their own healthcare. In this part, the general aspects of Tracebook which need to be adapted will also be taken into account. The results of the literature review conducted by the researcher prior to this study will also be used.

The scope of this research is limited to investigate the possibilities of implementation, the actual implementation is not of concern here.

2.3 Outline

Chapter 3 first summarized the literature needed for doing this research. The literature about checklists will be discussed. Then Tracebook will be thoroughly discussed, including its benefits and drawbacks. It will be shown how Tracebook can remove the before mentioned problems. Finally related methods will be described.

Chapter 4 describes the methods needed for doing this research. This chapter is divided in five parts. First the acquirement of the process model will be described. Secondly, the development of the prototype is the subject. Thirdly, the protocol for the evaluation sessions is described. Then, the method to develop guidelines and a methodology is given. And finally the methods to answer research question 3, regarding patient involvement, is point of discussion.

Chapter 5 will explain the important aspects of the chosen use case. Besides the guidelines and documentation it will also provide a stakeholder analysis. The landscape regarding the information systems is also point of interest.

Chapter 6 contains the results, similarly as chapter 4 divided in five parts.

Chapter 7 is the discussion, in this chapter the results will be examined and the focus especially will be on research question 3. The results regarding the general aspects will be combined with the interest of extending Tracebook towards patients. A scenario sketch will be developed, in which a future version of Tracebook is used where previous found problems are solved.

Finally chapter 8 will conclude this research. It will provide a resume on what this research contributes to literature. Also this research's limitations and potential future research directions will be discussed.

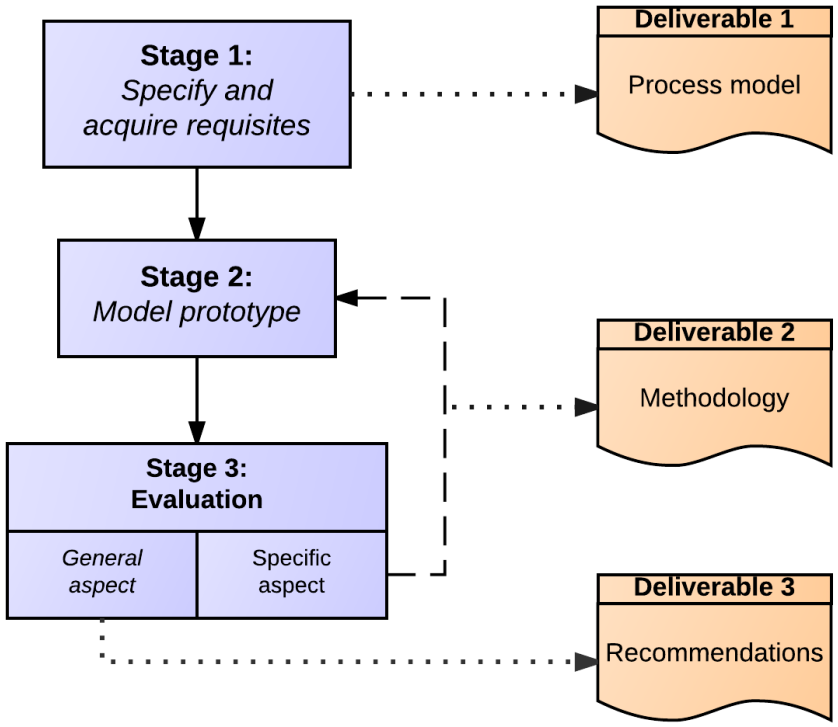


FIGURE 1: RESEARCH METHOD & DELIVERABLES

CHAPTER 3: LITERATURE

This chapter will summarize the used literature in the different parts of this study. First we will focus on the literature about medical checklists. Than the literature on Tracebook will be examined. This part will result in a conclusion on the requisites that are necessary for a Tracebook prototype. Finally we will examine related work.

3.1 CHECKLISTS

3.1.1 WHO SURGICAL SAFETY CHECKLIST

Checklists originate from aviation and are introduced in healthcare to increase patient safety. A thoroughly researched checklist is the surgical safety checklist by the World Health Organization (WHO). The WHO designed the surgical safety checklist and demonstrated that it could significantly reduce morbidity and mortality. They researched it in eight hospitals (among the U.S., Canada and UK) and concluded that after introducing the checklist the rate of death declined from 1.5% to 0.8% and the inpatient complications reduced to 7% from 11% at the baseline. Multiple studies however showed that the actual usage of the checklist was disappointing. Fourcade et al. (2012) found that the mean percentage of completed checklists was about 61%. In almost all of the researched centres (16 out of 18) the introduced checklist contained items that were duplicating with already existing checklists and procedures. The second most mentioned barrier was a lack of communication between surgeon and anaesthetist. Another much heard barrier was a lack of time to complete the checklist.

Also Levy et al. (2012) found that a large part of the checklist was not completed in most of the cases. There are several barriers mentioned for the inefficient usage of checklists. One of the main observed problems was a lack of timing. When a checklist is used at the wrong moment, checks are possibly irrelevant and will therefore be neglected. Vats et al. (Vats) also found a barrier related to hierarchy; since nurses are responsible for the completion of checklists they have to remind surgeons and anaesthetists about checking the items which can be awkward for them. Another barrier found by the same study was irrelevancy of the checklist. The WHO is a checklist which is internationally used, but medical procedures differ among countries, therefore some checks where considered to be superfluous when used in the UK.

3.1.2 SURPASS

A group of medical researchers and doctors in The Netherlands developed the SURgical PAtient Safety System (SURPASS) checklist (de Vries et al. 2009). They used a three-stage strategy for developing the checklist. First they collected surgery safety risk events from the literature. They checked whether these events corresponded with actual risk events in practice by observing processes. After the observation period they made some changes to the checklist before it was introduced in daily practice. After five months of checklist usage, structured interviews were used for evaluation. The results showed that 95% of the interviewees mostly or always completed the checklist. Reasons for not completing checklists were lack of time (34%), forgotten (66%), logistics (45%) and motivation (11%). When asking for suggestions to improve the logistics, 45% mentioned integrating the checklist into existing information systems, while 26% mentioned using an electronic checklist.

In a different study the developers evaluated the checklist on the basis of patient outcomes. They showed that introducing the SURPASS checklists reduced the in-hospital mortality from 1.5% to 0.8% and the postoperative complication rate from 27.3% to 16.7% (de Vries et al. 2010).

3.2 TRACEBOOK

Tracebook is a Dynamic Clinical Checklist Support System (DCCSS) that integrates workflow management with the use of dynamic checklists. It makes use of a number of underlying engines (more in part 3.3) to distribute dynamic checklists. This is different than the checklists mentioned previously, those were just single paper-based standard checklists.

Tracebook provides checklists digitally. Checklists can be accessed by medical professionals via portable devices, like tablets, or via their personal computer. The use of portable devices ensures that the benefit of paper-based checklists, that it can be carried along on the workplace, is maintained. The drawback of paper-based checklists, its information can become lost, is however removed. Although recent initiatives also researched digital checklists (Avrunin et al. 2012), the fact that Tracebook provides dynamic checklists and is aware of the patient's care process makes it the state-of-the-art.

There are two crucial aspects which make Tracebook different than its competitors, which are context-aware and process-oriented.

3.2.1 DIFFERENT ASPECTS

3.2.1.1 Context-aware

Unlike most production processes, medical processes are unstable and unpredictable. Patients differ and situations change, therefore a standard checklist does not suffice. Tracebook is context-aware in the sense that the checklists it provides to its users are automatically configured to the specifics of the situation; the checklists are context-aware. The patient's status is taken into account, for example lab tests, examinations, medicine prescriptions, allergies etc. Based on certain conditions Tracebook can remove irrelevant items and add items which are specific for the patient (e.g. for a patient with the comorbidity *diabetes mellitus*, which is not unlikely for bariatric patients, extra checks are necessary before the start of a operation). This is unlike traditional checklists, which are usually static, they do not contain patient-specific information and are irrelevant when the patient is an "unusual" case.

Furthermore, Tracebook can provide its users with warnings when certain conditions are met. For example: when a patient should not get a certain medicine due to allergy, the system can give a warning when this medicine is prescribed. The ability of the system to provide these warnings enhances the original goal of checklists; to increase patient safety.

Another function of Tracebook which shows it context-awareness is its ability to provide the decision maker with extra information using pop-ups inside the checklist. A pop-up can contain all sorts of information in different formats.

3.2.1.2 Process-oriented

The primary function of a checklist support system is to provide professionals with checklists. The functions of Tracebook however go beyond this primary function. Tracebook incorporates the clinical workflow of patients and is therefore process-oriented. Due to the fact that the system has up-to-

date knowledge of the patient's care process, it will make sure that checklists are assigned to the right person at the right moment in that care process. For this reason Tracebook can also be seen as a workflow distributor. Thereby, it provides users with messages to alert them a checklist is waiting to be checked.

Workflow management involves the automation of a business process in order to support and complement the transition of information and tasks between organisational actors (Georgakopoulos et al. 1995). Workflow is specifically important in sectors where large amounts of data are used and where timely receipt of this data is important (Dwivedi et al. 2001). The healthcare domain confirms to these conditions.

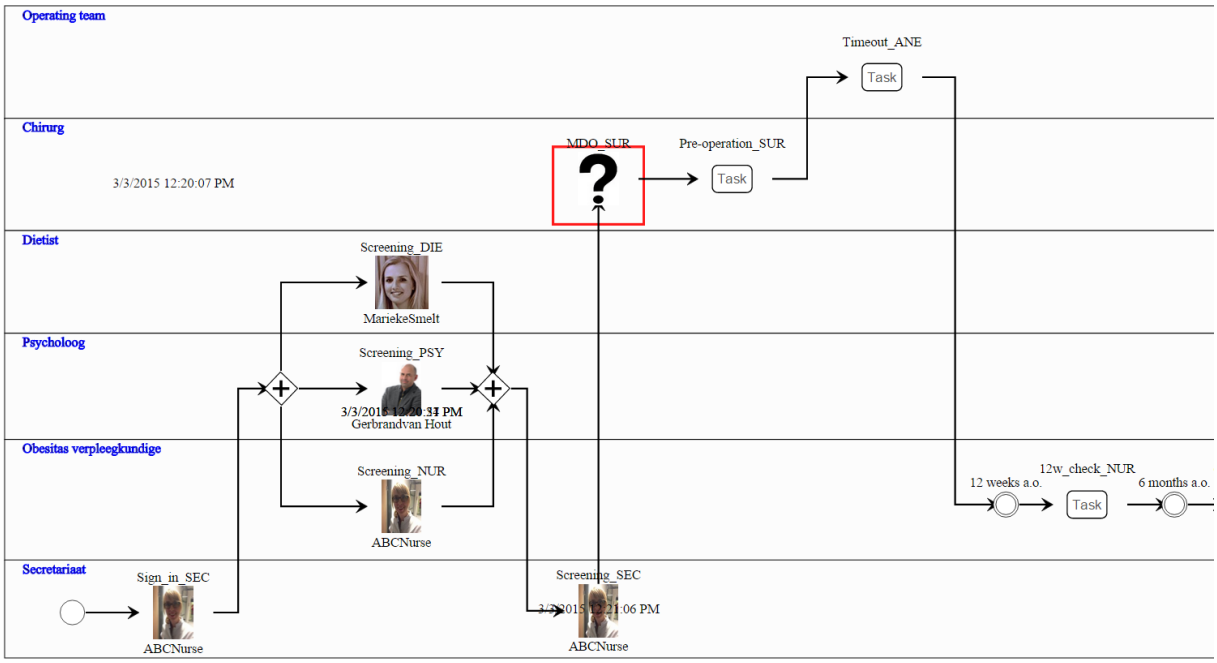


FIGURE 2: TRACEBOOK

Due to its process orientation, Tracebook provides more benefits to a department. Figure 2 shows a screenshot of Tracebook. In this picture the process is at the MDO_SUR stage, where the operating surgeon needs to fill in a checklist. As can be seen, Tracebook uses profile pictures to display the people that were involved in each step. This makes the care process more traceable and accountable. It provides a clear overview of where the patient currently is in the process (red square) and what activities were already done and by whom, as well as which steps still need to be done. This will make sure the actors are better in control of the care process.

The next example shows how Tracebook should be used by the surgeon who is making a decision on accepting a certain patient for bariatric surgery.

Bariatric Surgeon A opens Tracebook by starting the program at his desktop. The clinician selects patient John Doe in the patient management screen (Figure 3) and the system shows the bariatric process of this patient (Figure 2). The surgeon can see that patient John Doe underwent screening by the psychologist, the dietician and the bariatric nurse. By selecting a previous step the surgeon can see which checks his colleagues performed and whether they left any important notes (Figure 4). A profile picture not only shows which role (nurse practitioner) performed the checklist, but also which

exact person (ABC Nurse). Then the surgeon clicks on the checklist he needs to fill in, enters his credentials and the checklist will appear. An item in the checklist notes that the surgeon should check the results of the laboratorial examination of the patient's blood. The surgeon clicks on the underlined sentence and a pop-up appears which shows the lab results (Figure 5). Based on these results and the checks performed by his colleagues the surgeon can make the decision to accept the patient for bariatric surgery.

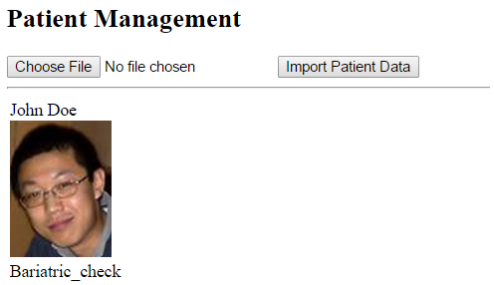


FIGURE 3: PATIENT MANAGEMENT

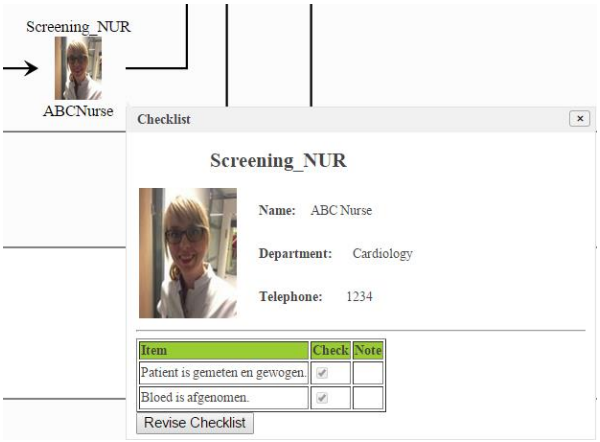


FIGURE 4: REVIEWING PREVIOUS CHECKLISTS

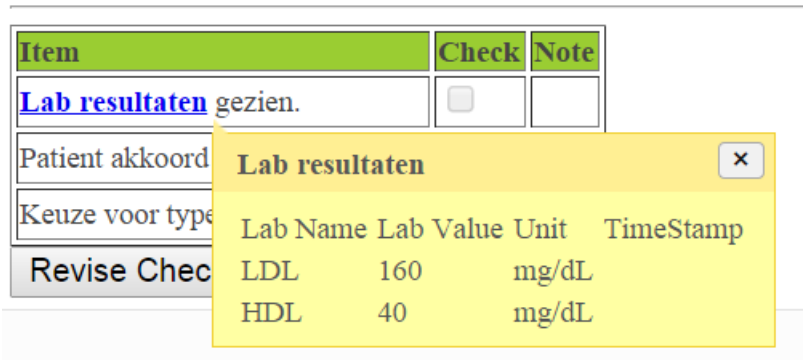


FIGURE 5: POP-UP

This example shows the advantages that Tracebook provides when making decisions (i.e. allowing a patient to be accepted for bariatric surgery). Due to a clear overview of the process and profile pictures of colleagues that are involved, a more transparent process is created. Furthermore due to its knowledge distribution the overall efficiency is enhanced.

3.2.2 INFRASTRUCTURE

In this section we elaborate on the engines which are used by Tracebook. Figure 6 describes the architecture of Tracebook.

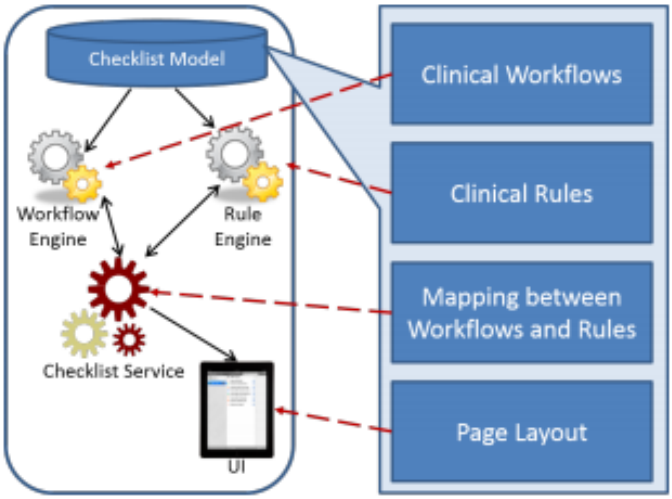


FIGURE 6: ARCHITECTURE

The basis of Tracebook is the *checklist model.* This model has the characteristics of a traditional process model, but is different on one crucial aspect. The activities in this model are not used to describe actual steps from reality, but are used to represent underlying checklists. Every activity in the checklist model is linked to a *flowchart*. The process part of the checklist model is managed by the workflow engine. This engine manages the distribution of tasks among actors based on the checklist model. The model is developed with Bizagi (Bizagi 2015), which also manages the distribution of tasks. The flowcharts linked to the checklist model are based on clinical rules, which are managed by the rule engine. These clinical rules are constructed in the wide-spread GuideLine Interchange Format (GLIF) (Peleg et al. 2003) and the supporting system is Gaston (De Clercq et al. 2004). The checklist service is implemented for interoperability between the two engines and the User Interface (UI). The UI interprets the flowcharts in XML format into HTML format to show them to users as checklists.

In order for Tracebook to be context-aware, Gaston can interface with hospital systems, in this case EZIS (Chipsoft 2015) of the CZE. Gaston retrieves patient-specific information from the EMR system, compares this to certain specified conditions and develops the content of the checklist. For our study an example of such a rule is:

When a patient's medication contains penicillin and the patient is allergic for penicillin, insert an item containing a warning in the checklist.

This means that Gaston first has to obtain the patient's information about allergies and checks if penicillin is among them. If it is, it will obtain all currently prescribed medication for this patient and looks if one of the medicines is penicillin. If this is also true, Gaston will provide an item in the checklist containing a warning for the allergy and given medicine. Otherwise no item will be provided and the system will continue with the next rule.

Patient information is not only used as a basis for rules, but can also be directly inserted in an item of the checklist. Another option is using a pop-up inside a checklist (Figure 5). It can be specifically modelled what those pop-ups need to contain and where they need to be showed. For example:

When during the screening process a blood sample is taken from the patient, the results of the laboratorial test can be provided to the surgeon using a pop-up in a checklist when he needs to decide on acceptance of the patient for bariatric surgery (Figure 5).

3.2.3 REQUISITES

A *Tracebook model* consists of two parts; on the one hand the checklist model and on the other hand the flowcharts.

A basis for these two parts is the conceptual process model. Process models describe in an abstract manner an actual process, containing the actors/roles, activities, events/states, and flow logic that are part of that process (Curtis et al. 1992). Process modelling is mainly used within organizations as a method to deconstruct complexity in the organization and to increase the awareness and knowledge of business processes (Bandara et al. 2005). There are many different kinds of modelling languages, but logically we are only interested in graphical modelling languages (Tracebook uses a graphical interface), like Unified Modelling Language Activity Diagrams (UML AD) and Business Process Model and Notation (BPMN). The Business Process Model Notation (BPMN) was developed by the Object Management Group (OMG), with the goal to provide a standard notation which is understandable for all sorts of users working with the process models (Business Process Model and Notation 2011). For non-technical users BPMN is considered to be an easy to learn language (Müller & Rogge-Solti 2011). Besides, it is an open and free standard, which enjoys broad tool support. Therefore we choose to model the process model in the BPMN 2.0 language, besides Tracebook is programmed to work with process models configured in the BMPN language.

3.2.4 PATIENT INVOLVEMENT

Currently Tracebook is mainly focused on distributing information within the boundaries of a hospital. A direction Tracebook is trying to evolve in is providing support to parties outside a hospital. This part focuses on advantages Tracebook could provide for the healthcare environment when these boundaries are crossed.

