Capacity management on the Ambulatory Surgery Ward

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Balancing the workload of the ambulatory surgery ward and hereby improving the quality of care of the patients and the quality of labor for the involved staff

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Preface

It has taken longer than I expected when I started studying at the University of Twente (UT) in 2002, but this is it: the end of both my studies at the UT and my life as a student. I have tried to fulfill my student life by being actively involved in several student associations, which has its ups and downs: both personally, regarding my education as a student of Industrial Engineering and Management, and as a human being.
I always knew I wanted to do 'something' in health care. Descending from parents both active in health care, I regarded Medicine as one of the options when I was in high school. An issue of Campus, a UT-magazine for high school students, changed that by showing me that there were other possibilities regarding health care. After reading that article it was clear to me that Industrial Engineering and Management, or "Technische Bedrijfskunde" at that time, focusing on health care management was more suitable for me. My premonitions were confirmed during my studies that the Dutch health care system is demanding to manage, like any other health care system, but I see that as a challenge and a kind of puzzle, which I hope I can (partly) solve in my future career.
I always went my own way but in this my parents have always supported me. During the writing of this thesis Leo and Erwin kept me in check several times when I deviated a bit and was unsure about what to do. I am grateful to them for bringing this thesis to the right end. I also thank Annemarie for supporting me with my questions regarding the hospital, helping me when I had to find the right person for specific questions, and supporting me in her quest to show what effect the OR and OPC had on her ward with data rather than hunches.

Last but certainly not least I thank all the nurses and support staff of the ASW at ZGT Almelo for all the stories and socializing during the coffee and lunch breaks but also outside of the hospital. It will be hard to leave such nice colleagues.

Petra Vrieler
May 2009

Management summary

Due to the demands of the government regarding cost containment on the delivery of health care in the Netherlands, there is a trend of doing more treatments in the ambulatory surgery ward (ASW), since this is cheaper than a patient taking up a bed on a nursing ward. The demand of patients continues to grow but the ASW in ZGT Almelo in the Netherlands cannot keep up. As a result, patients have to be moved to other nursing wards during peak periods, which affect quality of care and patient friendliness. Another effect on the ASW is that there is a large variability in the number of patients per day. This effect is common in almost all ASWs in the Netherlands (J. Oude Egberink – Visschedijk, board member of the NVDK).

To reduce this variability and moving of patients to other ward, this report presents a method for leveling the demand of patients for the ASW, so the capacity of the ASW can be used more effectively. This will result in a better quality of labor for the nurses and increased quality of care for the patients.

Conclusion

Based on interviews, data gathering, and analysis we show how the ASW is run and how it is affected by the two main suppliers of patients; the OR and the OPC. Our analysis shows that there is a lot of variability in the number of patients per day due to the influence of the OR and the OPC schedule on the ASW. To try and resolve this issue, we have developed a capacity analysis tool in MS Excel to analyze the situation based on average arrival data, and to measure what effect changing either the length of stay (LOS), the OR schedule and/or the OPC schedule has on the number of beds needed per hour.

Based on data analysis and on analysis of the schedules themselves, several organizational interventions can be done, which consist of moving OR and/or OPC programs to the days that can alleviate the pressure on the busy days (Monday and Tuesday) and have the possibility to move a program to another day. Within this set all

feasible interventions were tried. From this, two interventions in the OR schedule and three in the OPC schedule come out as the most effective. Changing the LOS of colonoscopies also benefit in reducing the number of beds needed on all days, since there is at least one colonoscopy program per day.

Combining all these moves did not lead to a more balanced schedule for the ASW within a week. However, reducing the number of interventions lead to a better projection on the expected number of beds per day than combining all favorable interventions. The variability in a week, measured in coefficient of variation, has increased from 1,8 in the original situation to 6,2. This high value is caused by a very low average and a low standard deviation, which are lower than in the original situation. Based on the projection the ASW only needs 27 beds if the OR and OPC schedule are changed based on the proposed interventions. This shows that by making relatively small changes in the OR and OPC schedule it is possible to balance the workload of the ASW during the week.

However, even these small changes result in a ripple effect to other schedules, making even one move in the schedules very difficult. It is difficult to predict what recommendations will be implemented in the future. Only recommendations that can be implemented within the boundaries of the schedules are going to be tried in the near future like reducing the LOS for colonoscopies.

Recommendations

Based on this research the following is recommended:

- Optimizing planning and scheduling in the whole hospital by creating the schedules of all departments in conjunction with each other instead of using the OR schedule as a blueprint for all other departments to conform to.
- Improve registration and access to data in the hospital information system to make analysis and therefore management of departments based on data possible.
- Try to predict the future regarding patient flows to have the possibility to adapt schedules to accommodate a growth and/or decline in certain patient groups making use of all resources as efficiently and effectively as possible.

- Further research can be performed regarding the specific subject of ambulatory surgery by expanding models regarding hospital bed capacity planning and looking at the possibilities of how sequencing surgeries and organizing ambulatory surgery with or separate from clinical surgeries affects the need for beds per hour per week.

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1 Introduction

Due to the demands of the government on cost containment on the delivery of health care in the Netherlands, there is a trend of doing more treatments in the ambulatory surgery ward (ASW) since this is cheaper than a patient taking up a bed on a nursing ward. With an increase in ambulatory surgery there is also a decrease noted in days of hospitalization (Ankoné 1999). This is beneficial for cost containment but this also has an effect on the ASW of the hospital. The supply of patients continues to grow but the ASW in a regional hospital in the Netherlands cannot keep up with this increase. As a result, patients have to be moved to other nursing wards during peak periods.

To prevent this from happening in the future, this report focuses on a method for leveling the supply of patients for the ASW so the capacity of the ASW can be used more effectively and will (hopefully) result in a better quality of labor for the nurses and quality of care for the patients.

This introductory chapter starts in § 1.1 with defining the terms related to ambulatory surgery, § 1.2 gives the context of this research, § 1.3 gives a problem description that culminates into a research objective in § 1.4 and research questions in § 1.5. Finally, § 1.6 gives the methodology used in this report.

1.1 Definitions

Internationally there is no consensus on the right term for surgeries, diagnostics and treatments that are performed in a timeframe of less than 24 hours. Based on statements of the Nederlandse Vereniging voor Dagbehandeling en Kortverblijf (IAAS 2003) the term ambulatory surgery will be used for the situation in the regional hospital in this report. The term ambulatory surgery ward (ASW) will be used to describe the nursing ward specifically assigned to treat this specific group of patients that undergo these kinds of treatments or diagnostics.

1.2 Context of this research

ZGT Almelo is a regional hospital that was opened in 1985. It was the result of the merger of the Sint Elisabethziekenhuis and the Prinses Ireneziekenhuis in Almelo and named Twenteborg Hospital. In 1998, the Twenteborg Hospital merged with the Streekziekenhuis Midden-Twente in Hengelo to form Ziekenhuisgroep Twente (ZGT). At first it was mainly a managerial merger but also the medical aspects are slowly getting more aligned between the two locations. ZGT is a general hospital, which delivers high-quality specialist treatment and diagnostics in an area of 300.000 people. Combined, in 2007 this group had 35939 clinical admissions and 27358 day admissions. The number of beds that are validated is 1045 (www.zgt.nl).

The ASW in the location Almelo of ZGT is located on the first floor next to the Operating Room department (OR), the Outpatient Procedure Centre (OPC) and across of radiology; the ideal location for this ward. The department has 44 beds of which 25 are located on the first floor and an additional 19 are located on the fifth floor.

1.3 Problem description

Due to a constant increase in treatment and diagnostics for which patients are laid in the ASW, there is a lack of capacity in peak periods during the year. As a result, patients have to be moved to other nursing wards. This sometimes leads to friction with these wards since they do not always have spare capacity for these extra patients. This lack of capacity can result in ‘stacking’ on the nursing ward; patients are put in hallways or diagonal in the middle of a room. This is not very patient friendly but is seen as a necessary evil by all parties involved.

The shortage in capacity occurs because of the schedule that is made for the OR and OPC. It appears that the schedulers do not take the capacity of the nursing wards into account. The moving of patients to other wards can have an effect on patient care and patient friendliness.

Filling the time slots for the OR and OPC that are given to them is the responsibility of the specialists themselves. These schedules are determined by the waiting list of patients. In case of the OR; both day surgery and clinical patients are planned in the same slot.

Summarizing this, the ASW has problems placing their patients on the available beds, resulting in moving patients to other departments in peak periods. The main cause is the OR and OPC schedule on which they do not have any influence.

1.4 Research Objective

Based on the problems seen on the ASW in ZGT Almelo, the following research objective is formulated:

"(1) To get more insight into the relation between the OR schedule, the OPC schedule and the resulting capacity problems at the ambulatory surgery ward, by analyzing a quantitative model of the patient flows;

(2) To propose methods to balance the workload of the ambulatory surgery ward and hereby improve the quality of care of the patients and the quality of labor for the involved staff."

In a preliminary assessment we found that the bulk of the patients originate from the OR and the OPC. Therefore the focus of this research is on these two suppliers of patients for the ASW. These are day surgery patients who are treated in the OR or in the OPC, and patients who undergo diagnostics at the OPC.

Insight into the OR schedule and the OPC schedule may give more possibilities to improve the quality of labor and the quality of care of the ASW in the time span for planning of a couple of months and a couple of weeks.

A balanced workload means that the number of ASW admissions is more evenly spread throughout the week instead of the constant 'stopping and starting', which occurs now as a result of the OR and OPC schedule. With this balance, personnel can also be more evenly spread over several planning horizons, hereby increasing the quality of labor.

The balanced workload will also improve quality of care for the patients since they do not have to be moved as much to other wards, which has a positive effect on patient friendliness and patient care.

1.5 Research Questions

To obtain the above stated objective, we formulate the following research questions:

1. *What is the current situation and how significant is the problem?*
   We analyze the current situation in the OR and OPC and its effect on the ASW in number of patients. (Chapter 3)
2. *What are the possibilities for influencing the schedules of the OR and the OPC to come to a more evenly spread use of the capacity of the ASW?*
   We perform a literature search focused on capacity planning to gain more insight into possible theories that may help in increasing the efficiency of the ASW. (Chapter 2)
3. *How can the workload of the ASW be balanced over different time frames and how can this be implemented?*
   We design concept interventions that balance the workload of the ASW, calculate their effects and elaborate on how the best ones can be implemented. (Chapters 4, 5 and 6)

1.6 Methodology

To gain insight into the workings and politics of the OR and OPC schedule, interviews are held with the responsible managers and/or process coordinators of the involved departments. This results in an overview of the process of making the schedules for these departments and what is taken into account when making these schedules.

For assessment of the performance of the ASW, data is collected based on the daily schedules of the ASW (see an example in Appendix A: Schedule of the ASW), which shows which patients have been treated, by whom and at what time.

For the leveling of the capacity usage of the ASW, a literature study has been performed that focuses on capacity planning of the OR and OPC and how this can be used to spread the supply of the patients to the ASW more evenly. And also which performance characteristics should be taken into account. This has been used to create a model to calculate how the schedules of the OR and OPC have to be to take into account the number of beds the ASW has to lay their patients in. For this, not only the OR and OPC schedule has to be known but also the length of stay (LOS) of a patient who undergoes a certain treatment in the ASW. Since LOS cannot accurately be extracted from the hospital information system, the professional judgment of the process coordinator regarding LOS per patient type is used. Her judgment and that of the nurses is used daily in dividing the patients over the beds of the ASW every day.

2 Theoretical Framework

This chapter gives an overview of the literature concerned with hospital bed capacity planning and workload balancing. § 2.1 gives a framework for analysis, § 2.2 gives insight into the literature concerning hospital bed capacity planning, § 2.3 focuses on the effect of workload balancing based on the literature mentioned in § 2.2 and § 2.4 gives the conclusion of this chapter. The literature is used as a guide on what interventions are possible in the OR and OPC schedule and what effect they can have on the workload of the ASW in Chapter 5.

2.1 A framework for analysis

A framework gives the possibility to determine in which context this thesis regarding capacity management on the ASW is set and at what levels in the hospital. Figure 1 shows this framework.

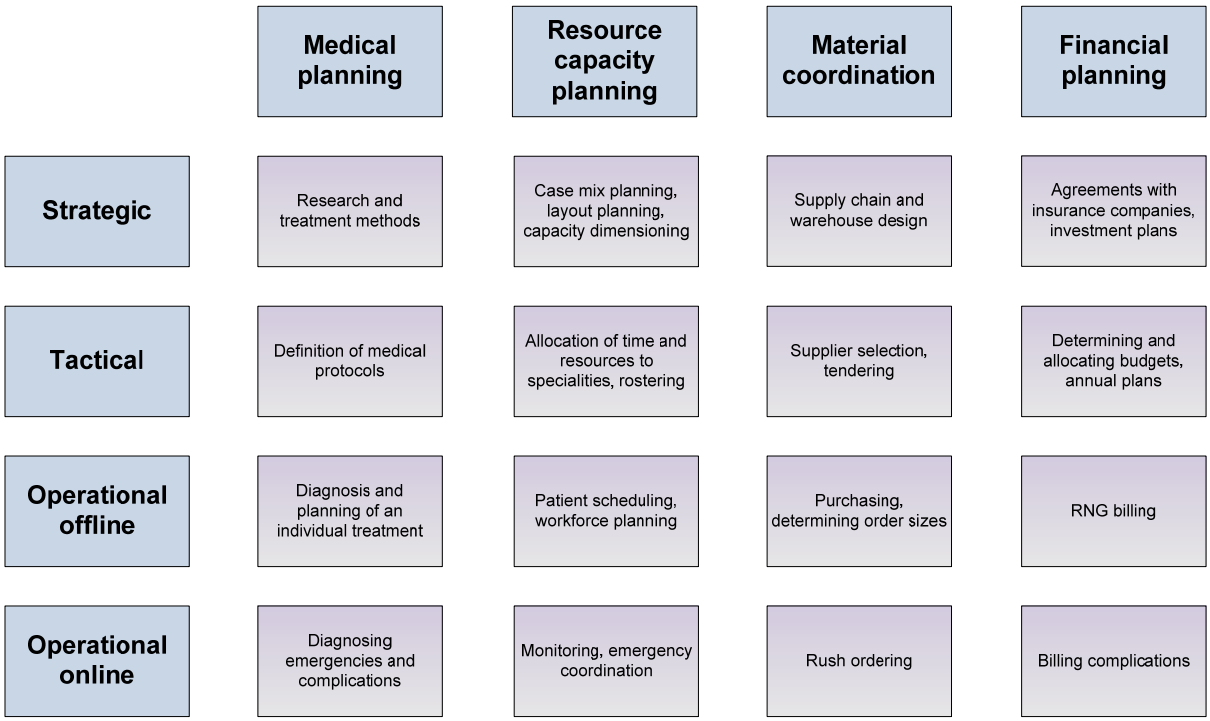

Figure 1: Framework for hospital planning and control

Source: Houdenhoven 2007

The levels that are distinguished are:

- The strategic level, which focuses on the formulation of long-term objectives.
- The tactical level translates strategic objectives into medium-term objectives.
- The operational level, which is divided into offline and online planning:
  - Offline planning is concerned with the in advance day-to-day control of expected activities
  - Online planning deals with the process of monitoring and control, which also encompasses reacting to unforeseen or unanticipated events.

