MASTER THESIS

RECOMMENDATION TOWARDS PATIENT PROCESS, FOCUSSING ON TREATMENT PLACES AT THE ROTTERDAM EYE HOSPITAL

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Recommendation towards patient process, focussing on treatment places at The Rotterdam Eye Hospital

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Summary

The Rotterdam Eye Hospital intends to increase the number of surgeries in day surgery. The aim of this research is to give recommendations to the team leaders and manager of the nursing ward and surgery department about the number of treatment places that are needed to be able to run the patient process smoothly and therewith increase efficiency.

To give substantiated recommendations, a literature study have been performed and data have been collected. The literature research shows that a smooth process contributes to good information for patients and can reduce workload for staff. In the literature study is also displays that multiple linear regression is a suitable way to predict the number of treatment places needed by calculating the occupancy time. Data from 222 patients were collected and formed the data set for this research. Multiple linear regression is used to calculate the duration a treatment place is occupied. This regression is part of a prediction model with which can be calculate how many treatment places are simultaneously in use per day. Based on this research, including a pilot of a month, can two trolleys (a type of treatment place) be removed to still be able to run the patient process smoothly.

The five most important recommendations to increase efficiency of the patient process for patients who undergo surgery are: (1) focusing on treatment places, it is proven the patient process can be smoothly performed by reducing the number of trolleys from 17 to 15; (2) to be able to keep the process running smoothly it is recommended to pay attention to the cards on the magnetic board by changing the card on the board when patients change location; (3) in addition the repetition of prioritization and distribution of tasks in the patient process for nurses on the nursing ward is recommended; (4) it is recommended to use a telephone-system which registers the times phone calls are made, furthermore to both departments is recommended that they use the phone- system as agreed on and answer the telephone as fast as possible.

Preface

Without the help of some people I would not have been able to accomplish this master thesis the way I did. Therefor I would like to say thank you to these people. Since everyone who I would like to thank is Dutch, is the rest of this preface in Dutch.

Dr.ir. Ingrid Vliegen en Dr. Jeannette van Manen Van Universiteit Twente, ik ben ontzettend blij dat jullie mij wilden begeleiden bij deze door mij zelf gezochte opdracht bij een zorginstelling aan de andere kant van het land. Specifiek wil ik mij bedanken voor de snelle en volledige reacties op mijn lange e-mails. Voor mij heeft jullie kennis elkaar goed aangevuld en kon ik met de concrete feedback iedere keer goed vooruit. Ingrid, ik heb het als heel prettig ervaren dat je naast het delen van je kennis ook altijd tijd had voor een praatje over privé zaken. Jeannette, al tijdens mijn student assistentschap waardeerde je mijn mening, dat stel ik erg op prijs.

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Rotterdam, augustus 2012.
Lara Vankan

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CHAPTER 1 - Introduction

“Excuse me, your surgery has to be cancelled because we do not have enough beds”. Nobody wants to hear this message. This is motivation for the nursing ward and surgery department of the Rotterdam Eye Hospital to look for the appropriate amount of capacity (employees and material), to give the patient a better than expected experience and to increase efficiency. This chapter briefly introduces the Rotterdam Eye Hospital and presents the research question.

1.1 The Rotterdam Eye Hospital

The Rotterdam Eye Hospital is a focused hospital, specialized in ophthalmic care. The hospital has three functions: first, the provision of medical ophthalmic care for the region Rijnmond and top clinical ophthalmic care for the Netherlands; second, the education of physicians to become ophthalmologists and facilitating internships; third, a research institute for research on medical ophthalmic care and quality of ophthalmic care (Het Oogziekenhuis Rotterdam, n.d.).

1.2 Background

Daily an average of 31 surgeries are performed in day surgery (ambulatory care or outpatient care) on the surgery department of the Rotterdam Eye Hospital. In the future it is intended to increase the number of surgeries with minimal capacity. Achieving output with the least possible input is called efficiency (Ozcan, 2009). In this research input refers to the capacity of the departments involved which consists of employees and material. Efficiency can for example be reached by using the same material sequential instead of having several materials. The patient process needs to run smoothly in order to ensure efficiency of the process by using the least amount of materials required. This means that the steps in the patient process follow each other with the least possible interruption. An interruption occurs for example when patients are missing, because they went outside for a cigarette break while a medical procedure needs to be performed. Such an interruption could cause the stagnation of the surgery schedule. A process with less capacity and less waste can enable a cost reduction. The reduction of capacity is not the only advantage of a smooth process. The patient process is developed in such a way that it fits into the contemporary lifestyle by making the patient feel as short as possible as ‘a patient’. When the patient process does not run smoothly the intended experience, based on patient perspective, will not be accomplished. Additionally a smooth process can contribute to fear reduction for patients, which is a hospital wide target. Patients with a good feeling will have more trust and will come back and/or recommend the hospital to someone else. For the medical staff a smooth process can decrease the number of peak moments, moments in which a lot of activities can and/or need to be performed at the same time. A well-structured process wherein it is clear for all employees what is expected of them and at which point in time, can provide more continuity in their work. In short, in order to increase efficiency and improve the experience for patients and staff, the patient process needs to run smoothly.

The capacity for the patient process consists of employees and material which are closely related. The team leaders and manager of the involved departments have a lack of knowledge about the capacity that is actually needed for the patients who receive surgery in day surgery. In the past, this has led to the extreme situation in which there were more patients than treatment places. Consequently the scheduled surgeries stagnated. It is necessary to avoid these moments because these cause stress for both patients and employees. Therefore the team leaders and manager of the departments are searching for the appropriate amount of capacity to be able to run the patient process smoothly.

1.3 Research question

The aim of this research is to give recommendations to the team leaders and manager of the nursing ward and surgery department about the number of treatment places that are needed to be able to run the patient process smoothly and therewith increase the efficiency. A treatment place is the umbrella term we use for all types of beds that The Rotterdam Eye Hospital uses for patients who undergo surgery. There exists a particular interest in the number of treatment places needed for day surgery patients. Recommendations will only be given in relation to the nursing ward, holding and recovery. We do not intend to change or influence the surgery times or master surgery schedule. The following research question is formulated:

How can the patient process that is needed for patients who undergo surgery, focussing on the usage of treatment places, be changed to be more efficient?

To answer this question, sub questions are formulated. Next the sub questions and their purposes are presented as well as the chapter in which these are discussed.

How is the current situation regarding treatments in day surgery?

It is important to gain knowledge about the number of surgeries, the different steps in the patient process, and the capacity (employees and material) on the nursing ward and surgery department to understand the current situation. This knowledge is represented in Chapter 2 and accumulated by observing at the departments, consulting protocols, and talking and walking along with medical staff. The problems that came forward after spending time with medical staff are linked to the different steps in the patient process.

What is already known about this topic in literature and what can The Rotterdam Eye Hospital learn from other day surgery departments?
The answer to this sub question is given in Chapter 3. This chapter is subdivided in two sections. First, the available literature is reviewed. The goal of this part is to explain concepts regarding patient perspective, workload and represent what is known in literature about prediction models. Second, the best practices of four ophthalmology day surgery departments that we visited are listed (Erasmus Medical Centre, Sint Franciscus Gasthuis, Medisch Spectrum Twente and Moorfields Eye Hospital). This part of the research is completely in line with the philosophy of The Rotterdam Eye Hospital: share knowledge and learn from the best.

How can the occupancy time of a treatment place be predicted?
The method section is represented in Chapter 4 and is built up in sequential parts. First of all, the method of data collection and data collected are described. Secondly, based on these data a multiple linear regression is performed to calculate the occupancy time of a treatment place. The multiple linear regression is part of the prediction model that is made to determine when treatment places are needed and what the duration of an occupied treatment place is.

What can be concluded from the data and what recommendations can be made?
Per subject conclusions and recommendations are presented in Chapter 6. First, we give recommendations according to the research question. Second, we give recommendations to contribute to a smooth process. This chapter includes a paragraph which recognizes the limitations of this research.

To which other projects has this research contributed?
During the research period it became clear that collected data proved to be valuable to other projects within the hospital. The final chapter describes the purpose of the other projects and in what exact way this research has contributed.

CHAPTER 2 - Current situation

The main goal of this chapter is to explain the patient process. Before the process is explained, the process is placed in a broader perspective by presenting three ways of patient classification and looking at the numbers of surgeries in the past. After the description of the patient process, the capacity of the involved departments is described. Furthermore the surgery planning is briefly mentioned. Problems regarding the patient process indicated by the staff are listed.

2.1 Patient process

This section starts with explaining three different methods of patient classification as background information to obtain a better overview of the patient population. In this context we refer to the number of surgeries that have been performed in the past and related terminology is explained. After which, the patient process and how the staff keeps track of patients during the day is described.

2.1.1 Patient population

2.1.1.1 Classification of patients

This paragraph represents three classification methods that are used for patients who go through the patient process at The Rotterdam Eye Hospital. Characteristics are used to distinguish classifications. Characteristics refer primary to type of care and intensity of care. This enables anticipation of characteristics which contribute to standardisation and improvement of the patient process. First the classifications are explained, after that the delineation for this research is described. At last the numbers related to the classifications and delineation are given.

A distinction in patients can be made between inpatient and day surgery (outpatient). Inpatient means that the patient is admitted for at least one overnight stay. Day surgery is planned or unplanned hospitalization in a healthcare facility for a diagnostic or therapeutic treatment by a medical specialist. At day surgery the dismissal takes place on the same day after a recovery period under (para)medical supervision. Consequently the patient does not spend the night at the hospital (Go, Rutten, Grasveld- van Berckel, & Montfort, 2002; Barczewska, Eijkman, Nederlof, & Gorniak, 2010).

Patients can also be categorized based on the type of anaesthesia: general anaesthesia and local anaesthesia. General anaesthesia is a state, caused by an anesthetic drug, in which the entire body is unconscious and there is an absence of pain (Hilton & Uretsky, n.d.*a*). Local anaesthesia consists of administration of an anesthetic drug with an injection or application for a specific part of the body (Hilton & Uretsky, n.d.*b*). The specific body part applicable in this research is the eye. At The Rotterdam Eye Hospital local anaesthesia is mainly administrated by injection. Another form of local anaesthesia is the infliction of the anesthetic drugs by the means of eye drops named topical anaesthesia. From now on, we will use the term local anaesthesia for anesthetic drugs administrated by injection or eye drops. The classification within general and local anaesthesia can be made for two reasons: (1) the patient process differs for general and local anaesthesia which has consequences for the occupancy time of a treatment place, (2) the intensity of care for the types of anaesthesia is different.

Another method to classify patients is to divide them into care pathways. Vanhaecht, Panella, Zelm, van, and Sermeus (2010) defined a care pathway as “a complex intervention for the mutual decision making and organization of predictable care for a well-defined group of patients during a well-defined period”. The Rotterdam Eye Hospital identifies six care pathways: cataract, cornea, glaucoma, strabismus, oculoplastic surgery and retina. Within each care pathway arrangements are made, aiming to coordinate the multidisciplinary care for that patient group (Hiddema & Sol, 2010). All surgeons at The Rotterdam Eye Hospital are specialized in one care pathway.

2.1.1.2 Delineation

It is our goal to contribute to improve the patient process for patients that receive surgery, therefore we delineate this research to surgeries that are performed at the second floor of The Rotterdam Eye Hospital where the nursing ward and surgery department (OR 1 to 4) are located. In this research all three classification methods are used, only patients that undergo surgery at OR 1 to 4 are included. The team leaders and manager claim that the problems only occur during the regular surgery schedule. This can be logically explained since during the regular surgery schedule most patients are treated. The regular surgeries are scheduled from Monday until Friday, mostly between 7:45h and 16:00h. Every day emergency surgeries can be added to this schedule. If necessary emergency surgeries are also performed in the evening or during weekends. For these reasons, it has been decided to include the regular surgeries at the second floor of The Rotterdam Eye Hospital where the nursing ward and surgery department (OR 1 to 4) are located.

2.1.1.3 Historic data

Historic data per classification from the included surgeries are presented. In total 7198 surgeries have been performed in 2011 by 30 different surgeons. This is equal to an average number of 31,3 surgeries per day. 87,0% of the total surgeries were labeled as day surgery. To get more insight in the quantities and distribution see Table 1. Of all patients 65,7% received surgery under general anaesthesia. When the type of anaesthesia is not registered, it is labeled as unknown.

Table 1: Number of surgeries in 2011 subdivided in day surgery and inpatient and per type of anaesthesia for OR 1 to 4 from Monday to Friday (n=7198, data obtained from the hospital database Opera).

		Total 2011		Per week			Per day		
		Number of patients	Percentage	Average	Minimum	Maximum	Average	Minimum	Maximum
Inpatient		937	13,0	18,0	12	26	3,7	1	10
Type of anaesthesia	General	751	80,2	14,4	8	21	3,0	0	10
	Local	184	19,6	3,5	0	9	1,4	0	6
	Unknown	2	0,2	1,0	0	1	1,0	0	1
Day surgery		6261	87,0	120,4	40	155	27,8	8	37
Type of anaesthesia	General	3980	63,6	76,5	32	97	15,7	3	23
	Local	2206	35,2	42,4	8	76	8,9	1	23
	Unknown	75	1,2	2,0	0	6	1,2	1	3
Total		**7198**	**100,0**	**138,4**	**55**	**172**	**31,3**	**1**	**42**

Classifying the patients into care pathways shows that the retina care pathway constitutes the largest patient group. For the distribution of patients per care pathway in 2011 see Table 2. The patient process on the day of surgery is equal for every care pathway. The patient process is explained step by step in the next paragraph.

Table 2: Percentage of patients per care pathway in 2011, n = 7198 (data obtained from the hospital database Opera).

Care pathway	Percentage
Unknown	2,5
Oculoplastic surgery	10,0
Strabismus	12,8
Glaucoma	13,3
Cornea	13,5
Cataract	14,4
Retina	33,5
Total	**100,0**

2.1.2 The patient process step by step

In this section, the process is explained step by step for patients who undergo surgery in day surgery. The flow chart of the steps is shown in Figure 1. This process is based on observations, talking and walking along with medical staff, and protocols.