One of the problems mentioned earlier was a lack of patient participation. The most important reason for this is that the healthcare system insufficiently encourages patient to be active players in their own care. A survey showed that 96% of the patients wanted to be asked about their opinion and be offered choices (Bodenheimer et al. 2008). Another study of over 1000 visits with 124 physicians showed that only in 9% of the cases the patient participated in a medical decision (Braddock III et al. 1999). These examples show that the coordination of care between provider and patient is not adequately conducted.

A lack of adequate care coordination between provider and patient is an important reason for the lack of patient participation. Care coordination is the information sharing between different providers, but also between provider and patients/families, to help ensure that patient's needs and preferences for health services are met over time (Bodenheimer et al. 2008). A study from 2005 conducted among more than 2000 adults in six countries showed some clear examples of how the coordination of care between provider and patient/family is lacking (Schoen et al. 2005). About 17%

of the adults that were hospitalized in the last two years reported that care had not been communicated to them, 48% reported not routinely receiving information about side effects of their medication and 23% reported that there were delays in getting notice of lab results or they received inaccurate information on these results.

Especially in the care for bariatric patients, involvement of the patient is crucial. These patients need to maintain their weight and are therefore supposed to follow training and nutritional programs. As explained in RQ3, we want to research the possibilities for involving patients in their own care. Tracebook could anticipate on this problem by providing its benefits to patients. Tracebook gives a clear overview of the clinical process and is therefore an ideal informative tool for patients. A presentation of the clinical process patients go through will give valuable information, since a picture is worth a thousand words. It will be clear to patients what steps are conducted and what steps need to be taken in the remainder of the process. Besides that, Tracebook also gives a clear overview of which doctors / nurses are involved in each activity. By attaching profile pictures to the different professionals, it will give the care process a more personal touch. Besides making the care process more understandable for patients, it could possibly also be used by patients to complete checklists themselves. This way, during the aftercare, it could be checked whether patients performed their duties (taking medication, performing activities).

An interesting consideration to make is the level of disclosure towards patients. The consequence of a highly informed patient, is that the relationship between provider and patient will change. Traditionally, the doctor, the person with most of the knowledge, tells what is best for the patient and decides on that. There is however an increase in research claiming patients should be involved in making decisions (Entwistle et al. 1998). It is however reasonable to argue that patients will need education to rightfully interpret the information they get presented. In the case of Tracebook the information they will get access to does not have to be complicated, but the level of complexity increases with the level of disclosure.

3.3 Related work

In 2007, Vanhaecht et al. (2007) described the term care pathway as follows: *"A care pathway is a complex intervention for the mutual decision-making and organisation of care processes for a well-defined group of patients during a well-defined period."* The thesis of Wesley van Renswouw focused on developing a method to transform paper-based care pathways into executable workflow models (van Renswouw 2013). In further research this methodology was extended to be applicable for a CDDSS such as Tracebook and to automate the process of transforming a paper-based care-pathway to a workflow model via annotation software (Claessens 2014). The first step of this methodology, the transition from a paper-based care pathway to a conceptual process model was also addressed by Vermeulen (Vermeulen).

CHAPTER 4: METHODS

In this chapter we will explain the methods used for the different parts of this research. The first part of *stage 1* is completed, since we have specified the requisites for modelling a prototype of Tracebook. Next we will acquire those requisites in order to continue with *stage 2*, modelling the prototype. The methodology for this part is explained in 4.1. In part 4.2 the methodology for modelling the prototype is explained. Part 4.3 explains how the prototype is going to be evaluated, which is *stage 3*. Then in part 4.4 the method for developing the guidelines and methodology will be given. Finally, part 4.5 explains what methods were used to answer research question 3, regarding patient involvement.

4.1 DEVELOPING PROCESS MODEL

As was specified in the previous chapter a BPMN 2.0 process model for the use case needs to be build. Therefore we took a critical look at the methodologies from Vermeulen (2013) and van Renswouw (2013) (including the adjustments of Claessens (2014)). These methodologies both start with specifying a care pathway and transform this into a conceptual model. This conceptual process model in the case of Vermeulen has a high level of detail and complexity, which is not directly required as input for Tracebook. In this research the following steps were taken to come to the process model. These steps are related to Vermeulen's methodology (2013), although it was simplified to only perform the most necessary steps.

1. First the use case needed to be specified, which starts with exploring the available guidelines via the internet as well as acquiring documentation directly from the use case.
2. Based on this documentation, a stakeholder analysis was made. This relates to the step of Vermeulen's methodology, although only direct stakeholders are point of interest, since these are required for the development of the process model.
3. Next the information systems were researched in order to make a clear evaluation of the current state of systems.

Based on this information a process model was made. For actual modelling of the process model, the guidelines of Mendling et al. (Mendling) were used (Table 18, appendix A).

4.2 DEVELOPING PROTOTYPE

To make a prototype of Tracebook for the use case, we previously made clear what the requisites are. A tracebook model as described in 3.4, is build up out of two elements; a checklist model and flowcharts. A checklist model describes graphically the way in which the attached checklists are ordered. Flowcharts describe the content and the order of the items in the checklists. The combination of the two results in the checklist model as shown to the user in the UI of Tracebook. This part will explain how a prototype can be developed and in the results section the checklist model and checklists are given. As documentation we used the manual *'Handleiding CDSS version 3.5'* (Vermeulen 2014), which explains how to use the different engines to build a model of Tracebook.

4.2.1 Systems set-up

This part elaborates on the different engines (Figure 6) that serve as backend for Tracebook and the software programs that are connected with these engines.

The database is stored in a virtual environment, since this reduces any risks attached to physical computers (viruses, crashes). Such an environment can be created using a Virtual Machine (VM). VMs emulate an environment which is identical to an actual computer (Bullers Jr et al. 2006). It provides the user with the possibility of using multiple operating systems on one real machine. Due to the safety of VMs, they are optimal for testing operating systems and applications. In our case Sharing Hosted Autonomous Research Environments (SHARE) was used, since it easy to use and to access and do not require the user to have VM software installed on the computer (Van Gorp & Mazanek 2011).

On this virtual machine the software for modelling the process model in BPMN 2.0 is installed, called Bizagi. Bizagi is the tool for the workflow engine, Gaston for the rule engine, and furthermore the VM contains software for the checklists services and UI. This setup does not involve any real patient data, therefore all the data needed for testing needed to be manually entered (which was mostly already done for this research).

4.2.2 CHECKLIST MODEL

A requirement for this part is that the process model is available in BPMN notation. The method for this part is described in part 4.1. The next step is to transform the process model into a checklist model.

The second part of van Renswouw's methodology (2013) is specified on transforming the conceptual process model into a workflow process model. The workflow process model contains all kinds of information so that it can be used for various workflow management systems and has therefore a high level of complexity. In comparison, the workflow model used for Tracebook, called the checklist model, is much simpler, we therefore choose not to use this methodology.

Developing this checklist model is not an easy job done. It requires some practice and many stages of redesign. There are some considerations that need to be made. First of all, it need to be considered at which parts of the model a checklist will be inserted. Then, the detail of these checklists need to be determined. Therefore we did not follow a clear methodology, but trial and error. After the model was evaluated however, we had a better idea on how the checklist model should be developed. This will be translated in a methodology.

After the checklist model is made, the model needs to be linked with the web services that are needed for Tracebook to function. Therefore Bizagi offers a web service connector (being part of the integration layer) to promote easy configuration to invoke SOAP web services. More on this in Appendix B.

4.2.3 FLOWCHARTS

After the workflow model is made, the *flowcharts* that eventually will be displayed as checklists in the UI need to be configured. For this step Gaston is used. For each checklist we have to make a *flowchart*, in which it is modelled what items the checklist will contain, as well as in which order those items will be shown. A flowchart can contain different types of *Primitives*. An overview of the available primitives is shown in Figure 7.

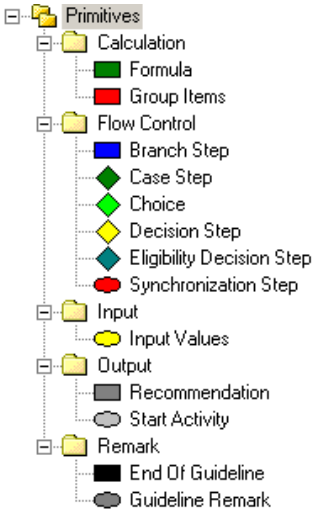


FIGURE 7: OVERVIEW OF PRIMITIVES

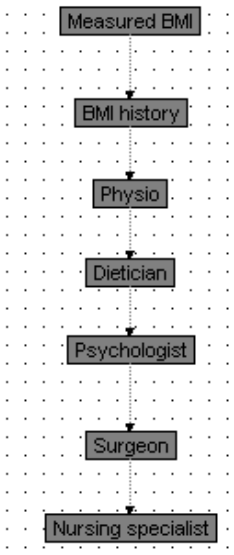


FIGURE 8: SIMPLE CHECKLIST

The primitive most commonly used is the *Recommendation*; which contains the actual text that will be shown in the checklist. The recommendations need to be linked to each other in the order you want them to be displayed in the actual checklist. An example of a simple checklist which only contains recommendations is shown in Figure 8. More on how to add flowcharts and specify their content in Appendix C.

The primitive *Decision step* can be used to decide whether a certain condition can be answered with "yes" or "no"; the system will then continue with the next primitive connected to the chosen outcome. Two decision steps are used in the part when it is checked if the patient is allergic for Penicillin and Penicillin is also among the prescribed medicine, see Figure 9. On the top there is a decision step that checks whether Penicillin is among the patient's allergies. The next step is to check whether Penicillin is also among the medication that have been given to the patient. If the result of this decision step is also "yes" there will be a check in the checklist alerting the user the patient is given medicine for which allergic reactions can occur to the patient. In Figure 10 the *Timeout* checklist (which is used in our use case just before the operation) is shown, which contains this warning (the seventh check[1]). It was chosen to make this warning extra outstanding by marking it in red. For more details on this decision step see appendix C.

[1] Since this study was for hospital in the Netherlands all information in the checklist model is in Dutch.

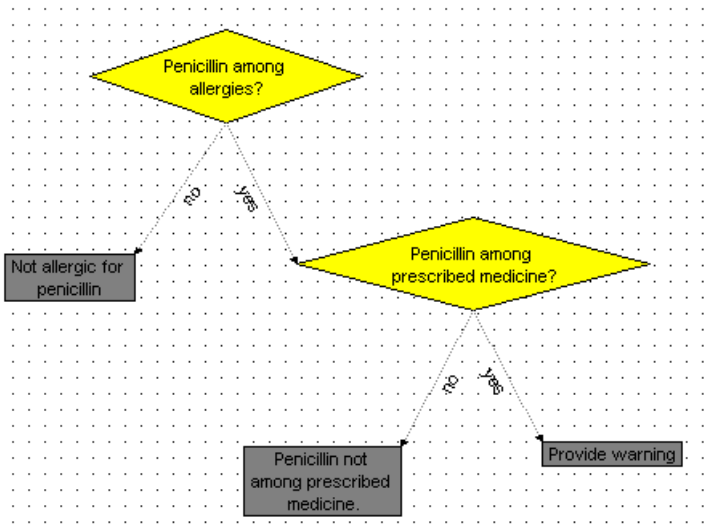


FIGURE 9: DECISION STEP

Item	Check	Note
Patient John,Doe,Male is gezien.	☑	
Geboortedatum patient 1932-02-15 is correct.	☐	
Ingreep is genoteerd.	☐	
Te verwachten **bijzonderheden** zijn genoteerd.	☐	
Zijde is gemarkeerd.	☐	
Positionering patient is bekend.	☐	
Patient allergisch voor Penicilline!	☐	
Anesthesietechniek is gecheckt.	☐	
Stollingsstatus is gecheckt en zo nodig gecorrigeerd.	☐	
Antibiotica is volgens protocal toegediend.	☐	
ASA classificatie is gecheckt (>2 expliceren).	☐	
Bloedproducten zijn beschikbaar en aanwezig.	☐	
Beschikbaarheid instrumenten, protheses en apparatuur is gecheckt.	☐	

bijzonderheden ×
Diabetes

Abort Save Submit

FIGURE 10: TIMEOUT CHECKLIST

Apart from plain text it is also possible to insert patient information, lab results or prescribed medicine into the items of the checklist (more information in Appendix C). This information can be inserted directly from the hospital information system. All sorts of content can be inserted, like videos, pictures and/or hyperlinks.

4.2.4 LINK FLOWCHARTS TO CHECKLIST MODEL

The final step is to connect each flowchart with its corresponding task in the checklist model. The *Checklist editor* (Figure 29 in Appendix D) is used to import the xpdl-file containing the checklist model that was exported using Bizagi in an earlier step. When imported, the next step is to give every *Scenario* (read activity) a *Scenario ID* (unique for every checklist) (Figure 28 in Appendix D). The scenario ID can be found in Gaston by opening the *properties* of the corresponding flowchart, see Figure 30.

The next step is to specify users that can log in to Tracebook to complete a checklist. In the manual it is explained how to add users and roles, which is done using the web interface of Tracebook (Figure

27 in appendix D). There is a difference between users and roles, a role can for example be a *Cardiologist* and there can be multiple users that are assigned to the role *Cardiologist*.

To add roles in the system Microsoft SQL Server Management is used. This is a relational database management system. Its primary function is to serve as a database and store and retrieve data as requested by other systems. For this research there were three databases that serves as backend for Tracebook. The *ChecklistRunTime* database is used to store all the information about roles, users and the status of the checklists. The *ChecklistWorkFlow* database is used for the workflow engine. And the *EHR* database simulates EZIS and contains all the information on patients, medication, treatments, complications and so on.

4.3 Developing evaluation method

This part introduces the Usability Evaluation Method (UEM) used for this research, which describes the procedures to evaluate the prototype.

In a demo-video we walked through the complete care process of a bariatric patient using the prototype of Tracebook. By voice, is was explained how Tracebook can be used and what its benefits are. In the evaluation sessions the demo was showed and explained how it will be used in the scenario of a patient going through the bariatric process. A different example of an UEM is field observation, which lets the users use the actual prototype of the system while they are being observed by the evaluator (Holzinger 2005). Since Tracebook differs from standard applications in the sense that multiple users are involved during the patient's process this was not an option. In our case the user needed to be explained the scenario in which Tracebook is used and walked through the steps of the patient's care process. The surgeons are the ideal candidates for this method, since they usually have good knowledge of the complete care process, besides they have the highest professional status (Nembhard & Edmondson 2006), which most likely implicates they can easily convince other colleagues. To acquire results semi-structured interviews were conducted, for which interview guides were developed. An interview guide contains the list of topics and questions that will be followed during the conversation, but there is the freedom for the interviewer to stray from the questions in this guide.

Two viewpoints of the prototype needed to be evaluated by the interviewee(s):

1) The specific aspects for the use case.
2) The general aspects of Tracebook

Therefore we developed two interview guides:

The first interview guide (Appendix E) focused on Tracebook in general. The first part served as introduction (also done prior via email); to explain what tracebook is, what the progress is thus far and introduce this research. Then the prototype was showed via the video-demo. We explained the scenario in which Tracebook is used for the bariatrics department. The second part focused on gathering the interviewee opinion on Tracebook. First the interviewee's first impression on Tracebook was topic of discussion. Then the drawbacks and benefits of tracebook were discussed. Also some practical problems the interviewee might experience were discussed. The next question focused on the improvements the interviewee thought would be necessary. Finally we discussed the future developments of Tracebook such as patient access to Tracebook.

The second interview guide (Appendix F) consisted of two parts. The first goal of this interview was to walk through every step of the prototype. For every step it needed to be checked whether a checklist at that point was necessary and if so what items it should contain. The second goal of this interview was to gather the opinion of the surgeon on the level of disclosure of information, more on this in part 4.5.

4.4 Development of guidelines and methodology

After the prototype has been evaluated and changes have been made to the checklist model and flowcharts, the goal is to deduce from these changes some guidelines that should be taken into account for future projects. Besides guidelines, this part will also provide a more technical methodology that should be used as baseline when developing a prototype of Tracebook for a specific use case.

4.5 Researching patient involvement

This part describes the method we used for exploring the possibilities for patient involvement. First the literature review conducted prior to this study will be explained. Then the method for researching the level of disclosure towards patients will be discussed.

4.5.1 Literature review

An upcoming trend at the field of patient involvement is the Personal Health Record (PHR). A PHR is an electronic, universally available lifelong resource of all the medical information on a patient (e HIM Personal Health Record Work Group et al. 2005). There are however some barriers among patients and caregivers with PHRs. These barriers may as well be applicable when involving patients in Tracebook.

In the literature study the goal was to find the barriers among healthcare providers and patients about the usage and adoption of PHRs (Van Heyningen 2013). The applicable literature was scoped to 35 articles, which were examined for any containing barriers. These barriers were then categorized in the user group for which the barrier accounted for: patient or healthcare provider. After the most mentioned barriers were found, the next step was to decide whether each barrier was critical or not. When a barrier is critical, solutions for that barrier are not immediately available in literature. The results are given in the next chapter.

4.5.2 Patient involvement

In order to investigate the optimal level of disclosure towards patients, a small research was set-up. In this research an interviewee was questioned which level of disclosure towards patients would be appropriate. First however, it needed to be decided which levels of disclosure were possible. Therefore several levels of disclosure were set-up, with the higher the level, the higher the disclosure towards patients. These levels could then be used to gather the opinion of the interviewee.

CHAPTER 5: CASE STUDY

5.1 BARIATRICS

Bariatrics is a branch of medicine concerned with the causes, prevention and treatment of obesity. Dieting, exercise and behavioural therapies are common treatment forms. In some cases these techniques do not provide satisfactory results and other measures are needed. As a sort of final option, bariatric surgery can be performed. There are multiple types of operating treatments possible (Mechanick et al. 2009). There exist techniques that place a band around the stomach and thereby decrease the size of the stomach or limit the amount of food entering it. This band can be adjustable (LAGB) or non-adjustable (VBG). The gastric bypass is a more advanced operation and involves decreasing the size of the stomach and redirecting the flow of food. The gastric sleeve is a less advanced operation and mostly used as a first step with more critical obesity patients. The option then remains to transform this procedure to a gastric bypass.

5.2 GUIDELINES

There do exist multiple sources of guidelines, for example the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) provided guidelines for safety, quality and excellence in bariatric surgery (Melissas 2008). The National Heart, Lung and Blood Institute (NHLBI) also provided a practical guide containing guidelines for the identification, evaluation and treatment of obesity (Panel et al. 1998).

Analysis of these guidelines resulted in a number of specifications. The following criteria are used when determining whether a bariatric surgery is suitable: BMI, comorbidities, losing weight attempts and commitment.

The most important criteria is BMI, therefore the following criteria exist:

1) BMI ≥40 kg/m^2 or
2) BMI 35-40 kg/m^2 in combination with a relevant comorbidity:
    - Diabetes Mellitus type 2;
    - Hypertension
    - Obstructive sleep apnoea
    - Joint disease

Secondly, the patient's non-surgical attempts at weight reduction.

Thirdly, the commitment of the patient. It needs to be expected the patient will adhere to postoperative care. The patient needs to participate in follow-up visits with physicians and team members. And a nutritional program needs to be followed.

5.3 DOCUMENTATION

In Appendix G and H the most important documentation on the CZE's bariatric processes is shown. These process diagrams from Appendix G were made in Microsoft's Visio. In the rows the different stakeholders are shown and the columns contain milestones, which show in which stage the process is. The models however lack some important modelling rules. In some parts arrows are used to

indicate a flow of work, but most of the times these arrows are left out, which sometimes makes it unclear in what manner the process continues.

A second source of information were the tables shown in Figure 35 and Figure 36 (Appendix H). The first figure shows the screening stage, and which roles are involved at the different steps. The second figure shows the after-care stage, where it can be seen after which time certain after-care activities were performed.

This documentation already provides us with graphical flowcharts that describe the processes of the care for a bariatric patient. This reduces the useful part of the methodology of van Renswouw (2013) since for example, checklists (as depicted in care pathways) do not have to be transformed in activities of a process model.