The areas of interests are:

- Medical planning, which comprises the planning of the medical activities like diagnoses and treatments.
- Resource capacity planning deals with efficiently using the hospital's scarce resources.
- Material coordination deals with the distribution of materials to support the primary process.
- Financial planning is concerned with all functions regarding hospital finances.

2.2 Hospital bed capacity planning

Chapter 1 showed that the OR schedule has a significant impact on the ASW. Several studies have been performed either (1) into the effect of the OR schedule on several resources including hospital beds and nursing workload (e.g. Harris 1985, Beliën et al. 2006, Carter et al. 2005, De Vries 1984, Vissers 1994, Santibanez et al. 2005, Chow et al. 2008, Cardoen et al. 2007), (2) using the number of hospital beds as a restriction in planning the OR (Vissers 1998; Santibanez et al. 2005) or (3) predicting or redistributing the number of beds (and other resources) needed based on several factors (Harper et al. 2002, Harper 2002, De Bruin et al. 2007, Li et al. 1996, De Vries 1984, Bekker et al. 2007, Dumas 1985, Meier 1985, Iskander et al. 1991). These studies are researched more closely in this paragraph in light of their connection or lack of with ambulatory surgery.

2.2.1 The effect of the OR schedule on resources

The focus in these studies has mostly been the 'traditional' clinical nursing wards, which nurse patients for several days until they go home. Several studies (Beliën et al. 2006, Vissers 1994, Chow et al. 2008, Cardoen et al. 2007) have taken ambulatory surgery into account, but since these patients are assumed to stay the whole day there is no mentioning of using beds more than once during the day. However it is possible that Chow's model did incorporate LOSs less than one day since this was drawn from historical patient files.

2.2.2 The number of hospital beds as a fixed constraint

These studies seem rare. Most of the time the researchers suggest that the number of beds has to be redistributed, mostly resulting in a lower number of beds in the whole hospital but better bed occupancies for the different wards (Vissers 1998, Santibanez et al. 2005). Vissers used an average LOS over all kinds of patients and made no distinction between day surgery and clinical patients. If this split was added a more detailed analysis can be made. The lower average LOS of the day surgery would also increase the average LOS for the clinical patients, resulting in a more farer comparison in the need for beds for clinical wards and the day surgery ward in a hospital.

2.2.3 Predicting or redistributing the number of beds

These studies focus on either predicting the number of beds for for example a new facility or redistributing the number of beds within an existing facility. A few take the effect of the OR schedule into account (Meier 1985, Bekker et al. 2007, Harper 2002) but most do not in making their analysis. They assume the current patient flows or make a forecast of the patient flows in the future and predict what will happen with the number of beds needed. In redistributing the number of beds within a facility, several measures are used and discussed in how the number of beds needed should be measured (Dumas 1985, De Bruin et al. 2007).

Regarding this subject research has been done concerning ambulatory surgery wards. Both focused on predicting what the number of beds should be in a new facility or organization considering several factors, sometimes including LOS (Iskander et al. 1991,

Meier 1985). Also in these studies there is no mention of using beds more than once in a single day.

However some models of the authors mentioned in this paragraph could be adapted to incorporate the ASW. This mostly regards changing the LOS to hours in several models or making an explicit distinction between clinical wards/surgery and day surgery (Harper 2002, Dumas 1985, Iskander et al. 1991). Bekker et al. already does this, however regarding an ER, but this could be expanded upon. The formulas for utilization rates used by De Bruin et al. could be adjusted to calculate these for the ASW showing that the ASW still has room to expand within the number of beds it has.

2.3 Workload balancing

Many studies (e.g. Beliën et al. 2006, Vissers 1998, Harper 2002) have leveled bed occupancy as a goal or the goal of their research. The result of this is that it also reduces the peaks and valleys in the workload of the nurses on the wards. Sometimes this reduction of stress is the goal and the leveled bed occupancy is the solution to the problem. The leveling of the workload has been shown to have a positive effect on the workload perception of the nurses (Vissers 1994).

2.4 Conclusion of the literature

As can be seen in § 2.2 there has been a lot of research on hospital bed capacity planning and some of it has taken the ASW into account. However they always assumed that patients stay a whole day which leads to the conclusion that if there are *x* day cases then you need *x* beds. The unique aspect of this thesis is that it will take into account the different LOS of the different kinds of patients the ASW in ZGT Almelo receives. However this does not mean that the proposed solutions in the articles cannot be applied to the stated research question.

Changing the master surgery schedule by exchanging blocks of OR time per specialty and/or programs in the OPC will be tested in Chapter 5 with the help of the model that has been programmed and is described in Chapter 4. The effects of this will be measured to show if the change has a positive and/or a negative effect on the workload of the ASW.

3 Context description

This chapter discusses the processes, control and performance of the departments that are directly involved with the ASW as well as the aforementioned characteristics of the ASW itself. This will give a picture of the current situation in ZGT Almelo regarding the ASW and its interactions with the departments that influence the ASW the most.

§ 3.1 gives the process description of the OR, the OPC, internal medicine and the ASW. § 3.2 goes into the control involved with the aforementioned departments and § 3.3 gives insight into the performance of these departments. Finally, § 3.4 gives a conclusion regarding the current situation.

3.1 Process description

The ASW receives patients from three departments, namely the Operating Room department, the Outpatient Procedure Centre and from internal medicine (see Figure 2). The OR sends patients to the ASW when they have to undergo day surgery, the OPC sends patients who have to undergo a certain procedure there and internal medicine sends patients who have to receive either drug treatment or a blood transfusion.

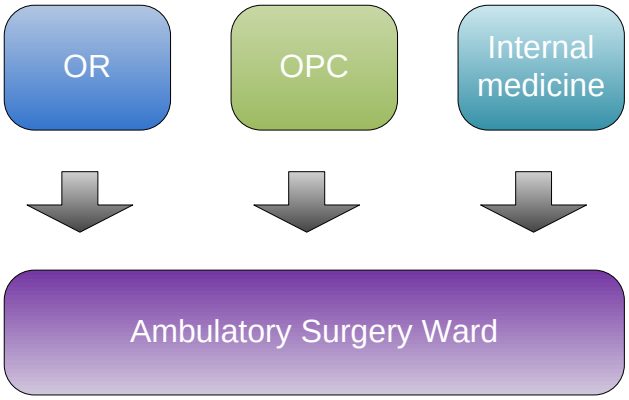

Figure 2: The different sources of patients of the ASW

Every Monday, Tuesday and Wednesday, children who have to undergo either a tonsillectomy and/or receive tympanostomy tubes are also treated at the ASW. But since these children are treated in specifically designed rooms, they do not occupy the regular

beds of the ASW and therefore do not influence the flow of patients through the ASW. Other possible patients for the ASW, that can also be treated and discharged within one day, are patients who have to undergo chemotherapy or give labor, but in ZGT Almelo these are performed on respectively the oncology ward and the maternity ward.

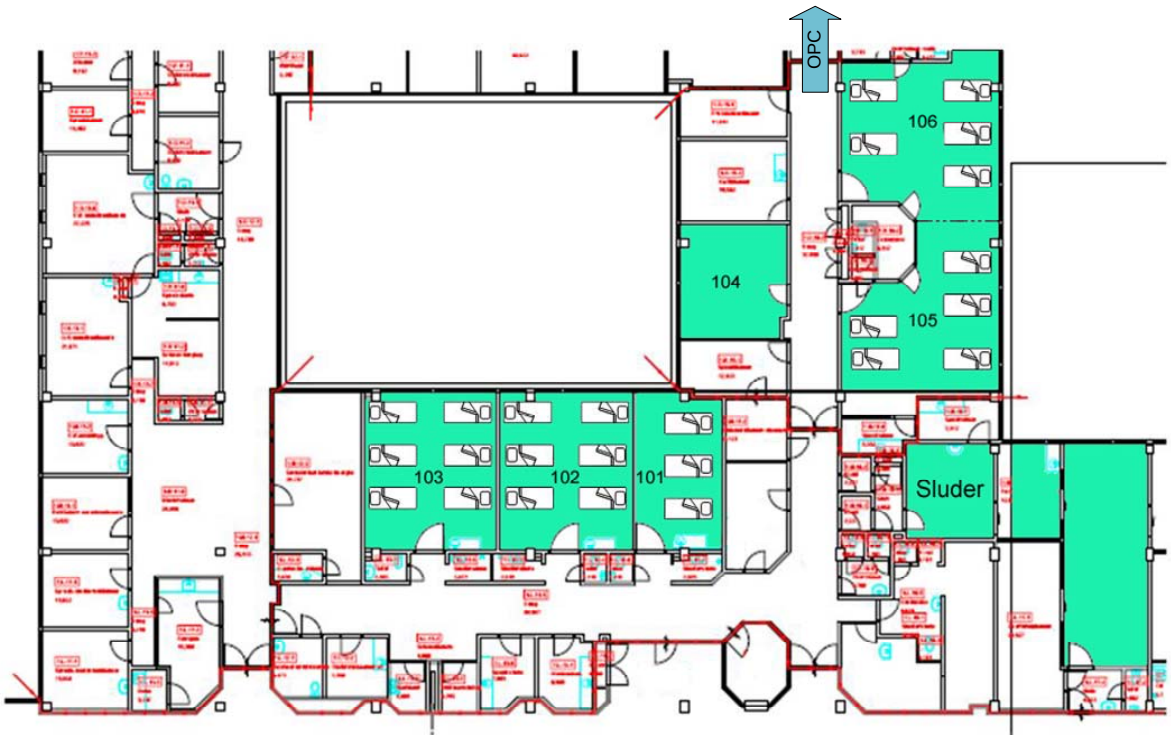

Figure 3: Floor plan of the ASW

Chapter 2 gave a framework regarding hospital planning and control (Figure 1). Applying this framework to the problem described in Chapter 1 it can be concluded that it is confined to the area of interest of resource capacity planning. Figure 4 shows the framework applied to our problem.

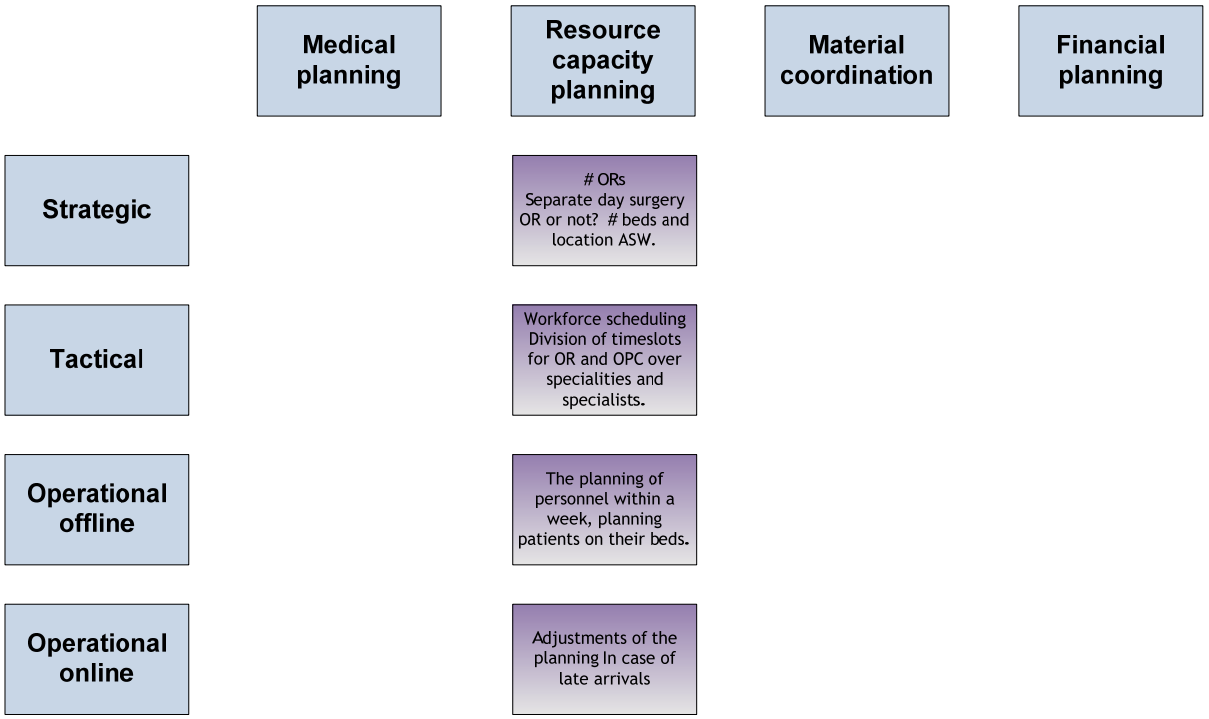

Figure 4 Framework of hospital planning and control specified for ZGT Almelo

Source: based on Houdenhoven 2007

Our problem specifically focuses on the operational offline planning, but also aspects of the tactical level, the OR and the OPC schedule, are taken into account in this research.

3.1.1 The Operating Room department

The OR department is located on the first floor and consists of 10 operating rooms (ORs). On Monday all 10 are used, but from Tuesday to Friday 9 are used. The ORs operate from 7:45 am to 3:30 pm during weekdays and one OR is always reserved for trauma patients and is open till 5:00 pm. The ORs are divided over the specialties by way of several performance measures, namely:

- Utilization rate[1]: how much of the allotted operating time is actually used by the specialty. This has to be equal to or larger than 85 %.
- The previous OR schedule
- Waiting lists

[1] In ZGT Almelo, utilization rate is calculated based on the gross OR time. The gross OR time excludes changing times between ORs but includes inducing anesthesia and waking up. The gross OR time is divided by the actual used OR time. Not the time that was planned for a certain operation.

- The number of OR sessions that have been returned by the specialists to the scheduler per quarter.

From all the patients that are operated upon, about 45,24 % of the number of patients undergoing surgery is sent to the ASW based on analysis of data from the OR for 2008.

3.1.2 The Outpatient Procedure Centre

The OPC is located on the first floor behind the ASW (see Figure 3). It consists of ten treatment rooms of which two are small operating rooms. The OPC operates from 8:00 am to 4:15 pm during weekdays and closes at 5:00 pm. The only patients from the OPC that are sent to the ASW are patients who undergo a colonoscopy, a bronchoscopy, pain relief or cataract surgery. Other patients do not require a bed in the ASW.