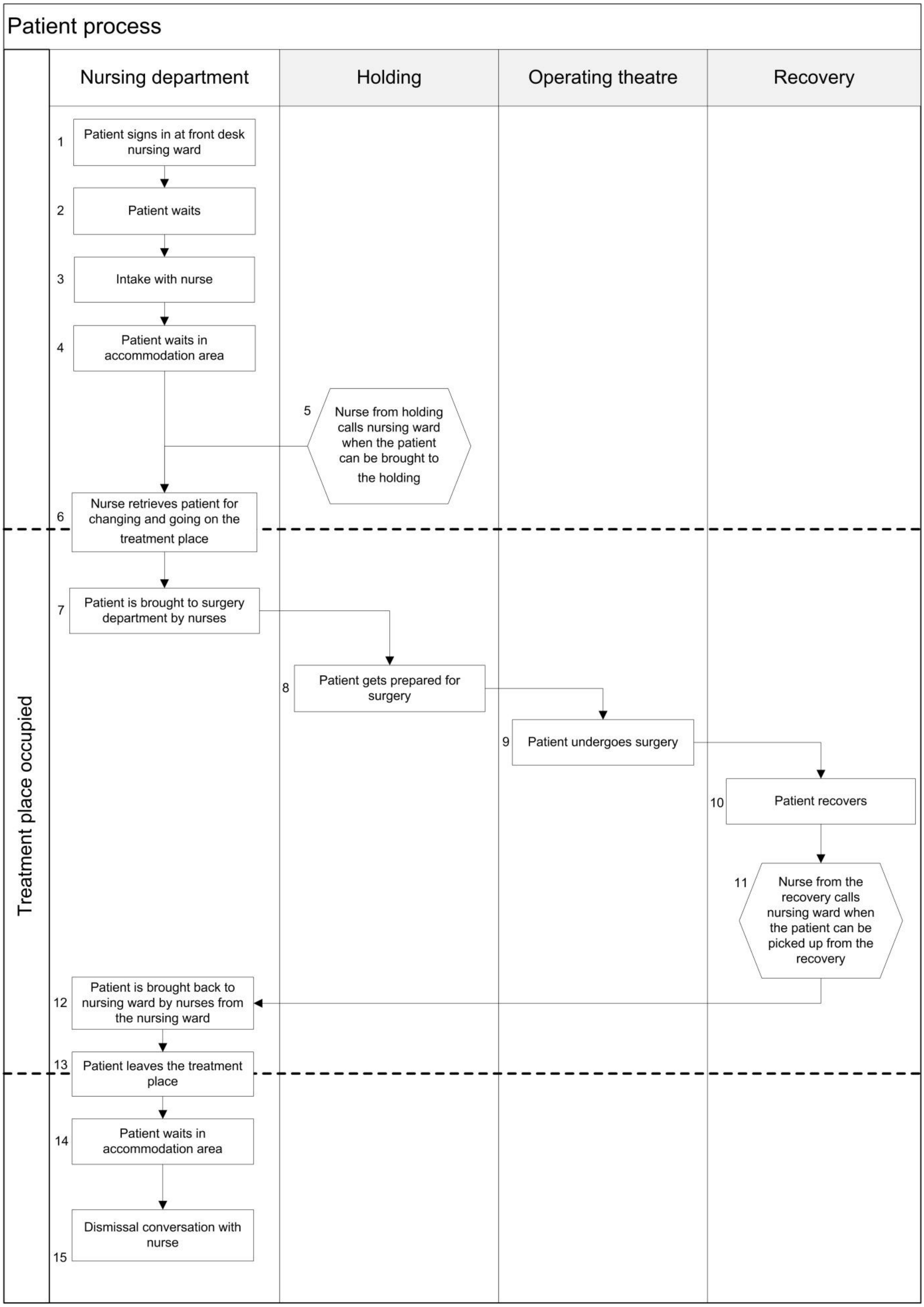

Figure 1: Flowchart patient process. This flowchart is not applicable for children.

Per step it is explained what and where activities need to be done. The numbers in the enumeration correspond with the numbers of the different steps in Figure 1. In these steps, a few times is referred to specific rooms. The mapping of the ward is explained in paragraph 2.2.1 including a floor plan in Figure 5.

1. **Patient signs in at front desk nursing ward**

   When they arrive at the hospital, patients and the escort sign in at the front desk. The front desk employee tells patient and escort where they can sit down and that the nurse will pick them up. Patients are asked to sign in two hours before the planned surgery time. These two hours are scheduled to make the patient feel more comfortable in the environment of the hospital and to be able to respond to fluctuations in the surgery schedule.

2. **Patient waits**

   Patient and escort wait in the appointed room. This can either be the accommodation area or the waiting room next to the hallway. Which room is appointed, depends on the point of time during the day.

3. **Intake with nurse**

   For the intake, the nurse picks up patient and escort and guides them to an intake room. During the intake the following activities take place (Barczewska et al., 2010):

   - The personal data from the patients are checked.
   - The eye that will receive surgery is dripped according to protocol.
   - It is checked whether all necessary information is present in the patient file.
   - The patient and escort receive information about the course of the rest of the day.

4. **Patient waits in accommodation area**

   After the intake patient and escort wait in the accommodation area.

5. **Nurse from holding calls nursing ward when the patient can be brought to the holding**

   Before the planned surgery time, the nurses from the holding call the nurses from the nursing ward to let them know that a specific patient can be brought for surgery. It is not recorded in protocol how long before the (scheduled) start time of the surgery this call takes place. Conversations with nurses revealed that the duration between the call and the scheduled surgery time is based on the signal of the surgeon, experience with the working method of the surgeon, the type of surgery, and the situation of that day. A situation could be for example less medical staff due to illness.

6. **Nurse retrieves patient for changing and going on the treatment place**

   After this call, a nurse is going to pick up patient and escort. The patient can use the toilet and changes into the surgical gown. When changed, the patient goes onto a treatment place. In this step the following activities performed by the nurse (Barczewska et al., 2010):

- The personal data from the patients are checked.
- The eye that receives surgery is dripped again according to protocol.
- It is checked in the patient file whether all necessary activities have been performed.
- It is checked if the patient is wearing any make-up or jewelry.

7. **Patient is brought to the surgery department by nurses**

   The patient is brought, by two nurses, from the nursing ward to the holding while lying on the treatment place. The escort can walk along until the lock gate of the surgery department. Here the patient and escort have to say goodbye.

8. **Patient gets prepared for surgery**

   Arrived at the holding, the nurse from the nursing ward transfers the patient according to protocol to the nurse from the holding. At the holding the patient is connected to the monitor. The following activities need to be performed by the nurse (Veerman, 2012):

- Personal data from the patient are checked again.
- Patient is connected to the pulse oximeter to register the oxygen.
- Patient is connected to ECG to register the heart rhythm.
- Patient is connected with a tension band to register the blood pressure.
- Patients' hair is covered with a surgical cap.
- If necessary dental prosthesis and/or hearing aids are removed.
- Infusion is applied.
- It is checked whether the medication that should be given to the patient corresponds with the medication registered in the file.
- It is checked whether additional laboratory measurements should be done.
- It is checked whether medication or prescriptions from the internist should be consulted with the anesthesiologist.
- All test values needed are entered into the computer system.

Some types of anaesthesia are administered at the holding by the anesthesiologist with the support of a nurse.

9. **Patient undergoes surgery**

   When the nurses are ready with the previously described activities, the patient waits at the holding until picked up for surgery by the medical staff of the operating theatre.

10. **Patient recovers**

   After the surgery, patients are brought to the recovery by the medical staff of the operating theatre. From this point on, in some steps we will make the distinction between local and general anaesthesia. When no distinction is made, one can assume that the step is equal to both types of anaesthesia.

- A patient with local anaesthesia is transferred from the medical staff of the operating theatre to the medical staff of the recovery. While the surgeon completes the patient file, the nurses remove the surgical cap and ECG-stickers. If necessary, additional monitoring takes place. The patient can go back to the nursing ward (Persijn, 2012b).

- A patient with general anaesthesia is transferred from the medical staff of the operating theatre to the medical staff of the recovery and is connected to the monitor. The patient wakes up at the recovery accompanied by a nurse. Patients who had general anaesthesia can go back to the nursing ward when their file is completed by the nurses and is signed by the anesthesiologist (Persijn, 2012a). The anesthesiologist signs the file when the patients' vital functions are at least stable for one hour, if there exist no breathing problems, blood values are within normal range and the patient feels good (Zudowski, 2010). In conversations nurses explained that it is not predictable how long it will take before the patient is awake and stable.

11. **Nurse from the recovery calls nursing ward when the patient can be picked up from the recovery**

    The nurses from the recovery call the nurses from the nursing ward to let them know the patient can be picked up.

12. **Patient is brought back to nursing ward by nurses from the nursing ward**

    Two nurses from the nursing ward go to the recovery. Here the patient is transferred from the nurses of the recovery to the nurses of the nursing ward. The nurses from the nursing ward bring the patient on the treatment place back to the nursing ward.

13. **Patient leaves the treatment place**

    - Once patients who had local anaesthesia arrive at the nursing ward, the nurse fills in the file, notifies the escort, removes the infusion, and prepares the information patients take home. When feeling good, the patient can change back to their own cloths and go with their escort to the accommodation area. Patients who had local anaesthesia should stay at least one hour after the surgery in the hospital (Zudowski, 2010).

    - In the first hour back at the nursing ward, patients who had general anaesthesia are bound to the treatment place. On arrival the nurse fills in the file, notifies the escort and the patient receives a cup of water. After one hour the blood pressure and pulse are checked and the patient is asked whether there are any feelings of sickness or pain. The patient receives food and drinks. When the patient has eaten, feels well and the infusion has been removed, the patient can change back to normal clothes. Patients who had general anaesthesia should stay at least four hours after the surgery in the hospital (Barczewska et al., 2010; Zudowski, 2010).

14. **Patient waits in accommodation area**
    This step is almost the same for patients with local and general anaesthesia. After changing, patients and their escorts take place in the accommodation area. Patients who had local anaesthesia receive food and drinks here. Patients who had general anaesthesia should at least stay another hour in the accommodation area and have to use the toilet before they can go home.
15. **Dismissal conversation with nurse**
    The dismissal conversation with the nurse takes place. In this conversation patients and escort receive information about medication usage, prescribed measures and follow-up appointments (Zudowski, 2010). Patients also receive a little gift from the hospital (Barczewska et al., 2010).

2.1.3 Magnetic board

The nurses of the nursing ward keep overview by means of cards on a magnetic board of where the patients are in the process (Figure 2). For every patient a card is made. When the patient signs in at the front desk, the front desk employee puts the card in a tray on the front desk. A card in the tray is a signal for the nurses that a patient has signed in and can be welcomed. The card is displayed on a magnetic board from the moment the intake conversation starts. When the patient continues in the process, the card is manually moved on the board. The card indicates where the patient physically is located, whether the patient is on the nursing ward before the surgery, on the surgery department or in which room on the nursing ward after surgery.

Figure 2. Magnetic board. Each card represents the name and type of anaesthesia of one patient. For privacy reasons, the names are not shown in this photo. For men blue cards are used, women receive yellow cards and for children pink cards are used.

2.2 Capacity

In this paragraph the capacity of the nursing ward and surgery department are illustrated.

2.2.1. Nursing ward

In this section the capacity of the nursing ward will be described. The pre-assessment department is part of the nursing ward, however, it is not included in this research as it is not related to the process on the day of surgery. The nursing ward can be subdivided into day surgery and the ward for inpatients. As previously mentioned, the capacity can be divided into employees and material. The department has 28 nurses available which are equal to 20,1 full-time equivalent (FTE). One FTE is equivalent to 36 hours per week. The nurses work in different shifts. Filling in the different shifts cannot be done with a fixed iterative schedule since most of the nurses work part-time. By scheduling the nurses, it is strived for having at least six nurses during the day and two during the night. The material of the nursing ward consists of treatment places and other material. As mentioned before a treatment place is the umbrella term for all types of beds. Classified as treatment places are: 17 trolleys, 13 clinical beds from which two are also used for children older than 4 or length greater than 115 centimeter, 3 beds for children between 6 months and 4 years with bars and 1 baby cradle for babies until 6 months (Knoppe, 2011). A trolley is smaller, lighter, more flexible and easier to clean than a clinical bed. Trolleys are used for patients that undergo surgery in day surgery (Figure 3). Clinical beds are used for inpatients, for older and larger children, and for day surgery patients that are not able to lie on a trolley for medical reasons (Figure 4). Examples of other materials are tables or alarm buttons.

Figure 3: Picture of trolley used in patient process

Figure 4: Picture of clinical bed used in patient process.

The equipment is divided over five treatment rooms and one boarding room. A floor map of the nursing ward is presented in Figure 5. A description to this floor map is discussed next, because the current layout of the department is a prerequisite constraint to this research that cannot be changed.

Room 1 has space for one treatment place and is used for patients that need to be placed in quarantine. *Room 2* is the boarding room in which patients go into and out of the treatment place. Treatment places that are not in use are stored in this room. *Room 3* is the accommodation area. In this room patients and their escort can take place before and after surgery. In this room 30 chairs and one stool are situated. To give the patients and escort a good experience while they are waiting, the refurbishment of the accommodation area is planned. *Room 5* is a treatment room in which a maximum of six patients on trolleys can be treated. This room is mainly used for patients that return from the surgery department and who had general anaesthesia. *Room 6* is the room for the inpatients. Here a maximum of four treatment places can be situated and clinical beds are almost always used. *Room 7* is used as for children. The room is too small for four trolleys and/or beds. Because beds with bars for children are used, four patients can be treated in this room. *Room 8* and *9* are both treatment rooms for two treatment places. If these rooms are in use, they are mostly used for inpatients. The two rooms marked with an 'a' are the rooms where intake and dismissal conversations are held. The front desk is indicated with the letter 'b'. The room with the letter 'c' is the office of the nurses.

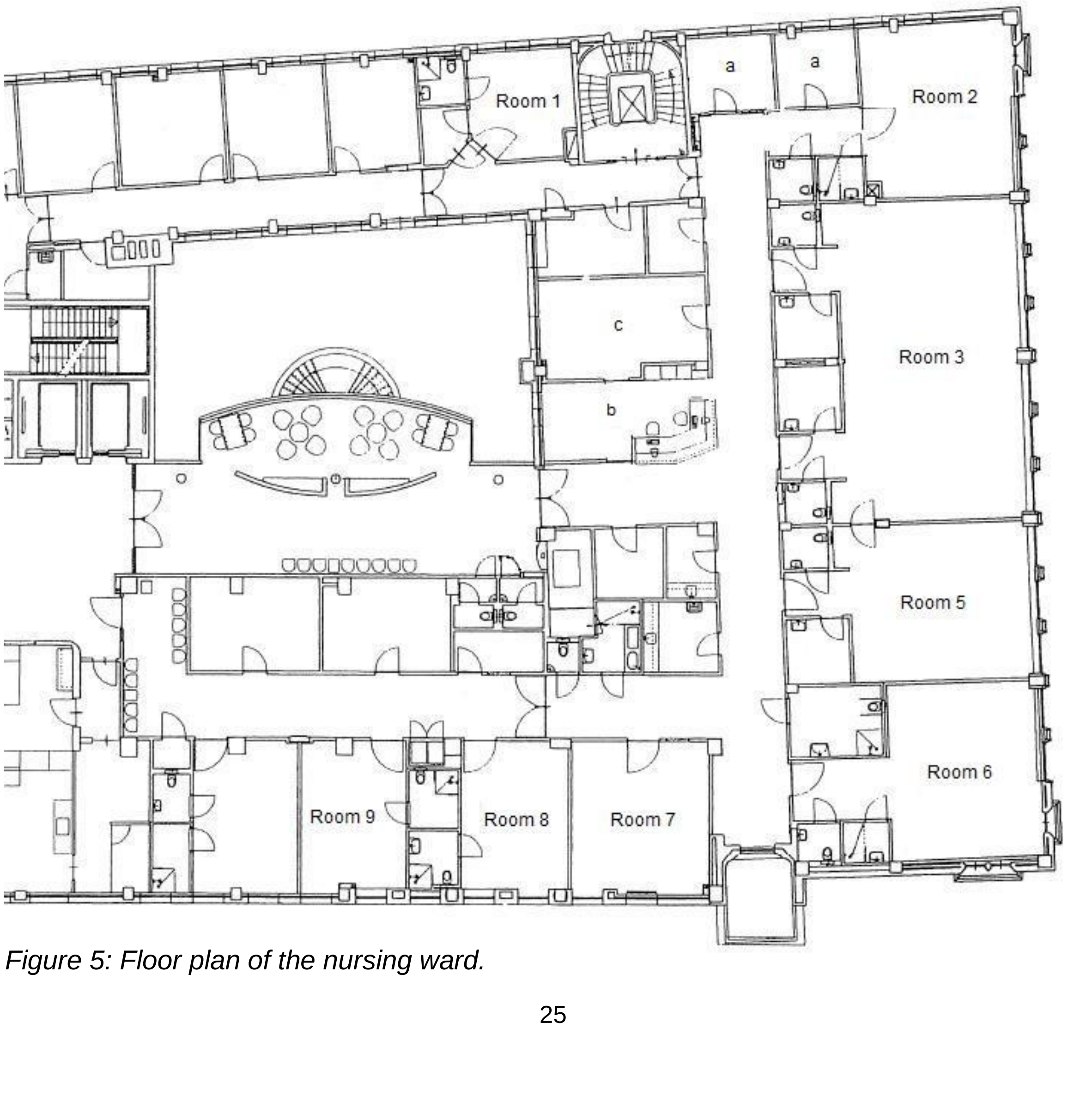

Figure 5: Floor plan of the nursing ward.