5.4 Stakeholder analysis

For this part there was made use of the website of the Catharina Hospital in Eindhoven (cze.nl), as well as the documentation acquired previously. The website provides a variety of information on their centre of obesity. There are employed: five bariatric surgeons, two cosmetic surgeons, five psychologists, five 'maag-darm-lever'-artsen, four dieticians, four physiotherapists, four obesity nurses, one nursing specialist and finally two physicians assistants. As mentioned in the methods description only direct stakeholders were examined.

5.5 Information systems

To determine how we can introduce a checklist support system to overcome the mentioned problems, we need to analyse the current landscape with regard to information systems; how are they supporting the healthcare professionals in their working processes.

5.5.1 EZIS

The existing Hospital Information System (HIS) EZIS is of importance to this research, since it is the centre of all the hospital's information. EZIS is a HIS developed by the Dutch company ChipSoft. They have a large market share in the Netherlands; their products are deployed at 43% of all Dutch hospitals (egbertzen & Van Eekeren 2014). Their product CS-EZIS.net is a workflow management system. EZIS is a broad information system, that encapsulates many important functions for different departments. During the bariatrics care process, the system is used in multiple manners. When performing standard activities, like prescribing medicine, or planning an operation. Mostly plain text is entered into EZIS, for example the results of the different screenings.

5.5.2 Excelsheet

Besides the usage of EZIS, they keep track of patients who need to undergo a special trajectory before they are ready for bariatric surgery using an excel-sheet. Also the after-care of patients, and whether they are attending after-care group sessions is being documented in an excel-sheet. We were not able to acquire further details about these sheets.

5.5.3 BePatient[2]

The BePatient module, developed by a French company, is focused on the patient and can be categorised as e-health. E-health is a broad term, but is basically concerned with health services delivered through the internet and related technologies (Eysenbach 2001). E-health is becoming a more and more important mechanism to enhance efficiency and quality of the provided care. A study among 440 health care organizations discovered that 80% are delivering some sort of e-health to their patients (Wilson & Lankton 2004). Just as there are many different definitions of e-health, there are also many different applications falling under the e-health classification. E-health can be used to provide patients online questionnaires, prescription refills, test results and for communication with care providers.

The BePatient module encompasses some of these functions. The screening step is an important step during the pre-operation phase. Part of this step is the exchange of questionnaires between provider and patient to judge whether the patient is suitable for bariatric surgery. The BePatient module is designed to support this exchange of forms digitally. This makes the process more efficiently. In Figure 38 (Appendix J) on overview screen is shown containing questionnaires for patients.

Another important function of the module is the ability to track patients that underwent surgery at home using several devices. This increases the efficiency of steps during the post-operative process, because these measurements can be done from the patient's home environment. This is not only more efficient from a business point of view, but it also increases the patient's involvement into maintaining their health. It is important to state here that the care for obesity patients doesn't stop after the surgery, which is a common believe among patients (Odom et al. 2010). To achieve and maintain optimal weight loss after surgery lifestyle changes are critical, such as nutritional optimization, increased physical activity and cognitive restructuring. It is shown that post-operative self-monitoring behaviours are strongly associated with an increased self-awareness and therefore prevent regaining weight (Odom et al. 2010). A study among 122 patients showed that patients who measured their blood pressure and weight at home, had significant decreases in among other things their weight and cholesterol levels compared to patients receiving standard hospital care (Goulis et al. 2004).

The rise of medical applications such as the BePatient module, changes the traditional view on healthcare. Traditionally a disease or comorbidity was noticed once the patient went to see a healthcare professional and the diagnosis was made. But with the use of home devices, a problem can be automatically noticed by a system comparing the patient's values against clinical cut-off values. The healthcare professional will then be noticed of this change in parameters and calls the patient for a visit. In the future you can even imagine nano bio devices that are implanted onto the patient, and automatically keep track of those parameters, without patient involvement (Daim et al. 2008).

[2] The BePatient module is at time of writing still in the testing phase.

CHAPTER 6: RESULTS OF APPLIED METHODS

This chapter will provide the results of the conducted research. The results are divided in four parts, which are related to the chronological phases of this research. First, the process model of the bariatric department will be provided (6.1). The second part of the research was the development of the prototype (6.2). Then we provide the results of the evaluation sessions (6.3). Part 6.4 provides the guidelines and methodology. Finally part 6.5 provides the results regarding patient involvement.

During the evaluation of the prototype insights were done with regards to our earlier made process model. As expected (see research method) changes needed to be made to the prototype. Separating this chapter in a part were the intermediate process model and prototype are shown an a part in which the final model and prototype is inconvenient.

6.1 PROCESS MODEL

6.1.1 OVERVIEW PROCESS

The bariatric process model consists of three steps and is basically a simple overview of the bariatric process. The process begins with a pre-operative subprocess, then the actual operation takes place and finally there is the post-operative subprocess. Figure 11 shows the overview process.

The surgical process is mostly for every surgery the same. It involves among others the patient meeting the surgeon and the anaesthetist. We choose to not further elaborate on this process. The pre- and post-operation steps however have subprocesses, which means those blocks in the overview process each represent a complete underlying process.

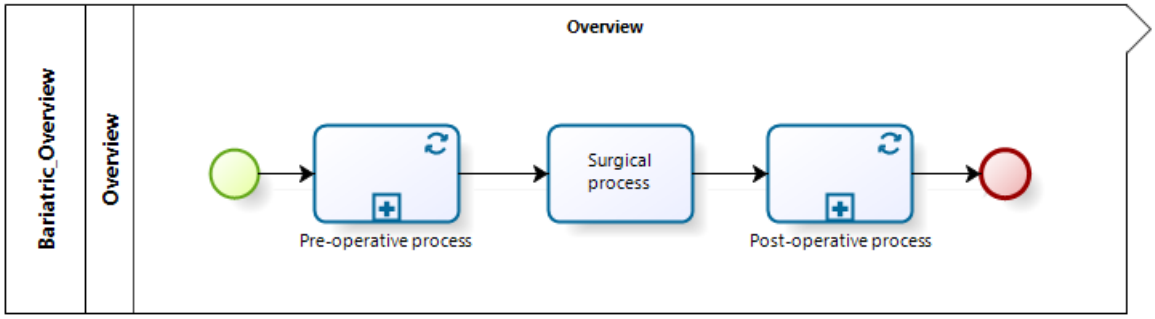


FIGURE 11: OVERVIEW PROCESS

6.1.2 PRE-OPERATIVE PROCESS

The pre-operative process is depicted in Figure 14. At the top there are the different milestones of the process, which starts with *Screening* and ends with *Perioperation*. At the left side of the model the different roles are depicted. The process starts at the left bottom with a subprocess in the Secretary lane. The subprocess is displayed in Figure 12. The first step is to register the patient at the policlinic. If this is done the secretary sends a questionnaire, which contains some global questions about the mental and physical state of the patient. After the questionnaires are retrieved again they are scanned and the patient is ready to be screened. The secretary plans the screeningsday, which is part of screening the patient for suitability for operation.

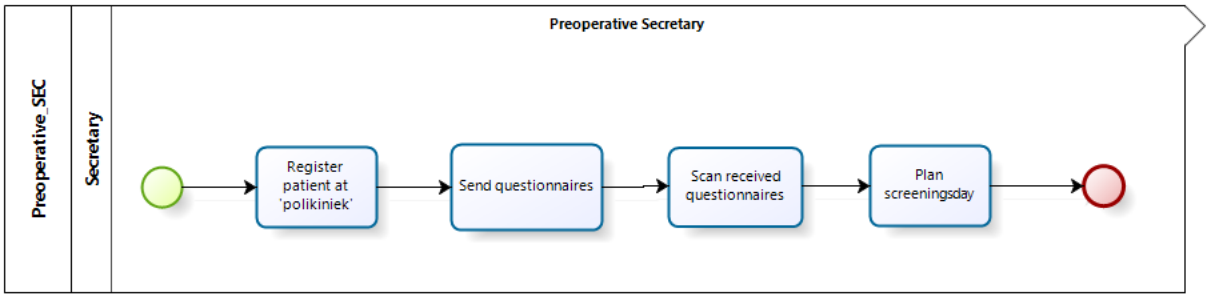


FIGURE 12: PRE-OPERATIVE_SEC

During the screeningsday three roles are involved, the *Psychologist*, the *Dietician* and the *Obesity nurse.* The activity of the psychologist is again a subprocess (Figure 13).

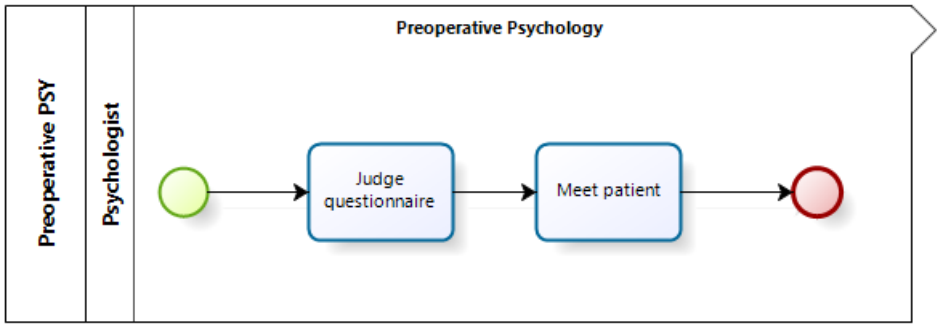


FIGURE 13: PRE-OPERATIVE_PSY

The tasks of the other two roles are meeting the patient, to get a first impression of the patient's ability to cooperate and the suitability of bariatric surgery. After these three steps have been completed the secretary checks whether all the data is complete for the multi-disciplinary counsel (in dutch: *Multidisciplinair Overleg* (MDO)). The MDO is a meeting between members from different disciplines; a surgeon, a psychologist, a dietician and a nurse practitioner. They will come to a final decision on whether the patient will be accepted for bariatric surgery.

There are three possible outcomes from the MDO, which will be communicated with the patient by the surgeon. The patient can either be immediately approved, not approved at all or needs to follow a pre-phase in order to be accepted for bariatric surgery. The pre-phase can be conducted by the dietician or the psychologist depending on the situation. During such a pre-phase the patient meets the responsible specialist multiple times. After the patient is accepted, the surgeon will make an operation planning. The patient will be informed about the operating proceedings and receive further information through a groups presentation, with multiple patients undergoing bariatric surgery.

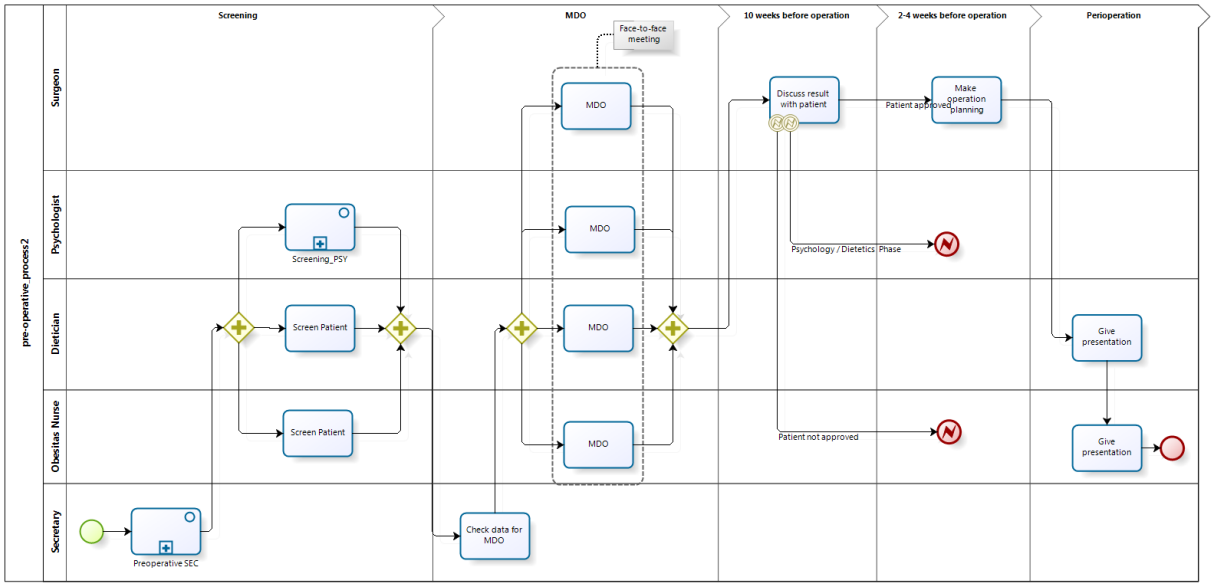


FIGURE 14: PRE-OPERATIVE PROCESS

6.1.3 POST-OPERATIVE PROCESS

The post-operative process is the aftercare plan. This plan consists of several different check-up steps that repeat after a certain time period until 5 years after the operation. Since the corresponding process model is quite long (see the figures in appendix K), we will present here a clearer overview of this aftercare plan in Table 1. This table shows each time after a certain time period which check-ups are done and by which role. The psychologist only has one group session and after this a personal scheme is made, individually tailored to the patient.

Roles														
Surgeon														
Psychologist							Individual careplan							
Dietician														
Nurse Specialist														
Obesity nurse														
Physiotherapist														
Time after operation	***3 weeks***	***6 weeks***	***3 months***	***6 months***	***9 months***	***1 year***	***1,5 years***	***2 years***	***2,5 years***	***3 years***	***3,5 years***	***4 years***	***4,5 years***	***5 years***

TABLE 1: AFTER-CARE PROCESS (ORANGE FOR GROUP SESSIONS, GREEN FOR INDIVIDUAL SESSIONS)

6.2 PROTOTYPE

6.2.1 MODELLING STEPS

For the bariatrics demo we modified the table *dbo.Dict_Role* in the *ChecklistRunTime* database. This table has three columns and we added three rows, one for each role we added. For each role we had to fill in the *Role_ID* and the *Role_Name*, the third column *Note* is not used. We added the *Psychologist* with abbreviation *PSY*, the *Dietician* (*DIE)* and the *Secretary* (*SEC*). Next we used the web interface of Tracebook to add some users that were assigned to the newly made roles.

As explained in Appendix C, new variables need to be inserted in the database behind Tracebook. In Appendix L we provide the views of the variables we created for this research. The following variables were created: *Allergy*, *Bloodtype* and *BMI*. The other variables already existed and we only added values for them.

6.2.2 CHECKLIST MODEL AND CHECKLISTS

This part will present the checklist model (Figure 15) as well as the checklists. The model is separated in three parts, the pre-operation, the operation and the aftercare[3]. Since, a clear method for developing the checklist model was not at hand it will be explained specifically for every step why we choose for a checklist on that location. What will be explained in this part are the design choices of the checklist model. Why was it chosen to place a checklist at a certain step? What items should be in the checklist? Then we will show for each checklist what changes were made after the evaluation session and explain these changes below the final checklist. Note that the checklists are in Dutch, since we modelled it for a Dutch hospital. When in an item is linked to a pop-up in which additional information is showed, this link is underlined and marked blue.

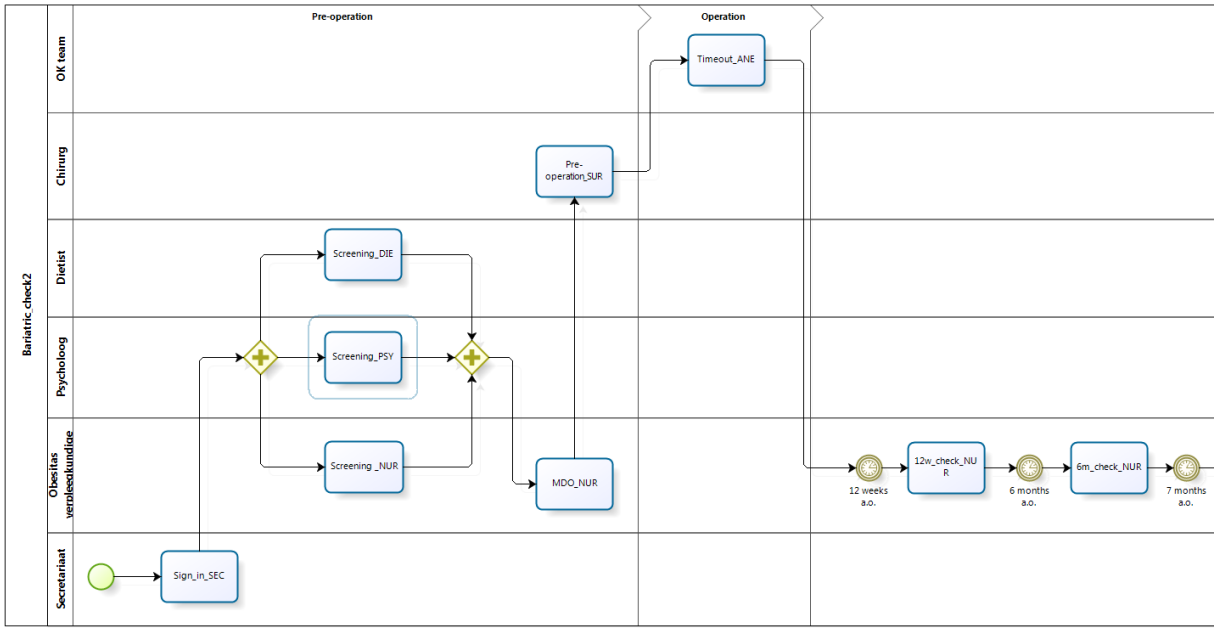


FIGURE 15: CHECKLIST MODEL

6.2.1.1 Sign_in_SEC

The sign-in checklist is filled in by the secretary as soon as the patient is registered and all the accompanying activities are performed. This related to the sub process pre-operative_SEC (Figure 12). In this case a subprocess is transferred into a checklist.

Item	Check	Note
Patient geregistreerd bij polikliniek		
“Algemene screeningsvragenlijst” verstuurd		

[3] For the sake of convenience, the aftercare part only shows 2 steps of the 13 steps originally in the model. The rest is the same based on the time period from table 1.

Vragenlijst ontvangen en goedgekeurd		
Screeningsdag gepland		
Informatiemap incl. informed consent verzonden		

TABLE 2: SIGN_IN_SEC OLD

Item	Check	Note
Patient geregistreerd bij polikliniek		
Vragenlijsten verstuurd		
Screeningsdag gepland		

TABLE 3: SIGN_IN_SEC

After the evaluation is became clear that the secretary sends more than one questionnaire. And that these questionnaires are not examined by the secretary, but by the role corresponding to the questionnaire. Besides the information content is provided to the patient when visits the hospital.

6.2.1.2 Screening_DIE

The screening stages of the process model were copied directly into the checklist model. For the dietician this resulted in a list of items which needed to be discussed with the patient. First however, the BMI of the patient is shown via a pop-up. It could also be chosen to display more elaborated information, such as the different body measures.

Item	Check	Note
BMI level gezien		
Comorbiditeiten besproken		
Gewichtsverlies geschiedenis besproken		
Betrokkenheid van patient besproken		
Huidige alcohol/drugs gebruik besproken		

TABLE 4: SCREENING_DIE OLD

Item	Check	Note
BMI gezien		
Klaar voor MDO		
Extended or short MDO? (drop-down menu)		

TABLE 5: SCREENING_DIE

After the evaluation session it became clear it was unwise to copy every step from the process model into the checklists (see results evaluation session part 6.3.1). Only ‘check BMI’ was kept. The main function of the checklist became to check whether the patient was ready to be discussed at the MDO. Then it has to be decided whether the patient should be discussed in a short or extended MDO (see results evaluation session for the differences). As a result the checklist is much clearer and to the point.

6.2.1.3 Screening_PSY

This is one of the three screening steps.

Item	Check	Note
Screeningsvragenlijst toegezonden		
Vragenlijst ontvangen en goedgekeurd		
Extra vragenlijsten verzonden (optioneel)		
Individueel screeningsgesprek gevoerd (optioneel)		

TABLE 6: SCREENING_PSY OLD

Item	Check	Note
Klaar voor MDO		
Extended or short MDO? (drop-down menu)		

TABLE 7: SCREENING_PSY

The same discussion can be held here for the simplification of the checklist.

6.2.1.4 Screening_NUR

This is also one of the three screening steps.