3.1.3 Internal medicine

Every week there are several patients from internal medicine who have to undergo either a certain drug treatment or a blood transfusion. These patients are planned based on their medical need and (depending on the kind of treatment) require a bed. The process coordinator of the ASW has an agreement with internal medicine to plan these patients as close as possible to the end of the week because these are relatively quiet days in a week (as can be seen in Figure 9) and the ASW then has the capacity to receive these patients.

3.1.4 The Ambulatory Surgery Ward

The ambulatory surgery ward is opened from 7:00 am to 6:00 pm during weekdays. If patients have to stay until after 7:00 pm but can still leave the same day they are transferred to either the observatory ward (if it has enough room for an extra patient) or to a nursing ward until they can leave. This can occur when a program runs late and people still have to recover from their treatment and/or anesthetics.

Figure 5 shows what steps the patients (and nurses) have to go through from when the patient shows up at the desk until the patient leaves the ASW.

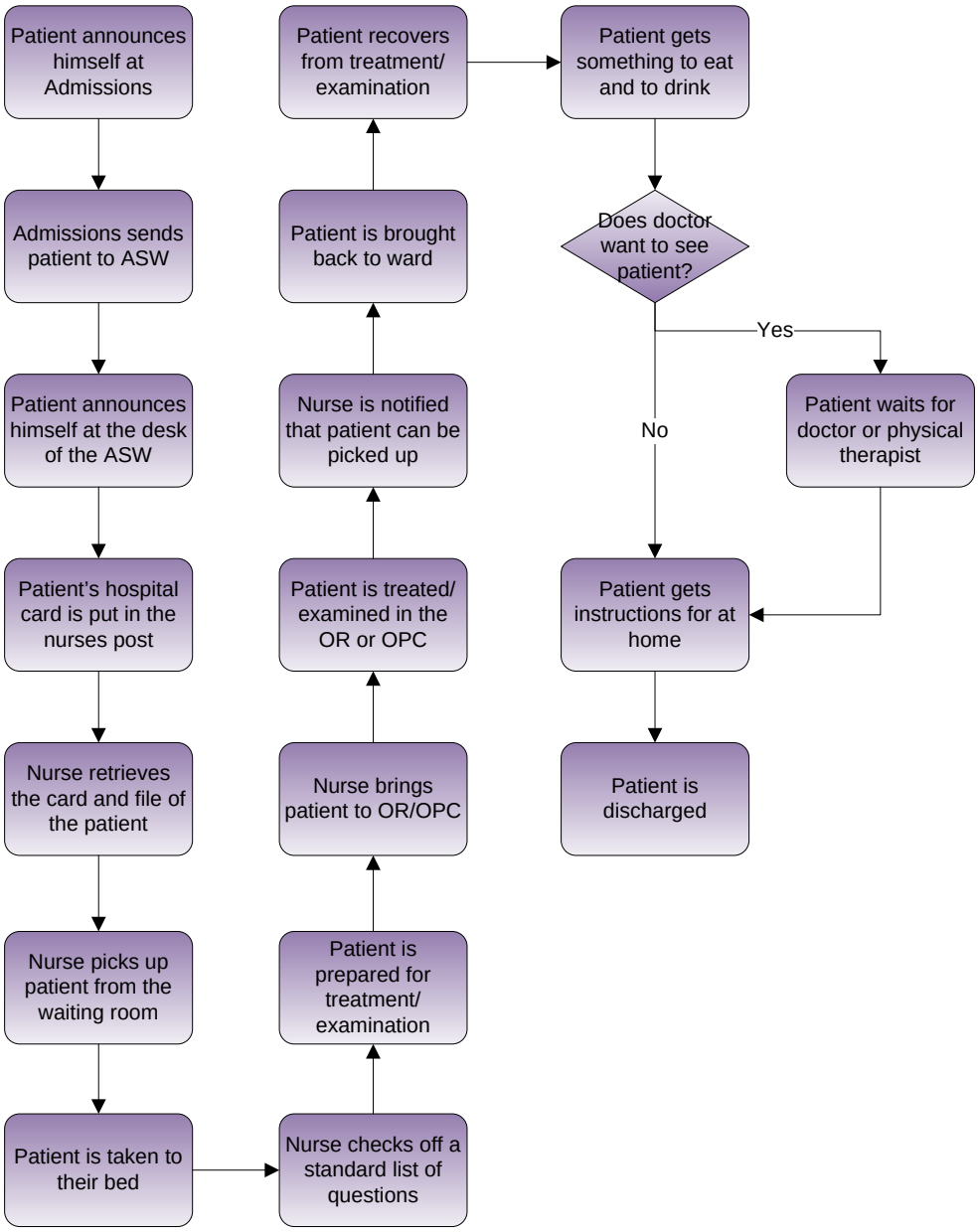

Figure 5: Flowchart of a patient in the ASW

3.2 Control

We define control as the system of planning and scheduling in an organization. The ASW is mostly influenced by the schedules of the OR and OPC so these will be discussed in further detail in § 3.2.1 and § 3.2.2. Internal medicine will be discussed in § 3.2.3. The daily scheduling of the ASW is based on the patients that have been called up and have to stay in the ASW. These are discussed in § 3.2.4.

3.2.1 The Operating Room department

Based on interviews with different schedulers

For every three to four months there is a schedule from each specialty that shows when a specialist operates or has consulting hours. This schedule is used by the scheduler of Admissions to schedule the individual surgeries. For every patient that needs surgery there is a waiting list note that shows, among other details, the duration of the surgery. Schedulers adjust the duration of the surgery to their experience regarding this, since it sometimes occurs that surgeons underestimate the duration. The whole process is on paper except inserting the surgeries into the hospital information system. The scheduler of the OR then checks if all constraints can be met and all surgeries can be performed on the planned days.

The specialist and the scheduler mostly determine the order of the surgeries. Unfortunately they do not always take into account that a patient for the ASW has to be treated early since they have to leave that same day. It occurs that a surgeon operates a patient that has to be nursed on a nursing ward, with the risk of overrunning the schedule of the OR, is operated upon before a patient that could be discharged on the same day. However, this may be a consequence of several constraints:

- The number of instruments available
- Children are always operated upon in the morning
- From delicate surgeries to more coarse surgeries
- From ‘clean’ to ‘dirty’ surgeries

Overrunning the schedule leads to frustration in the ASW because a patient leaves later than planned and sometimes even after closing hours of the ASW. Occasionally this results in moving the patient to another ward.

The OR schedule is mainly fixed in the three weeks before operating starts. There is little change possible. But sometimes it occurs that a scheduler calls to add a patient a day before surgery. These are emergency patients who can be treated on the ASW.

3.2.2 The Outpatient Procedure centre

Based on an interview with the process coordinator of the OPC

Just as with the OR schedule there is a schedule for the OPC on which day which specialist performs certain procedures. This schedule is made by the process coordinator of the OPC and is given to the specialists. This schedule is valid for approximately a year. Changes are made when necessary, principally due to major changes in the OR schedule which influences the schedules of the specialists and as a consequence the OPC schedule has to be changed. The schedule is used by the secretaries of the specialist to plan the patients based on the timeslots that are given to them by the process coordinator of the OPC, or by a visit of the patient themselves to the OPC, to schedule an appointment on a date and time that the patient suits best.

The schedule of the OPC is optimized for the spread of personnel over the week and is based on a 100 % occupation of the timeslots and a leveled workload per day. However, the process coordinator realizes that this has an effect on the workload of the ASW, because not every program that affects the ASW is carried out every day. See Appendix B: Schedule of the OR and the OPC in 2008.

It may occur that a time slot has not been filled by the secretary of the specialist due to a lack of patients or other circumstances. When it is incidental, as judged by the process coordinator, for a certain program then this is not a problem, but when this occurs regularly then the process coordinator of the OPC will negotiate with the specialist and the secretary to look for a solution and maybe reduce the number of time slots for that specialist.

3.2.3 Internal medicine

Since these patients are treated based on a more urgent need than the regular patients on the ASW, this cannot be controlled. Because nurses can treat these patients, no specialist's schedule is involved.

Certain patients have to come every few weeks for medical reasons. However others are sent based on a lab result in that week and need for example a blood transfusion as fast as possible. These patients are scheduled by the ASW.

3.2.4 The Ambulatory Surgery Ward

Every day after 11:15, which is the last moment for the department of Admissions to put in new patients, the coordinator prints out the schedule for the next day. This list is then observed and the patients are spread over the available rooms. In general, surgical patients are placed in rooms 101 to 103 since this is more convenient in moving the patient to pre-op. Rooms 105 and 106 are mostly used for patients who are treated in the OPC where small interventions and medical examinations are performed. Room 104 is a waiting room. It is sometimes used for patients who prefer to sit when receiving drug treatment.

The ASW has extra beds on the fifth floor, which are mostly used for surgical patients. The patients who go to the OPC stay on the first floor, because this is more convenient when transporting them.

When the eye specialist has a day with cataract patients, four chairs instead of beds are placed in room 106. Cataract patients are in and out of the ASW in about two hours, so this can be seen as a conveyor-belt of patients. A new patient arrives about every half hour.

Figure 6: Close up of the ASW floor plan and the room itself with chairs instead of beds for cataract patients

When it is possible, two patients successively use the same bed; one in the morning and one in the afternoon, or even more if possible. This method is called ‘doubling’ on the ASW. This scheduling is based on the experience of the nurses, who know how long a patient will need the bed. When the capacity of the department has reached its maximum, including the extra beds and ‘doubling’ patients, then the coordinator meets with the heads of the nursing wards on the fifth floor to see whether patients can be moved to their nursing ward. This floor is chosen due to their expertise with surgical patients, so these are moved there when needed. Aside from the rooms being divided, during scheduling, based on intervention, the arrival time of the patients is also taken into account, since some nurses start at 7:00 while others start later at 9:00 or 9:30.

Last minute arrivals or cancellations

Almost every day it occurs that after the schedule for the next day is finished; the coordinator receives a call that an extra patient or patients are scheduled or are cancelled by the department of Admissions.

When a last minute arrival occurs, the coordinator has to add in the patient on a free bed if there is one, or else move the patient to another department. Since specialists do not call off their patients they have to be fitted in somewhere. Cancellations are off course not a problem and can even lead to patients being scheduled on the ASW again instead of being moved to another ward if there was a shortage of beds.

3.3 Performance

Performance entails, in this context, how the different sources of patients for the ASW impact the ASW in an average number of patients per day and as an average percentage of the total number of patients per day per source. This data is also used to show how these sources influence the variability on the ASW. The performance of the ASW itself is also analyzed based on average occupancy rate. Arrival data is used to give a projection on the average number of beds that are needed per hour. All this will give a picture of how the ward performs and will serve as a basis for improvements.

3.3.1 The Operating Room department

Data from the OR over a period of one year shows that 45,24 % of all surgery is day surgery. Circa 90,30 % of these patients are laid in the ASW. The remaining 9,70 % is moved to other nursing wards, assuming all moved patients are surgical patients. However this is not always the case, sometimes also internal medicine patients are moved to nursing wards for internal medicine.

The average percentage of surgical patients on the ASW over the measured period is 45,00 % and the average number of surgical patients per day is 14,88. These numbers are corrected for the number of patients that are sent to other nursing wards.

3.3.2 The Outpatient Procedure Centre

Data shows that on average 29,37 % or 10,95 patients on the ASW originate from the OPC excluding cataracts but including colonoscopies, bronchoscopies, nasendoscopies and pain relief.

The average number of cataract patients, when there is cataract surgery, is 10,07. This is, on days with cataract surgery, on average 23,97% of the patients.

3.3.3 Internal medicine

Of the patients on the ASW, about 9,66 % are internal medicine patients, on days when internal medicine patients are sent to the ASW, which results in an average of 3,04 patients per day. Partly this is a consequence of patients that are under medical supervision of which certain blood levels are checked every week. When these levels necessitate a blood transfusion, this will occur in the same week. To comply with a maximum period in days between the blood test and the transfusion, these are mostly planned at the end of the week. Otherwise they are planned earlier in the week.

3.3.4 The Ambulatory Surgery Ward

The ASW receives on average 34,27 patients per day, excluding patients who have been moved, measured over 2008. Data shows that on average 3,63 % of the patients of the ASW end up on one of the nursing wards. The occupancy rate of the ASW is 122,48 %,

excluding patients that have been moved. This is more than 100 % because the ASW can and does use beds more than once per day.

Figure 7 shows the number of admissions divided over the days and between four flows, namely the OR, the OPC, internal medicine and cataracts. Cataracts have been measured separately from the OPC since they can have a big influence on the number of admissions on a certain day, but use no more than four chairs.

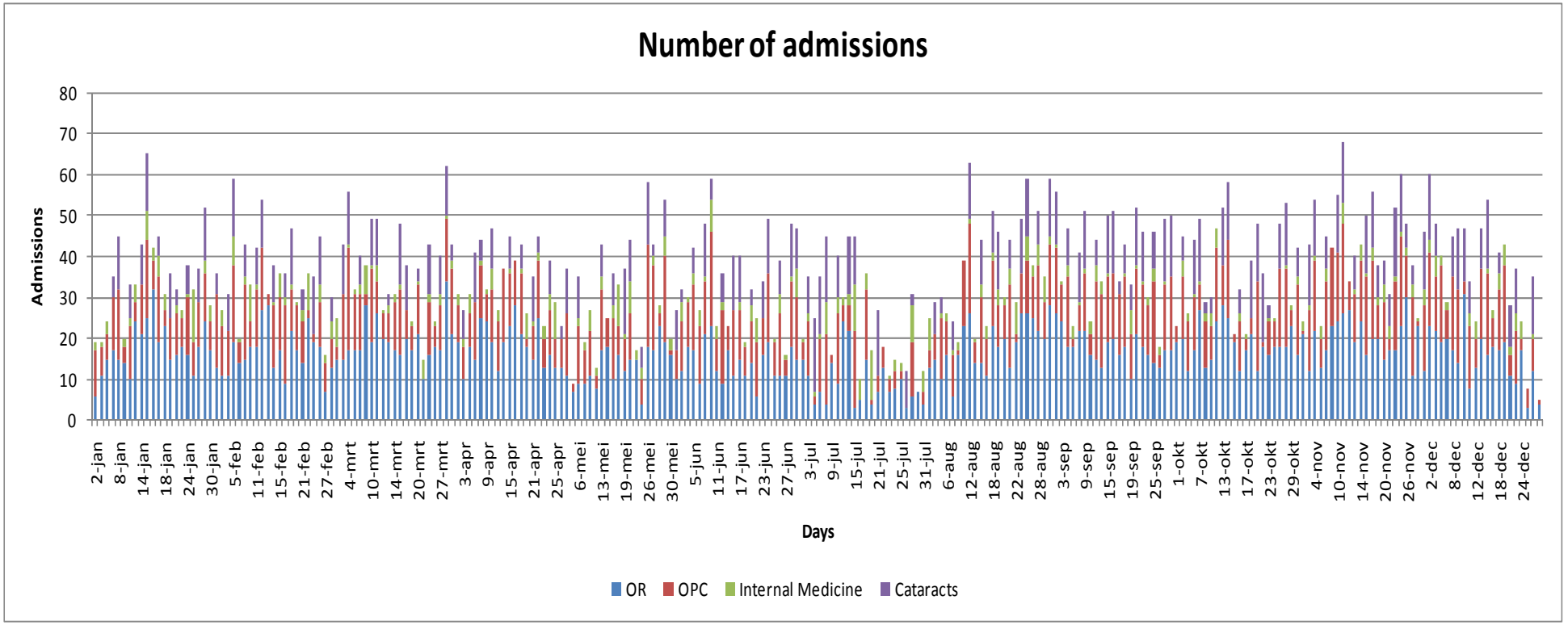

Figure 7: Number of admissions per day divided over the source of the patients

Source: Data from daily schedules of the ASW, measured over 2008 representing 9039 patients.