2.2.2. Surgery department

The surgery department consists of four operating theatres (OR 1 to 4), the holding, the recovery and the central sterilization department. The central sterilization department will not be included in this research since this component is not directly involved in the patient process. As mentioned earlier the surgery time and master surgery schedule fall outside the delineation of this research. The focus will be on the activities that have influence on the duration of occupancy time of a treatment place and therewith influence the duration of the patient process, namely the activities performed at the holding and recovery.

Both holding and recovery have the equipment to treat a maximum of six patients. Through the lay out of the building, the holding and recovery are located next to each other and are connected. They form two separate components in terms of the activities that are performed, since the patient deals with the holding and recovery at a different point in time in the patient process. A total of nine nurses, equal to 7,5 FTE, work at the holding and recovery. Per day five nurses work in a shift of nine hours. To maintain overview, the nurses divide themselves over the two components: three nurses work at the holding and two nurses work at the recovery. This distribution is not strict: at peak moments and during breaks they support each other.

2.3 Surgery schedule

This paragraph contains background information on how the surgery schedule is made since this has influence on the patient process. Details which are not relevant for this research will be omitted.

The surgery schedule is made by the planning department of the hospital. The basis for the surgery schedule of operating theatres 1 to 4 is the master surgery schedule. This is a fixed schedule: per operating theatre and per day part it is set which surgeon from which care pathway operates. Most of the time operation theatre 1 and 2 are used for surgeries on the anterior segment of the eye and operation theatre 3 and 4 are used for surgeries on of the posterior segment of the eye (Vliet, van, 2011). Generally surgeries on the posterior segment of the eye occupy more time. To fill up shorter time slots, several surgeons perform cataract surgeries between the surgeries of their own care pathway. Beside the master surgery schedule agreements within the hospital exist. These agreements relate primarily to the number of patients and are made based on the capacity of the different departments. An example of such an agreement is a maximum of seven children that may be scheduled on one day. When a patient needs surgery, the surgeon writes in the patient file in what time period the surgery should take place. Based on the master surgery schedule, the indication from the surgeon, agreements within the hospital and possible preferences of patients, the day of surgery is planned a few weeks in advance. Patients receive a letter which informs them about the date of surgery from the planning department. The day before surgery, the order of the surgeries becomes final. On this day, patients receives a phone-call from the front desk employee. The front desk employee informs them about the time they are expected to sign in at the front desk and that they should be sober if applicable. As mentioned in the patient process the time patients should sign in at the front desk is two hours before the surgery is scheduled. The surgery schedule has a great impact on the progress of the day because this determines how many patients and at what point in the time patients are treated at the nursing ward and surgery department. The realization of the surgery schedule is not included in the delineation of this research, since it cannot be influenced.

2.4 Problems related to the patient process

By observing and talking to employees experienced problems have been identified. For clarity the problems are represented in order of the patient process, steps without problems are not displayed.

1. **Patient registers at front desk nursing ward**
   - Patients are often not aware that the sign in time is two hours before the scheduled surgery time. It is not pleasant for patients when they are not aware of the fact that the scheduled waiting time is two hours.
2. **Patient waits**
   - If the accommodation area is too crowded, patients and their escort have to wait in the waiting room next to the hallway. This occurs especially during the peak period between 11.00h and 14.00h. This is not pleasant for patients and their escort since the hallway does not offer any comfort and hardly any amusement. Nurses lose the overview if the accommodation area is too crowded, this may cause a restless feeling.
4. **Patient waits in accommodation area**
   - Patients do not have enough insight about the time their surgery will start. As a result patients are only waiting and are not encouraged to take an active role in the process.
5. **Nurse from holding calls nursing ward when the patient can be brought to the holding**
   - It is not clear how long in advance a patient can go to the holding. This makes it hard for the nurses on the nursing ward to anticipate on the process.

- Nurses from nursing ward and holding, complained about the bad communication and mutual understanding.

6. **Nurse retrieves patient for changing and going on the treatment place**
   - Instructions towards the patient about how to put on the surgical gown are not always clear, therefore the dressing takes longer than necessary and provides a delay in the process. This is not patient friendly since the patient has to perform an extra activity.
   - Especially at the end of the day, a lot of untidy trolleys are located in *room 2*. Some nurses have the feeling this makes a sloppy impression on patients.
7. **Patient is brought to surgery department by nurses**
   - Two people are supposed to transport patients on a treatment place between the wards. Due to a shortage of staff, the nurses complain that they have to bring the patient quite often by themselves, which is physically demanding.
11. **Nurse from the recovery calls nursing ward when the patient can be picked up from the recovery**
   - The medical staff from the recovery has to call several times if the phone is not picked up at the nursing ward. This is frustrating for the staff of the recovery but also stagnates the patient process.
   - Some medical staff members from the recovery do not use the appropriate phone number. This means that nurses on the nursing ward receive messages not intended for them but are expected to handle them which cause inefficiency through additional actions which contribute to.
   - Nurses on the nursing ward complain about the number of patients that can be pick up at once; one phone call is used to pass on that more patients can be picked up. Due to limited nurses on the nursing department there are not enough nurses to pick the patients up individually and to give medical care when the patients return to the nursing department.
13. **Patient leaves the bed**
   - Nurses often do not know where the bathrobe and slippers from patients are located, therefore they have to check all the closets which is time consuming.
   - Patients and escort are regularly searching for their clothes and belongings. They do have a key but are not able to know or remember where their locker is located. Staff agrees that this is not patient friendly.
15. **Dismissal conversation with nurse**
   - Dismissal conversations do not have priority; thereby, patients have to wait longer than medically necessary. For patients this is not pleasant because their hospitalization is over and they want to leave the hospital. Patients and escort waiting

for their dismissal conversation can contribute to a restless feeling, since more people are present at the nursing ward.

Problems not related to a specific step

- Employees of the surgery department have the feeling that the employees of the nursing ward take lunch breaks with several employees at the same time regardless what is or should be happening at the department.
- Once in a while, surgeons cannot continue their program because the patient is not ready for surgery. From the point of view of employees of the surgery department most of the time the problem is caused by the nursing ward, since they have to wait so long before the patient arrives. This leads to frustration on the nursing ward since they are always perceived as the cause of the delay. If the surgery schedule stagnates, the situation is analyzed by team leaders and the manager of the nursing ward and surgery department to figure out what happened. This process is time consuming and disturbing since a lot of people on both departments need to be consulted.

The above shows that several other problems exist beside the main problem: lack of information about the number of treatment places needed. All these problems cause indirect stagnation of the patient process which takes place on the nursing ward and surgery department of The Rotterdam Eye Hospital. It is necessary to underpin the problems with data to be able to provide insights in these problems and possible solutions. In Chapter 4 the methodology on data collection is represented. Preceding Chapter 4 the literature study and best practices of comparable hospitals are provided in the next chapter.

CHAPTER 3 – Literature and best practices

This chapter starts with a twofold review of the studied literature. The first part concentrates on the patient perspective and workload in the current patient process. The second part reflects literature concerning prediction models. This chapter finishes with the best practices of comparable departments that were visited.

3.1 Patient perspective and workload in the current patient process

The aim of this research is to give recommendations regarding the treatment places to make the patient process more efficient. The patient process becomes more efficient when the different steps in the process follow each other smoothly. A more efficient process can increase the number of surgeries and can save costs. To accomplish these advantages the patient perspective and workload for employees are important within The Rotterdam Eye Hospital. After discussing the patient perspective, the concept workload is explained.

3.1.1 Patient perspective

The patient process for day surgery was changed a few years ago. In these changes the patient perspective was the key element to achieve a high patient satisfaction. Patient perspective can be defined as (the quality of) health care seen from the point of view of the patient (Thesaurus zorg en welzijn, n.d.). In the current patient process (described in paragraph 2.1.2) the patient has to feel as short as possible ‘a patient’. Changes in the patient process have been made in line with the hospitals’ vision of fear reduction. This vision is based on the assumption that everyone with an ophthalmologic disorder is afraid to become blind. A way to reduce this fear is to give adequate information and make the process predictable (Het Oogziekenhuis Rotterdam, n.d.). Fear reduction is not the only way to reach high patient satisfaction. Gill and White (2009) conclude in their literature review that no unambiguous and consistently used definition of the term patient satisfaction exists. Based on their conclusion that patient satisfaction is an unpredictable and important construct, Gill and White (2009) recommend to focus on the patient perceptive as a tool to improve results and quality. Lack of an uniform definition of patient satisfaction is underlined by Sixma, Kerssens, Campen, van, and Peters (1998), who stated whether a patient is satisfied is regarded as a multidimensional concept based on experiences and expectations. This is also supported by the literature review of Ware, Davies-Avery, and Stewart (1977), where it is shown patient satisfaction can be classified into eight dimensions: *art of care*, *technical quality of care*, *accessibility/convenience*, *finances*, *efficacy/outcomes of care*, *physical environment*, *availability*, and *continuity*. Not all eight subjects are equally relevant for this research. The dimension that is most related is *continuity* which refers to the regularity of care from the same facility and the availability of continuous medical care (Ware, Davies-Avery, & Stewart, 1977). A study performed in Sweden on the perceived quality dimensions of health care regarding to overall patient satisfaction for day surgery patients, shows that having “to wait at the reception without getting information correlated negatively to patient satisfaction, and participation in the medical decision making correlated positively” (Rahmqvist & Bara, 2010). The participation in decision making is consistent with the increasing patient empowerment at The Rotterdam Eye Hospital (Hiddema & Sol, 2012). An increasing patient empowerment implies that patients play a more important role by receiving more responsibility and become co-director in the treatment plan (Hiddema & Sol, 2012). When patients receive more power, information about the course of the day and the expected departure time become more important. This is related to *calculability* of the process. Calculability is one of the four main dimensions of McDonaldization, the other three are *efficacy*, *control*, and *predictability*. Ritzer (2010) developed the term McDonaldization and defines it as “the process by which the principles of the fast-food restaurant are coming to dominate more and more sectors of American society as well as of the rest of the world” (p. 4). One can also recognize these principles in terms of the dimensions in health care. Mottram (2011) draws the analogy between the four main dimensions and day surgery. The author could draw this analogy based on her research which aimed to explore the experience of day surgery patients. The Rotterdam Eye Hospital often finds inspiration in other industries for their projects, for example in aviation to increase safety (Korne, de, 2011). In line with this mindset, the relation between day surgery and the four dimensions of McDonaldization will be further illustrated and applied to the patient process at The Rotterdam Eye Hospital.

- *Efficacy* can be defined as the optimal method to complete a task with minimum waste of time, money or effort (Ritzer, 2010). Reduction of waste of time and effort can lead to a reduction of costs. A method to eliminate waste is to analyze each step and distinguish value adding steps from the non-value adding steps. Repetitive actions are a form of waste of effort and time, as the repetition adds no value. Lean thinking is a philosophy to continuously improve the process, by using different methods including a method to reduce waste (Womack, Byrne, Fiume, Kaplan, & Toussaint, 2005). According to this method, waste can be subdivided in categories: overproduction, inventory, waiting, transporting, defects, motion, unnecessary processing, and waste of unused human talent (Womack et al., 2005; Mittal Consultants and Enterprises, n.d.). Possible repetitive actions and non-value adding steps will be considered to increase efficiency in the patient process at The Rotterdam Eye Hospital.
- *Control* is about the replacement of humans by non-human techniques (Mottram, 2011). Eye surgery is highly depending on technology. On the surgery department a

lot of non-human techniques are available. On the other hand at the nursing ward not many human tasks are replaced by non-human techniques.

- *Calculability* relates to the fact that every aspect becomes more quantifiable (Ritzer, 2010).

  In this case calculability can be recognized in time estimation and capacity. When a patient is hospitalized for day surgery, assuming no complications occur, the patient and escort are certain that they will leave the hospital the same day. The estimation of the duration of different types of surgeries is mostly based on experience. The data from this research can contribute to a more precise time estimation, as well provide a base for capacity calculations.
- *Predictability* refers to a process which is organized in such way that the product and outcomes are standardized (Ritzer, 2010). At McDonalds the predictability can be found in for example the 'scripts' to control conversations between the employee and the customer. By using these scripts, every customer is approached in the same manner. In health care we want patients with the same type of disease to receive equal treatment. To achieve this, protocols are applied in health care. Therewith protocols aid to increase efficiency (Mottram, 2011).

The notion *putting customers to work* was later added to these four dimensions (Ritzer, 2010). This means that patients have to perform actions themselves. The responsibility for aftercare has shifted from the medical staff at inpatients, to the patients and relatives of day surgery. The care and responsibility they have to take themselves at home gives the patient empowerment (Mottram, 2011). As previously explained The Rotterdam Eye Hospital strives to increase patient empowerment. A checklist for patients is designed to encourage this. The aim of this checklist is to give the patient a tool to verify whether they received all the information with regard to their treatment (Hiddema, Sol, Mol, & Gaalen, van, 2009).

This literature review on patient perspective shows the importance of a structured process and therewith its predictability. The process becomes predictable when the different steps are seamlessly integrated. A smooth patient process can provide reliable information and contribute to patient satisfaction.

3.1.2 Workload

The changes of the patient process entailed consequences for the staff. The staff had to adapt to the renewed process while facing an increase in task differentiation. This could have contributed to the feeling that the workload has increased. Workload is a neutral concept. Workload can become a problem if the amount of work exceeds the limit an employee can cope with, and the employee cannot or may not influence the causes. The amount of workload an employee can handle is determined by the amount of work, the quality of work and the time available (Stichting van de arbeid, 2006). Often, workload is used as a subjective concept which covers the perceptions and experience of an employee (Kraaij & Kruif, 1998). If the requirements of the activities are too demanding, the employee may experience work stress. Prolonged exposure to excessive work stress can lead to too much tension which in extreme cases can lead to absenteeism (Rooij, de, 2004).

Absenteeism of staff, whether or not caused by workload, contributes to workload of the present staff since more is demanded. The activities of the medical staff of the nursing ward has peaks and dips. Workload is especially experienced during peak moments. Peak moments are moments in which a lot of activities can or should be done at the same time. Van den Bent (2004) distinguishes the concept workload in three organizational levels: individual, team and organization. In this research, especially the workload on individual level and the workload on team level are applicable. Every nurse has to perform their own activities and the nursing ward and the surgery department have to cooperate as a team to get the job done; the nurses have to transfer between shifts and take over each other's activities within the same shift. To reduce the feeling of workload the work can be distributed among the staff (Arbo Catalogus Architecten, n.d.). If each staff member is responsible for a specific task the workload will be divided. Task differentiation can contribute to a smooth patient process for example by subdividing the different steps.