Item	Check	Note
Patient is gemeten en gewogen		
Bloed is afgenomen		

TABLE 8: SCREENING_NUR OLD

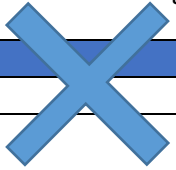
Item	Check	Note
Patient is gemeten en gewogen		
Bloed is afgenomen		
Klaar voor MDO		
Extended or short MDO? (drop-down menu)		

TABLE 9: SCREENING_NUR

This checklist was already quite clear, it only contained the necessary steps. The patient needed to be weighted and measured, to determine the patient's BMI. The second step was to take a blood sample of the patient. This blood sample needs to be tested and the results are discussed in the MDO. Two items are added for choosing the MDO.

6.2.1.5 Screening_SEC

This step was added to check whether the different screening stages were completed.



Item	Check	Note
Alle data complete voor MDO		

TABLE 10: SCREENING_SEC OLD

After the evaluation session it was decided this checklist can be removed. In this step the secretary checks if all the information is complete to start the MDO. We decided to remove this step, since it can be done automatically. It could be argued to keep this step, since it needs to happen and therefore it needs to be checked. We decided to remove it, since it not a manual step anymore. If the step is kept, it can be automatically checked when the previous 3 roles indicate that the patient is

ready to be discussed in the MDO. As soon as the three roles previous to the MDO have completed their checklists there is enough information available to start the MDO.

6.2.1.6 MDO_NUR

During the MDO the lab results were needed of the blood sample test. This information can be extracted from EZIS and therefore we choose to provide this during the meeting in a pop-up. Then an item is needed for checking whether the patient is approved. Finally it is decided on the type of operation for the patient.

Item	Check	Note
Lab resultaten gezien		
Patient akkoord na MDO		
Keuze voor type operatie bekend		

TABLE 11: MDO_SUR OLD

Item	Check	Note
Lab resultaten gezien		
Patient akkoord (drop-down menu)		
Patient naar voortraject (drop-down menu)		
Patient afgewezen (drop-down menu)		

TABLE 12: MDO_NUR

After the evaluation session it became clear this task should be assigned to the nurse practitioner. The nurse practitioner uses the computer during the MDO session.

6.2.1.7 Pre-operation_SUR

This checklist corresponds to the step “Make operation planning” from the pre-operative process. The second item we included in this checklist is based on a rule. This rule checks whether the patient also has Diabetes Mellitus, which is common for a patients with obesity, and if this is true the patient needs to be forwarded to a “Diabetes consultant”.

Item	Check	Note
Operatieplan is gemaakt		
Patient heeft diabetes; doorverwezen naar diabetes consult!		
Behandelplan is bepaald en besproken met patient		
Type operatie is besproken met patient		

TABLE 13: PRE-OPERATION_SUR

Item	Check	Note
Patient gezien na MDO		

TABLE 14: PRE-OPERATION_SUR

Afterwards, it was chosen this checklist also needs to be simplified. The main task of the surgeon is to meet with the patient. What the surgeon does for preparation and what is discussed with the patient does not have to be checked specifically.

6.2.1.8 Timeout_ANE

The time-out checklist is a common used checklist just before surgeries. We copied the checklist completely from the original one (Appendix N), but made a slight addition with regard to patient safety. The seventh line shows a warning, which is based on a rule. The rule checks if *Penicillin* is among the allergies of the patient, and then it checks whether the penicillin is among the medication of the patient, if both are true this warning will be provided.

Item	Check	Note
Patiënt … gezien		
Geboortedatum patiënt .. is correct		
Ingreep is genoteerd		
Te verwachten **bijzonderheden** genoteerd		
Zijde is gemarkeerd		
Positionering patient is bekend		
Patient allergisch voor Penicilline!		
Anesthesietechniek is gecheckt		
Stollingsstatus is gecheckt en zo nodig gecorrigeerd		
Antibiotica in volgens protocol toegediend		
ASA classificatie is gecheckt (>2 expliceren)		
Bloedproducten zijn beschikbaar en aanwezig		

TABLE 15: TIMEOUT_ANE

6.2.1.9 12w_check_NUR

In the aftercare part the patient is seen by different specialist. The aftercare plan is changes regularly, the documentation from the bariatrics department reveals this. These schemes in appendix E and F are not consistent. Therefore we only worked out one aftercare checklist, and linked all of the other checklists to this one. Working out all of them would be a time consuming and irrelevant job.

Item	Check	Note
BMI gemeten		
BMI geschiedenis gezien		
Physiotherapeut heeft patient gezien		
Dietist heeft patient gezien		
Psycholoog heeft patient gezien		
Chirurg heeft patient gezien		
Nursing specialist heeft patient gezien		

TABLE 16: 12W_CHECK_NUR

6.3 Evaluation

Our potential research sample consisted of the five surgeons operating in the bariatric department of the CZE. However, the allocation of people who were available for interviews went via an anaesthetist, who is active in multiple departments introducing Tracebook. Together, we figured the surgeons must be the first ones to be convinced for cooperation.

The first participant was surgeon N, to whom we introduced Tracebook and gathered his first impression. In this interview we did not specifically address the two viewpoints. This interview was at an early stage of this research. In order to make progress at this department we wanted to convince the surgeon Tracebook could be beneficial for them.

The second participant was surgeon S, who was available for two interviews, each with a time of 1,5 hours. Where the interview with surgeon N was more introductory, the interviews with surgeon S gave us deeper insight on both viewpoints. For the sake of clarity, all quotes from interviews are translated from Dutch to English.

First we will discuss the interview with surgeon N.

6.3.1 Interview Surgeon N

First, the demo was provided to surgeon N from the bariatrics department and an appointment was made to discuss the demo. This first meeting was used to introduce the system and gather his opinion and thoughts on Tracebook. Before this meeting we already had contact via e-mail, in which he already made clear the main obstacle he had with Tracebook: *"Truly said, It strikes me that in the example more than 100 clicks are needed in a separate program for something that is already running automatically."*

During the first part of the meeting we discussed the demo and surgeon N provided us with his opinion on Tracebook. He repeated his main obstacle with the system; the increase in workload when using the system. Also he mentioned the problem with the lack of interoperability with EZIS, in the sense that a different program needs to be used instead of EZIS itself. Surgeon N told us that their current working processes were already fully supported by EZIS and an additional program was unnecessary for them.

The second part of the meeting was used by surgeon N to show us a project his was enthusiastic about, namely BePatient. He showed how BePatient in the future will serve the role as patient informer. Furthermore he gave us access to BePatient during the testing phase, in which we could use BePatient as a patient, and experience how it can be beneficial here. During this testing phase it was found that patients have access to a variety of information about the bariatric processes. Videos are provided which explain some procedures and more. Furthermore BePatient also relocates some steps of the bariatric process, by letting the patient fill in their questionnaires online.

6.3.2 Interviews Surgeon S

6.3.2.1 Specific aspects

Evaluation of the specific aspects resulted in changes to the checklists as explained in the previous part. We can summarize the results of the interview regarding this subject in three parts (besides the minor changes explained earlier).

6.3.2.1.1 MDO

From the interview with surgeon S we obtained that there are two different types of MDO's. When the decision is easy to make, a 'quick´ MDO is arranged, which involves a surgeon, a dietician, a psychologist and a nurse practitioner. The quick MDO only involves some basic checking, since the outcome of the decision they need to make is already clear. When there is no consensus among the dietician, the psychologist and the nurse practitioner an *extensive MDO* needs to be held. During the extensive MDO there are more people involved; 2 to 3 people of every aforementioned role. The nurse practitioner is the person responsible for documenting the results during this meeting (Figure 37 in Appendix I shows the screen in EZIS which is used).

6.3.2.1.2 Granularity

This was due to an issue surgeon S had with the current way of forming the checklists; they were too specified. For example, the dietician knows exactly what she needs to discuss with the patient, therefore a checklist indicating that she needs to check the patient's history concerning diets and alcohol usage is needless. As Surgeon S said, "I don't need a checklist for driving from home to work, containing checks like *open the car door* and *start the engine*." The risk of specifying tasks like we did, is that the specialist will feel undermined. Surgeon S: "Let the specialists do their job, without trying to find out what they do exactly". Therefore we choose to simplify the original checklists from detailing every activity to simple to-the-point checklists. Instead of detailing every subject the screening roles need to discuss with the patient (alcohol usage etc.), we only let them select via a drop-down menu whether they think a 'quick' or 'extended' MDO session is necessary.

6.3.2.1.3 Automatic checking

The third important change requested by the interviewee was automatic checking. As soon as a staff member needs to check an item and the related activity was previously performed in EZIS, it becomes a superfluous step. If it involves an activity which can be tracked by Tracebook, this can be automatically checked.

An example of such a step is selecting the outcome of the MDO. This is done by choosing an option in a drop-down menu in EZIS (figure 23 in Appendix E). This choice is most likely saved in a database connected with EZIS, which means Gaston could access it. Based on this choice a rule can be made in Gaston, which determines the further continuation of the care process on the basis of the outcome of the MDO. This is one example of an automatic checking step. Steps that involve inserting plain text into EZIS are however difficult to check automatically.

6.3.2.2 General aspect

Here we will discuss the evaluation of the general aspects of Tracebook. For this interview, interview guide 1 (Appendix E) was used. Next the answers will be provided, although not for every question separately.

Overall impression

We can summarize the overall impression the surgeon S had of Tracebook as following: he recognized the importance of a system as Tracebook, but was not satisfied with the extra workload it carried with it.

Benefits

He agreed that a system such as Tracebook, designed to control a process, can be beneficial. And it becomes even more interesting when you can analyse afterwards why a certain patient completed a certain process in a longer time period than the 'standard' patient. Secondly we discussed the benefit of the process becoming more clear and transparent, by giving an overview of the process and the staff involved at every step. Although he acknowledged the benefit of the process-oriented aspect of Tracebook, he did not valued it as very important. The third main benefit of Tracebook we discussed was the checklists being patient-specific. He highly valued the fact that the system was getting its information from EZIS and therefore provided up-to-date information when making decisions.

Drawbacks

Similarly to surgeon N, surgeon S also revealed that the biggest obstacle was the increased workload. As surgeon S said: *"The computers should be there for us and not the other way around"*, to indicate that any additional health application should be beneficial for the surgeons and should not increase their workload. They are currently experiencing problems with DICA, which is a Dutch institute for the registration of all kinds of medical data (clinicalaudit.nl). DICA requires hospitals to record every operation and other medical procedure in a database, to make a comparison between hospitals and provide it as a source of information for health insurance companies. Since this registration is not automated, it is a time-consuming and inconvenient process. This increases their demand for additional applications to have a perfect fit with their working processes.

As he also mentioned, the working hours of a surgeon are well-paid, therefore unnecessary tasks are a waste of money. What he and his colleagues mostly not like is searching in different screens, to be sure they filled in/checked all the boxes they should do. Especially when the result are not immediately visible. For example surgeon S mentioned: "When staff members don't see the value of recording every step, they will do it once or twice but then it will be neglected."

Improvements

Surgeon S made it very clear that any additional application should first of all not increase their workload. It would be optimal if items can be automatically checked based on activities they perform in EZIS. For example, when the administrator sends some form in EZIS, this is automatically tracked by Tracebook, and a check is placed with the corresponding item. Secondly surgeon S mentioned that applications such as Tracebook should be user friendly. With user friendly he basically meant that it should be immediately clear what to do when opening the user interface, he thought this was not immediately clear when seeing the checklist model. He himself is someone who has minimal knowledge of computers and it should therefore be not to complicated. A third recommendation from surgeon S was that it should be easy to adapt any part of the checklist model, in the sense that the sequence of the steps can be changed and additional steps could be added. This should be done by one of the stakeholders of the process, without involvement of an external programmer. Of course, he mentioned, configuring the process should only be allowed by staff that is qualified for these activities.

Practical problems

Furthermore we discussed the practical problems that would arise when using Tracebook. Besides from the extra workload which we already discussed, surgeon S also mentioned the use of multiple computer screens. Currently, in most of the cases he needs two screens when using his computer. One for the usage of EZIS and the other one to register data in the database for DICA. A third screen is not an option, since he does not want to lose direct contact with the patient. When mentioning Tracebook as an application on a portable device, such as a tablet, he still did not liked the idea of using three different screens.

Future developments

During this part of the interview we discussed the potential future developments. We gathered his opinion on patient involvement on Tracebook. This started a discussion on safety of patient data. As soon as the information can be accessed from the outside, it would be vulnerable for attacks, he

mentioned. It would also hold back doctors in their open and direct way of communication. They have to be careful in the notations they make, since some things may shock patients or can be misinterpreted.

Surgeon S also mentioned BePatient and how this application will serve the roll as informant towards the patient. Therefore the idea of Tracebook as an e-health application seemed unnecessary to him.

Finally surgeon S revealed that there are future plans for 'patient terminals', which can be used by patients to gather information about their appointment and for logistic reasons.

6.4 Guidelines & Methodology

Our experiences regarding the design changes to the prototype that were found necessary after the evaluation session can be translated in three important guidelines.

6.4.1 Level of detail

The first guideline is concerned with the level of detail of checklists. A lengthy checklist will increase the resistance among clinicians to fill in the checklist. As the previous results showed, checklists that specify activities which are straight-forward are not recommended. Therefore the first guideline is;

Guideline 1

Make checklists concise and to-the-point.

6.4.2 Location

The second guideline is concerned with the location of checklists. The original goal of checklists is to guarantee the patient safety. Therefore checklists should first and foremost be used at situations where the patient safety could be at stake. An example is the moment before a surgery. Since Tracebook is more than just a checklist support system and also supports processes, the usage of checklists is also necessary in other situations. For example when an important decision needs to be made on the continuation of the patient's care process. In this case the checklists serves not directly with the goal to increase patient safety, but is used to track the patient process. A third case in which checklists could be particularly helpful is the moment at which a complex decision needs to be made, which requires multiple sources of information as well as a good overview of the previous performed checks.

Guideline 2

Position a checklist at points where either (or a combination of);

- *the patient's safety needs to be guarded (e.g. before a surgical action to check for equipment, correctness of methods etc.);*
- *the continuation of the patient's care process needs to be determined (either manually or automatically);*
- *a complex decision needs to be made which requires a variety of information or/and an overview of previous performed checks.*

6.4.3 INTEGRATION

The third and final guideline that should be taken into account when modelling a prototype of Tracebook is concerned with the integration between Tracebook and the Hospital Information System. Every activity that is done in the HIS, and does not only require inserting plain text, could possibly be tracked by Tracebook. Therefore it should be examined how these activities can be tracked by Tracebook, so the checklist's items can be automatically checked.

It is important to note, that it should be carefully questioned whether an item should be automatically checked. In some cases this might not be desired, since the safety of the patient is at stake. Only items with can be checked with certainty due to some activities that are done in the HIS should be automatically checked. Situations where automatic checking might be dangerous should be avoided.

Guideline 3

For every activity which is done in the HIS and which can be tracked by Tracebook, examine whether automatic checking is desired.

6.4.4 METHODOLOGY

This part provides a concise methodology, which should be used as basis when developing a prototype of Tracebook. The timeline of this research had no room for the evaluation of this methodology.

1. Determine at what points in the care process checklists are needed, these points are called *checklist points*. An exact method for determining these *checklists points* is hard to define, since it depends on all kind of aspects. Guideline 2 gives an indication on where to place checklists.
2. Determine for each *checklist point* which role will be responsible for filling in the related checklist. The process model will usually provide suggestions for this, since here tasks are positioned in the lane of a certain role.
3. When the *checklist points* are determined, transform the process model (including subprocesses) into the checklist model, which only contains activities at the *checklist points*. This step usually means the process model needs to be reduced (since it contains too specific tasks), but checklist points at crucial points can also be added. When the model is to large and complex after this step: divide the checklist model into multiple checklist models.
4. For every activity in this checklist model add an abbreviation of three letters for the corresponding role to the end of its name. These abbreviations are used by Tracebook to read out the responsible role.
5. Model the flowcharts. Each checklist point is connected with a flowchart, which determines the content and order of the items in the checklist. Modelling these flowcharts is done in Gaston as explained in part 4.2.3. For each flowchart the following aspects need to modelled:
    a. Determine what items (called *primitives* in Gaston) the flowchart needs to contain (use guideline 1).
        i. Use a decision step when an item needs to be shown depending on a certain condition. When a decision step is needed, first model this step in a different flowchart. Then link to this 'sub'flowchart in the original flowchart.
    b. Determine the order of these items.

c. Determine whether items need to contain information from HIS and how to present this information (pop-up or inline).
d. Determine whether items need to contain other relevant information (pictures, videos, hyperlinks etc.).
e. Determine whether items need to be out-standing by marking them with a colour.
f. Determine whether a check can be automatically checked on the basis of information from the HIS (e.g. certain value is ok), guideline 3.

6. Connect the flowchart with the checklist model (explained for the use case in chapter 4).
7. Insert roles and users in the database.
8. Test the checklist model (when experiencing problems consult manual (Vermeulen 2014).

6.5 PATIENT INVOLVEMENT

6.5.1 LITERATURE REVIEW

In Figure 16 the results of the literature review are shown categorized in whether it was a barrier for the patient or for the caregiver.

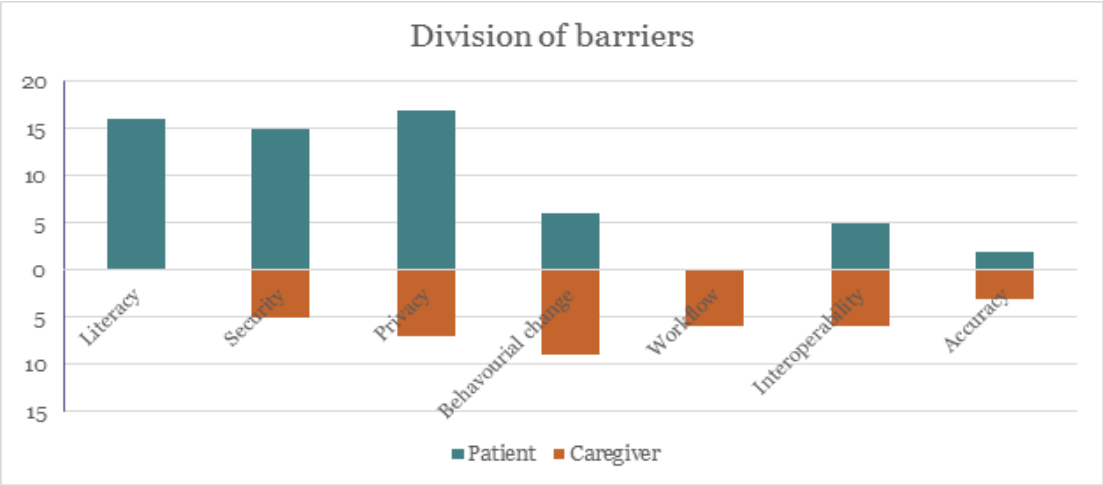


FIGURE 16: DIVISION OF BARRIERS

Of the seven major barriers that were identified with using or adopting a PHR, three were critical, namely *privacy*, *workflow* and *interoperability*.

Privacy is related to the unwilling exposure of a person's clinical information to parties that are not supposed to see this information. Privacy is connected to security; a poorly secured PHR is more prone to attempts of improperly accessing the PHR. Privacy is however a point of interest in the current state of literature, for example MyPHRMachines provides the patient with a secured cloud-based PHR in which it can be chosen with whom to share medical data (Van Gorp & Comuzzi 2012).

What in this research is called the increased workload, corresponds to the barrier workflow from the literature review. The main cause for the increased workload is the interruption of a caregiver's workflow while using the PHR (Linder et al. 2006).

The third critical barrier is interoperability. In the optimal situation the input of data into the patient's PHR is done automatically by integrating it with the EHR available of the patient. The

literature review however showed that in many instances the interoperability between the PHR and the existing systems was lacking.

When we relate this to the barriers found in this research, we see some similarities. The increased workload with using Tracebook was the most important barrier for surgeon S and it was also a critical barrier from the literature review (workflow). Secondly, a mentioned problem by surgeon S is that Tracebook is not interoperable with the current systems, since too much steps are needed for completing a checklist (interoperability). Finally, the third critical barrier was privacy, which is important when considering patient involvement opportunities for Tracebook. Patients are uncomfortable with the idea that all their information is stored at one place, since this makes it vulnerable with regard to security and privacy.