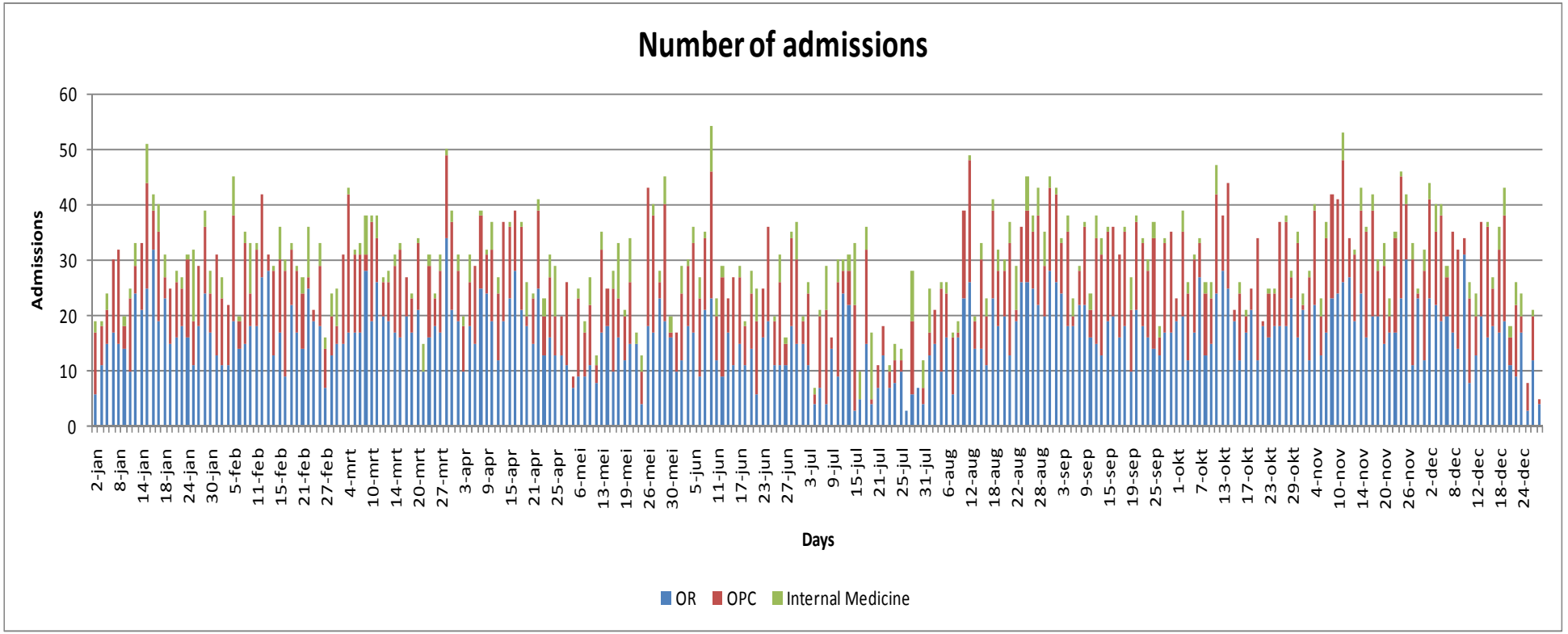

Figure 8: Number of admissions per day excluding cataracts

Source: Data from daily schedules of the ASW, measured over 2008 representing 7519 patients.

Figure 7 clearly shows that there is a lot of variability in the number of patients that come to the ASW. What can also be clearly seen is the variability within a week (these are divided by the weekends). Wednesdays and Fridays generally have fewer admissions than Mondays, Tuesdays and Thursdays (also see Figure 9). This can partly be explained by the fact that cataracts take place on Mondays, Tuesdays and Fridays, but this effect is still visible when cataracts are left out (see Figure 8). The period from the 21st of July until the 8th of August can be marked as a holiday period but the holiday period for personnel already started at the beginning of July resulting in the moving of patients due to a lack of personnel. The variation can also be observed based on the coefficient of variation that is 0,35. Vissers states that a coefficient of variation larger than 0,2 justifies corrective actions. A coefficient of variation lower than 0,2 is considered to indicate a smooth workload. We thus conclude that the variability of the ASW in the number of patients should be reduced.

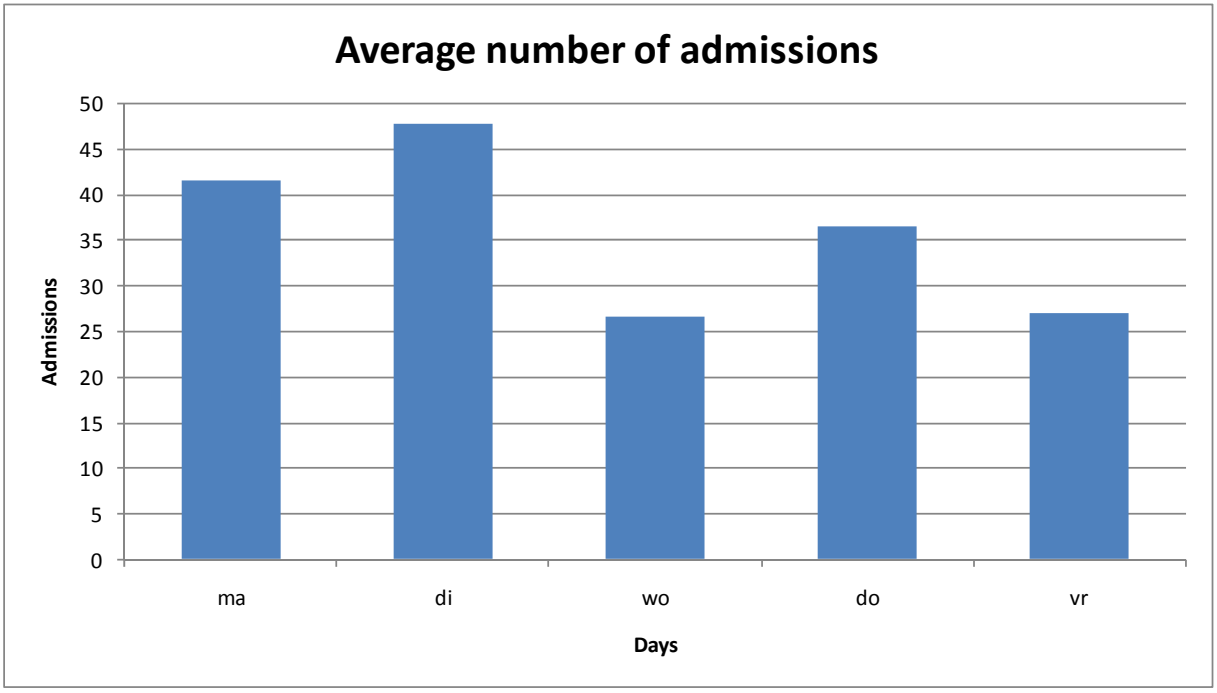

Figure 9: Average number of admissions per day

Source: Data from daily schedules of the ASW, measured over 2008 representing 9039 patients.

Arrivals

As stated, the ASW gets patients from three departments. Patients from different sources have different arrival patterns. This can be clearly seen in Figure 10.

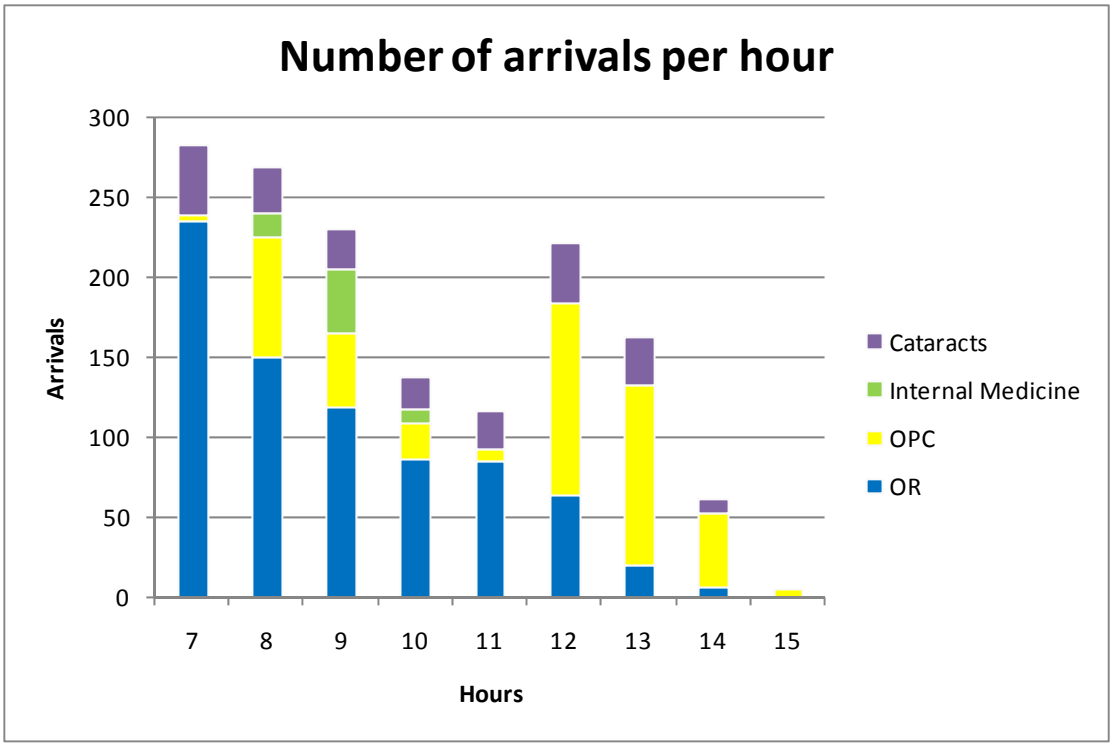

Figure 10: Arrivals per hour divided over the different sources

Source: arrival data based on the period January – February 2008

The patients from the OR mainly arrive at 7:00 am and then the number of arrivals decreases in the following hours. The arrivals of the OPC show two peaks, one in the morning and one just after lunch. These are the times at which the programs are started. It depends on the kind of program at what interval patients arrive. Internal medicine patients are usually called up for 9 o'clock since treatments like a blood transfusion take all day. The cataract patients are also called up at regular intervals, usually one per half hour. This can also be clearly seen in Figure 11 because the arrivals per hour are more or less the same except, just as with the OPC, in the morning and after lunch, which show a slight increase. When the arrivals are shown as stacked columns in Figure 10, the peaks at the beginning of the day and after lunch are clearly visible.

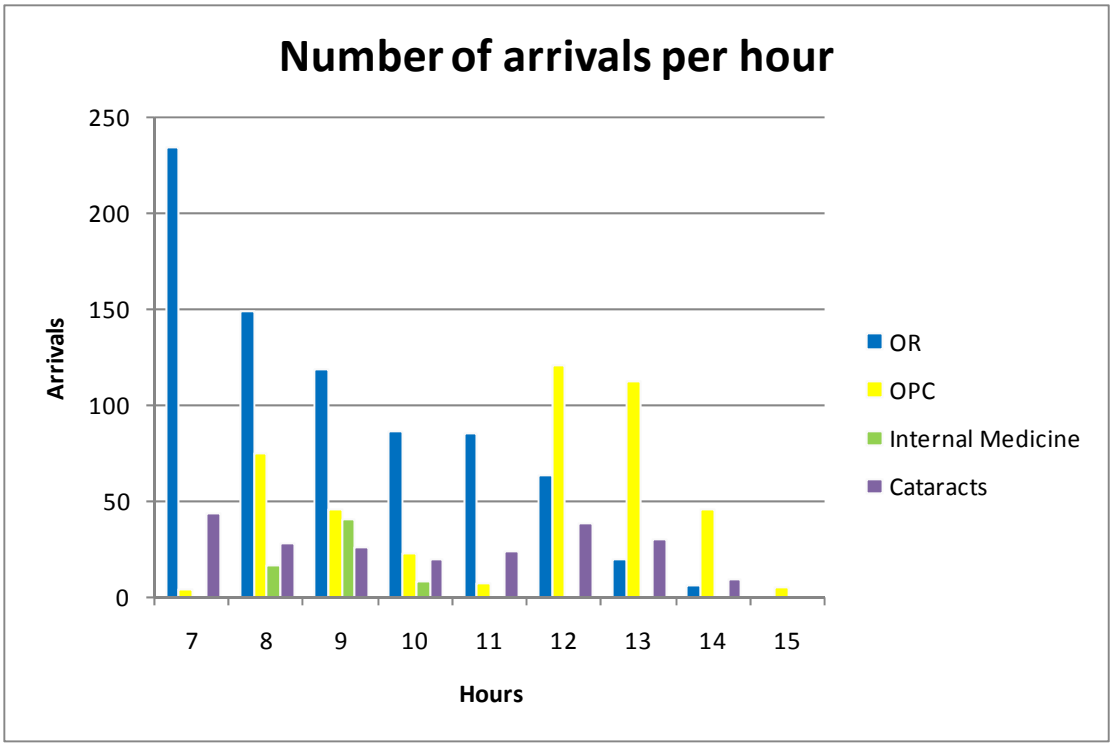

Figure 11: Number of arrivals per hour divided over the different sources

Source: arrival data based on the period January – February 2008

Projection of the number of beds needed

Using the arrival times of patients per hour, a projection can be made on the number of beds that are needed per hour. For this purpose, the LOS (in hours) for every kind of arrival is used to project the maximum, minimum and average number of beds that is needed per hour per day.