3.2 Prediction models in literature

The team leaders and manager of the nursing ward and surgery department requested specifically to look at the number of treatment places needed to run the patient process smoothly. Foster, Hosking, and Ziya (2010) show that operations research methods can be very helpful in health care: "it can be very useful in gaining deeper understanding of this complexity and exploring the potential effects of proposed changes on the system without making any actual changes". To determine the number of treatment places needed a prediction model can be used. A model is a simplified representation of a system that represents the actuality (Vissers & Vries, de, 2005). Literature on prediction models that determine the occupation of treatment places has been studied. Since 2007, researches have been published to determine the number of beds with the use of a model to gain insight and to be able to anticipate on the capacity needed (Littig & Isken, 2007; Beliën & Demeulemeester, 2007; Kokangul, 2008; Penel, Mallet, Roussel-Delvallez, Lefebvre, & Yazdanpanah, 2008; Bruin, de, Bekker, Zanten, van, & Koole, 2010; Kumar & Mo, 2010; Berg, Denton, Ayca Erdogan, Rohleder, & Huschka, 2011; Vanberkel, 2011). The use of historical data to forecast is a common feature in most of these researches (Littig & Isken, 2007,Bruin, de, Bekker, Zanten, van, & Koole, 2010; Kumar & Mo, 2010; Berg, Denton, Ayca Erdogan, Rohleder, & Huschka, 2011). Vanberkel (2011) developed methods to tackle logistic health care problems. One of the methods is aimed at “optimizing strategic capacity and case mix planning decisions” (Vanberkel, 2011, p. 203). This can be done by determining “the workload placed on hospital departments by recovering surgical patients” (Vanberkel et al., 2009, p. 3). The model combines the *fraction of patients that receive treatment* with *the length of stay*. It assumes that the arrival rate on hospital departments is influenced by surgical blocks. Every block consists of a number of cases. These are depending on the specialty and every specialty has its own variation. This is equal to the patients arriving at the departments. Assuming that patients occupy a bed the entire period they are present at the department, the occupancy time of a treatment place can be modeled as the variable length of stay. Since most master surgery schedules are cycles, it is possible with this model to calculate “the distribution for the number of patients anticipated in the system” (Vanberkel et al., 2009, p. 3). The model can be adjusted to calculate: per day the distribution of ward occupancies, admissions/discharges, and number of patients in a specific day of their recovery (Vanberkel et al., 2009). Kumar and Mo (2010) successfully used three prediction models to determine bed occupancy: Poisson, simulation and regression. The Poisson model was based on the input *length of stay* and *number of admissions*. “This model can be used to optimize the allocation of hospital beds to improve patient care” (Kumar & Mo, 2010). The simulation used data from one year on *daily number of admissions, average length of stay over one year*, and *average number of available beds for each class of patients.* This simulation is a tool “to fit input probability distributions based on actual data and analyse output data” (Kumar & Mo, 2010). The aim of the regression model was to predict the “the following week’s bed occupancy” (Kumar & Mo, 2010). Data from the previous week and the schedule form the present week were used as independent variables. The authors concluded that the regression model has a “sufficient predictive ability” to forecast average occupancy (Kumar & Mo, 2010). To be able to calculate the number of treatment places needed, regression seems the most suitable of the three methods Kumar and Mo (2010) investigated. Therefore the literature study is narrowed to regression to explore whether other literature also demonstrates that regression is an appropriate method for this study.

“Regression analysis is a statistical tool for the investigation of relationships between variables” (Sykes, 1992, p. 1). Three types of regression can be distinguished: simple linear regression also referred to as linear regression, multiple linear regression and non-linear regression (Di Bucchianico, 2003). Multiple linear regression is the prediction of one variable, based on a combination of other variables. The predicted variable is depending on the combination of the independent variables. This type of regression seems the most suitable for this research since several independent factors influence occupancy time of a treatment place. The advantage of this method is that the influence of the independent variables is calculated by a weight that is assigned to every independent variable based on historical data. Multiple linear regression can be used in health care to determine the epidemiology of a disease based on a combination of determinants (Bouter, Dongen, van, & Zielhuis, 2005). The literature study shows that linear regression is also applied to calculate the throughput time and length of stay (Deyo, Cherkin, & Ciol, 1992; Silberbach, Shumaker, Menashe, Cobanoglu, Morris, 1993; Bell, Cramer-Benjamin, & Anastas, 1997; Rathlev, Chessare, Olshaker, & Obendorfer, 2004; Smith, Elton, Ballantyne, & Brenkel, 2008; McClure, Salter, Meyer, Foley, Kruger, & Teasell, 2011; Varhabhatla & Zuo, 2011). For inpatients the term *length of stay* is used to calculate the period of time the patient stays in the health care facility ("Length of stay", 2009). Most literature available on bed occupancy focusses on inpatients and therewith calculates the length of stay in days. In this research the occupancy of a treatment place is applied in hours as the patient population consists of mainly outpatients. Based on this the term occupancy is used instead of length of stay. When using a multiple linear regression it possible to calculate the occupancy of a treatment place in hours since it is a formula in which the entity of the output is related to the entity of the input.

Based on the literature study, it can be stated that a smooth patient process can contribute to a higher patient satisfaction by being able to give more reliable information and less workload for the staff by subdividing tasks. A smooth patient process is necessary to increase the efficiency. Efficiency can be reached by the least possible number of treatment places. By means of a multiple linear regression model, the occupancy time of a treatment place will be calculated and therewith contribute to determine the number of treatment places needed. The choice for multiple linear regression rests on several reasons: number of researches have already confirmed that this type of regression is a reliable method to calculate the length of stay; this type of regression makes it possible to include several factors that influence the occupancy time of a treatment place; and due to limitations in terms of time multiple linear regression is a relative simple and fast way to calculate the occupancy time of a treatment place.

3.3 Comparable departments

In the context of learning from others, four other ophthalmology day surgery departments were visited to view how they designed the patient process. The hospitals that were visited are Erasmus Medical Centre in Rotterdam, Sint Franciscus Gasthuis in Rotterdam, Medisch Spectrum Twente in Enschede, and Moorfields Eye Hospital in London. It is listed per visit what can be learned from that particular department since it proved to be a successful working method in the visited department. All learning points are directly related to the number of treatment places and improvement of the patient process.

At the *Erasmus Medical Centre* (Erasmus MC) in Rotterdam the day surgery department treats patients of twelve different specialisms of which ophthalmology is one.

- By linking one nurse to one patient, the number of transfer moments is reduced and therewith also the chance of mistakes during transfers.
- The transfer of patients from the nurses in different shifts takes place in a separate room. In this room the nurses sit in private. The private setting decreases the chance that some information will be forgotten and all nurses are informed on the running processes.
- In the Erasmus MC they do not experience problems when using the telephone between the departments. This proves that it is possible to have flawless information transfer per telephone.
- The escort is not permitted in the treatment rooms. This rule is implemented to reduce the unrest in the treatment rooms to a minimum. This rule has never led to problems for patients and/or escort.
- Patients receive a telephone consultation the day after surgery. Beside the medical information and questions this moment is also used for improvement of the process. If for example several patients take the view that the temperature on the department was too low, they can adjust this directly. Goal of this is to be able to improve at a level that attunes to the experience of the patient.

At the *Sint Franciscus Gasthuis* (SFG) in Rotterdam the process of day surgery for cataract surgery was observed. From the 1000 cataract surgeries that are performed at the SFG, 95% is performed in the *SurgiCube*. This is a compact operating theatre-unit in which cataract surgeries can be performed cost efficiently (“SurgiCube”, n.d.).

- By reducing the number of medical staff that treats a patient, the chance of mistakes during transfer moments is reduced. The SFG takes the view that a limited number of medical staff per patient also contributes to a greater responsibility from the medical staff and fear reduction from patients’ point of view, due to recognition.

- The staff scheduling takes into account that one employee is scheduled to relieve other employees in their lunch breaks. Another department within The Rotterdam Eye Hospital, the day center, also works with this method.
- When a surgery is delayed, the surgical staff calls the preparation room to inform them. Then the information is passed to the waiting patients.
- In the waiting room signs are located with the text “the order of coming in is not the order of treatment”. This is assumed to create a better understanding on the order of treatment by patients that are waiting. Within the accommodation area on the nursing ward of The Rotterdam Eye Hospital this could also cause more tranquility.
- In general one escort per patient is allowed due to limited space.

At the *Medisch Spectrum Twente* (MST) the patient process and patient scheduling was explained. Most of the cataract surgeries are performed at the location of the hospital in Oldenzaal.

- The first patient of the day does not arrive two hours before the planned surgery time but only 45 minutes before the planned surgery time.
- The patient process is step by step described on the website, including pictures.
- Directly after the decision for surgery is made, patients receive their appointment at the front desk. Patients have indicated that they experience this is as pleasant. Because the appointment is made in the presence of the patient, the time of the surgery can directly be adjusted to the agenda of the patient. This reduces re-scheduling afterwards.

At *Moorfields Eye Hospital* at City Road in London, the patient process was shown and explained step by step. Moorfields Eye Hospital has eight operating theatres that are comparable with the theatres of The Rotterdam Eye Hospital. During the day they perform surgeries for National Health Service patients and during the evening privately insured patients are treated.

- The surgical team leader in the operating theatres decides when the next patient can be brought from the ward to the surgery department. The phone calls between departments are registered (who and when). This information contributes to a more rapid analysis of the situation in case of a problem.
- Moorfields Eye Hospital does not have a holding since they take the view that a holding was a non-value adding step that created unnecessary waiting time. Before the patient enters the operating theatre the patient is positioned in an anesthetic room. Every operating theatre has an anesthetic room. The time spend by the patient in this room is brief, consequently no unnecessary delay is created. Another

advantage of this room is the maintained privacy of the patient and the received treatment is from the same staff that will also be present during the surgery.

- Patients who receive local anesthesia only wear a surgical gown on top of their own clothes. Patients who receive general anesthesia have to change from their own clothes into a surgical gown.
- They are equipped with a separate recovery for children. The advantage is that other patients are not disturbed by crying children. It has to be noted that Moorfields Eye Hospital has an additional hospital for children (Richard Desmond Children's Eye Centre) and therewith probably perform more surgeries on children.
- Moorfields Eye Hospital exchanges staff between the main hospital and the locations.

This chapter started with a review of the studied literature. The underlying reasons for this research have been supported by literature; the patient perspective is a good starting point and peak moments can cause negative workload. Similarities between day surgery and McDonaldization are displayed. The last part of the literature study shows that multiple linear regression is a suitable way to predict the number of treatment places needed by calculating the occupancy time. This chapter ended with a paragraph in which the best practices were enumerated of four visited ophthalmology day surgery departments.

CHAPTER 4 – Methods

In this chapter the different methods are explained. First of all, the motivation for data collection and method of data collection are described. The collected data are represented. Next, based on these data, a multiple linear regression is performed to calculate the occupancy time of a treatment place. After that, the multiple linear regression is combined with a formula, together forming the prediction model, to determine when and for how long a treatment place is occupied.

4.1 Data collection

To be able to make recommendations for the problems indicated, it is desirable to have data that underpin the problems. Except for the start and end times of surgeries, the hospital does not centrally register any data on the course of the patient process in day surgery. To collect data on the patient process, we joined forces with Project DORA (Digital Operating Room Assistant). Project DORA aims to track patients with tags to give staff, patients and escort up-to-date information about the process. In collaboration with Project DORA observations were made to register the start times of almost every step in the patient process. The start time of the next step, is the end time of the previous step. The steps in the process can be subdivided in five subsections: (1) before surgery on the nursing ward, (2) on the holding, (3) in the operating theatre, (4) on the recovery, and (5) after surgery on the nursing ward. The data were manually recorded by two people at the same time: one person recorded the times on the holding and recovery at the surgery department (subsection 2 and 4), the second person recorded the times at the nursing ward (subsection 1 and 5). The times from subsection 3 were obtained from the hospital dataset. Table 3 represents per subsection from which steps the times where gathered. To increase the reliability of the research, during the measurement two attuned watches were used. Measurements were performed at eight weekdays (two Mondays, two Tuesdays, two Wednesdays and two Fridays). This could enable to see a pattern in the different days. The days were chosen on the condition that a regular surgery schedule was applicable, with four operating theatres.

Table 3: The steps in the patients process from which data were collected.

The content of this table is confidential and is for that reason not presented in this version.

All patients from the surgery schedule were included. When possible times of emergency patients were registered. By assigning numbers to each patient, the anonymity of patients could be guaranteed and no permission of patients was needed. The times registered were combined with patient data that already were available (see Table 4). Together this formed the basic dataset for this research.

Table 4: The available patient data.

– Date of surgery	– Type of anesthesia
– Number of operating theatre	– Day surgery / Inpatient
– Gender	– Scheduled surgery start time
– Age	– Pre-arranged sign in time
– Surgeon	– Actual surgery start time
– Operation	– Actual surgery end time

The dataset can substantiate the indicated problems. The results are presented in Chapter 5. Based on these data the occupancy time of a treatment place can be calculated. In order to determine the appropriate number of treatment places, an additional step is needed: a prediction model. This prediction model forms the second part of the methods and is described in the next section. The section starts with the regression model to calculate the occupancy time of a treatment place.

4.2 Multiple linear regression model

To forecast the number of treatment places needed in the future, a prediction model can be applied.

A multiple linear regression analysis is a model which examines the relationship between multiple independent variables to predict the value of a single dependent variable: the occupancy time of a treatment place (Aiken, West, & Pitts, 2003; Houwelingen, Stijnen, & Strik, van, 2000). To calculate the value of the dependent variable, a formula is developed. This formula is the sum of the intercept and the variables multiplied with their weight factor (the coefficient). It is desirable that the least number of independent variables have a large impact on the dependent variable (Di Bucchianico, 2003). The impact is called *explained variance*, R-square. The percentage of explained variance constitutes an important measure to assess the multiple linear regression analysis (Houwelingen, Stijnen, & Strik, van, 2000). The higher the percentage of explained variance, the more impact the independent variables have on the dependent variable. If R-square is 100%, the prediction is perfect and entirely based on the independent variables. If the R-square is for example 70%, the prediction of this model can be indicated as strong (Table 5). However, it should be taken into account that the predicted outcome cannot be determined by the independent variables for 30%.

Table 5: Interpretation impact per percentage of R-square (Doorn and Rhebergen (Eds.), 2006).

R^2	**Explained variance**	**Interpretation impact**
<0,1	< 10%	Very weak
0,1 – 0,25	10 – 25%	Weak
0,25 – 0,5	25 – 50%	Moderate
0,5 – 0,75	50 – 75%	Strong
0,75 – 0,9	75 – 90%	Very strong
>0,9	> 90%	Exceptionally strong

Before the formula of the multiple linear regression model can be formulated, it first must be determined whether the independent variables have a significant influence on the dependent variable. The significance can be determined with aid of the p-value. In a 95%-confidence interval the p-value should be lower than 0,05 to be sure the analysis is not based on chance. If the p-value of the independent variable in multiple linear regression is larger than 0,05, the variable can be deleted and the regression can be performed again (Meervoudige lineaire regressie analyse, n.d.).