6.5.2 Results patient involvement

By means of an interview we acquired the opinion of surgeon S on what level of information sharing would be acceptable. Different levels are possible with regard to information sharing. When all information would be disclosed, patients would have the same view on tracebook as healthcare professionals, only without writing access. When certain information is not shared with patients, a different view on Tracebook needs to be made where only the information is showed that patients have access to.

The levels of information sharing which are possible, with the higher the level, the higher the disclosure towards patients are shown in table 1.

Level	Checklist model	Checklists	EZIS information	Notes
Level 1	×			
Level 2	×	×		
Level 3	×	×	×	
Level 4	×	×	×	×

TABLE 17: LEVELS OF DISCLOSURE

After explaining the design change and scenario sketch, the different levels of disclosure (Table 17) were topic of discussion. The first question aimed on what level of disclosure the surgeon thought would be appropriate.

He had no problems with sharing an overview of the care process with the patient, which is level 1. Level 2 also involves sharing the checklists. This already seemed not as a good option to him. He mentioned the following two problems that could arise:

1) Imagine a situation where the patient has a meeting with a doctor who slightly deviates from the steps he should do according to the checklist. The patient could address this, and tell what the doctor actually should do, which will result in strange patient-doctor relationships.

2) Secondly, the checklists contain information on decisions, for example the decision to reject the patient for a bariatric surgery. When the patient has access to this, the possibility exists the patient has to read this sensitive information from a patient terminal instead of communicated via a professional.

Then we discussed why it was important not to share all information with patients. He answered that for people without medical education a lot of information can be misinterpreted. Secondly, he motivated that sharing all information (including notes) would restrict staff to openly communicate.

We also discussed the scenario we sketched earlier, with regard to the patient terminals. He mentioned some practical problems when patients can see extended information on these terminals;

1) The waiting times for using these machines would become large;

2) Since it is quite some personal information there is the issue of how to keep this information private. Screens should be only visible for the patient working on it. When the patient leaves the terminal the personal information should not stay on the screen.

He suggested the terminals would be particularly useful for directing the patient and following the patient throughout the hospital. This to reduce the waiting times for patients, and better help the many patient that are currently 'lost' inside the hospital. Some departments require patients to 'pick a number', which could be done automatically as soon as patients enter the hospital, this will reduce waiting times.

Furthermore the idea of social insights, by providing patients access to profiles of their doctors, was not positively evaluated by surgeon S. All this information was already available at the CZE website, and therefore not necessary to display on patient terminals.

CHAPTER 7: DISCUSSION

The evaluation sessions revealed some important information regarding the general aspects of Tracebook. In this chapter this information will be discussed. The key findings can be seen as the main aspects that the surgeons want to see different regarding Tracebook (part 7.1). Based on these key findings we will sketch a scenario (part 7.2), which describes a situation where a future version of Tracebook is used and in which those key findings are processed. Then in part 7.3 we will discuss the development recommendation that are implicated by this future scenario.

7.1 KEY FINDINGS

The following key findings are derived from the interviews with the surgeons. These can also be seen as the main drawbacks of the current version of Tracebook.

7.1.1 WORKLOAD

The most important change the surgeons wanted to see, is that Tracebook would lighten their work instead of burden it. To diminish this negative aspect as much as possible, we should therefore try to make the task of completing the checklist as less tedious as possible. This means that we should aim even more at providing context-aware checklists at the appropriate time, to the appropriate person and especially without any actions necessary for them to find the checklists. To realise the last part, Tracebook could be implemented in EZIS such that a tab will contain the patient's checklist model.

Another aspect of the same drawback is automatic checking. As surgeon S mentioned, *"automation is about automating processes and not giving doctors more work to do",* the automating checking aspect of Tracebook is important. Currently Tracebook is able to automatically check items based on certain conditions which are stated in Gaston. Gaston can for example check the availability of the patient's blood type in EZIS and Tracebook provides a checkmark with the item *"check availability of blood product".* The desire of the surgeons however, goes beyond this kind of automatic checking. To illustrate this with an example, they desire that Tracebook automatically checks the item *"prescribe medication to patient"* when the surgeon actually prescribes the medication in EZIS. This is related to the integration of Tracebook with EZIS, since without a good integration between the two systems such automatic checking is not possible.

7.1.2 EFFICIENCY OF ADAPTABILITY

Adaptability is considered to be one of the building blocks of a solid information system. It is also called maintainability in the software literature (Ortega et al. 2003). A software product is considered to be maintainable when the software can be modified, this can include corrections, improvements or adaptations to changing environments. A software tool can be maintainable, but as Surgeon S mentioned this should also be done easily, without the input of external parties. So partly this also involves efficiency, which is also an important aspect of a solid information system (Ortega et al. 2003). This implicates that maintaining a software tool should be done efficiently. When we compare this to the current maintainability and efficiency of Tracebook, we can make some recommendations. First of all, Tracebook can be adapted to every process; the checklist model can be configured to be suitable for every care process. When we consider the efficiency of adapting Tracebook to a changing care process, we must conclude this is still a lacking aspect. The process of altering the workflow model in Bizagi, connecting it with the right web service, uploading it into Tracebook, connecting it with the checklist from Gaston and so on is quite cumbersome. This can be

learned by a staff member, with the help of the guide on Tracebook, but considering that most doctors, like Surgeon S, are unfamiliar with such complicated tasks, that may perhaps be unrealistic. However, when comparing this to the current situation, in which an external developer needs to be hired to make a change in EZIS, the adaptability of Tracebook is already quite an improvement.

7.2 FUTURE SCENARIO SKETCH

Next an ideal future scenario will be described in which Tracebook plays an important role. Since this scenario implicates changes that are beyond the scope of this master thesis, we can only sketch the scenario. An actual demo is not realistic and therefore not the focus of the remainder of this chapter.

In this scenario the patient John Doe arrives at the hospital for the screeningsday, he needs to undergo a bariatric surgery. When John was at the hospital for the first time and registered to start to follow the bariatric care process he was given a patient identifier, which is a card to identify himself. At the entrance of the hospital there are 'patient terminals', which are electronic poles, that direct the patient to the appropriate department after they scanned the patient identifier. John scans his card and gets to see some personalized information. He can see he has an appointment with a dietician, a psychologist and a surgeon and the location and times of those appointments. Furthermore the screen shows him the directions to the bariatrics department.

Arriving at the bariatrics department again a device scans the patient identifier and automatically tracks John's location in his care path. The application behind the scanning device, called Tracebook, now knows John Doe is at the bariatrics department. Tracebook is aware of the patient's care path and looks up the patient's progress in the checklist process the patient currently is in and can for example provide the secretary with a pop-up containing the checklist. This implicates that the secretary does not has to search for the checklist in either a different screen or a tab in EZIS, but the checklists pops up at her main screen. Items that need manual checking are showed, and items that can be automatically tracked are already shown checked. The patient then waits for his appointments with the dietician, psychologist and the nurse practitioner. Meanwhile the device used for scanning the patient's id, can be used by John for informative reasons. When John scans his id card, the screen will show him all sorts of information. The screen can give him personalized information that is specifically centred at John and his disease. By showing John the checklist model, he acquires specific info on the care path he is currently in; what activities does he need to undergo and what specialists are involved? An extra option would be here to show John the different operations that are common for bariatric surgery, and videos that explain some concepts unknown to him.

When John then arrives at the consulting room of the dietician, a device is used to scan his patient identifier. Since Tracebook now knows which patient is at the dietician's office, it can pull its information from the database. At the dietician's computer immediately a checklist appears. The dietician can see which activities he needs to perform and checks them. Just as with the 'regular' version of Tracebook, the checklist is specific for John Doe. Also the other features are still present; the dietician can make notes, review other steps in the process model and so on. After the dietician is done with John Doe, he completes the checklist and submits it. Tracebook processes this information and goes on with the next step in John's care path.

The above sketched scenario implicates a system which is hospital wide, it however doesn't replace the current hospital system EZIS. The doctors still need to fill in the relevant information in EZIS. By providing the clinicians with a checklist that immediately pops up as soon as the patient is identified,

there is no increase in workload. There will be even a decrease in workload, since all the relevant information can be immediately showed in checklist, without searching for it in EZIS. What Tracebook does, is providing a quick overview on what needs to be done on the patient.

7.3 DEVELOPMENT RECOMMENDATIONS

In the previous part we sketched a scenario in which Tracebook is extended to also solve the problem regarding the lack of patient involvement. Besides the patient involvement part, this scenario also presented Tracebook in a different manner, containing features which are currently not possible.

7.3.1 PATIENT IDENTIFICATION

The previous made scenario sketched some changes regarding patient identification. First of all, by scanning the patient id, a pop up can be shown. Secondly, the progress of the checklist model will change when tracking patients this way.

Since the *scanning feature* currently is partially possible, this section will only try to stress the importance of this development. When the checklist is pop-upped on the caregiver's main computer as soon as the caregiver's sees the patient, it reduces the manual steps that currently have to be done: the caregiver first has to open Tracebook, then he has to search for the right patient, then he has to look up at which step the patient currently is, he selects that step, has to fill in his credentials before he can eventually see the checklist he needs to fill in. In the newly described situation all those steps are not needed anymore since the right checklist will automatically pop-up on the caregiver's screen, without involvement of the caregiver, as soon as the patient's id is scanned.

Currently it is possible to scan a QR-code, which links to the page where the patient's checklist model is given. The next step is then to select the checklist in this model, fill in the credentials and the checklist is displayed. This will already lower the *increased workload* barrier. However, as soon as the progress in the checklist model for some reason is not updated to the actual progress of the patient(i.e. a previous checklist still needs to be filled in) in the current *scanning method* the clinicians first needs to search for the right checklist to fill in. For our case study the checklist model was not that complex, but this could be a cumbersome task.

In the newly described situation the patient is tracked in real time by means of scanning the patient code. As soon as the patient arrives at the dietician, and the previous staff member did not completed their checklist yet, the dietician still gets to see the checklist which needs to be filled in. Of course there are situations in which it is dangerous to continue with the process if a previous checklist was not completed yet. This needs to be specified when configuring the checklist model.

As the interview revealed, a supporting application such as Tracebook should be designed to support the working processes of the clinicians. Making this change in the manner of presenting the checklists to the clinicians is therefore an important decision, because it reduced (perhaps removes) the barrier of extra workload. Obviously another benefit of presenting the checklist as a pop-up on the clinicians main screen, is that it cannot easily be forgotten to fill in the checklist. To indicate why this is important; at the time of the interview with Surgeon S, he still had to register the data of three surgeries he had performed earlier in the DICA database.

7.3.2 PATIENT INVOLVEMENT

Perhaps the most important design change of Tracebook is patient involvement. As described in the scenario sketch, the patient is informed by a patient terminal about his or her care process. This device can be some sort of tablet, or a computer and monitor build inside some kind of pole. How this exactly will be presented in reality depends on different factors, like costs and logistics.

As mentioned in the problem description, a current issue in healthcare is the level of involvement of patients in their own health care. More active patients, benefit more easily from the care they receive (Brody et al. 1989). This is particularly true in the care for obesity patients, since they need to maintain their weight by being actively aware and involved. BePatient is an e-health module currently focused on this aspect. Tracebook does not play a role in this yet.

Besides using these patient terminals for efficiency reasons (better directing the patient through hospital and reducing their hospital stay), we propose they could also be used to inform patients. The patient can see when their appointment is and with whom. The patient can select the specialist with who they are meeting by clicking on the specialist's profile picture. The specialist's profile contains all their relevant information, with a background story. This will make the contact between the patient and the specialist more personalized. It was found by O'Leary et al. (O'Leary) that patients are often unaware of the identities and roles of the people taking care of them; only 32% of the in-hospital patients could correctly name a single one of their hospital physicians.

Besides the information about the specialist, the patient can also see information about the process they need to follow. It will show, just as in the regular version of Tracebook, the steps that are done and need to be taken. Identical, it will show which specialists are involved at each step. When we focus on bariatrics, the *patient terminal* could display information on the patient's progress with regard to losing weight. To focus even more on the main task of Tracebook, it could also be used by patients to complete checklists, which would be particularly interesting for the after-care stage.

Combining e-health with Tracebook would have been another option to increase the patient involvement. By using an e-health version of Tracebook a checklist can be made to check whether the patient completed his or her steps (taking medication, weighing, physical activities). This however raises issues of security and privacy, which were much mentioned barriers among patients with regard to using a PHR (see results literature review).

We choose to provide patients access to the system during their in-hospital time. This was partly motivated by a remark of surgeon S about *patient terminals*, although he thought more of it as a solution for logistical issues. According to Vawdrey et al. (Vawdrey) the empowerment of patients can be particularly done when patients are admitted to the hospital. Patients will feel alienated, uncertain and anxious when there is a lack of information and active engagement in their hospital care (O'Farrell et al. 2000).

In the scenario sketch we presented the patient involvement change in the form of a patient terminal, which is located at different places throughout the hospital. Another more direct option, is a bedside terminal (Svanæs et al. 2010). This is basically a PC where the patient communicates via a touch screen. The terminal is mounted on a movable arm, so that it can be used by the patient in multiple positions.

In a previous part we already researched the surgeons feeling about disclosing information towards patients, since it requires a change in behaviour. Patients should therefore be offered a different view on Tracebook. The UI should thus be different than the UI the specialists get to see. This needs to be separated, since otherwise it will withhold the caregivers from communicating in their own, direct way. Besides that, some information might be irrelevant, unclear, or can be misinterpreted by the patient.

Research by Vawdrey et al. (2011) showed that in-hospital patients are eager to use a tablet computer for accessing health information, such as their medication history and social information, such as photographs of involved caregivers. They remarked however, that some patients were uncomfortable when interacting with the device. Therefore such a system should not be enforced on patients, but should be presented as a fun optional tool for patients to play an active role in their own care.

CHAPTER 8: CONCLUSION & FUTURE RESEARCH

In this chapter we will reflect on the essence of this research. What can we conclude on the results of this thesis? Have we achieved what we wanted to achieve? In what sense does this research contribute to the current state of research? What is the academic value of this thesis? In what way can future research projects develop on the found results?

8.1 CONCLUSION

This research tried to solve the following global research problem:

How can Tracebook facilitate process coordination, checklist usage and patient participation in the bariatrics domain?

An answer was found to this question step by step, using three sub research questions.

RQ1: How can a prototype of Tracebook be developed?

The first step was to specify what is needed to model a prototype of Tracebook; the requisites. We concluded in this part that a conceptual process model should be the basis of a checklist model and flowcharts. We demonstrated how a prototype of Tracebook can be developed for a specific use case.

RQ2: How can a prototype of Tracebook be evaluated?

The next step was the evaluation of the prototype. We constructed a demo, in which the prototype was walked through, with voice guidance. This demo was then evaluated by two surgeons and with the assistance of constructed interview guides their opinions were gathered. This way, we demonstrated a method for the evaluation of a Tracebook prototype. The results of these evaluations were two-fold;

1. One the one hand the aspects that are specific to the use case were evaluated. This resulted in specific changes to the prototype. It also resulted in three guidelines and a more technical methodology which should be taken as basis for further projects.
2. On the other hand the general aspects of Tracebook were evaluated. The results showed that the increase in workload Tracebook brings along was being perceived as the most important barrier.

RQ3: How can Tracebook be extended to also involve patients?

In the third research question we focused on the third observed problem, the lack of patient involvement. This is a trending topic Tracebook is currently not active in, but could provide benefits for. We made a scenario sketch in which Tracebook is used as a tool to involve and engage patients in their own care. An important aspect in this matter is the level of disclosure of information towards patients. This was researched by interviewing a single surgeon. Due to this small sample size it is impossible to draw conclusions on this subject, but it was found this subject is sensitive among surgeons.

Finally we want to conclude on whether Tracebook is a good tool to facilitate process coordination, efficient checklist usage and patient involvement. Based on this study's results, we must conclude that Tracebook still has some issues which needs to be worked on. With the right software programming skills the drawback of increased workload can however be diminished. And when this barrier is removed, Tracebook can indeed facilitate efficient checklist usage and process coordination. To also facilitate patient involvement, an extension needs to be developed for Tracebook. We have shown a solution in which Tracebook hypothetically can also facilitate patient involvement.

The final deliverables of this research are; the process model for the CZE's bariatric department, the recommendations on the further development of Tracebook and the guidelines and methodology for future projects concerned with building a prototype of Tracebook for a specific use case.

8.2 LIMITATIONS

It is important to reflect on what was reached with this research, and how this could have been done better. This can then also be the basis for related future research.

First we will focus on the academic value of this research. The larger the sample size, the better conclusions can be made on the entire population. In the case of viewpoint 1 (specific aspects for the use case) the population consists of all the medical staff involved in the care for bariatrics patients at the CZE. In the case of viewpoint 2, where we evaluated the general aspects of Tracebook, the population consists of all potential medical Tracebook users. For viewpoint 1 the sample size consisted of two surgeons and for viewpoint 2 only one surgeon was questioned. Therefore our results are potentially not significant enough to make the conclusions we made.

Of course every research is dependent on the resources that are available, including time and manpower. Also the method of data collecting depends in some way how large your sample can be. When we would have chosen for a quantitative research, our sample could have been greater, since it requires less time per participant. On the other hand, a quantitative requires more work for preparing the questionnaires.

As also stressed by the researchers of SURPASS it is important to have a company champion, a supporter (de Vries et al. 2010). In our case there was an anaesthetist who knew all about Tracebook and supported it. He knew how to convince important players throughout the hospital. When contacting the surgeons without such a *champion* it would be much harder to convince them for cooperation. The presence of this *champion* was therefore the reason to start this research in the Catharina Hospital Eindhoven. In spite of the fact we had the support of the anaesthetist we still had trouble convincing the first surgeon we met. Therefore this research had to endure some resistant. Finally we had to chance to cooperate with a different surgeon, which accelerated the progress of this research. This all shows that it can be difficult to find the right people for cooperation and therefore acquiring a broader research sample would have taken more time.

A second crucial limitation is the fact that this study produced a methodology without evaluating it. Usually, a methodology would first have been developed, then used in practice, in order to finally redesign it. Since there was no clear guide available on how to develop a checklist model and attached flowcharts, this was mainly done by trial and error. Besides this was the first study to formally evaluate Tracebook with a use case. However, this methodology should have been

evaluated by people who had some experience with the implementation of Tracebook in other departments.

8.3 FUTURE RESEARCH

Besides the surgeon obviously there are also other roles involved in the bariatrics care process. Further research should therefore be aimed at gathering evaluations from those roles as well. The nurse practitioner, the dietician, the psychologist and the secretary might have completely different opinions about Tracebook then the surgeons we questioned. Broadening the research sample inside the bariatrics department should therefore be the first objective of a future research project.

Apart from the configuration of Tracebook we also investigated the general aspects of Tracebook that should be improved. Those general aspects were also only investigated by two surgeons. Although the information we gathered was important and might have been representative for more colleagues, the academic value of this research takes a rapid fall by only collecting the opinions of two potential users. Here also interviewees from other departments could be questioned.

A large part of this thesis was concerned with designing the changes that Tracebook should undergo to serve as an adequate checklist support system. We made a scenario sketch, and stated that hypothetically these changes will solve several problems. Of course we cannot conclude that these changes do indeed solve the observed problems, since the design changes were not tested in practice. Future research should therefore also aim on testing the effectiveness of these changes in practices. Since some of them are logistical design changes, it is difficult to test them in practice, without actually developing the changes.

Additional research is necessary to assess the benefit Tracebook could provide towards patients. A prototype of Tracebook for patients should be produced. A *patient view* of Tracebook needs to be made, displaying less information of the original version of Tracebook. Instead of a patient terminal, this patient view can be provided via a tablet. Different groups of patients (i.e. old vs young) should be asked to evaluate the system with regard to the features they find beneficial.

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APPENDIX A: 7PMG GUIDELINES

G1	Use as few elements in the model as possible
G2	Minimize the routing paths per element
G3	Use one start and one end event
G4	Model as structured as possible
G5	Avoid OR routing elements
G6	Use verb-object activity labels
G7	Decompose a model with more than 50 elements

TABLE 18: 7MPG (MENDLING ET AL., 2008)

APPENDIX B: ADD AND LINK EXPRESSION

In Bizagi first an expression needs to be made, which can be done in the section of Bizagi called *Modules*, see figure 16. Figure 17 shows the screen when a new expression is made. The web service location which should be inserted is shown in the screenshot.