The kinds of arrivals that are distinguished are:

- Surgical patients; with an assumed LOS of a whole day. These are divided in the specialties: general surgery (CHI), orthopedics (ORT), gynecology (GYN), ear, nose and throat (KNO), plastic surgery (PLA), urology (URO) and dental surgery (MON).
- Internal medicine patients; an assumed LOS of a whole day
- Cataract patients; an assumed LOS of two hours
- Colonoscopy patients; an assumed LOS of four hours
- Bronchoscopy patients; an assumed LOS of two hours
- Patients for pain relief; an assumed LOS of one hour
- Nasendoscopy patients; an assumed LOS of two hours

Table 1 show the totals of adding the minimum, maximum and average numbers of beds needed per kind of arrival.

Min	Time	Monday	Tuesday	Wednesday	Thursday	Friday
	7:00	0	3	1	1	0
	8:00	0	3	1	1	0
	9:00	0	3	1	1	1
	10:00	0	4	1	1	1
	11:00	2	5	1	2	1
	12:00	3	7	2	3	1
	13:00	4	9	2	3	2
	14:00	3	8	2	3	2
	15:00	2	6	2	3	2
	16:00	0	5	2	3	2
	17:00	0	5	1	2	2
	18:00	0	4	1	2	2

Max	Time	Monday	Tuesday	Wednesday	Thursday	Friday
	7:00	18	18	16	12	12
	8:00	36	38	30	28	29
	9:00	49	54	46	44	45
	10:00	52	65	55	54	54
	11:00	62	70	61	58	58
	12:00	72	78	67	66	68
	13:00	77	82	71	71	77
	14:00	77	80	71	69	80
	15:00	71	75	72	63	77
	16:00	61	71	72	59	73
	17:00	56	65	69	57	68
	18:00	55	62	65	54	64

Avg	Time	Monday	Tuesday	Wednesday	Thursday	Friday
	7:00	7,38	10,25	5,22	5,67	4,67
	8:00	13,88	18,38	10,00	10,89	10,44
	9:00	16,88	24,75	14,78	16,78	15,11
	10:00	16,63	27,63	17,44	18,00	18,00
	11:00	18,38	28,13	19,22	18,11	20,56
	12:00	24,00	33,13	22,33	22,22	24,22
	13:00	27,63	35,75	23,67	25,00	25,67
	14:00	28,38	33,75	23,22	24,44	24,56
	15:00	24,88	29,25	23,44	21,89	23,78
	16:00	21,38	27,00	23,44	20,11	23,44
	17:00	18,00	24,25	21,44	18,56	22,56
	18:00	16,63	22,50	19,67	16,89	21,89

Table 1: Projection of the added minimum, maximum and average number of beds needed per hour

Source: arrival data over the period January to February 2008 representing 1482 patients

During January and February of 2008, the measured period, the ASW had 25 beds at their disposal. The numbers marked in green are above this limit and that could have meant that patients had to be moved to another nursing ward. This is especially the case when the maximum and the average number of arrivals are considered.

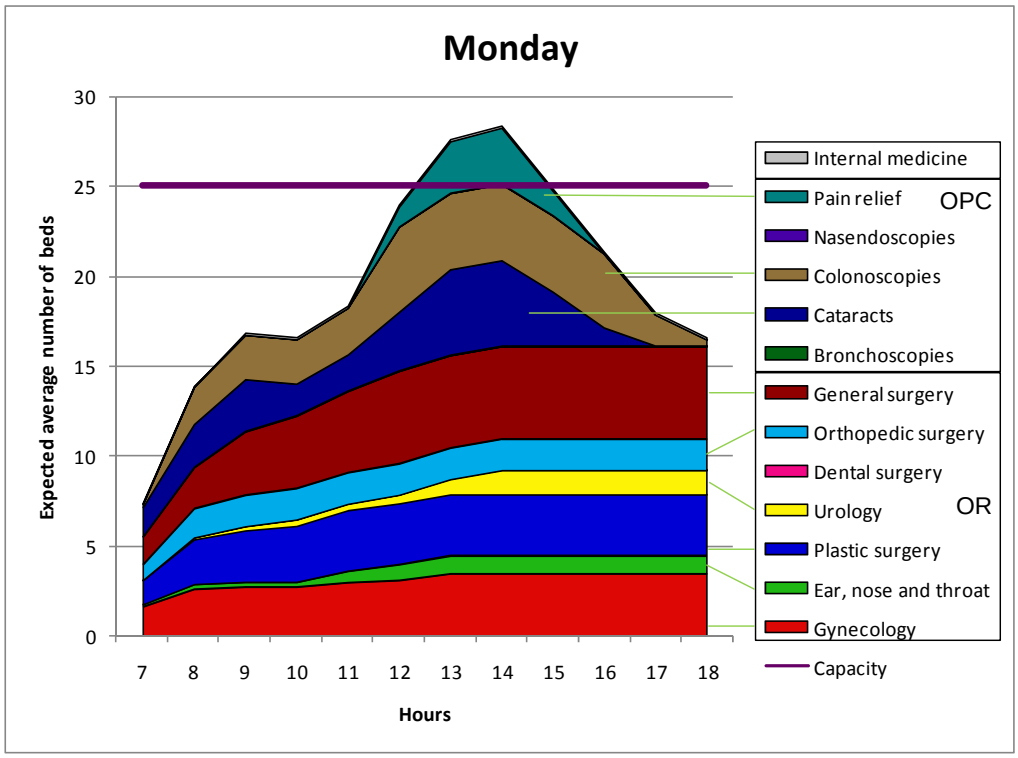

Figure 12: Average expected number of beds needed on Monday

Source: Arrival data based on the period January – February 2008

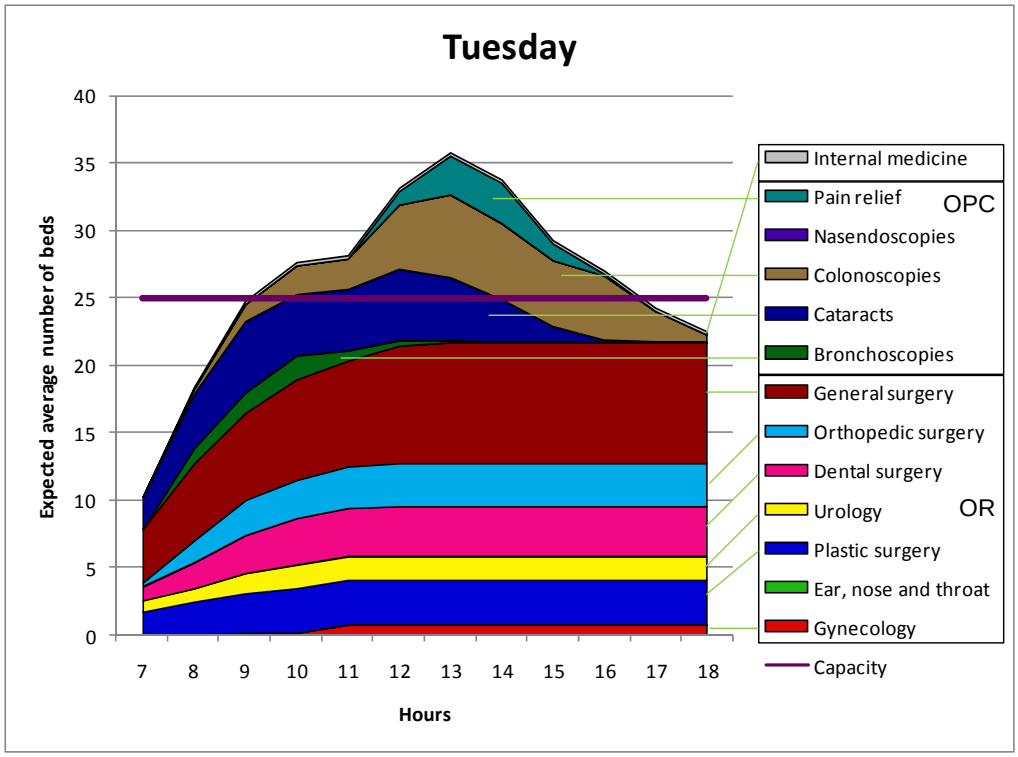

Figure 13: Average expected number of beds needed on Tuesday

Source: Arrival data based on the period January - February 2008

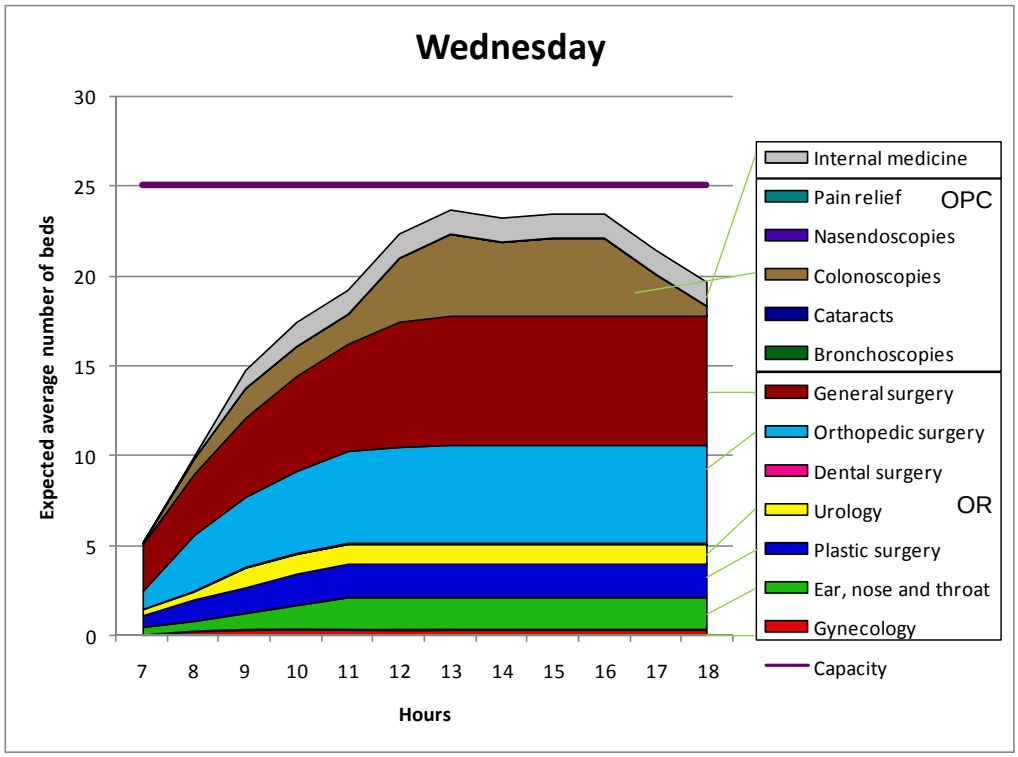

Figure 14: Average expected number of beds needed on Wednesday

Source: Arrival data based on the period January - February 2008

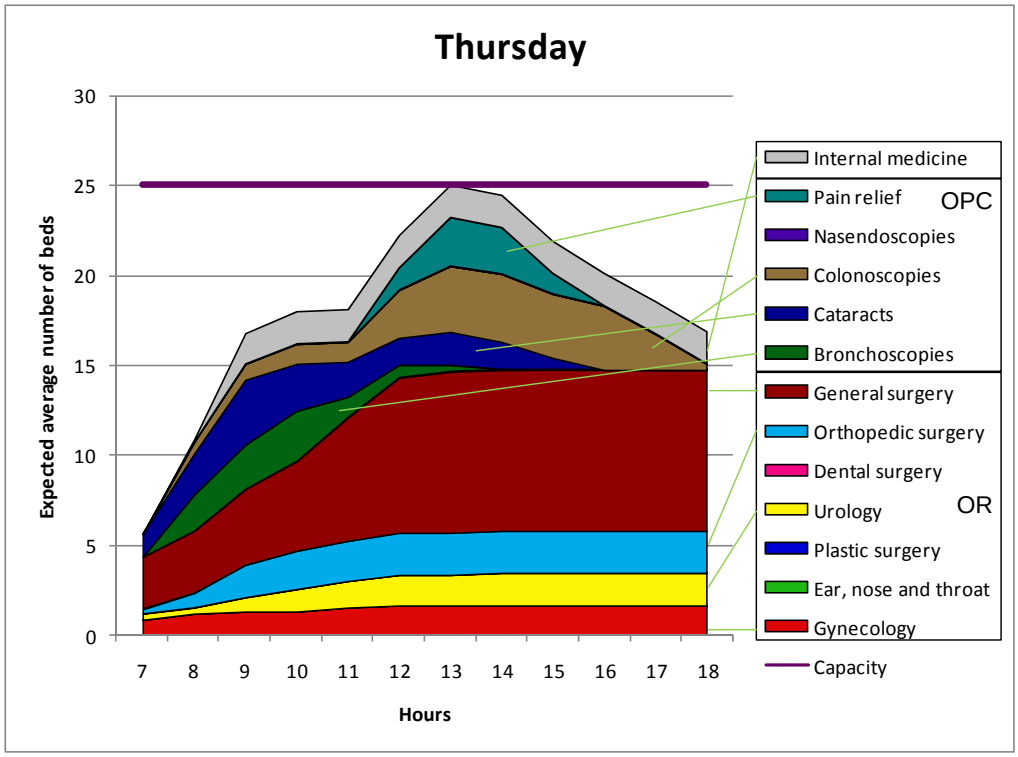

Figure 15: Average expected number of beds needed on Thursday

Source: Arrival data based on the period January - February 2008

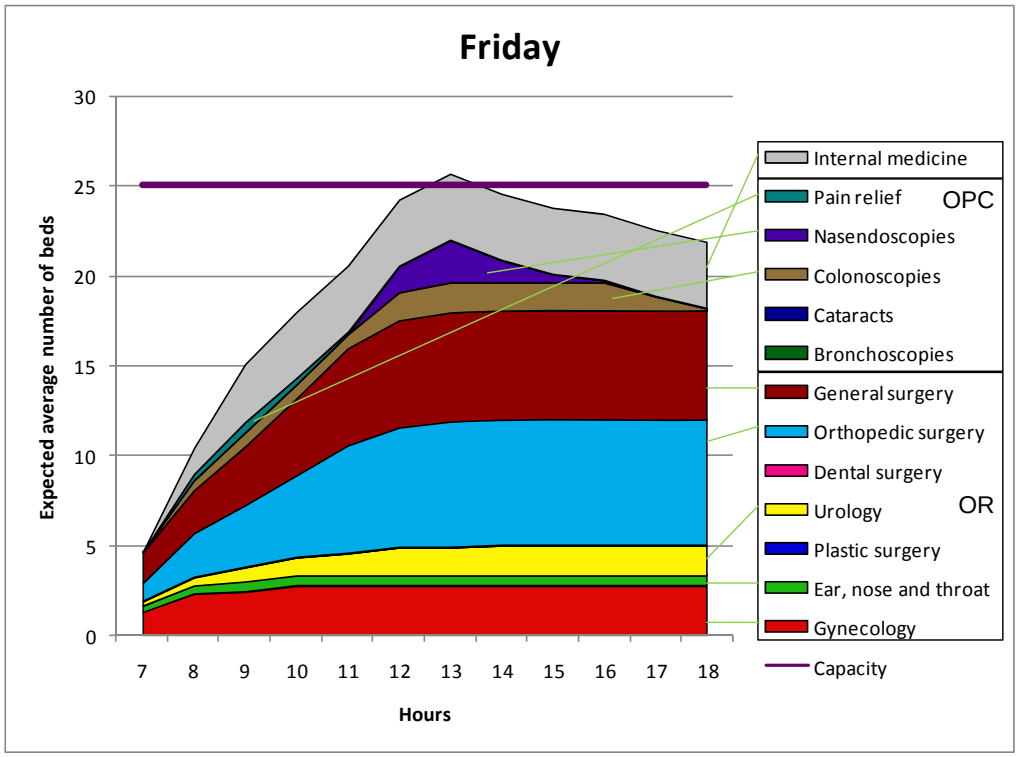

Figure 16: Average expected number of beds needed on Friday

Source: Arrival data based on the period January - February 2008

Figure 12 to Figure 16 shows the added averages of the specialties based on the projection in averages in Table 1. The purple line indicates the capacity of the ASW (25 beds). The colors clearly show that there is a lot of variation in the specialties that use the ASW. This can especially be seen in the graph of Tuesday. Dental surgery (MON) and Plastic surgery (PLA) has a certain impact on the averages, making the need for beds greater. Wednesday is clearly a quiet day with fewer specialties using the ASW on that day. Thursday picks up again with more specialties and Friday shows the same number of specialties as Thursday but due to the fact that the nasendoscopy program follows the pain relief program neatly, no extreme rise is patients is seen because of this, but because of general surgery and orthopedics. Generally it can be stated that Monday and Tuesday are comparable and Thursday and Friday. Wednesday is clearly an off day.