Based on the dataset and a discussion with the team leader of the nursing ward, nine variables have been selected that may have an influence on the occupancy time of a treatment place: *availability of treatment room, nurse, number of nurses working, surgeon, care pathway*, *type of anaesthesia*, *scheduled start time surgery*, *gender,* and *age*. The variable *sign in time* was also available but was excluded from the beginning because this is directly related to the scheduled surgery time; the sign in time is two hours before the scheduled surgery time. No data were available regarding the variable *availability of treatment rooms* and therefore was not included in the analysis. The variable *nurse* represents which nurse is working. It is assumed that the nurses are equally skilled to perform their work activities in about the same amount of time. In addition, the nurses change their activities during the day. The data collecting could have become too extensive and almost impossible for one person to also keep track of the activities every nurse performs. Data were not gathered on a nurse's personal level, therefore this variable cannot be included. The small variation that may occur is included in the data collection since data were collected when different nurses were working. For the variable *number of nurses working* the total number of nurses working during the day is used. As mentioned earlier it is strived to have at least six nurses during the day. If less than six nurses are working during the day, this is mostly caused due to sudden absenteeism. The variables *surgeon* and *care pathway* are directly linked. Each surgeon is specialized and classified to a specific care pathway. Within each care pathway different surgeons are active and a case mix of multiple operations is performed. It is debatable whether the surgeons within each care pathway are comparable. On the day of surgery, surgeons influence the occupancy time of a treatment place by the duration of surgery. Therefor we compared the average surgery duration of the two most performed surgeries by surgeons who are classified in the same care pathway in 2011, only taking the surgeons into account that performed surgeries during our data collection. These data are presented in Appendix A. Based on this, can be inferred that the surgeons within each care pathway are comparable. For this reason the usage of *surgeon* and *care pathway* would be a duplication. It is chosen to use the variable *care pathway* as it is unlikely that the care pathways will change dramatically in the upcoming year, however the surgeons may change in the foreseeable future. After this critical selection process six variables remained that may have an influence on the occupancy time of a treatment place: *number of nurses working, care pathway*, *type of anaesthesia*, *scheduled start time surgery*, *gender,* and *age*.

MS Excel was used to perform regression analysis for the six variables with data from 175 patients from the dataset. These 175 patients consist of day surgery patients and inpatients. Since there was a lack of information on children, all children were excluded. The insufficient data on children have led to the exclusion of the care pathway strabismus from the analysis, since in the dataset this pathway consists of almost 50 % children. The prognostic value of six independent variables is tested. The variables *type of anaesthesia* and *gender* are binary variables, whereas *scheduled start time surgery number of nurses working,* and *age* have a ratio scale. A ratio scale was used for the *scheduled start time* because it is a quantitative level in which the distance between the levels is equal and the zero point refers to the start of a new day has a new surgery schedule. A dummy variable was made for *care pathway* whereby glaucoma was chosen as reference. The different combinations with the resulting R-squares are displayed Table B.1 of Appendix B. Based on the results of R-square, the number of independent variables, and the test with data of three patients, it can be concluded that the most applicable combination of independent variables to calculate the occupancy time of a treatment consists of *care pathway*, *type of anesthesia* and *scheduled start time*. These three independent variables have a R-square of 71,2%. This means that

71,2% of the calculated occupancy time of a treatment place can be explained based on the three independent variables mentioned above.

To calculate the occupancy time of a treatment place the formula for the multiple linear regression analysis is formulated.

$$Occupancy\ time\ of\ a\ treatment = 0{,}142108526108195 +$$
$$-0{,}00799920202385616 * Cataract +$$
$$-0{,}00360232809096357 * Cornea\ +$$
$$-0{,}00591010905588735 *\ Oculoplastic\ surgery +$$
$$0{,}0092119753514671 * Retina +$$
$$0{,}0869692253543522 * Type\ of\ anesthesia +$$
$$-0{,}110199887945919 * Scheduled\ start\ time\ surgery$$

Where by:
Cataract = 1 when the patient belongs to the care pathway cataract.
Cornea= 1 when the patient belongs to the care pathway cornea.
Oculoplastic surgery = 1 when the patient belongs to the care pathway oculoplastic surgery.
Retina = 1 when the patient belongs to the care pathway retina.
When the patient belongs to another care pathway, Cataract, Cornea, Oculoplastic surgery and Retina = 0.
Type of anaesthesia = 1 when the patient receives general anaesthesia, for local anaesthesia Type of anaesthesia = 0.
Scheduled start time surgery = the time the surgery is supposed to start according to the schedule.

The occupancy time of a treatment place depends on different variables and is an estimate for the actual occupancy time. This estimated occupancy time therefore has a confidence interval that is associated with the confidence intervals of the independent variables. To calculate the limits of the 95%-confidence interval, the formulas for minimum occupancy time and maximum occupancy time of a treatment are also formulated. The coefficients are therefore replaced by the coefficients of the lower and upper limits of the 95%-confidence interval. These coefficients can be found in Figure B.2 in Appendix B.

$$Minimum\ occupancy\ time\ of\ a\ treatment = 0{,}110377564021158 +$$
$$-0{,}0234689460835479 * Cataract +$$
$$-0{,}0195770486770327 * Cornea\ +$$
$$-0{,}0239448369776538 *\ Oculoplastic\ surgery +$$
$$-0{,}00374750942639776 * Retina +$$
$$0{,}07415451257203412 * Type\ of\ anesthesia +$$
$$-0{,}161956492065328 * Scheduled\ start\ time\ surgery$$

$$Maximum\ occupancy\ time\ of\ a\ treatment = 0{,}173839488195232 + 0{,}00747054203583553 * Cataract + 0{,}0123723924951056 * Cornea + 0{,}0121246188658791 * Oculoplastic\ surgery + 0{,}022171460129332 * Retina + 0{,}0997839381366704 * Type\ of\ anesthesia + -0{,}0584432838265109 * Scheduled\ start\ time\ surgery$$

Where by:
Cataract = 1 when the patient belongs to the care pathway cataract.
Cornea= 1 when the patient belongs to the care pathway cornea.
Oculoplastic surgery = 1 when the patient belongs to the care pathway oculoplastic surgery.
Retina = 1 when the patient belongs to the care pathway retina.
When the patient belongs to another care pathway, Cataract, Cornea, Oculoplastic surgery and Retina = 0.
Type of anaesthesia = 1 when the patient receives general anaesthesia, for local anaesthesia Type of anaesthesia = 0.
Scheduled start time surgery = the time the surgery is supposed to start according to the schedule.

These formula will be used to calculate the occupancy time of a treatment place.

4.3 Prediction model

To calculate the number of treatment places needed is it necessary to know how many treatment places are simultaneously in use. With the multiple linear regression it is possible to calculate the duration a treatment place is occupied per patient but it is not known at what point in time during the day the treatment place is occupied. When it is not known at what point in time during the day the treatment places are occupied, then neither can be calculated how many treatment places are occupied simultaneously. Therefor the point in time during the day the start of the occupancy of the treatment place needs to be determined. A method to obtain this information is to link the start of the occupancy time of a treatment place to a reliable moment in time that is known and that is not included in the formula. A reliable moment in time is the pre-arranged sign in time. It can be concluded that this is a reliable moment since 80,8% of the patients signed in at the pre-arranged sign in time or earlier than the pre-arranged sign in time (Table 6).

Table 6: Difference between the pre-arranged sign in and the actual sign in time of patients (n=193).

Patient signed in later than scheduled (n=37; 19,2%)	
Average difference (hh:mm)	0:10
Minimum difference (hh:mm)	0:01
Maximum difference (hh:mm)	1:08
Patient signed in earlier than scheduled (n=156; 80,8%)	
Average difference (hh:mm)	0:18
Minimum difference (hh:mm)	0:00
Maximum difference (hh:mm)	0:15

The duration between the pre-arranged sign in time and the moment the treatment place will be occupied we denominate this period of time "average waiting time before surgery". The calculations of this average waiting time before surgery have the limitation that the sizes of the pre-arranged sign in times are unequally distributed. Nevertheless, using these times is the best available option since these times are the same for each surgery and most patients sign in in time. The average waiting time before surgery is per pre-assigned sign in interval represented in Table 7.

Table 7: Average waiting time before surgery (n=175). Patients that have to sign in at 6:45h are directly brought to a treatment place. Subsequently, they occupy the treatment place from the moment they sign in.

Pre-arranged sign in time	**Average duration (hh:mm)**
6:45h - 6:59h	0:00
7:00h - 7:59h	1:01
8:00h - 8:59h	1:21
9:00h - 9:59h	2:08
10:00h - 10:59h	2:09
11:00h - 11:59h	1:47
12:00h - 12:59h	1:35
13:00h - 13:59h	1:15
14:00h - 14:59h	1:32

Consequently it is possible to predict per patient from which moment and how long a treatment place is occupied based on average waiting time before surgery and occupancy time of a treatment place. This is graphically presented in Figure 6.

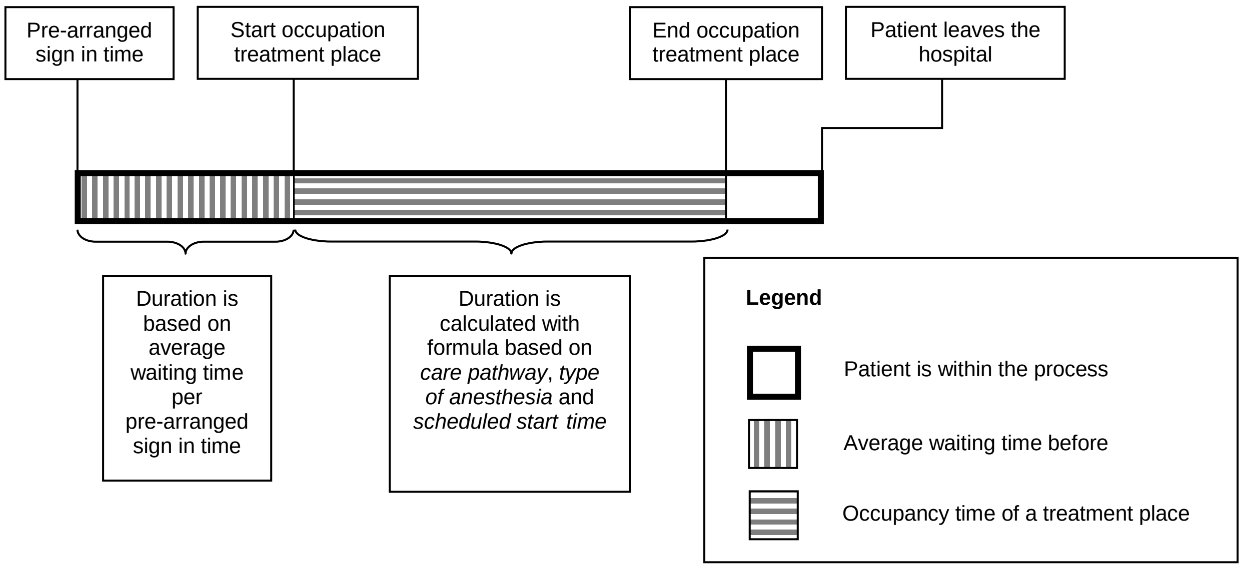

Figure 6: Graphical representation of the prediction model to calculate when a treatment place is occupied.

The formulas for this prediction model are as follows:

$$\begin{aligned} &\textit{Start occupation treatment place} \\ &\qquad = \textit{Pre-arranged sign-up time} + \textit{Average waiting time before surgery} \end{aligned}$$

$$\begin{aligned} &\textit{End occupation treatment place} \\ &\qquad = \textit{Pre-arranged sign-up time} + \textit{Average waiting time before surgery} \\ &\qquad + \textit{Occupancy time of a treatment} \end{aligned}$$

Where by:

Average waiting time before surgery can be read from Table 7

$Occupancy\ time\ of\ a\ treatment = 0{,}142108526108195 + -0{,}00799920202385616 * Cataract + -0{,}00360232809096357 * Cornea + -0{,}00591010905588735 * Oculoplastic\ surgery + 0{,}0092119753514671 * Retina + 0{,}0869692253543522 * Type\ of\ anesthesia + -0{,}110199887945919 * Scheduled\ start\ time\ surgery$

To calculate the range standard error should be taken into account. For the lowest limit the minimum occupancy time of a treatment place should be used and for the highest limit the maximum occupancy time of a treatment place should be used:

$$Minimum\ occupancy\ time\ of\ a\ treatment = 0{,}110377564021158 + \\ -0{,}0234689460835479 * Cataract + -0{,}0195770486770327 * Cornea + \\ -0{,}0239448369776538 * Oculoplastic\ surgery + -0{,}00374750942639776 * Retina \\ + 0{,}07415451257203412 * Type\ of\ anesthesia + -0{,}161956492065328 * Scheduled\ start\ time\ surgery$$

$$Maximum\ occupancy\ time\ of\ a\ treatment = 0{,}173839488195232 + \\ 0{,}00747054203583553 * Cataract + 0{,}0123723924951056 * Cornea + \\ 0{,}0121246188658791 * Oculoplastic\ surgery + 0{,}022171460129332 * Retina + \\ 0{,}0997839381366704 * Type\ of\ anesthesia + -0{,}0584432838265109 * Scheduled\ start\ time\ surgery$$

With this prediction model is it possible to calculate when the occupancy of a treatment place starts and the duration a treatment place is occupied. To calculate the number of treatment places that are at the most simultaneously in use on one day, the outcomes from the prediction model of all patients scheduled of that day should be added.

4.3.1 Testing the prediction model

The data from seven random chosen days have been used to test the outcomes the prediction model. These days fall outside the period of data gathering. The test is been performed by filling in the formulas *start occupation treatment place* and *end occupation treatment place*. To calculate the range, also *minimum occupancy time of a treatment place* and *maximum occupancy time of a treatment place* been used to calculate the end time of treatment place occupation. The results are represented in paragraph 5.4 after the results from the data collection which are first presented in Chapter 5.

Chapter 5 - Results

This chapter is subdivided in two types of results. First, the results from the data collection are given. Second, the results from the prediction model are discussed. Within the results from the data collection, a distinction is made between the distribution of patients, usage of treatment places, and remaining results. The results of the prediction model show outcomes from seven random days that have been tested.

5.1 Patients

In total 222 adults were tracked during the data collection. Men and women were exactly evenly divided (Table 8) and had an average age of 61,8 years for men and 60,4 years for women. The patients can be classified in the three methods as explained in paragraph 2.1.1: type of patient, type of anaesthesia and by care pathway (Table 9 to 11). Most patients received treatment in day surgery. General anaesthesia is the most used type of anaesthesia. Our dataset confirms that the retina care pathway constitutes the largest patient group.

Table 8: Distribution of the tracked patients per gender (n=222).

	Patients	
Gender	**Number**	**Percentage**
Male	111	50,0
Female	111	50,0
Total	222	100,0

Table 9: Distribution of the tracked patients per type of patient (n=222).

Type of patient	**Percentage of patients**
Day surgery	92,7
Inpatient	6,0
Unknown	1,4
Total	100,0

Table 10: Distribution of the tracked patients per type of anaesthesia (n=222).

Type of anaesthesia	**Percentage of patients**
General	72,7
Local	25,2
Unknown	2,1
Total	100,0

Table 11: Distribution of the tracked patients per care pathway (n=222).

Care pathway	**Percentage of patients**
Oculoplastic surgery	9,1
Strabisma	11,9
Glaucoma	21,6
Cornea	13,6
Cataract	17,6
Retina	26,1
Total	100,0

On average 28,8 patients were treated per day, with a minimum of 25 patients and a maximum of 34 patients. To get an overview of the number of patients simultaneously in the process, we plotted the number of patients per 15 minutes. Figure 7 shows that between 11.00h and 13.45h more than 11 patients are in the process. This is the same time period the staff has their lunch break.