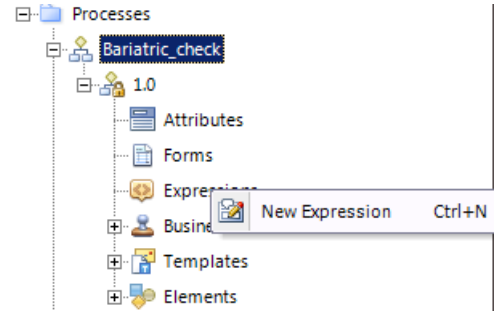


FIGURE 17: ADD NEW EXPRESSION

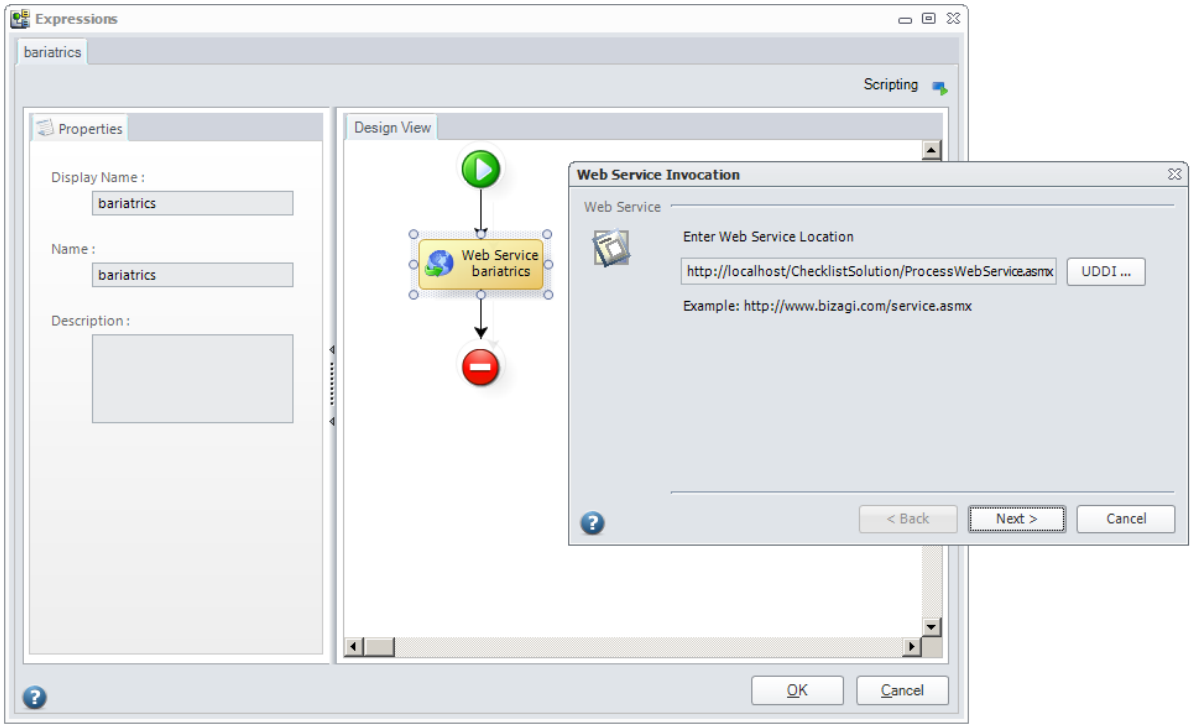


FIGURE 18: ADD WEB SERVICE LOCATION

Next a number of operations are shown that the web service provides, here the following operation needs to be selected: *CreateChecklistByScenarioName (String processID, String caseID, String scenarioName, string roleID).* Then for the parameters that are between brackets, the values displayed in table 18 should be inserted.

Name	Value

processID	Me.Case.ProcessDefinition.Name
caseID	Me.Case.Id
scenarioName	Me.Task.Name
roleID	Me.Task.Name.Substring(Me.Task.Name.Length – 3)

TABLE 19: EXPRESION PARAMETERS

When the expression is made every step in the workflow model needs to be linked to it. So when a certain step is 'activated' (the user selects the step in the workflow model) it communicates with the web service and sends the values from table 18 (appendix B) as parameters, in order to show the checklists in the UI. In Figure 18 it is shown that for the step Sign_in_SEC the bariatrics expression is added *On Enter*.

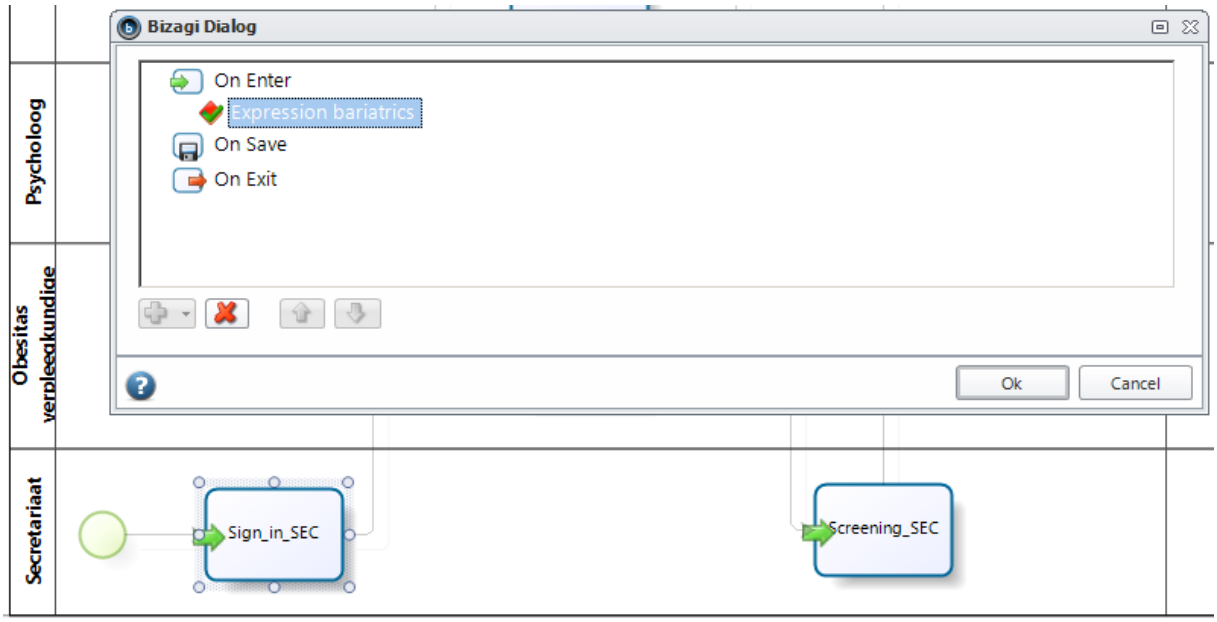


FIGURE 19: ADD EXPRESSION TO EACH STEP

APPENDIX C: GASTON MODELLING

When a simple item is required, the *recommendation* should be used. When adding it to a flowchart, a number of things should be specified. When a recommendation is opened, the screen in figure 19 is shown. There are two tabs important, the *Audit* tab is not used. In the *Structure* tab only the *General Settings* part is used. In *Label* it can be specified how the recommendation is named in Gaston.

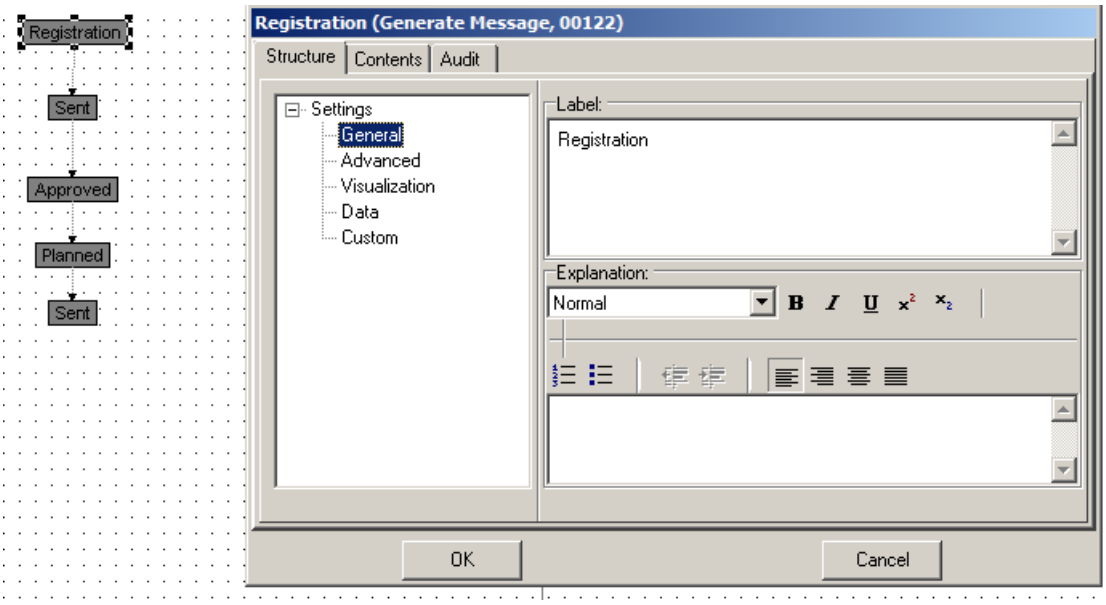


FIGURE 20: OPENING RECOMMENDATION

The *Contents* tab specifies what will be shown in the actual checklist, see figure 20. In *Message* the text needs to be entered which is shown as an item in a checklist.

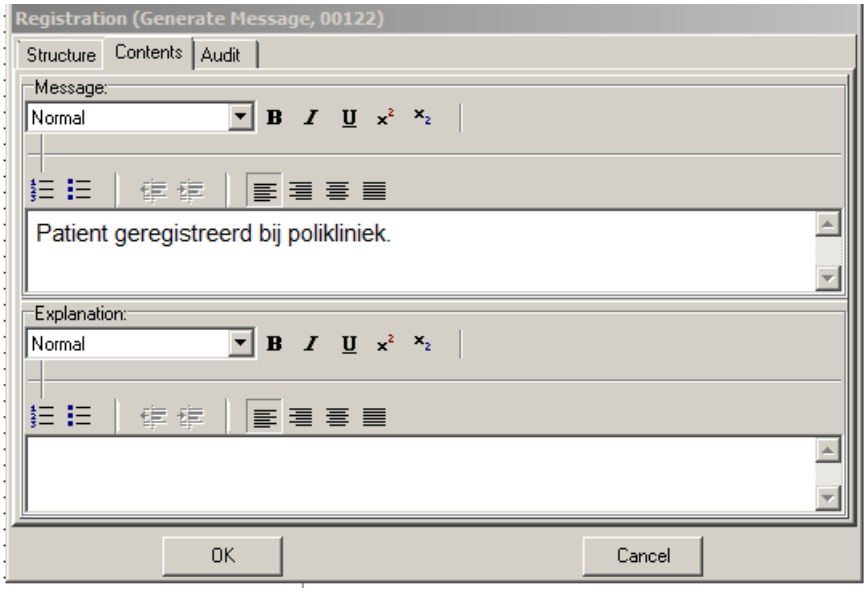


FIGURE 21: CONTENTS TAB

When information from EZIS needs to be displayed in the checklists it should be configured in Gaston. First however, in Gaston, new terminology needs to be created. This is quite complex, since it requires the usage of queries and sql statements. More on this in "handleiding CDSS v 3.5" (Vermeulen, 2014).

When the terminology is created in Gaston it will be shown at the left bottom of the screen, see Figure 22.

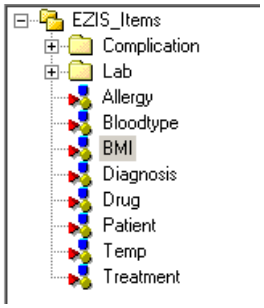


FIGURE 22: TERMINOLOGIES

When a certain variable should be shown in a checklist it needs to be dragged into the message screen. Then the attributes of the terminology should be chosen (BMI level and date in example). As well as the which values should be shown (the latest in example). Using this recommendation in a flowchart will result in an item showing the latest BMI level.

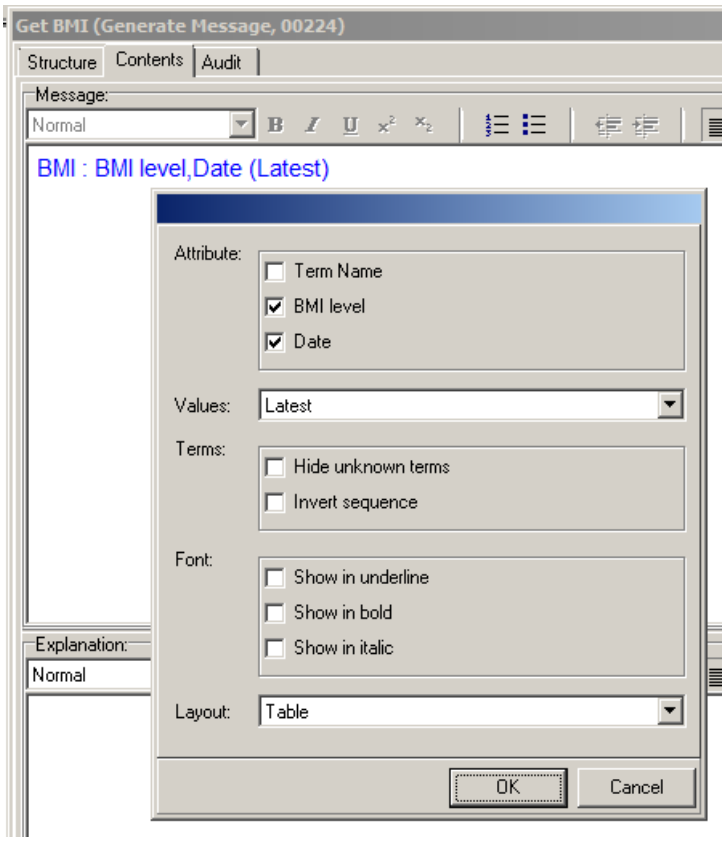


FIGURE 23: USING EZIS INFORMATION

When the BMI value should be showed in a pop-up however, the *hyperlink* should be used. In which you link to a different flowchart that contains the BMI value as shown in Figure 23. A flowchart which will display the BMI value in a pop-up is depicted in Figure 24. In the *Address* link you link to the ID of the corresponding flowchart.

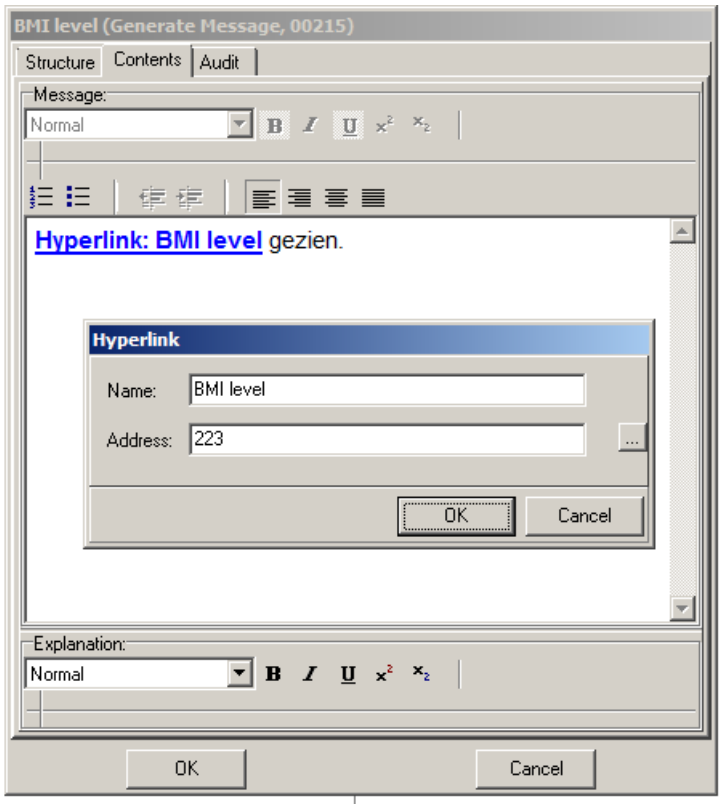


FIGURE 24: USE OF HYPERLINK

The decision step shown in Figure 9 is modelled as follows. In the first decision step it is checked whether Penicillin is among the patient's allergies, see Figure 25. If the result is *yes* the next step is to check whether Penicillin is among the patient's described medicine, see Figure 26.

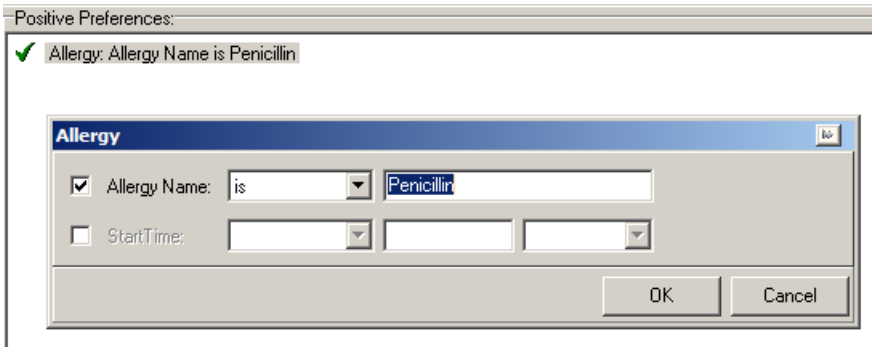


FIGURE 25: FIRST DECISION STEP

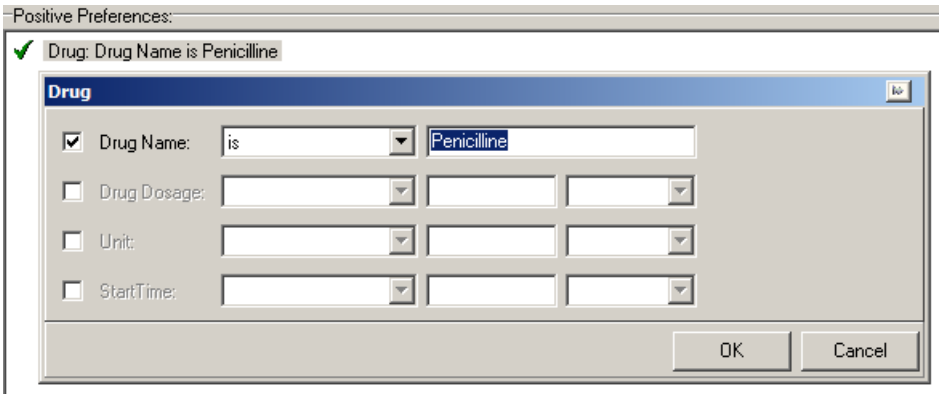


FIGURE 26: SECOND DECISION STEP

APPENDIX D: ADDITIONAL TOOLS

FIGURE 29: CHECKLIST EDITOR

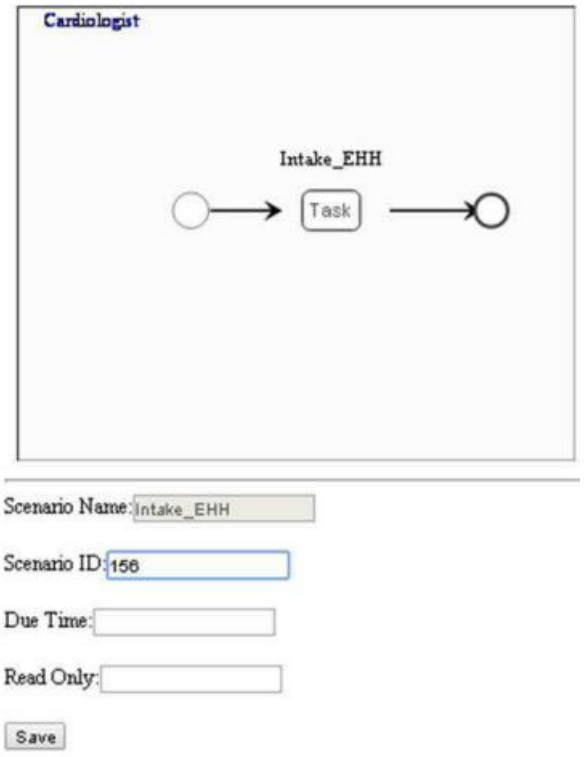


FIGURE 28: LINKING SCENARIOS

FIGURE 27: EDIT USER INFORMATION

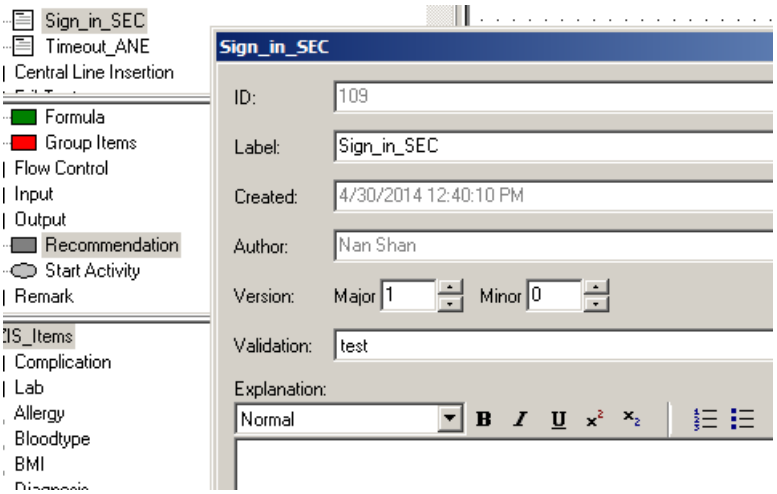


FIGURE 30: PROPERTIES OF FLOWCHART

APPENDIX E: INTERVIEW GUIDE 1

Introduction:

I. What is Tracebook.
II. What is the progress thus far.
    i. Intensive care Visite
    ii. Reanimatie
    iii. Mammacarcinoom
III. My research

1. What is your first impression of Tracebook?

2. How highly do you value the following benefits of Tracebook:
    I. Increase patient safety

    II. Process-awareness

    III. Context-aware (patient-specific checklists)

3. What do you think are the drawbacks of Tracebook?

4. Which practical problems would you experience when using the system?

5. Which improvements are necessary?

6. What do you think of future developments, like patient access to Tracebook?

APPENDIX F: INTERVIEW GUIDE 2

Where the previous interview was only focused on the general aspects of Tracebook, this interview will focus on the configuration of Tracebook for the bariatrics. Besides that we will go deeper in a single future development.