Min # beds	Time	Monday	Tuesday	Wednesday	Thursday	Friday
18	7:00	0,00	0,17	0,06	0,06	0,00
18	8:00	0,00	0,17	0,06	0,06	0,00
25	9:00	0,00	0,12	0,04	0,04	0,04
25	10:00	0,00	0,16	0,04	0,04	0,04
25	11:00	0,08	0,20	0,04	0,08	0,04
25	12:00	0,12	0,28	0,08	0,12	0,04
25	13:00	0,16	0,36	0,08	0,12	0,08
25	14:00	0,12	0,32	0,08	0,12	0,08
25	15:00	0,08	0,24	0,08	0,12	0,08
25	16:00	0,00	0,20	0,08	0,12	0,08
25	17:00	0,00	0,20	0,04	0,08	0,08
25	18:00	0,00	0,16	0,04	0,08	0,08

Max	Time	Monday	Tuesday	Wednesday	Thursday	Friday
18	7:00	1,00	1,00	0,89	0,67	0,67
18	8:00	2,00	2,11	1,67	1,56	1,61
25	9:00	1,96	2,16	1,84	1,76	1,80
25	10:00	2,08	2,60	2,20	2,16	2,16
25	11:00	2,48	2,80	2,44	2,32	2,32
25	12:00	2,88	3,12	2,68	2,64	2,72
25	13:00	3,08	3,28	2,84	2,84	3,08
25	14:00	3,08	3,20	2,84	2,76	3,20
25	15:00	2,84	3,00	2,88	2,52	3,08
25	16:00	2,44	2,84	2,88	2,36	2,92
25	17:00	2,24	2,60	2,76	2,28	2,72
25	18:00	2,20	2,48	2,60	2,16	2,56

Avg	Time	Monday	Tuesday	Wednesday	Thursday	Friday
18	7:00	0,41	0,57	0,29	0,31	0,26
18	8:00	0,77	1,02	0,56	0,60	0,58
25	9:00	0,68	0,99	0,59	0,67	0,60
25	10:00	0,67	1,11	0,70	0,72	0,72
25	11:00	0,74	1,13	0,77	0,72	0,82
25	12:00	0,96	1,33	0,89	0,89	0,97
25	13:00	1,11	1,43	0,95	1,00	1,03
25	14:00	1,14	1,35	0,93	0,98	0,98
25	15:00	1,00	1,17	0,94	0,88	0,95
25	16:00	0,86	1,08	0,94	0,80	0,94
25	17:00	0,72	0,97	0,86	0,74	0,90
25	18:00	0,67	0,90	0,79	0,68	0,88

Table 2: Utilization rates of the ASW per hour based on the projections in Table 1

Table 2 is based on the division of the projection of the number of beds per hour and the actual available beds per hour. Since the ASW starts with three early shifts there are only a maximum of 18 beds available from 7:00 am to 9:00 am. At 9:00 am and at 9:30 am three late shifts start making the total number of beds available 33. The utilization rates based on the averages show that they clearly come above one, necessitating the moving of patients to other wards.

3.4 Conclusions regarding context

The current situation shows that the ASW receives patients from three departments of which the OR and the OPC have the biggest influence. The ASW is in the perfect location for its patients since the ward is in close proximity of the OPC and OR.

Because the ASW is, according to Vissers (1994), a following resource it currently has to conform its scheduling of the patients to the schedules of the OR and the OPC. It has to fit in the patients on their own ward and is responsible for moving patients to a nursing ward if necessary. The consequence of being a following resource is also that there is a lot of variability in the supply of patients. This can be seen from the coefficient of variation as stated in § 3.3.4 and Figure 7. However, in an ideal situation there should be no distinction between a leading and a following resource but there should be a continuous process of interaction between the departments to reach the lowest possible variability and the highest efficiency for all involved.

The arrival pattern of the patients that are sent to the ASW shows that there are two peaks, one in the morning and one in the afternoon. The peak in the afternoon can be dealt with if patients that have arrived in the morning already have left, but this is not always possible due to the fact that some patients still need the bed because of the necessary aftercare for their treatment or diagnostics. The variability frustrates the process coordinator because on the busy days it is all hands on deck and on other days several beds can be closed for that day and even nurses can stay home because there are not enough patients.

Based on the graphs in § 3.3.4 we come up with the following interventions:

- Move the dental surgery program from Tuesday to for example Wednesday
- Move the plastic surgery program away from Monday and Tuesday to Thursday or Friday
- Move the cataract programs from Monday, Tuesday, Thursday to Wednesday, Thursday, Friday
- More beds on Monday and Tuesday
- Move the pain relief program to the morning and bronchoscopies to the afternoon

These interventions and their consequences will be implemented in a capacity analysis tool described in Chapter 4 and discussed in Chapter 5.

Therefore we recommended that the variability is reduced to improve the quality of labor for the nurses and the quality of care of the patients.

4 Quantitative model of the process

This chapter describes the capacity analysis tool we have designed to give the decision makers of the ASW the possibility to see what effect several changes have on the workload on the ASW.

§ 4.1 gives a description of the tool with its input, the method used and the output it gives. § 4.2 discusses the validation of the tool and § 4.3 sums up the limitations of the tool.

4.1 Description

The tool consists of two Excel-files. One file contains the averages per hour per specialty/program. The other file, the file with the tool, contains the means to analyze the data and has several worksheets to change input factors and to view the results. The macros in this file automate part of the analysis of the arrival data (as seen in § 3.3.4) and give the opportunity to change certain factors and see what its effects are on the workload of the ASW. The description of the files can be seen in Figure 17.

4.1.1 Assumptions

Within the model we assume:

- Surgical patients have a standard LOS of 11 hours (i.e. between 7:00 am and 6:00 pm).
- Since the chairs that are used for cataracts use the same physical space as a bed, these are equivalent.
- LOS is always in whole hours. This has also been implemented into the Control Room to prevent the user to insert half hours.
- Capacity, opening time, and closing time are also restricted to whole numbers in the Excel worksheet.

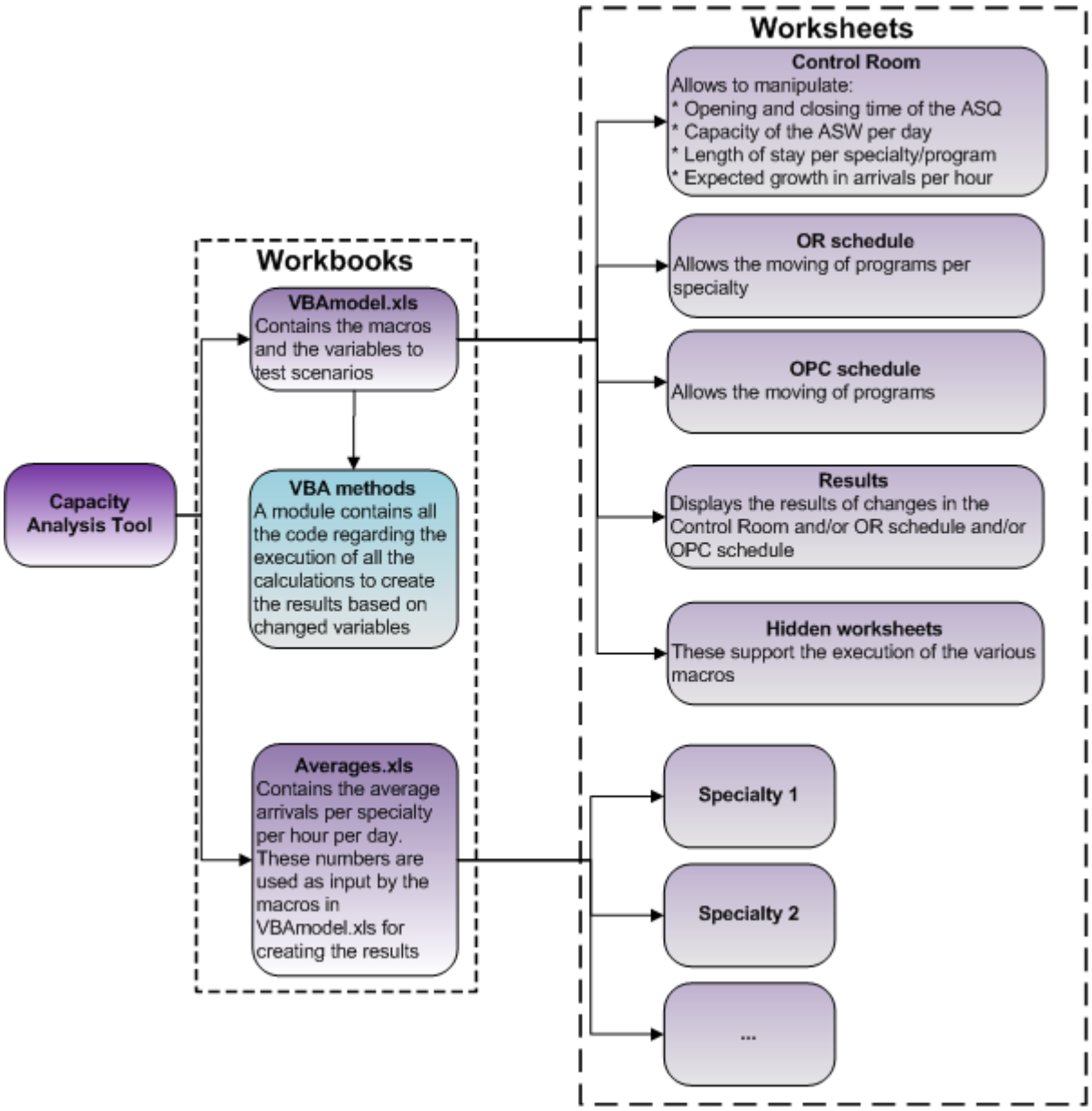

Figure 17: Overview of the capacity analysis tool

4.1.2 Input

As input for the tool, several factors are used that influence the ASW. These are:

- The weekly OR schedule
- The weekly OPC schedule
- The LOS of every specialty/program
- The opening hours of the ASW
- The capacity of the ASW in beds
- The average number of arrivals per day per hour per specialty/program based on the arrival data

All of these factors can be influenced in the model. The arrival data can be influenced by adding a growth factor in the arrivals per hour per specialty/program in a percentage. This can be used to analyze what the future effects are of a growth in patients.

Figure 18: The Control Room of the capacity analysis tool in Excel

4.1.3 Method

Calculations for the number of beds per hour per day are automated with Visual Basic for Applications (VBA) for Excel. The advantage of this is that the program can be used on every computer that has Excel on it, which is the case in this hospital.
The calculations that are made are sums of the number of beds per hour per day per specialty. The source of the average number of beds is based on two months of arrival data as described in § 3.3.4. In making these sums, the LOS of the specialty/program is taken into account. Per hour a patient uses a bed it has to be summed with the patients that arrive that hour for that specialty/program resulting in a certain number of patients on the ASW for that hour. The graph is a visual representation of this, showing how each specialty/program adds to the average number of beds needed on the ASW. The table with the totals shows the total sum of all these beds and shows when capacity has been breached by lighting that cell up in green.

4.1.4 Output

Output is given in the shape of stacked area graphs for every day as demonstrated in § 3.3.4 and in a table as demonstrated in Table 1. Figure 19 shows the whole output that is given in the worksheet with the results. The results are given per scenario that is run.