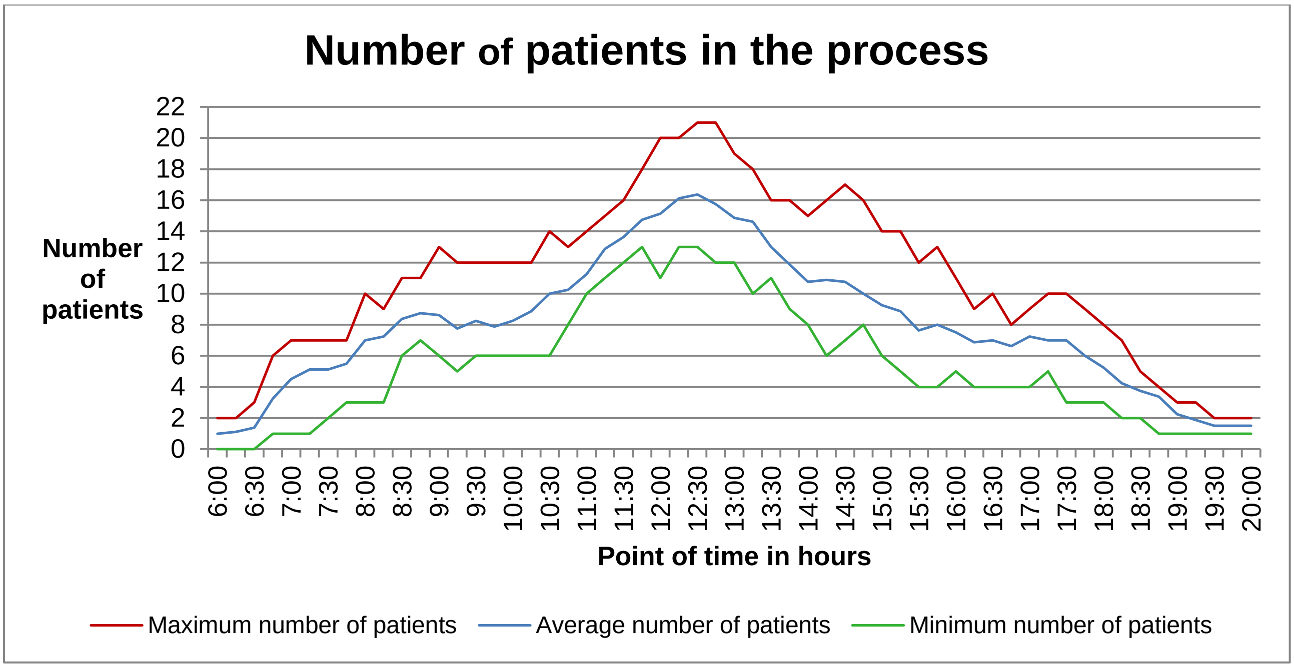

Figure 7: Number of patients simultaneously in the process.

5.2 Treatment places

To estimate the number of treatment places used, the number of treatment places simultaneously occupied are important. Patients keep treatment places occupied from the moment the holding calls the nursing deparment to let them know a specific patient can be brought untill the moment patients change back into their own clothes. The number of treatment places that were simultaneously in use per day are graphically represented in Figure 8. Overall the maximum number of treatment places simultaneously in use in the process vary between 12 and 17. In average where maximum 13 treatment places simultaneously in use.

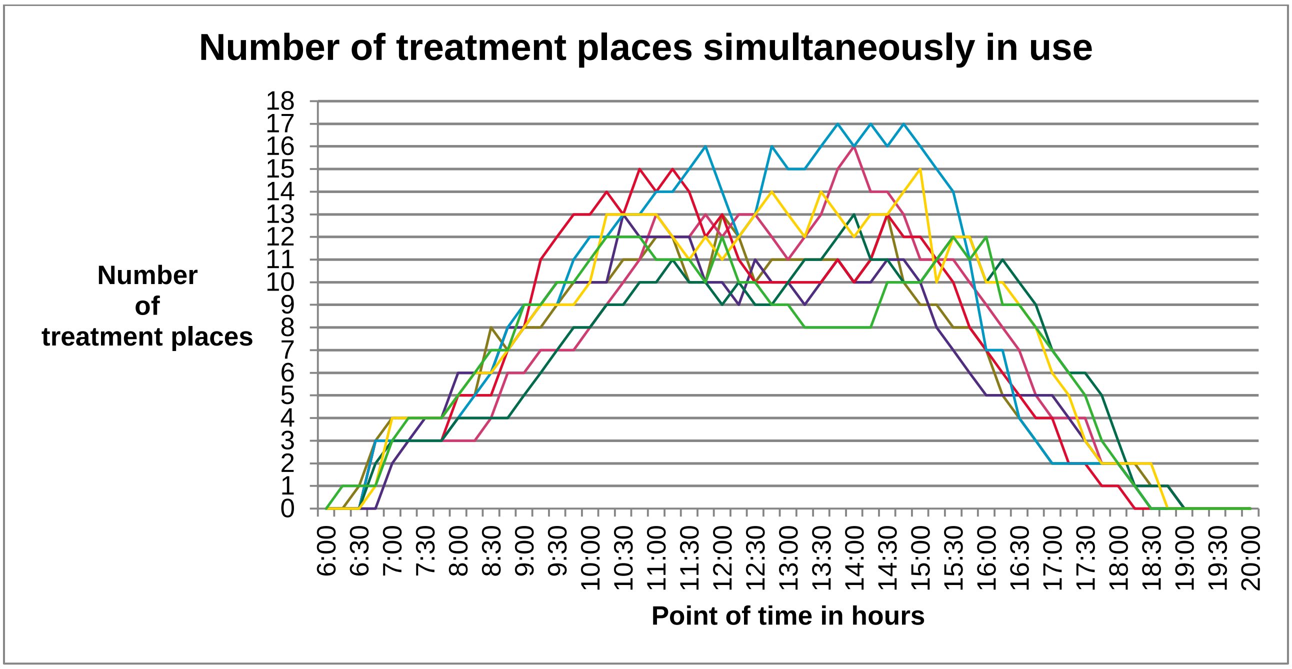

Figure 8: Number of treatment places simultaneously in use per day data were gathered. Every line represents one day.

Nurses from the nursing ward remember moments in the past where not enough space was available to treat patients on treatment places. In other words, the nurses on the nursing ward have the feeling that the spaces for treatment places are not sufficient. A shortage of space to treat patient on treatment places never existed on the holding and recovery. To gain insight in the amount of space needed for patients that occupy a treatment place on the nursing ward, a subdivision is made for the treatment places that were simultaneously in use on the nursing ward. To give more accurate information the treatment places have been divided into trolleys and clinical beds. The reason for this distribution is that different types of treatment places are situated in different rooms on the nursing ward. In Figure 9 the number of trolleys simultaneously in use on the nursing ward are represented. The maximum number of trolleys in use is six. It is not indicated in which room these trolleys are in use (room 2 or room 5). The same figure is created for the number of clinical beds (Figure 10). This figure shows that as a maximum four clinical beds were simultaneously in use.

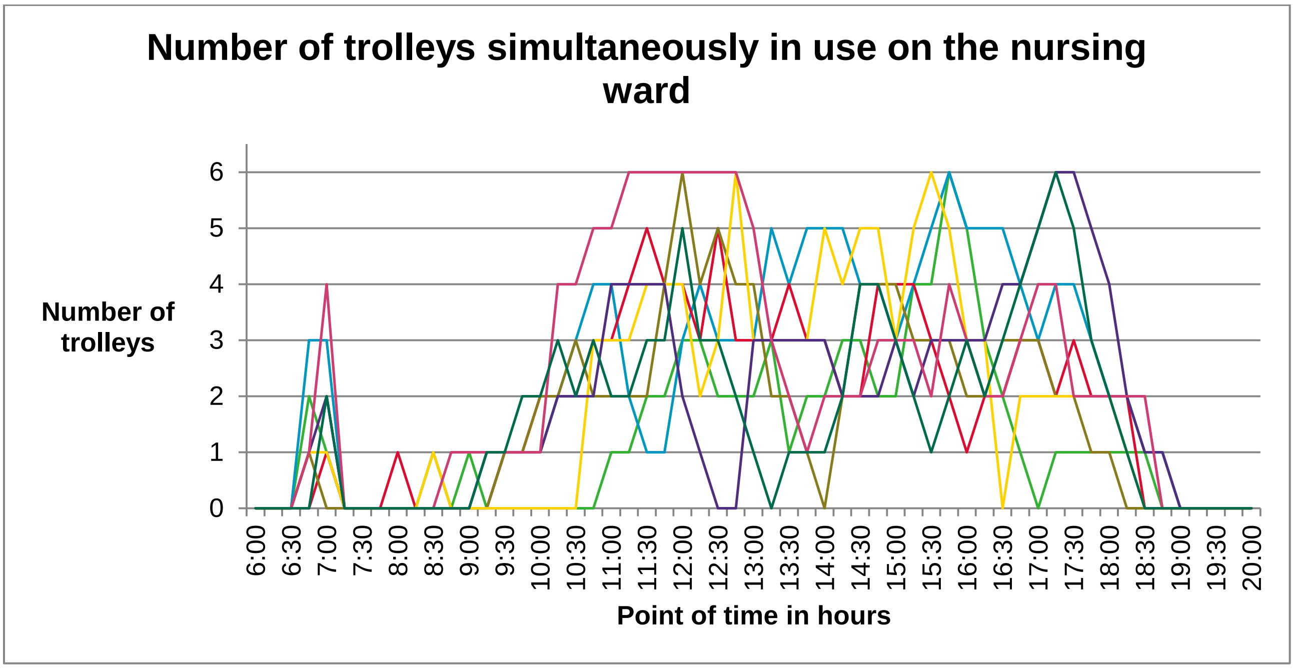

Figure 9: Number of trolleys simultaneously in use on the nursing ward per day data were collected. Every line represents one day.

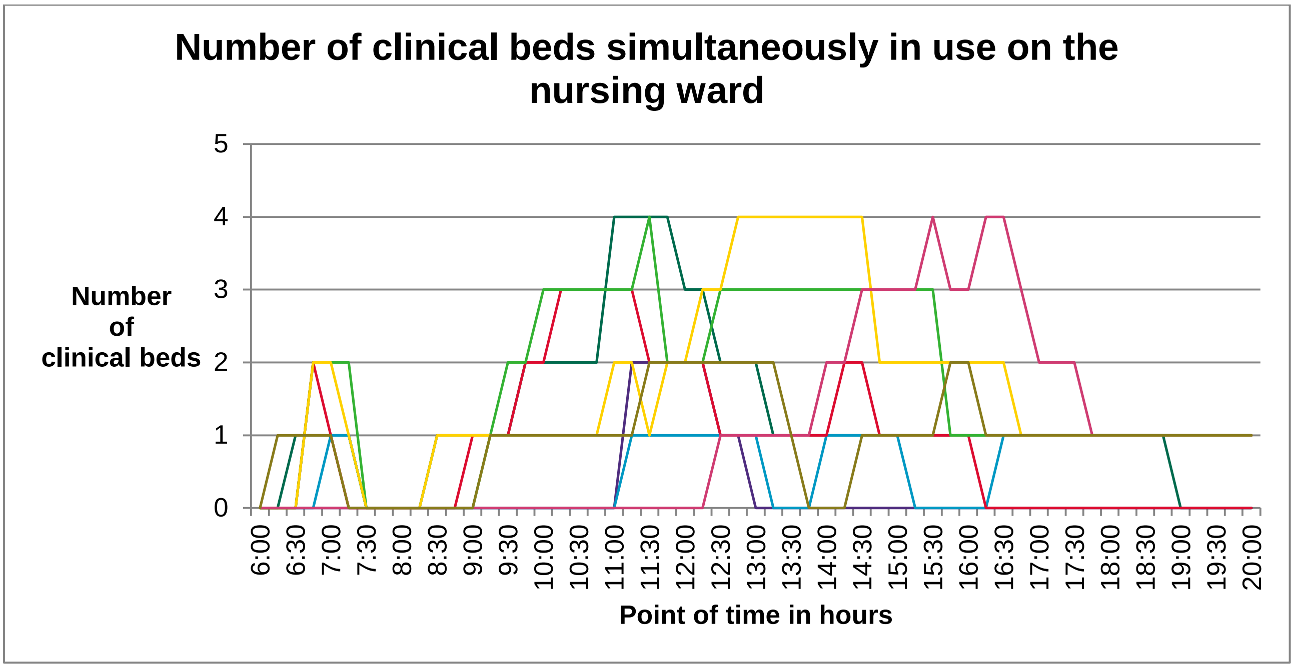

Figure 10: Number of clinical beds simultaneously in use on the nursing ward per day data were collected. Every line represents one day.

Based on these data it can be concluded that the number of treatment places and the required space in the different treatment rooms on the nursing ward is sufficient. To determine how many treatment places are needed per day, the outcomes of the prediction model have been tested. The results can be found in paragraph 5.4. In the next section other results from the data collection are presented.

5.3 Remaining results from the data collection

The results above relate primarily to the main question of this research which investigates how many treatment places are needed. In paragraph 2.4 more problems that occur in the process have been indicated. In this part the data related to these problems are represented. The goal is to determine how often these problems occur, based on data.

The content of Paragraph 5.3.1, 5.3.2 and 5.3.3 is confidential and are for that reason not presented in this version.

5.4 Results from the test of the prediction model

The data from patients of seven days, that were not included in the period of data collection, have been used to test the prediction model. The prediction model can be used as a tool to calculate when a treatment place is occupied. This is done by calculating the occupancy time of a treatment place and adding this to the start time to calculate the end time. The needed number of treatment places for one day can be calculated by filling in the patient data of the schedule on that day in the prediction model. The outcomes of different patients can be added to calculate the number of treatment places that are maximum simultaneously in use.

The test has been performed by comparing the actual number of treatment places used with the calculated number of treatment placed. Once every hour manually has been written down which treatment places were occupied to determine the actual use of treatment places. The model is used by filling in the patient data in the formula. The formulas for minimum and maximum occupancy time of a treatment place have also been filled in to calculate the range. The results are represented in Table 15. The table shows that the actual maximum number of treatment places simultaneously used per day, fall within the range calculated by the prediction model. The width of the range varies between 8 treatment places on Thursday 12th of July and 16 treatment places on Friday the 13st of July. In this test on average, rounded up, 15 treatment places are needed per day according to the prediction model. The actual data shows that on average, rounded up, 13 treatment places were needed. Except for Monday the 16th of July, all calculated number of treatment places needed are higher than the actual number of treatment places used. The prediction of the model lies in average 2,4 treatment place higher than actually were used simultaneously. The only deviation was 11th of July: the model predicted a occupancy of 15 treatment places simultaneously, in reality 9 treatment places have been used simultaneously. From this test can be concluded that the number of treatment places needed, calculated with the prediction model are realistic and in close proximity of the actual number of treatment places needed.

Table 15: Results of the sample to test the prediction model with data of seven random chosen days.

Day of surgery		Number of treatment places actual maximum simultaneously in use	Calculated with prediction model		
			Number of treatment places simultaneously in use	Number of treatment places minimum simultaneously in use	Number of treatment places maximum simultaneously in use
Friday	6 July 2012	13	16	9	24
Monday	9 July 2012	13	14	10	21
Tuesday	10 July 2012	12	13	8	19
Wednesday	11 July 2012	9	15	8	22
Tuesday	12 July 2012	13	15	11	19
Friday	13 July 2012	15	17	8	24
Monday	16 July 2012	17	15	9	21

It was possible to support most of the problems indicated by the staff with figures and calculations. During the test period of the prediction model all the actual number of treatment places simultaneously in use fall within the range calculated by the aid of the model. Furthermore the test shows that in most cases the model estimates of the number of treatment places simultaneously in use were a little higher than the actual usage. The conclusions and subsequent recommendations are described in the next chapter.

CHAPTER 6 – Conclusions and recommendations.