1. Walkthrough checklist model::
    a. Is the checklist model correct? / Are the checklists correct?

    b. *For every step*: Is this step done in EZIS and how?

2. Do you think it is important to hide certain information from patients? YES / NO
    a. Why?

3. There are different levels of information sharing with patients:

    Level 1; process model.

    Level 2; process model and checklists.

    Level 3; process model, checklists and pop-ups.

    Level 4; process model, checklists, pop-ups and notes.

    Which level do you think is the most appropriate?

4. Other information that should **not** be shared.

5. What information **should** be shown in a *patient terminal* according to you?

APPENDIX G: PROCESS DIAGRAMS IN VISIO-FORMAT (IN DUTCH)

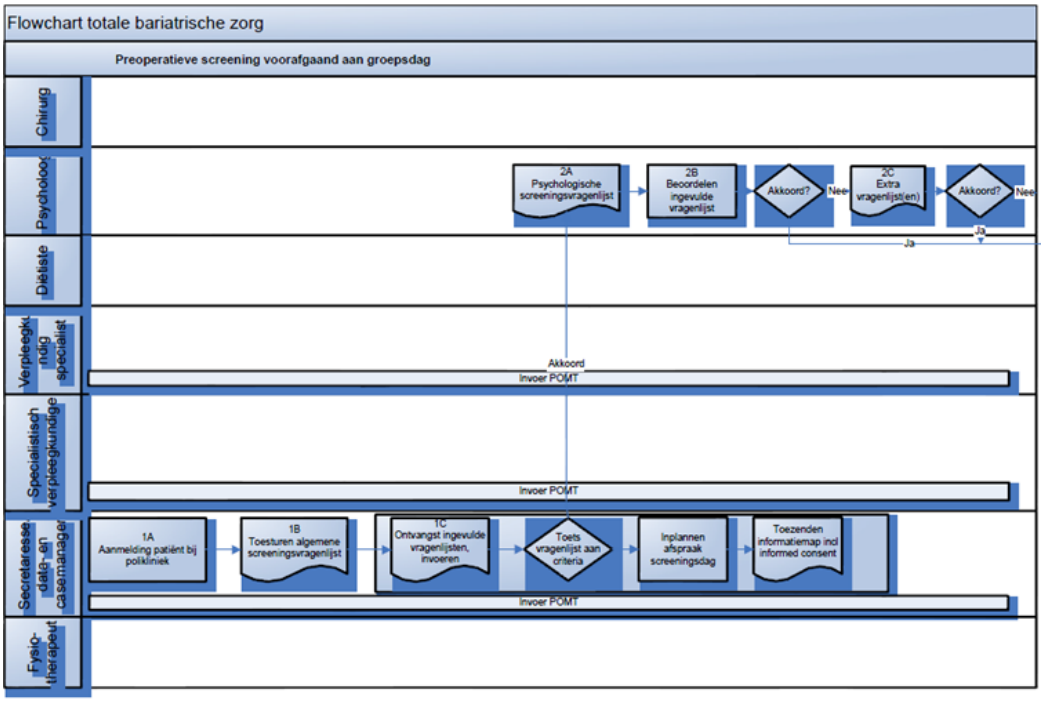


FIGURE 31 PROCESS DIAGRAM 1/4

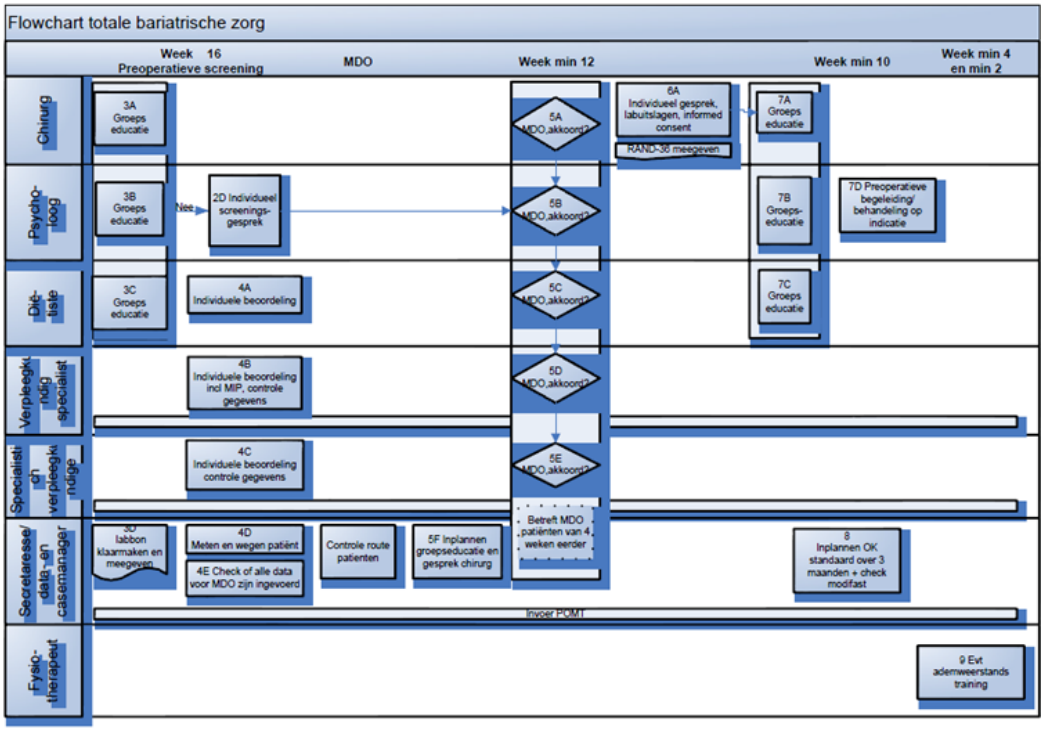


FIGURE 32: PROCESS DIAGRAM 2/4

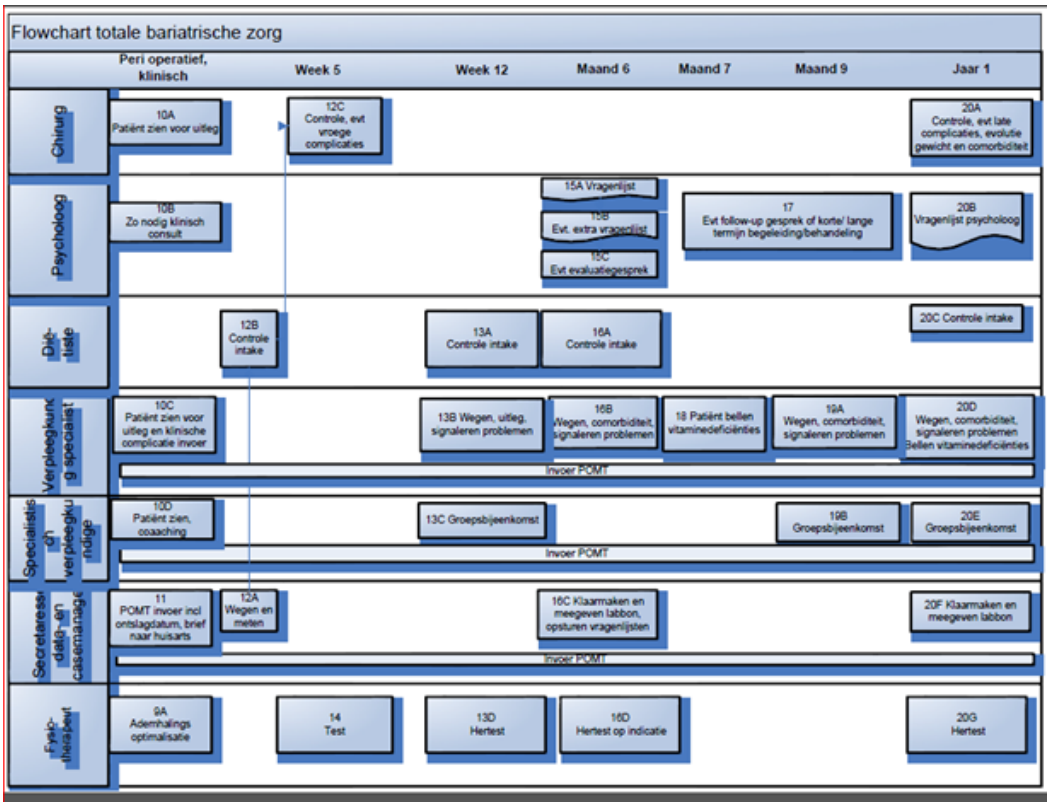


FIGURE 33: PROCESS DIAGRAM 3/4

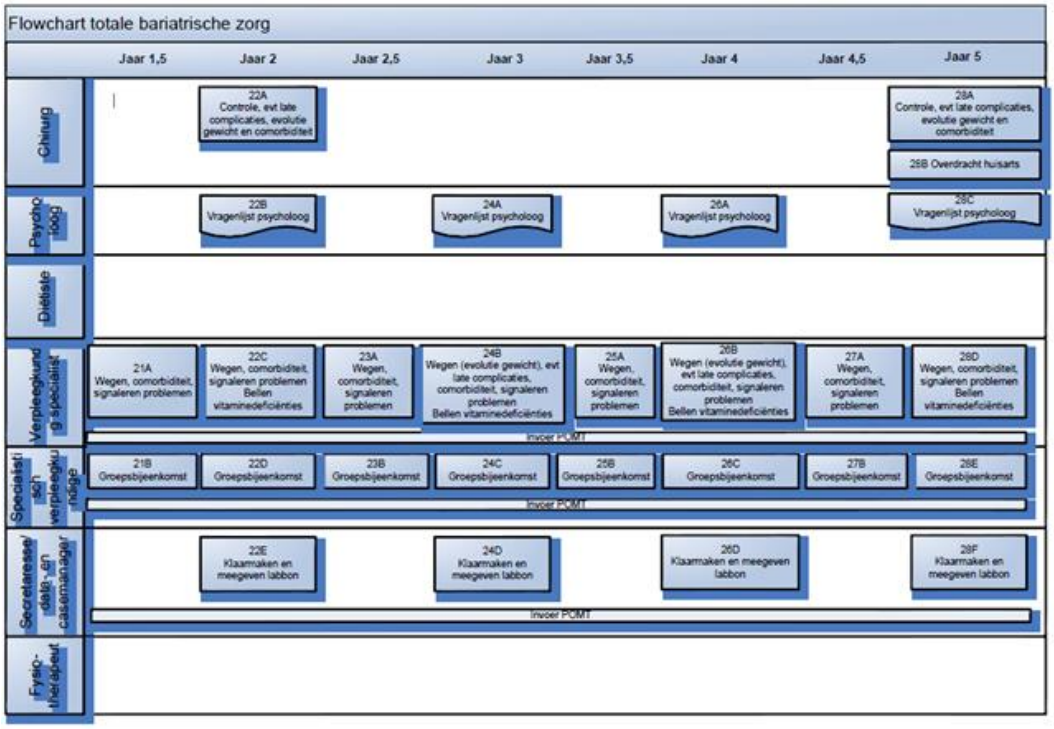


FIGURE 34: PROCESS DIAGRAM 4/4

APPENDIX H: DOCUMENTATION (IN DUTCH)