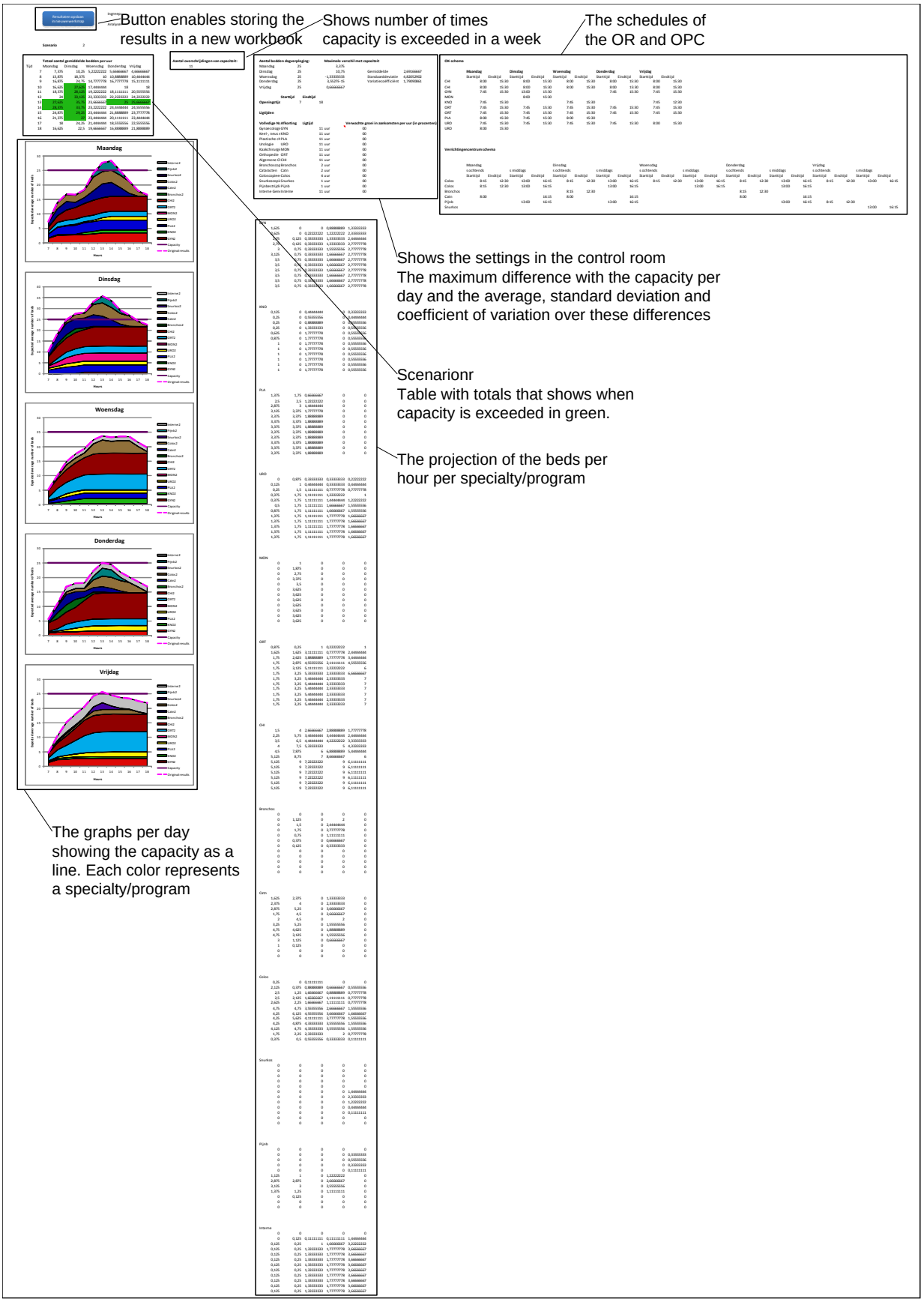

Figure 19: Overview of the output of the capacity analysis tool in a worksheet of Excel

The improvement or deterioration as a consequence of a change is measured in the difference between the maximum per day and the capacity in beds of that day and also shown in the sheet with the results. A negative results means it is below capacity and positive that it is above capacity. The number of times per day the number of patients exceeds the capacity of the ASW is also shown visually in the table with the totals through using the color green when it exceeds the capacity.

4.2 Validation

Based on an analysis of the averages and the coefficient of variation between periods it can be concluded that the period of January and February 2008 is representative of the whole year.

Averages	OR	OPC	Internal Medicine	Cataracts
Jan/febr '08	18	10,2	1,49	5,09
Oct/nov '08	18,88	12,63	1,47	7,60
2008	16	11	2,40	6,03
Coefficient of variation				
Jan/febr '08	0,33	0,48	1,04	1,03
Oct/nov '08	0,25	0,55	0,91	0,83
2008	0,36	0,54	1,00	0,96

Table 3: Validation of the arrival data

Due to the low amount of values (n=4) and the lack of a normal distribution in these values, no paired t-test could be performed to test if there is or there is not a significant difference between the values for January/February 2008, October/November 2008 and the whole of 2008. Validation is based on the difference between the paired values and the difference between January/February 2008 and the whole of 2008 is lower than between October/November 2008 and the whole of 2008. Based on this, January/February 2008 is deemed more representative for 2008 than October/November 2008.

4.3 Limitations

Only one move per specialty/program is possible in the model due to the restrictions in comparing the original schedule with the new schedule. And the basis for the data concerning the averages is the arrival data over a period of two months at the beginning of 2008. These months were seen as busy months by the ASW, which had only 25 beds at their disposal in that period and this is used as capacity in the tool. Currently the ASW has even 44 beds. The changing number of beds makes comparison difficult between periods. Also the arrival data is limited to two months because of the difficulties in retrieving the data digitally. This limits the model because the process of extracting the averages from the arrival data cannot be automated due to the complex nature of the arrival data itself. Not every source has arrivals at every hour in every day making automated extraction from a pivot table impossible even if arrival times had been extracted from the hospital information system.

5 Interventions

Chapter 4 described the capacity analysis tool with which several changes can be made in the input factors, which relate to possible interventions that can benefit the ASW. This chapter evaluates these interventions and what effects they have on the workload of the ASW. The tool gives the possibility for roughly two types of interventions, namely changing the day and/or timing of a program, which we discuss in § 5.1, and changing the LOS, which we discuss in § 5.2. Although the model gives the possibility for more interventions, like; expanding the opening hours, differing capacity per day or projected growth per hour, but since these expand on the original situation these are not included. § 5.3 shows the results of the combined changes and draws a conclusion based on it.

In § 3.3.4 we developed several interventions based on the analysis of the projection made. These were:

- Move the dental surgery program from Tuesday to for example Wednesday
- Move the plastic surgery program away from Monday and Tuesday to Thursday or Friday
- Move the cataract programs from Monday, Tuesday, Thursday to Wednesday, Thursday, Friday
- More beds on Monday and Tuesday
- Move the pain relief program to the morning and bronchoscopies to the afternoon

In this chapter all these suggested interventions are tested except increasing the number of beds.

5.1 Changing the day and/or time of a program in the OR or OPC schedule

The tool gives the possibility to evaluate a move of certain programs from one (part of the) day to another. For each possible intervention we create a scenario in the tool and display it in the way as shown in Figure 19.

Results are compared on how a program that has been moved reduces the pressure on the number of beds per hour on the day it has been moved away from and how it has added beds to its new day. The comparison is based on a visual examination of the resulting graphs and on the numbers in the table with the number of beds per hour per day.

5.1.1 The OR schedule

The most logical moves are the ones that take the pressure off the exceptionally busy Monday and Tuesday (see Figure 12 to Figure 16) and have the room in the program to be moved. For example it is not logical to move orthopedics or general surgery because they run at least one program every day.

Based on this criterion the following moves should be considered:

Dental Surgery:

1. From Tuesday to Wednesday
2. From Tuesday to Thursday
3. From Tuesday to Friday

Ear, nose, throat surgery:

4. From Monday to Thursday

Plastic surgery:

5. From Monday to Thursday
6. From Monday to Friday
7. From Tuesday to Thursday
8. From Tuesday to Friday

Urology (the second program):

9. From Monday to Wednesday
10. From Monday to Thursday
11. From Monday to Friday

Gynecology:

12. From Monday to Wednesday
13. From Tuesday to Wednesday. It should be noted that the Tuesday program is an afternoon program.

All these scenarios have been tested and the results can be found in Appendix D: Results scenarios regarding moves in the OR schedule. Based on a comparison of these results with the original situation (see Appendix C: The original results and Appendix D: Results scenarios regarding moves in the OR schedule) it can be concluded that regarding moves in the OR schedule scenarios 1 and 7 are the most profitable changes because these are the ones that can reduce the coefficient of variation the most and therefore variability in a week leveling the workload.

A good example of this is scenario 1: the move of dental surgery from Tuesday to Wednesday. The Tuesday graph (Figure 20) clearly shows that the graph has been pushed back by 3,6. In the Wednesday graph (Figure 21) the graph has been filled until above the capacity line but since the standard deviation and therefore the coefficient of variation is reduced. The difference can be seen in the graph by comparing the new result with the pink dotted line in the graphs which shows the original results for those days. The difference between the original results and these results can also be seen by looking at the maximum difference per day between the capacity and the maximum of that day. For this intervention this results in the following values:

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,1	**Average**	2,7
Wednesday	25	2,3	**Standard deviation**	2,8
Thursday	25	0,0	**Coefficient of variation**	1,0
Friday	25	0,7		

Table 4: The maximum difference with capacity per day and measures of improvement for scenario 1

The average over these differences is the same as the original results (2,7) because you only move a program, making the average the same but standard deviation has reduced from 4,8 to 2,8 and the coefficient of variation from 1,8 to 1,0 showing that this move reduced variability.

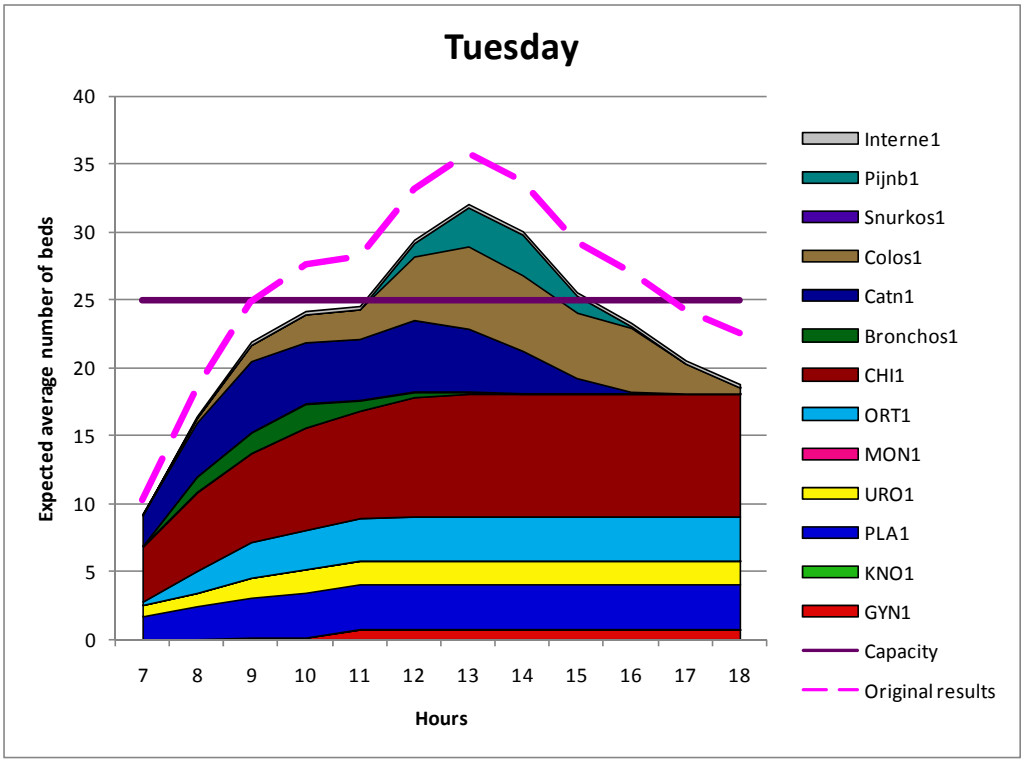

Figure 20: Projection of the number of beds on Tuesday resulting from scenario 1

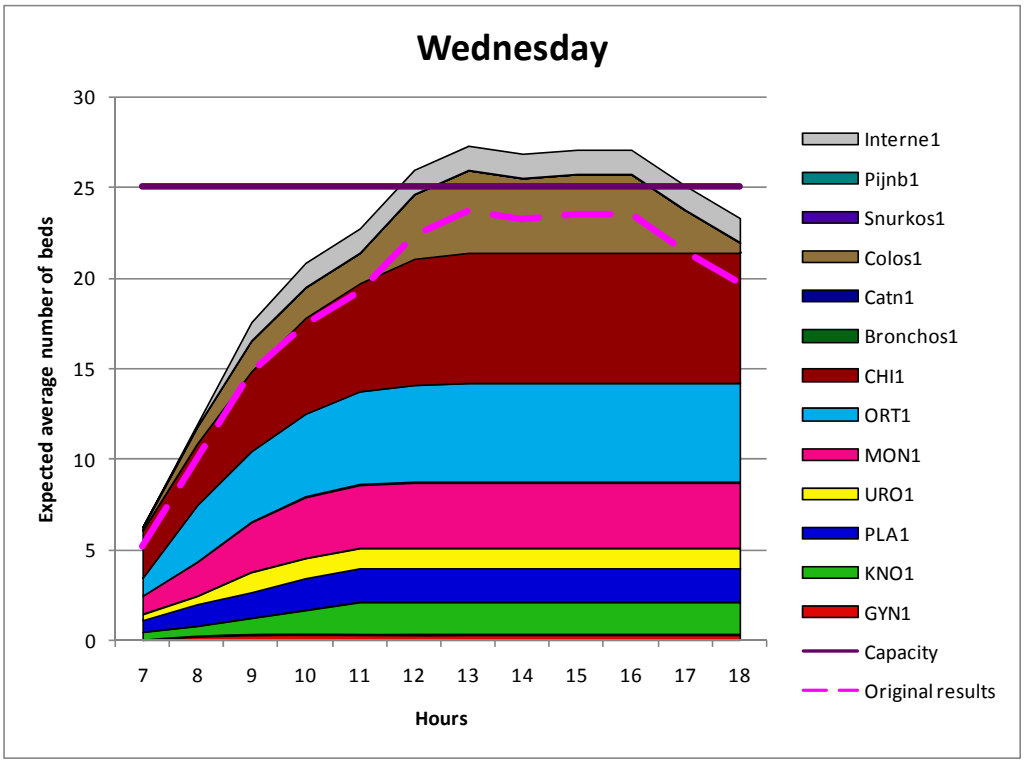

Figure 21: Projection of the number of beds on Wednesday resulting from scenario 1

5.1.2 The OPC schedule

In the OPC schedule changes are possible in every program since none of the programs run every day. However there are restrictions.

The same holds for the OPC schedule as for the OR schedule. It is only logical to move programs away from the busy days to the days that still have some room to expand on the number of patients.

Colonoscopies and bronchoscopies

Colonoscopies are performed every day, but the second program can be moved. However there can only be two programs using scopes in one part of the day so either two colonoscopy programs or one bronchoscopy and one colonoscopy program. Thus this has to be taken into account in moving these programs.

Colonoscopies

The second colonoscopy program on a day can be moved to another day taking into account the restriction mentioned in the previous section.

Bronchoscopies

Bronchoscopies can be moved to another (part of the) day. And just as with the colonoscopies the restriction regarding a maximum of two scope programs per part of the day should be taken into account.

Cataracts

Cataracts are now performed on Monday, Tuesday and Thursday. To relief some pressure on the Monday and Tuesday the cataracts can be moved to a program running from Wednesday to Friday. This also gives room to four more beds on the ASW on Monday and Tuesday relieving some pressure in that way also.