In this chapter conclusions are drawn and recommendations based on these conclusions are represented. Per subject the conclusion and thereafter the recommendation are represented. The key point of the recommendation is presented in italics. First, the conclusion and recommendation regarding the question 'How many treatment places are needed to run the patient process smoothly?' are given. After that, the remaining conclusions and recommendations are presented. This chapter ends with the recognition of limitations within this research.

6.1 Number of treatment places

Until now treatment places have been seen as a whole in the calculations. The term has to be dissembled to be able to make specific recommendations. As already explained treatment places is the umbrella term for all types of beds used: trolleys, clinical beds and beds for children. No conclusion or recommendation will be made regarding the number of beds for children since the data on children were insufficient and therefor left out of the dataset. Consequently, the term treatment places need to be separated in trolleys and clinical beds. The dataset shows that 84,5% of the patients were treated on a trolley and 15,5% of the patients received treatment on a clinical bed. Linking this to the rate of day surgery patient and inpatients scheduled, it shows that 93,9% of the patients in the dataset came for day surgery and 6,1% were inpatients. From this can be concluded that 9,4% (15,5%-6,1%) of the day surgery patients were treated on a clinical bed. Given the fact that the dataset, consisting of 175 patients, is the only data that can provide information on the ratio between the types of treatment places, it is assume this distribution is correct. The numbers of treatment places needed have to be corrected with the applicable percentages (trolleys-84,5%, clinical beds-15,5%) to give recommendations per type of treatment place. Two tables are used to base recommendations on. Both tables show the number of treatment places corrected with the applicable percentages; Table 16 presents the days data were collected, Table 17 presents the seven days that were used to test the prediction.

Table 16: Number of treatment places corrected with the applicable percentages: trolleys - 84,2%, clinical beds - 15,5%. Data of days data were gathered.

Day of surgery		Number of treatment places maximum simultaneously in use	Corrected number of trolleys (rounded off)	Corrected number of clinical beds (rounded off)
Wednesday	18 April 2012	13	11	2
Monday	23 April 2012	16	14	2
Tuesday	24 April 2012	13	11	2
Wednesday	25 April 2012	15	13	2
Friday	27 April 2012	17	14	3
Tuesday	1 May 2012	13	11	2
Friday	4 May 2012	15	13	2
Monday	14 May 2012	12	10	2
	Average	14,3	12,1	2,1
	Min	12	10	2
	Max	17	14	3

Table 17: Number of treatment places maximum in use. Data of seven days data were gathered to test the prediction model.

Day of surgery		Number of treatment places actual maximum simultaneously in use	Number of trolleys actual maximum simultaneously in use	Number of clinical beds actual maximum simultaneously in use
Friday	6 July 2012	13	13	2
Monday	9 July 2012	13	13	2
Tuesday	10 July 2012	12	11	2
Wednesday	11 July 2012	9	9	1
Tuesday	12 July 2012	13	12	2
Friday	13 July 2012	15	15	2
Monday	16 July 2012	17	14	3
	Average	13,1	12,4	2
	Min	9	9	1
	Max	17	15	3

Correcting the maximum number of treatment places with the 84,5% to calculate the number of trolleys, the sample shows a maximum of 15 trolleys. The maximum number of clinical beds that would be needed for the inpatients scheduled, using the same correction (15,5%

for clinical beds), would be 3 clinical beds rounded upwards for all days. The same maxima, for trolleys and clinical beds, apply for data that were used to test the prediction model.

To test the 15 trolleys in practice, a pilot was performed. On the first day, two trolleys were removed from the department without informing the staff in advance. The prediction model calculated that on this day minimum 10 and maximum 15 trolleys would be used. On this day in total maximum 13 trolleys were used. Since the second day, the staff was informed about the recommendation to remove two trolleys and knew that two trolleys had been moved. On this second day 33 patients were scheduled which is relatively large number. The model predicted that minimum 8 and maximum 17 trolleys would be needed. Around 15.00h all 15 trolleys were used. Performing the process with 15 trolleys did not cause any problems since no patients or medical staff member had to wait until a treatment place was available. For one month the surgery schedule with four operating theatres has been performed with 15 trolleys without any problems. This pilot confirmed the conclusion that was made based by the use of the prediction model.

*Based on this research 15 trolleys and 3 clinical beds must be enough to run the process smoothly.*In other words, two trolleys are not needed. The reduction of the number of trolleys has the advantage that the maintenance costs and cleaning costs can be reduced. Additionally, this will yield a saving in the upcoming years since the depreciated trolleys will be replaced in the next few years. However with this recommendation, two trolleys less need to be replaced. Also less trolleys can contribute to less untidy trolleys in room 2. For one month a pilot has already been performed. After the first day of the pilot period, the staff was informed about the reduction of two trolleys. It emerged that the medical staff is aware of the fact that this recommendation is based on research but some staff members were not yet convinced from the execution in practice. This is probably because they still remember the rare but stressful moments in which insufficient treatment places for patients were available. During this pilot the staff experienced themselves that the patients process can still run smoothly with less trolleys and that this does not mean they will experience more workload. If in the future occasionally more treatment places are needed, it is not a problem to use a clinical bed instead of a trolley. According to the data, this will not be a problem since 10 clinical beds are available who are seldom used all at once. The distribution of clinical beds and trolleys as presented in Table 18 is suggested in the mornings. The number of beds for children will stay unchanged, it is advised to store these beds in room 1. It is advised to select the two trolleys that will be moved from the department based on age and model.

Table 18: Advised distribution of treatment places.

Room number	**Number of trolleys**	**Number of clinical beds**
1	0	1
2	7	0
5	8	0
6	0	4
7	0	4
8	0	2
9	0	2
Total	**15**	**13**

6.2 Magnetic board

The staff of the nursing ward uses the magnetic board to keep overview of the patients that are in the process. In the observations during the data collection, some problems were observed with regard to the magnetic board. Several times the cards of patients were not correctly placed on the magnetic board. This has several consequences: the number of patients in treatment rooms were incorrect through this patients had to wait shortly in the hall way until space was created in the treatment room; panic emerged when a patient that should be already in the hospital, was not traceable on the board; nurses were waiting for a patient to come back from the surgery department however this patient had already gone home; and escort were sent the wrong way. These consequences could not be underpinned with data. Despite this fact, it can concluded that a not up-to-date magnetic board causes confusion for the medical staff and can stagnate the patient process.

To avoid stagnation of the patient process and confusion due to the magnetic board, we strongly recommend to focus attention on keeping the magnetic board up-to-date. This means that the cards need to change when patients continue in the process and that cards should either be in the tray or on the magnetic board.

6.3 Cards of patients that have signed in

The tray for cards of patients that have just signed in at the front desk can be more practical and efficient. Almost every day during the observations cards in the tray at the front desk were rearranged several times. When the patients signs in at the front desk, the front desk employee puts the card of the patient in a tray. The tray is perceived as impractical because the opening of the tray is very narrow and the tray must be picked up to put the cards in the correct order. The order of cards in the tray is the order the patients signed in. The order of intake with the nurses is based on the order of the surgery schedule. In practice this means that nearly every nurse that is doing intake, takes all the cards out of the tray, orders them according to the surgery schedule, takes out the card of the patient that they are going to welcome and puts the other cards back into the tray. This is a form of waste because the same activity is executed repeatedly.

For more convenience and efficiency we recommend to replace the tray for cards on the front desk. This recommendation is based on two reasons; first, the current tray is inconvenient in use; second, the tray does not give overview of the number of patients that already have signed in since the cards are positioned behind each other and not next to each other. An idea would be to use two shelves in which the cards can be positioned next to each other. The first shelf can be used by the front desk employees to put in the cards of patients that recently signed in. The second shelf can be used for cards that are already put in order. By using two shelves, the cards from patients on the first shelf that just have signed in, can easily be added in the correct place on the second shelf. Front desk employees support this recommendation and asked already when the tray will be replaced.

6.4 Prioritizing on the nursing ward

It is desirable that patients do not stay longer than medically necessary on the treatment place and that they leave the department after the dismissal conversation. The nursing ward directly has influence on the duration of time between changing and the dismissal conversation.

To decrease the waiting time for the dismissal conversation, it is recommended to discuss the prioritization and distribution of tasks on the nursing ward. The conversation about the prioritization can be seen as a repetition to make sure every employee has the same priority list. The distribution of tasks takes place during daily meetings. To make sure the dismissal conversation is not held at a treatment place and to respect privacy and give personal attention, the dismissal conversations should take place in a separate room. To ensure the patient leaves the department after the dismissal conversation, the patient could be escorted to the elevator.

6.5 Communication between departments

Problems about the communication between the nursing and surgery department were mentioned by both departments. On the surgery department it was claimed that "it takes long" for a patient to be brought or for a nurse to pick up the patient. Furthermore, it is bothersome when the phone is not picked up at the nursing ward. On the nursing ward it was claimed that the staff from the surgery department does not use the appropriate phone number to call the nurses from the nursing ward and that the surgery department calls for more patients at once regardless of the capacity of the nursing ward. A recommendation for these problems is very limited since that data hardly shows proof of these problems. Visits to other hospitals showed that it is possible to use the appropriate phone number without any problems. At Moorfields Eye Hospital every phone call between the operating theatre and nursing ward is manually recorded, inspired us to a recommendation also related to the communication. If surgeons cannot continue their program because the patient is not yet ready for surgery, it is this frustrating for all parties involved. In case the surgery schedule stagnates due to a delayed patient, the situation is analyzed by team leaders and manager of the nursing ward and surgery department to figure out what happened. This process is time consuming and intrusive since a lot of people on both wards need to be consulted. *We recommend to use a telephone system which registers the times phone calls between different handsets are made.* The advantage of this is that the waiting time can be supported with numbers because it can be tracked at what time phone calls were made. The information of who made the phone call is not highly relevant since The Rotterdam Eye Hospital aims at a blame free culture (Korne, de, Hiddema, Bleeker, & Klazinga, 2008).

6.6 Accommodation area

For the refurbishment of the accommodation area it is necessary to know how many people (patients and escorts) are using the room simultaneously to be able to calculate the number of seats needed. The number of escorts per patient were not specifically measured during the observations. In consultation with the team leader of the nursing ward it is assumed that every patient brings one escort. The visits to Erasmus MC and SFG showed that patients and escorts have understanding for the allowance of one escort per patient. The vision for the future is that, patients and escort will use the accommodation area in two periods of time in the patient process. The first period is the time between the intake conversation and the moment the patient changes for surgery. The second period is between the moment patients change back to their own clothes and the moment the dismissal conversation starts. The escort will be encouraged to leave the department while the patient is at the surgery department. The duration between sign in and intake conversation is not taken into account since patients often wait in the hallway. To calculate the number of people in these two time periods, the number of patients was calculated and multiplied by two, to include one escort per patient. At the days data were collected maximum 18 people were simultaneously in the accommodation area during these periods.

As seen in the SFG we recommend a sign for the accommodation area with the text "the order of coming in is not the order of treatment". At the SFG is shown in practice that this creates a better understanding and more tranquility with waiting patients and their escorts.

During the research period more elements came forward that can be improved. The following recommendations are not based on data but on observations. These recommendations are given in paragraph 6.8 and 6.9.

6.7 Change of clothes and lockers

The information can be better explained towards patients when they change from their own cloths into the surgical gown. Repeatedly during the observation period the surgical gown was put on incorrect or patients were still wearing glasses or jewelry. In these cases, the changing of clothes takes longer than necessary. Especially when more patients need to change clothes the process stagnates. *It is recommended that during the intake conversation the instruction is given that jewelry should be dismissed and just before changing the nurse explains clear the process of changing of clothes to the patient (What they should take off and how they should put on the surgical gown. Where they can leave their own clothes).* At Moorfields Eye Hospital patients who receive local anaesthesia do not have to change their clothes, this method also contributes to a more smooth patient process since less time consuming actions need to be performed.

In line with the previous recommendation *we recommend a clearer system for the keys of the lockers*. Escorts but especially patients have trouble finding their belongings after surgery. This can easily be solved by signs on the doors of the dressing rooms and bigger key chains.

6.8 Information towards the patient before surgery

During the observations, multiple times emerged that patients and/or escort were not aware of the course of the day. It was often unknown that the patient needs to be present two hours prior to the scheduled surgery time. The patient is called the day before surgery. During this call the patient receives the sign in time and should also be told that this time is two hours before the scheduled surgery time. The lack of knowledge can be caused by forgetfulness of the patient or of the employee that called the patient. *To ensure the patient and escort* *receive more knowledge about the course of the day, sufficient information towards patients is recommended.* Two suggestions on how this information can be provided are made. First, by adding the course of the day to the letter patients receive from the planning department which gives the date for surgery. Second, by making the course of the day available on the website. The websites of the SFG and MST can serve as an example, which show the course of the day step by step including photos. This recommendation contributes to increase patient empowerment.

6.9 Limitations of this research

Several acknowledged factors and decisions affect the impact and conclusions of this research and therefore will be listed and explained in this paragraph.

- The number of days are limited on which data were collected. In total 222 adult patients were tracked on eight working days. Consequently this means that the statements about specific days are based on data from two working days in which no Thursday was included. Due to limited time and manpower it was not possible to schedule Thursdays for data collection. Since the formula uses the variables *care pathway*, *type of anesthesia,* and *scheduled start time,* the prediction model can also be used to determine the number of treatment places needed on Thursdays. However, if Thursdays were included, more data about the care pathways on these days would be included. More data would probably increase the prognostic value (R-square) of the prediction model.
- It is possible that the recorded times have a deflection. To minimalize a deflection two attuned watches were used during the data collection. However, it must be noted that the times were manually recorded which increase the chance on errors.
- During the observations, it was the intention not to influence the process. The presence of the observers may have influenced the process by making the nurses more aware of duration and therewith they may have worked different than in moments no observation took place. By frequently explaining the goal of the research and emphasizing that the observations had nothing to do with the nurses on personal level, it was attempted to limit this measurement bias. Another aspect are the questions from patients and/or their escort during the observations. When the observers were approached with questions, for example medical questions or questions about the process, they did try to provide an answer for them as quickly as possible in terms of patient friendliness and service.
- The data on children appeared not to be sufficient enough and were therefore excluded from the analysis. As a consequence, no recommendations could be made

about the usage of beds for children. This research shows that no shortage of clinical beds exists and therefore it is not expected that problems regarding the number of beds for children will occur.

- The goal of this research was to give recommendations to increase the efficiency of the patient process. The wish from The Rotterdam Eye Hospital was to focus on the treatment places since this caused trouble in the past. The capacity is formed from materials and staff, treatment places is a part of materials. Consequently to increase efficiency the input from the staff should be critically viewed as well. The Rotterdam Eye Hospital preferred not to perform the research on a staff-member personal level. For this reason the assumption was made that all certified nurses are also competent to perform their jobs correctly. On top of the fact that the hospital preferred no research on personal level, would it probably not have been possible during the data collection to keep track of the different tasks the nurses were performing. Data about the different nurses could probably have led to more recommendations to increase efficiency, this could be a starting point for further research.

The most important recommendations that make the patient process more efficient for patients that undergo surgery are: (1) focusing on treatment places, it is proven the patient process can be smoothly performed by reducing the number of trolleys from 17 to 15; (2) to be able to keep the process running smoothly it is recommended to pay attention to the cards on the magnetic board by changing the card on the board when patients change location; (3) in addition the repetition of prioritization and distribution of tasks in the patient process for nurses on the nursing ward is recommended; (4) it is recommended to use a telephone-system which registers the times phone calls are made, furthermore to both departments is recommended that they use the phone- system as agreed on and answer the telephone as fast as possible.