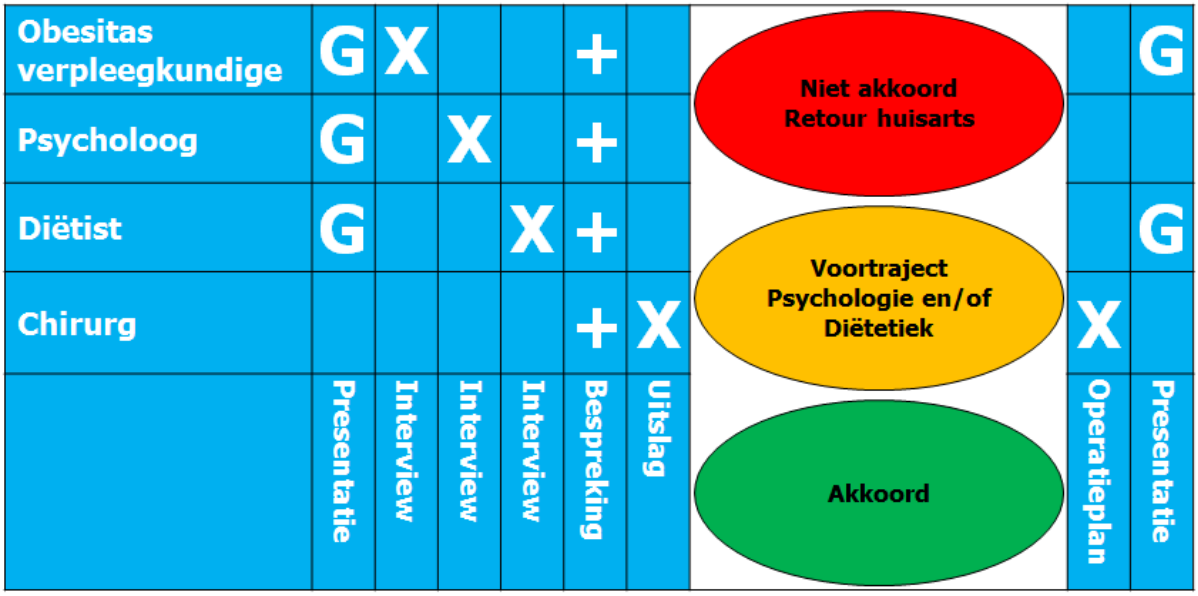


FIGURE 35: SCREENING STAGE

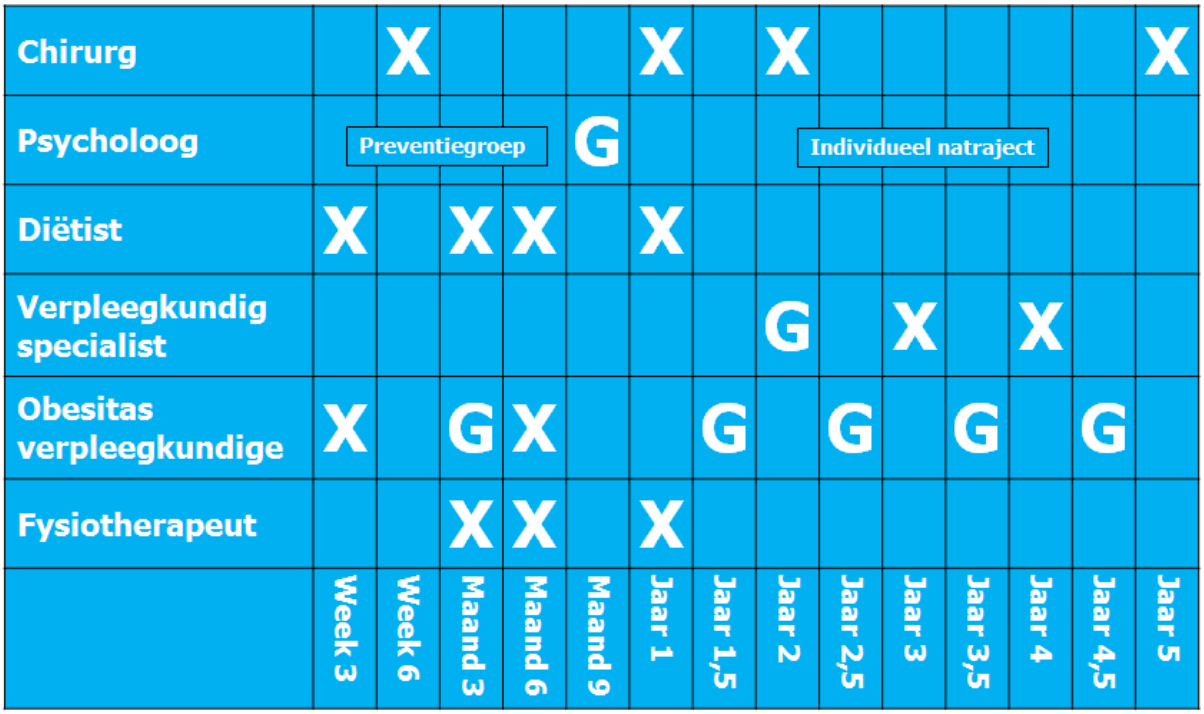


FIGURE 36: AFTER-CARE

APPENDIX I: SCREENSHOT EZIS

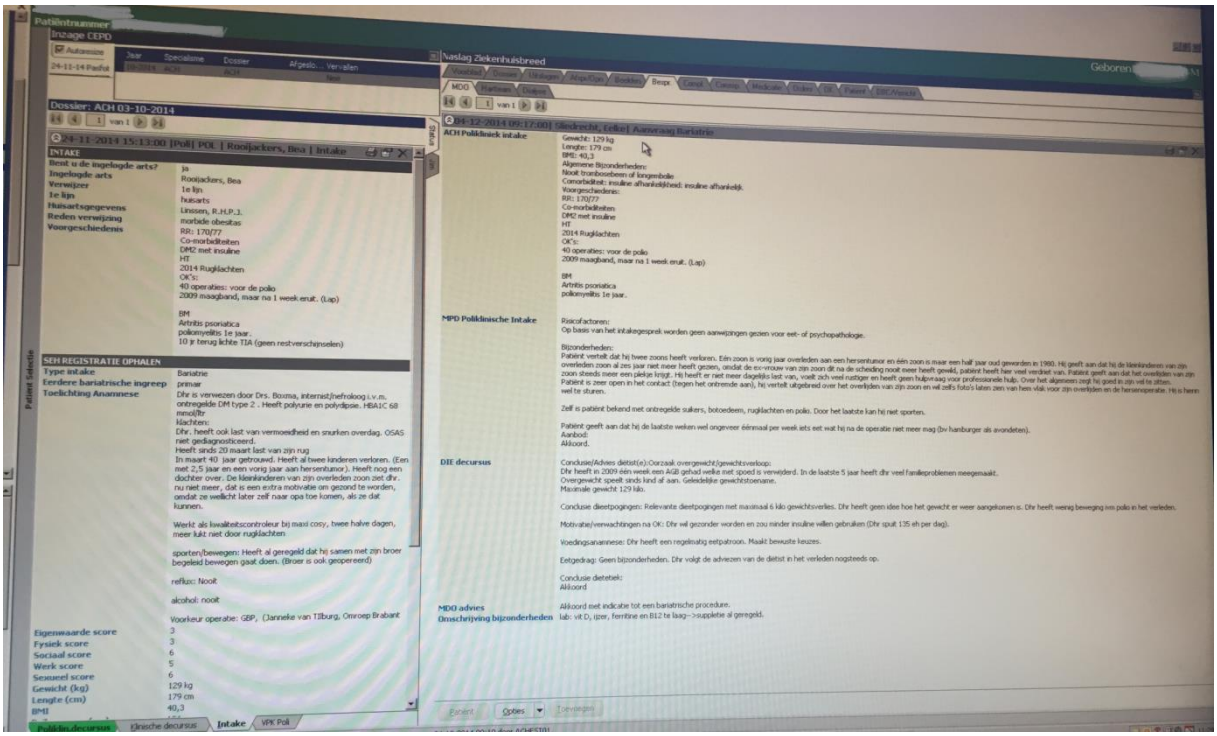


FIGURE 37: MDO SCREEN

APPENDIX J: BEPATIENT WEB-MODULE

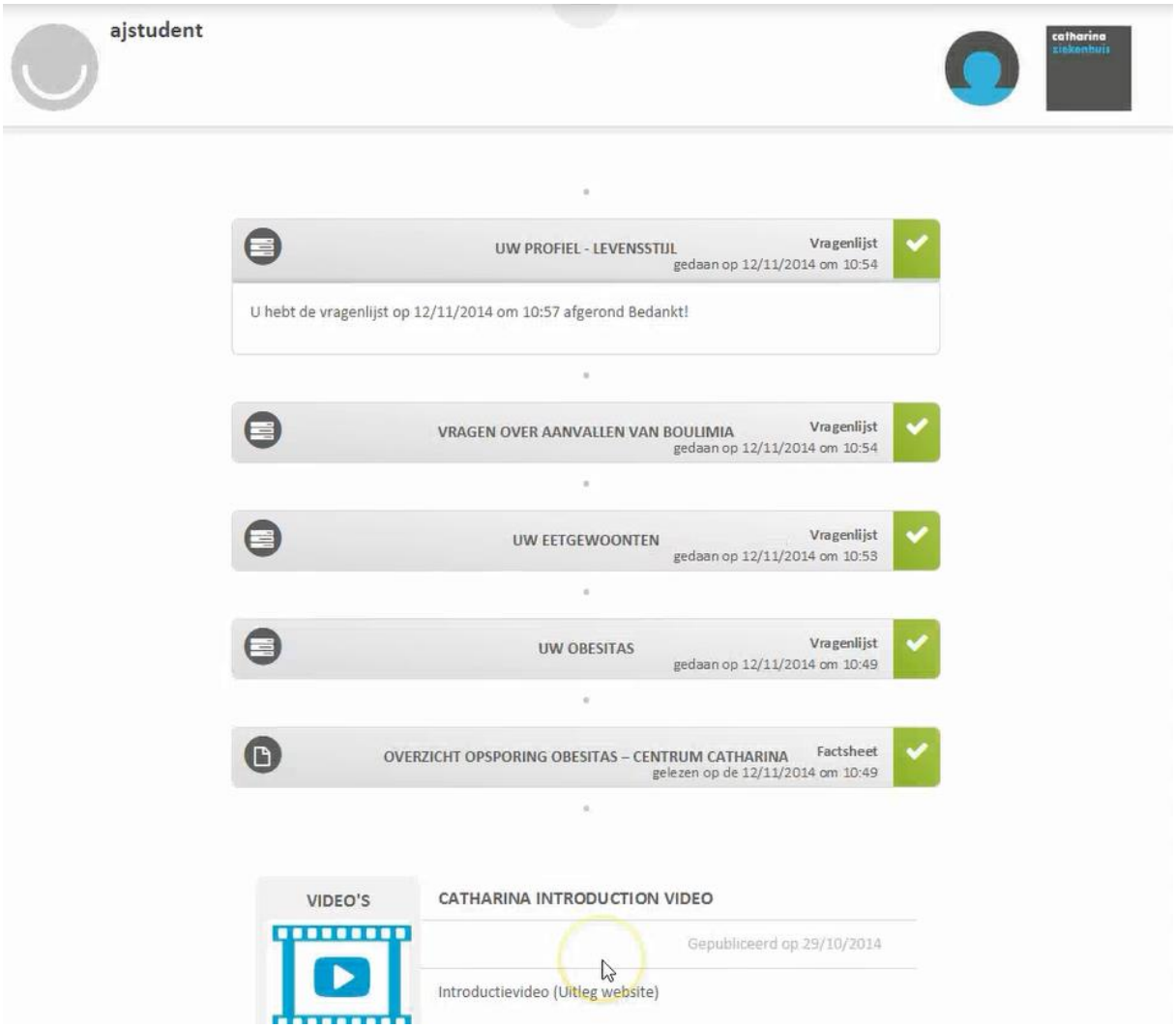


FIGURE 38: BEPATIENT FORMS OVERVIEW

APPENDIX K: POST-OPERATIVE PROCESS

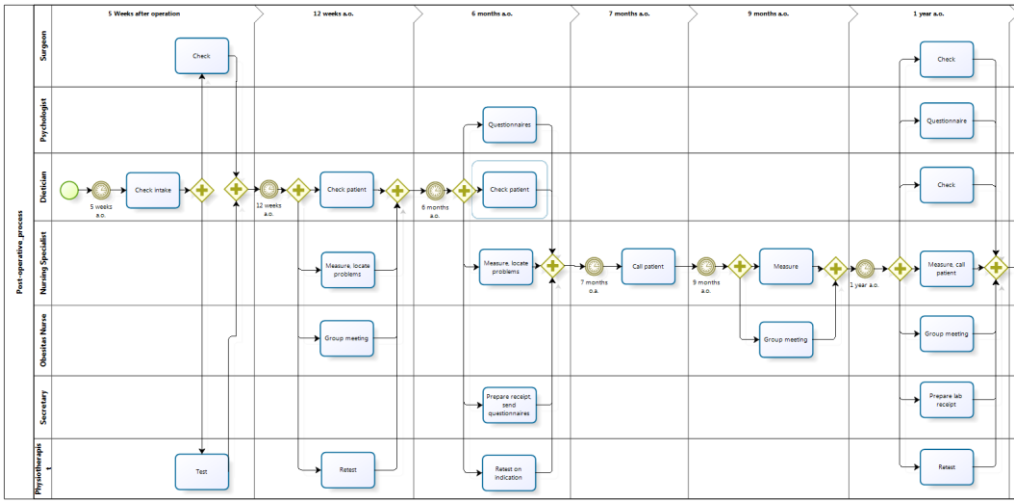


FIGURE 39: POST-OPERATIVE PROCESS 1/3

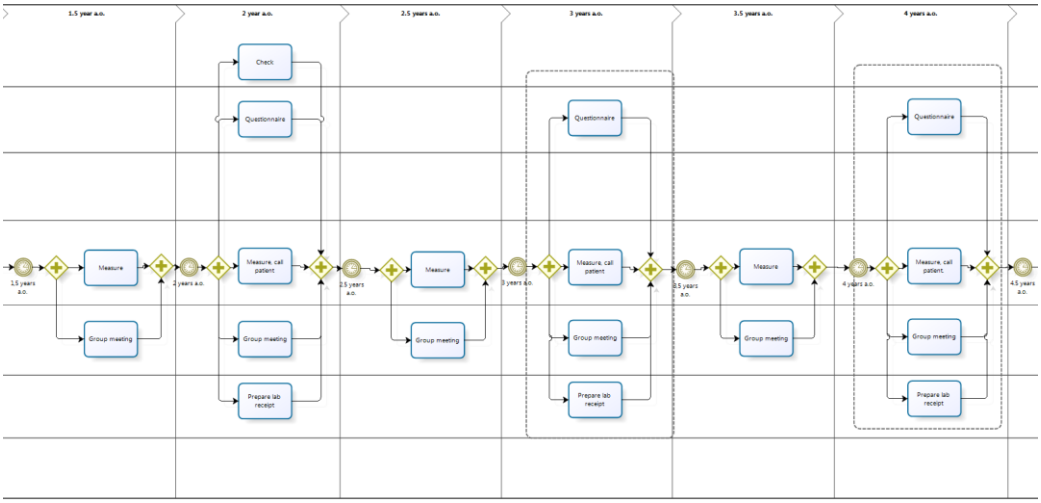


FIGURE 40: POST-OPERATIVE PROCESS 2/3

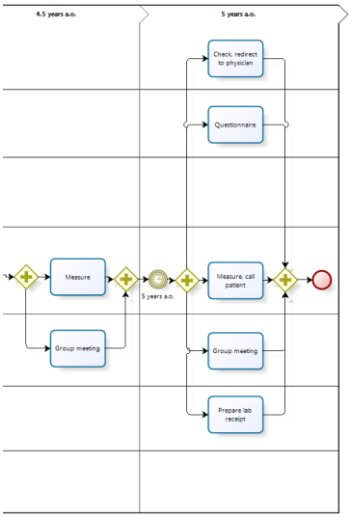


FIGURE 41: POST-OPERATIVE PROCESS 3/3

APPENDIX L: VARIABLES IN DATABASE

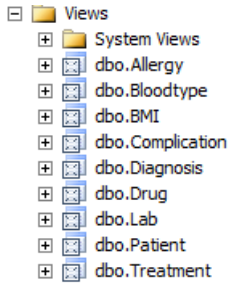


FIGURE 42: VARIABLES

	PATIENT_ID	ADMISSION_ID	Name	StartTime
▶	1101	1	Penicillin	2014-6-4
*	NULL	NULL	NULL	NULL

FIGURE 43: ALLERGY VIEW

	PATIENT_ID	ADMISSION_ID	Bloodtype	Time_Stamp
▶	1101	1	A	2012-11-6
*	NULL	NULL	NULL	NULL

FIGURE 44: BLOODTYPE VIEW

	PATIENT_ID	ADMISSION_ID	BMI_Level	Time_Stamp
▶	1101	1	44	2012-06-11
	1101	1	39	2012-09-28
	1101	1	38	2013-03-25
	1101	1	38	2013-09-27
	1101	1	37	2014-03-23
	1101	1	36	2014-09-24

FIGURE 45: BMI VIEW

	PATIENT_ID	ADMISSION_ID	Complication	TimeStamp
▶	1101	1	Diabetes	NULL
*	NULL	NULL	NULL	NULL

FIGURE 46: COMPLICATION VIEW

	PATIENT_ID	ADMISSION_ID	Name	Dosage	Unit	StartTime
✎	1101	1	Penicillin	2	mg/d	2014-6-4

FIGURE 47: DRUG VIEW

	PATIENT_ID	ADMISSION_ID	Name	Value	Unit	TimeStamp
▶	1101	1	LDL	160	mg/dL	NULL
	1101	1	HDL	40	mg/dL	NULL

FIGURE 48: LAB VIEW

APPENDIX M: LINK PROCESS MODEL AND CHECKLIST MODEL

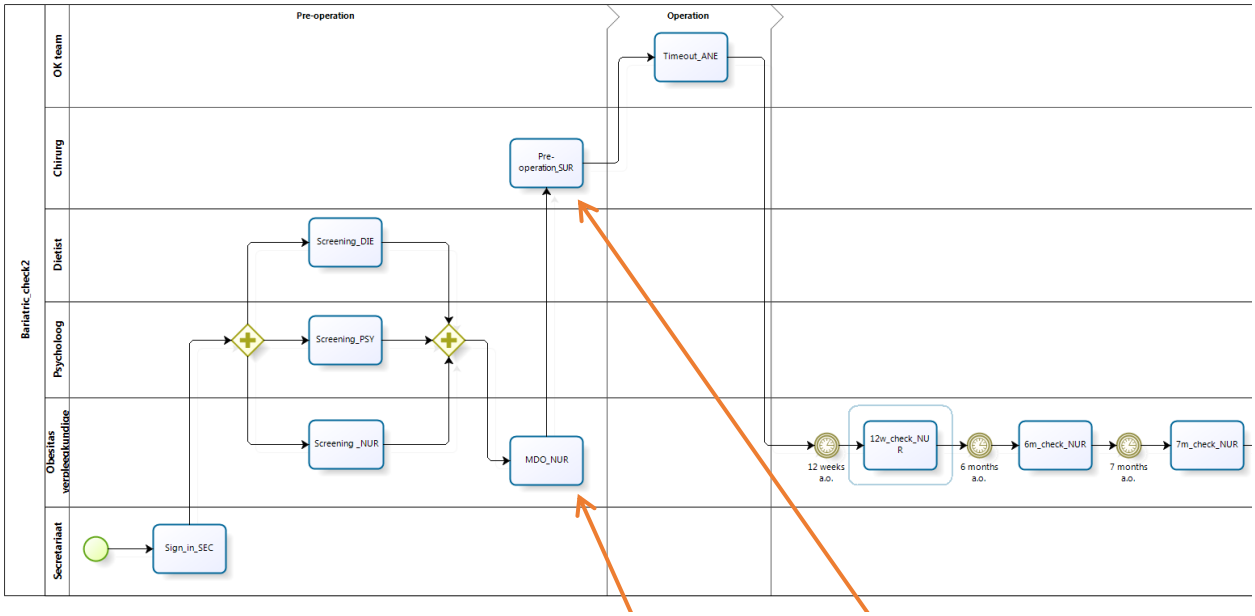


FIGURE 49: CHECKLIST MODEL

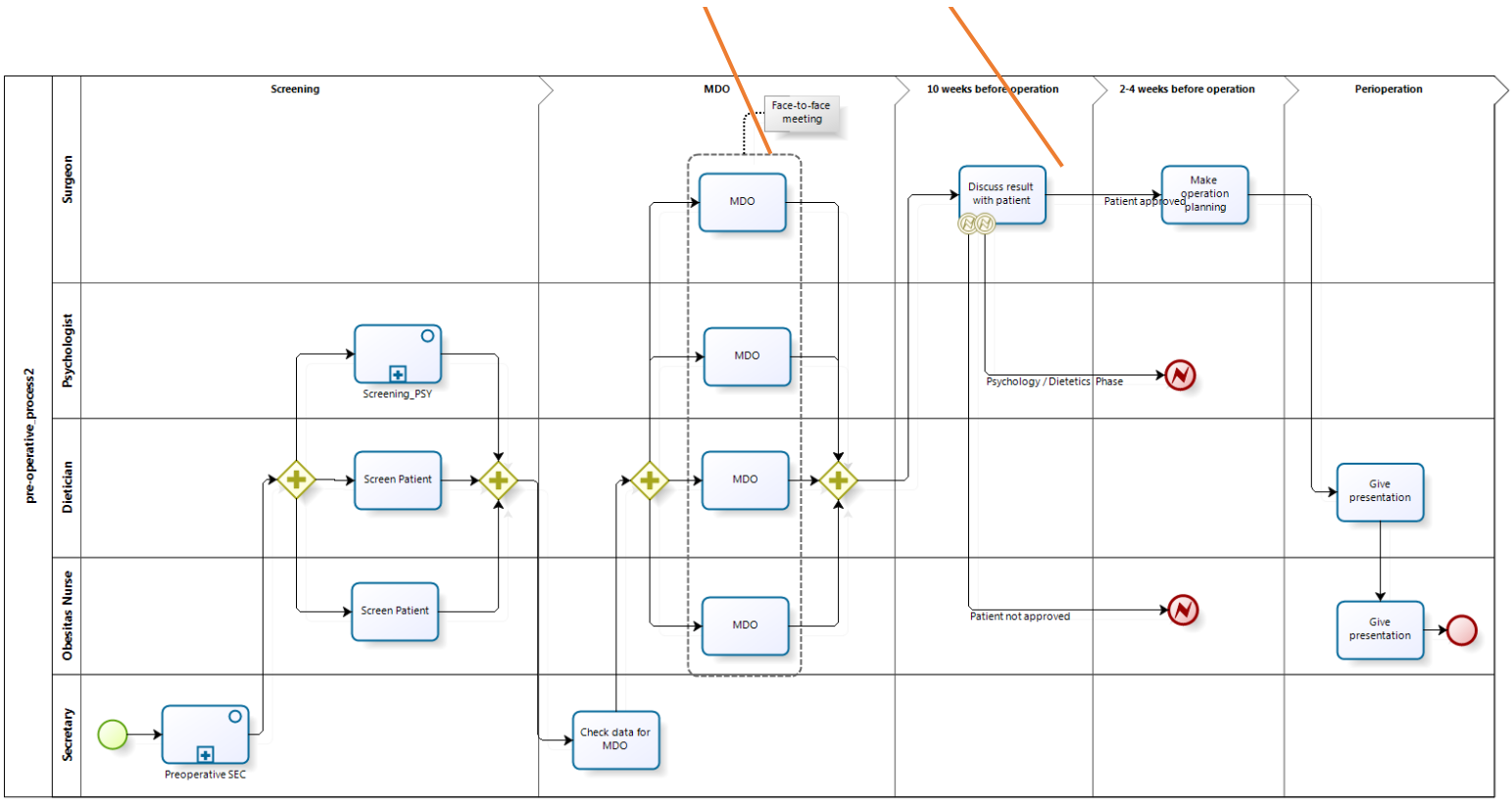
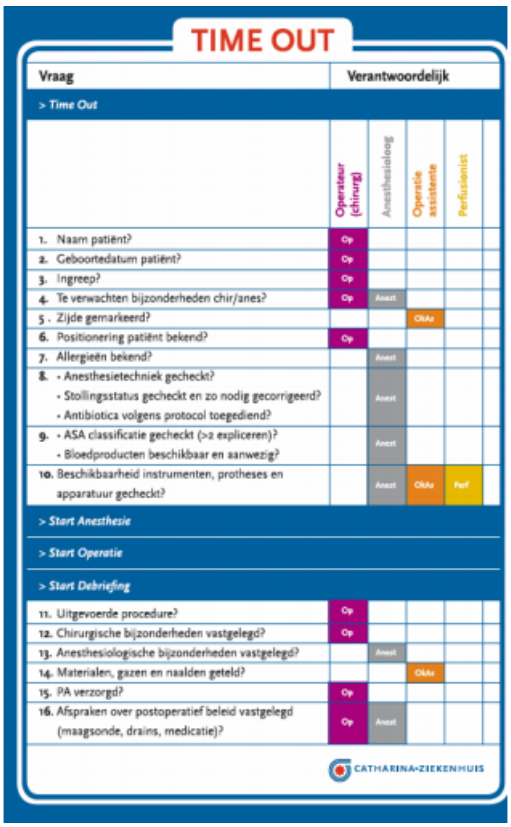


FIGURE 50: PRE-OPERATION PROCESS MODEL

APPENDIX N: TIME OUT CHECKLIST



TIME OUT

Vraag	Verantwoordelijk				
> Time Out					
	Operateur (chirurg)	Anesthesioloog	Operatie assistente	Perfusionist	
1. Naam patiënt?	Op				
2. Geboortedatum patiënt?	Op				
3. Ingreep?	Op				
4. Te verwachten bijzonderheden chir/anes?	Op	Anest			
5. Zijde gemarkeerd?			OkAs		
6. Positionering patiënt bekend?	Op				
7. Allergieën bekend?		Anest			
8. • Anesthesietechniek gecheckt? • Stollingsstatus gecheckt en zo nodig gecorrigeerd? • Antibiotica volgens protocol toegediend?		Anest			
9. • ASA classificatie gecheckt (>2 expliceren)? • Bloedproducten beschikbaar en aanwezig?		Anest			
10. Beschikbaarheid instrumenten, protheses en apparatuur gecheckt?		Anest	OkAs	Perf	
> Start Anesthesie					
> Start Operatie					
> Start Debriefing					
11. Uitgevoerde procedure?	Op				
12. Chirurgische bijzonderheden vastgelegd?	Op				
13. Anesthesiologische bijzonderheden vastgelegd?		Anest			
14. Materialen, gazen en naalden geteld?			OkAs		
15. PA verzorgd?	Op				
16. Afspraken over postoperatief beleid vastgelegd (maagsonde, drains, medicatie)?	Op	Anest			

CATHARINA-ZIEKENHUIS

FIGURE 51: TIME OUT SOURCE: THESIS OF VERMEULEN (2013)