CHAPTER 7 – Contribution to other projects

In this final chapter we describe briefly to what other three projects within The Rotterdam Eye Hospital this research has already contributed and including suggestions for further research. In these other projects especially the data of this research were used as a support. At the same time we as researchers were allowed to contribute in multiple sessions of projects to share our view and knowledge gained during the research period.

7.1 Surgery scheduling

Recently a project was started to improve the surgery scheduling. The goal of this project is to reformulate the constraints for the surgery scheduling taking the capacity of the different departments into account. The insight into the capacity of the departments, the information about the peak moments, and the impact the different care pathways have on the departments from this research were used in this project. For this project the data set can also be used to determine the duration of the different steps and the variation between care pathways. Besides the data set the data in Appendix A also provoked reflection by the management. This table gives a good overview of the difference in surgical time for the same type of surgery between the different surgeons and can lead to discussions and evaluations with/of surgeons. For example it raises the question whether all surgeons should perform all types of surgeries.

7.2 Project DORA

The tracking of patients, which was the data collection for our data set, was performed in cooperation with project DORA of the Delft University of Technology. This dataset forms the baseline measurement for project DORA in the Rotterdam Eye Hospital. The original goal of project DORA is to create a system that supports staff with accurate and timely information about the patient's location in the process (Wauben, et al., 2012). This will be done by giving patients a tag which will be tracked during the process. The location information from these tags will be presented real time on a so called 'Schiphol-board' which will show in which step of the process the patient is in. The Schiphol-board will also inform the escorts. For example that the escorts receive a message with a time estimation when the patient will return on the nursing ward. Future plans also aim to inform patients on what time they are expected to leave the hospital.

Data collection by means of the tags is a comprehensive and automatic modus to collect the same data as we have done. This system will be more accurate and is able to collect more data. With these data a simulation can be performed to test new methods directly without first having to make changes in the hospital. For example a simulation could test the impact of another master surgery schedule on the number of treatment places, the workload and the number of patients.

7.3 Staff scheduling

This research also contributed to a project proposal to change the staff scheduling. The aim of this project is to increase the employee satisfaction. By adjusting the supply of employees to the demand of patients, it is expected that the workload and therewith the absenteeism will decrease. Since 2011 the nursing ward had one nurse after another that was long absent due to sickness. In addition the percentage of short absence is relatively high compared within the health care sector. This causes a higher workload for the other nurses since they are often asked to work extra shifts on short notice. A few of the 28 nurses feel that always the same nurses work extra, which gives them a unsatisfied feeling. As already stated, the management team has a lack of knowledge about the capacity that is actually needed for the patients who receive surgery in day surgery. To get insight in the distribution of the number of patients during the day, the data of this research have been used. These data gave insight in the peak moments on the nursing ward. The scheduled shifts of employees were added. This made transparent when the supply of employees is needed and then the employees are present. The rise of the patients present on the nursing ward corresponds with the fall of the nurses present. For clarification the graph of this is represented in Figure 13. The graph is based on average numbers of the days data were gathered. The current distribution causes workload for the nurses which can lead to negative employee satisfaction. While keeping in mind that it is hard to find certified and qualified nurses these days, this project proposes changes to the staff scheduling to keep employees satisfied. The suggested changes anticipate to the number of patients and take the workload, breaks, and the various tasks on the nursing ward into account. This is anticipated by other shifts, more flexibility and less time to transfer the work between the different shifts. This proposal will probably save money for The Rotterdam Eye Hospital since the deployment of staff is more efficient and effective.

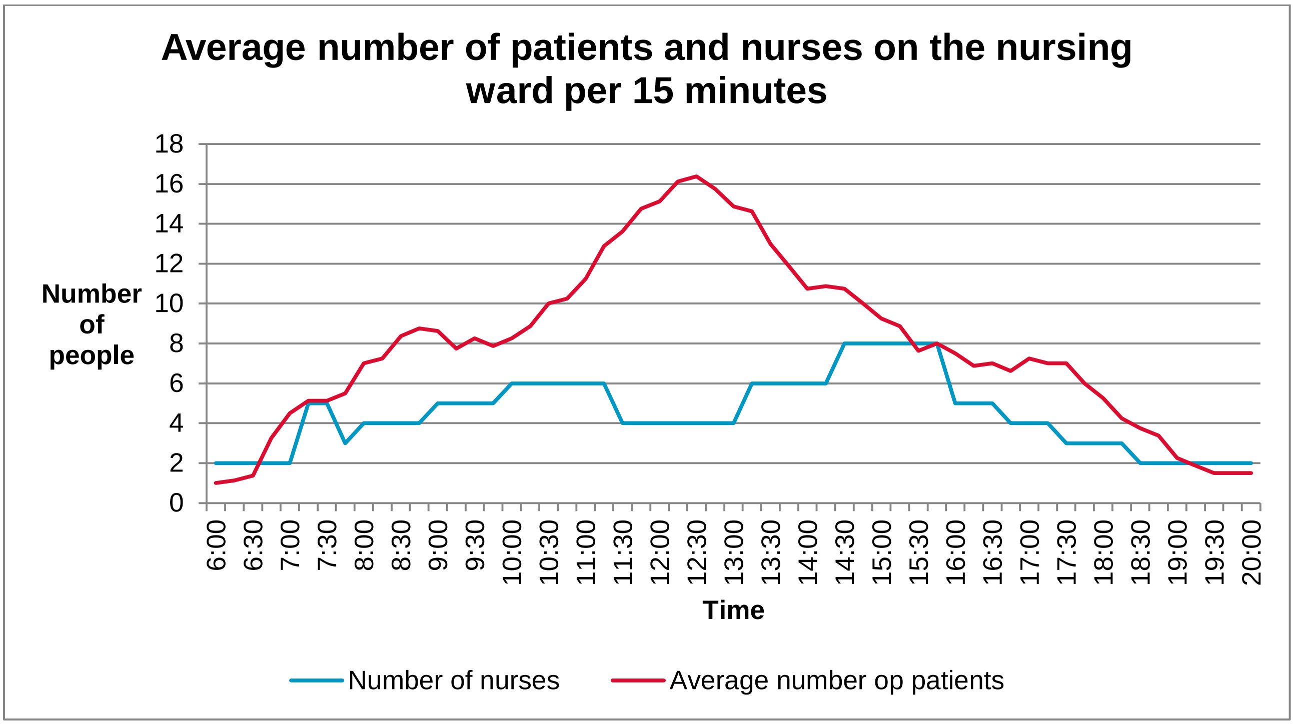

Figure 13: Graphically shown the number of patients and the number of nurses during the day.

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Appendix

Appendix A – Surgeons

Care Pathway	Number of surgeries	Average surgery duration	St.dev. surgery duration
Cataract	**997**	**0:29:01**	**0:10:34**
Operation A	**632**	**0:26:56**	**0:07:47**
Surgeon 1	266	0:25:45	0:06:59
Surgeon 2	179	0:27:16	0:07:44
Surgeon 3	98	0:26:36	0:07:56
Surgeon 4	63	0:28:52	0:08:45
Surgeon 5	26	0:33:21	0:09:14
Operation B	**365**	**0:32:36**	**0:13:26**
Surgeon 4	122	0:32:42	0:11:09
Surgeon 1	114	0:29:33	0:07:43
Surgeon 2	83	0:35:11	0:15:04
Surgeon 3	46	0:35:20	0:22:43
Cornea	**248**	**0:33:26**	**0:12:17**
Operation A	**131**	**0:31:31**	**0:11:47**
Surgeon 6	77	0:31:05	0:11:11
Surgeon 7	31	0:26:33	0:09:30
Surgeon 8	23	0:39:39	0:12:42
Operation B	**117**	**0:35:35**	**0:12:32**
Surgeon 7	40	0:25:58	0:06:26
Surgeon 8	40	0:43:27	0:12:30
Surgeon 6	37	0:37:28	0:10:50
Glaucoma	**621**	**0:48:53**	**0:19:00**
Operation C	**406**	**0:58:06**	**0:16:24**
Surgeon 9	177	0:50:12	0:12:43
Surgeon 10	137	0:58:26	0:15:14
Surgeon 11	92	1:12:49	0:13:59
Operation A	**215**	**0:31:27**	**0:08:22**
Surgeon 12	77	0:33:05	0:06:44
Surgeon 11	55	0:29:41	0:07:50
Surgeon 10	45	0:26:56	0:07:06
Surgeon 9	38	0:36:02	0:10:15

Care Pathway	Number of surgeries	Average surgery duration	St.dev. surgery duration
Strabismus	**342**	**0:38:52**	**0:09:10**
Operation D	**176**	**0:41:32**	**0:08:13**
Surgeon 13	120	0:41:54	0:08:47
Surgeon 14	56	0:40:45	0:06:49
Operation E	**166**	**0:36:01**	**0:09:17**
Surgeon 14	83	0:35:38	0:08:22
Surgeon 13	83	0:36:25	0:10:10
Oculoplastic surgery	**211**	**0:42:07**	**0:25:19**
Operation F	**108**	**0:57:41**	**0:25:53**
Surgeon 15	42	1:02:24	0:19:32
Surgeon 16	39	0:41:52	0:10:43
Surgeon 17	27	1:13:11	0:36:26
Operation G	**103**	**0:25:47**	**0:09:33**
Surgeon 16	48	0:21:14	0:06:16
Surgeon 15	33	0:31:20	0:12:02
Surgeon 17	22	0:27:25	0:05:55
Retina	**1347**	**1:19:03**	**0:32:40**
Operation H	**790**	**1:06:06**	**0:22:51**
Surgeon 18	200	1:03:47	0:22:54
Surgeon 19	176	1:06:10	0:18:54
Surgeon 20	167	1:09:31	0:20:46
Surgeon 21	148	0:59:14	0:18:31
Surgeon 22	99	1:15:12	0:32:46
Operation I	**557**	**1:37:25**	**0:35:34**
Surgeon 22	148	1:41:56	0:35:41
Surgeon 18	134	1:44:53	0:41:33
Surgeon 21	130	1:31:35	0:33:46
Surgeon 19	85	1:25:07	0:27:36
Surgeon 20	60	1:39:40	0:28:23

Figure A.1: Per care pathway the two most performed operations In 2011 by the surgeons that were also included in the data set. For confidentiality reason are the data anonymised.

Appendix B – Multiple linear regression

Different combinations have been tested to determine the influence of the variables on the occupancy time of a treatment place. The combinations that have been tested by means of MS Excel, the resulting R-squares are represented in Table B.1. The combinations are, from left to right, ordered from highest to lowest R-square. If the R-square is the same, the combinations are ordered based on the number of variables.

Table B.1: Overview of different combinations of the six independent variables with the resulting R-squares. 'X' indicates that the independent variable is used to estimate the prognostic value R-square.

	Combination	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Independent variables	Care pathway	X	X	X	X	X	X	X		X	X		X		X		
	Type of anaesthesia	X	X	X	X	X	X	X	X	X	X	X					
	Scheduled start time surgery	X	X	X	X	X	X	X	X		X		X	X			
	Gender		X	X		X		X									
	Age	X	X	X												X	
	Number of nurses working			X	X	X				X							X
	R-Square	0,714	0,714	0,714	0,713	0,713	0,712	0,712	0,703	0,682	0,682	0,663	0,405	0,277	0,275	0,051	0,011

Table B.1 shows that seven combinations have (almost) the same highest R-square. The next step is to decide which of seven regressions is more appropriate. The difference between 71,4%, 71,3%, and 71,2% is nil and therefore negligible. As already mentioned it is desirable to have the largest R-square with the least independent variables. Therefor would combination F; *care pathway*, *type of anaesthesia* and *scheduled start time surgery* be the most suitable to calculate the occupancy time of a treatment place.

The seven regressions with the highest R-square have been tested with data of three patients to test their accuracy. The patient data and results of the four combinations are presented in Figure B.1.

Patient data								
Patient number	**Clinical Pathway**	**Age**	**Type of anesthesia**	**Scheduled start time surgery**	**Start occupation treatment place**	**End occupation treatment place**	**Actual occupation treatment place**	**Number of nurses**
P1	Oculoplastic surgery	73	General	10:15	10:03	14:28	4:25	6
P2	Cornea	68	General	16:00	15:50	17:50	3:50	6
P3	Oculoplastic surgery	55	General	15:00	14:00	17:50	3:50	6

Combination	A			B		
Patient number	**4 Variables; Care pathway, Type of anaesthesia, Scheduled start time surgery, and Age.**			**5 Variables; Care pathway, Type of anaesthesia, Scheduled start time surgery, Gender, and Age.**		
	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place
P1	4:18	1:32	7:04	4:17	1:16	7:19
P2	3:41	0:42	6:40	3:41	0:27	6:55
P3	3:43	0:50	6:35	3:42	0:34	6:50

Combination	C			D		
Patient number	**6 Variables; Care pathway, Type of anaesthesia, Scheduled start time surgery, Gender, Age, and Number of nurses.**			**4 Variables; Care pathway, Type of anaesthesia, Scheduled start time surgery, and Number of nurses.**		
	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place
P1	4:16	0:09	8:23	4:12	1:03	7:21
P2	3:38	-0:41	7:59	3:36	0:12	7:01
P3	3:41	-0:31	7:54	3:41	0:17	7:04

Combination	E			F		
	5 Variables; Care pathway, Type of anaesthesia, Scheduled start time surgery, Gender, and Number of nurses.			**3 Variables; Care pathway, Type of anaesthesia, and Scheduled start time surgery.**		
Patient number	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place
P1	4:12	0:47	7:36	4:13	2:11	6:15
P2	3:36	-0:03	7:16	3:38	1:22	5:55
P3	3:40	0:01	7:19	3:42	1:25	5:58

Combination	G		
	4 Variables; Care pathway, Type of anaesthesia, Scheduled start time surgery, and Gender.		
Patient number	Calculated occupation treatment place	Minimum calculated occupation treatment place	Maximum calculated occupation treatment place
P1	4:13	1:56	6:30
P2	3:38	1:06	6:10
P3	3:41	1:09	6:13

Figure B.1: Outcomes of seven different combinations to calculate the occupancy time of a treatment place. Data of three patients were used. The figure is cut into pieces to increase readability.

From Figure B.1 can two things be read. First, the predicted occupancy time of a treatment from the regressions is reasonably correspondingly with the actual occupancy time of a treatment. Second, the difference between the combinations is very limited. For this reason, the combination of *care pathway*, *type of anaesthesia* and *scheduled start time surgery* is chosen as most applicable to calculate the occupancy time of a treatment place. The summary output of this regression is represented in Figure B.2.

SUMMARY OUTPUT					
Regression Statistics					
R-Square	0,712448722				
Factors	*Coefficients*	*Standard Error*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0,142108526	0,016072941	1,24274E-15	0,110377564	0,173839488
X1a Cataract	-0,007999202	0,007836015	0,308804971	-0,023468946	0,007470542
X1b Cornea	-0,003602328	0,008091804	0,656761099	-0,019577049	0,012372392
X1e Oculoplastic surgery	-0,005910109	0,009135277	0,518544294	-0,023944837	0,012124619
X1f Retina	0,009211975	0,006564473	0,162370659	-0,003747509	0,02217146
X2 Type of anaesthesia (1=General, 0= Local)	0,086969225	0,00649114	2,59669E-28	0,074154513	0,099783938
X3 Scheduled start time surgery	-0,110199888	0,026216691	4,26299E-05	-0,161956492	-0,058443284
Note: X1 are the dummy variables. Reference dummy: care pathway glaucoma.					

Figure B.2: Summary output of the multiple linear regression with the three most applicable variables.