Pain relief

These are mostly in the afternoon, sometimes leading to empty beds due to the lack of patients with a short LOS in the morning. The scenarios will look at moving these programs to other periods in the week where they are more convenient.

Nasendoscopies

This program on Friday afternoon currently fits very well with the pain relief program that runs in the morning because they directly follow each other. This does not give any problems since the same room can be used for both groups of patients and therefore a move of the nasendoscopy program is not included in the possible scenarios.

Based on these restrictions the following are possible:

Pain relief:

14. From Monday afternoon to Wednesday morning
15. From Monday afternoon to Wednesday afternoon
16. From Tuesday afternoon to Wednesday morning
17. From Tuesday afternoon to Wednesday afternoon

Colonoscopies, bronchoscopies and pain relief:

18. Colonoscopies from Tuesday afternoon to Tuesday morning, bronchoscopies from Tuesday morning to Tuesday afternoon and pain relief from Tuesday afternoon to Tuesday morning
19. Colonoscopies from Thursday afternoon to Thursday morning, bronchoscopies from Thursday morning to Thursday afternoon and pain relief from Thursday afternoon to Thursday morning

Colonoscopies:

20. From Monday morning to Wednesday morning
21. From Monday morning to Friday morning
22. From Monday morning to Friday afternoon
23. From Monday afternoon to Wednesday morning
24. From Monday afternoon to Friday morning
25. From Monday afternoon to Friday afternoon

Cataracts:

26. From Monday to Wednesday
27. From Monday to Friday
28. From Tuesday to Wednesday
29. From Tuesday to Friday

All these scenarios have been tested and the results can be found in Appendix E: Results scenarios regarding moves in the OPC-schedule.

Based on a comparison of the results of these scenarios we conclude that the scenarios 14, 18, 19 and 28 create the best results because they reduce the coefficient of variation and therefore level the workload within a week or even a day as with scenarios 18 and 19.

5.2 Changing the length of stay

The other main factor that can be influenced in the tool's Control Room is the LOS per specialty/program. Based on an analysis of the steps that are followed it can be concluded that for both bronchoscopies and colonoscopies a bed is only needed after the diagnostics has taken place because of the recovery period. Theoretically it is possible to reduce the recovery period by half for these programs if the steps taken before the diagnostics are being done in for example a separate room. This means a reduction of the LOS by half for both procedures, meaning from four to two hours for colonoscopies and from two to one hour for bronchoscopies.

If the LOS is differentiated more for the surgical patients than maybe doubling with these patients is possible. However this thesis does not go further into detail than an LOS per specialty/program.

Results are compared on how a reduction in a program's LOS has decreased the pressure on the number of beds needed per hour per day. The comparison is based on a visual examination of the resulting graphs and on the numbers in the table with the number of beds per hour per day. In Appendix F: Changing the length of stay the resulting graphs and table can be seen for a reduction in LOS for bronchoscopies (scenario 30) and colonoscopies (scenario 31). Based on an analysis of these results, the reduction of the LOS for colonoscopies has the biggest overall effect regarding the reduction of the expected number of beds on the ASW.

5.3 Conclusion of interventions

This paragraph discusses what are the best changes to be made and the effect of all these changes will be shown in § 5.3.3.

5.3.1 Changing the day and/or time of the program

For the OR the most profitable moves are:

- Scenario 1: Dental surgery form Tuesday to Wednesday
- Scenario 7: Plastic surgery from Tuesday to Thursday

The OPC has the following moves:

- Scenario 14: Pain relief from Monday afternoon to Wednesday morning
- Scenario 18: Colonoscopies from Tuesday afternoon to Tuesday morning, bronchoscopies from Tuesday morning to Tuesday afternoon and pain relief from Tuesday afternoon to Tuesday morning
- Scenario 19: Colonoscopies from Thursday afternoon to Thursday morning, bronchoscopies from Thursday morning to Thursday afternoon and pain relief from Thursday afternoon to Thursday morning
- Scenario 28: Cataracts from Tuesday to Wednesday

5.3.2 Changing the length of stay

The most effective change of LOS is that of the colonoscopies. Due to the reduction there is a clearer split between the morning and afternoon programs, making the doubling of beds easier to do and with fewer beds.

5.3.3 Result of all these changes

It is possible to implement all these results into the tool and calculate this and this has been done and it is shown in Appendix G, Part 1. Since all these changes cannot be performed in one go, the graphs are a montage of the graphs were as much scenario as possible will be combined.

As can be seen in the Appendix, implementing all these changes is a bit too much, especially on Tuesday and Wednesday. Tuesday is 6,2 under capacity while Wednesday is 6,1 over capacity. Also the coefficient of variation is 17,8 due to a low average but a high standard deviation. By removing either scenario 1 or scenario 28 from the set of best scenarios the situation on Tuesday and Wednesday can be improved since these scenarios affect both Tuesday and Wednesday. In Appendix G, Part 2 scenario 1 has been removed and in Part 3 scenario 28.

Based on a comparison between Part 2 and Part 3 it can be concluded that removing scenario 28 results in a lower coefficient of variation because of a lower average and a lower standard deviation. The results are shown in Table 5 and Table 6.

Since it is probably harder to implement changes in the OR schedule, the preference lies with changes in the OPC schedule. Implementing only these changes (scenarios 16, 17, 22, 25 and 31) you get the following results:

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	9,8	7,3	9,4	4,7
8	13,9	17,9	14,8	15,7	10,4
9	16,9	22,8	20,7	21,7	15,1
10	16,4	21,5	22,1	20,7	18,0
11	16,3	20,5	21,8	19,9	20,0
12	20,6	22,3	24,4	22,0	23,4
13	24,4	23,0	26,5	25,3	25,4
14	25,1	21,9	26,8	25,7	24,6
15	21,0	19,0	25,1	24,4	23,0
16	17,6	16,1	23,3	21,2	22,0
17	16,3	15,4	23,0	20,6	21,8
18	16,3	15,1	22,7	20,3	21,8

Table 5: The number of beds as a result of scenarios 1, 7, 14, 18, 19 and 31

The results for the interventions:

Number of beds on ASW		Maximal difference
Monday	25	0,1
Tuesday	25	-2,0
Wednesday	25	1,8
Thursday	25	0,7
Friday	25	0,4

Measures of improvement	
Average	0,2
Standard deviation	1,4
Coefficient of variation	6,2

Table 6: The maximum difference with capacity per day and measures of improvement for implementing scenarios 1, 7, 14, 18, 19 and 31

When implementing all the favorable interventions, the results are:

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,1		
Tuesday	25	-6,2	**Average**	0,2
Wednesday	25	6,1	**Standard deviation**	4,4
Thursday	25	0,7	**Coefficient of variation**	17,8
Friday	25	0,4		

Table 7: The maximum difference with capacity per day and measures of improvement for implementing scenarios 1, 7, 14, 18, 19, 28 and 31

The graphs for all combinations can be seen in Appendix G: Results.

All combinations of scenarios show the same average due to the reduction in LOS for colonoscopies (moving a program does not affect the average), but the best combination of interventions (Part 3) show a lower standard deviation and coefficient of variation than the combination of all favorable interventions. The graphs on four of the five days are over capacity, which are seven hours in a week, but this is still much better than the 11 hours in the original situation.

This solution proofs that the suggested interventions in the schedules and the reduction in LOS of a specialty/program, the number of beds needed per day can be leveled within a week.

6 Organizational implementation

"Implementation of change is often the most difficult part of the change process. Until people use the new idea, no change has actually taken place." (Daft 2001)

This quote shows that implementation is an important part of a successful change. This chapter will give insight into theories specific to health care concerning simulation models (§ 6.1) and then in general (§ 6.2) regarding successful implementation in the whole organization. § 6.3 will focus on the reaction of the stakeholders at the ZGT Almelo that are affected by the results of this thesis and § 6.4 will give the conclusion of this chapter.

6.1 Organizational implementation in health care

There are theories concerning implementation in health care specifically which will be discussed in § 6.1.1. § 6.1.2 will compare the recommendations made in § 6.1.1 with the circumstances regarding this thesis. The basis of the theories in § 6.1.1 is the implementation of simulation models. The tool developed for this thesis does not entail a simulation but since the requirements for both are similar the theories are seen as suitable to apply to the tool described in Chapter 4.

6.1.1 Theory

Both Jun et al. (1999) and Carter et al. (2005) state that people that are affected by a simulation study, i.e. the stakeholders, should be involved in the process of executing it. Based on a review, Jun et al. make the following recommendations to increase the chance of success:

- The system studied is in need of a decision
- The project must be completed before a deadline
- Data must be available
- The organizer or the decision maker must participate in the project

Jun adds the following key elements necessary for a successful implementation of a simulation:

- Total commitment and support from the user
- Credibility of the model
- The analyst must work with the real operations on hand instead of any esoteric studies

6.1.2 Theory applied to ZGT Almelo

Comparing the recommendations in § 6.1.1 with the reality of the study performed in this thesis the following can be said:

- A decision had to be made regarding the overrunning of the ASW, until now the problem has been reduced by adding beds.
- There was not a clear deadline
- Only little data (from the OR) was directly available. The data regarding the ASW and its patients had to be manually retrieved from the daily schedule of the ASW. From the OPC no data was available.
- The decision maker, the head of the OR and the director of health for the hospital, were not directly involved in the project. But they did show an active interest in the results from the data analysis in Chapter 3.
- The proposed user of the tool, the process coordinator of the ASW, was kept up to date about the progress of the study including data analysis and the tool.
- The model was seen as credible for the stakeholders directly involved.
- Real data was used based on the daily schedules of the ASW and the researcher was up to date with the daily operations of the ASW.

6.2 General theories on implementation

After a tool has been developed and results are generated these have to be communicated and suggested changes have to be implemented as good as possible in the organization. This section will give insight into the general theories concerning implementation (§ 6.2.1) and based on these theories try to predict how these theories apply to ZGT Almelo (§ 6.2.2).

6.2.1 Theory

Daft (1997) states that implementation is one step in a process of change, which starts with either an idea or a need for change and can or cannot result in a change in an organization. The extent of a successful implementation depends on several factors. These are:

- How one deals with a resistance to change: employees seem to prefer the status quo and there are several reasons to resist change. By understanding these, managers can implement change more effectively.

  The possible forms of resistance are:

  - Self interest: a change will take away something of value like power or pay.
  - Lack of understanding and trust: the intended purpose of change or the intentions behind it are not understood
  - Uncertainty: there is a lack of information about future events. It is a fear of the unknown.
  - Different assessments and goals: the affected assess the situation differently from the initiator.
- What implementation tactics are used to overcome resistance to change. These are:
  - Communication and education are used when information about the change is needed by users and others that may resist implementation.
  - Participation involves users and potential resisters in designing the change.
  - Negotiation uses formal bargaining to win acceptance and approval of a desired change.
  - Coercion uses formal power to force employees to change. However, this should only be used in crisis situations when a rapid response is urgent.
  - Top management support symbolizes to all employees that the change is important for the organization. Especially when multiple departments are involved.

There are also different kinds of changes which require a different approach. And one kind of change can necessitate other changes. The different types of planned change are:

- Strategic change
- Technology change: pertains to the organization's production process
- Product change: a change in the organization's product or service output

- Structural change: any change in the way in which the organization is designed and managed
- People/cultural change: a change in employees' values, norms, attitudes, beliefs and behaviour. (Daft 1997)

6.2.2 Theory applied to ZGT Almelo

This section expands on what resistance can be expected, what tactic should be used and what kind of planned change the implementation is based on the theories described in § 6.2.1.

What kind of resistance can be expected?

- Different assessments and goals concerning the need for change and also how one change in the schedule will affect other departments like clinical wards, radiology, the laboratory or the outpatient clinic.

What tactic(s) should be used?

Communication is not seen as an option since this tactic implies that when the right people are informed that they will directly implement the suggested changes. Since a hospital is a complex organization with every department having different interests, we do not expect that this is the correct tactic and that more formal approaches are necessary to change people's minds.

- Participation: since the user also has to agree with the tool developed and in collecting the necessary data this is an important tactic
- Negotiation: this more formal means of cooperation has to be used when the changes are taken to other departments like the OPC, the OR and the outpatient clinic and the doctors that are affected by the change.
- Coercion: if all else fails this is the last resort with support by top management. Forceful coercion should be avoided if possible. Using a less aggressive form of coercion could be tried, but you should be aware of how the stakeholders involved can react.

What type of change?

- Structural change: the results implicate another kind of organization because the making of the schedules for different departments have to be implemented with the following departments in mind and not just the leading departments´ own agenda.
- People change: the change also requires another way of thinking about how one change can affect the whole hospital and see beyond the walls of their own department.

6.3 Reaction of stakeholders

As Carter et al. 2005 stated, the physicians control the master surgery schedule. In ZGT Almelo there is a general understanding that a specialist has to conform his schedule to the needs of the hospital for an efficient organization. And if that means that a schedule has to be changed in the best interest of the hospital it should be implemented. Of course with the participation of all the departments and stakeholders involved and taking several constraints into account. This is contrary to the reaction Carter had in his research where specialists were seen as the ones that were opposed to even minor changes in their schedule.

6.3.1 Reaction regarding the capacity analysis tool

The process coordinator of the ASW responded positively to both the tool and the accompanying user guide. She understood what the possibilities and restrictions of the tool are and what factors she could manipulate. There was only one request: a button to return the original OR or OPC schedule to start a move with a clean slate.

6.3.2 Reaction regarding the results generated

Process coordinator of the OPC

It is very difficult to change their whole schedule because of the interdependence of the OPC schedule with the OR schedule and the outpatient clinic schedule. They rather look for solutions within the current schedule before real structural changes are made. She states that there should be a discussion with the involved doctors if one wants to change

the schedule. She is however receptive to the idea of reducing the LOS of colonoscopies by preparing the patients in a separate room instead of using a bed. Maybe there will soon be a trial where this will be tested and observed how patients respond to this. She is also looking at the possibilities to introduce changes within their own schedule to use their resources more efficiently.

Head of the OR*

** This includes the OR, the OPC, the ICU and the ASW*

It is practically impossible to introduce any of the proposed interventions in the OR schedule. The OR schedule is defined by a lot of constraints mainly regarding the surgeon's schedules and its link through these schedules with the OPC schedule. New specific contracts for OR personnel who combine work with the care for children, are only used on Thursdays and are mainly deployed for day surgeries. The ASW would benefit if some were moved to Wednesday, since this is still a quiet day. However, this is not possible because Dutch children in primary school are home on Wednesday afternoons. This proves that the model shows an ideal situation but reality is more uncompromising. Completely changing the OR schedule also depends on the results of an analysis by a consultancy firm that is performed in ZGT including the link between the OR schedule and the clinical wards.

But there is some hope. Orthopaedics has already started with one OR dedicated to day surgery on Wednesday and the head of the OR will use this as an example for the other specialties. The suggestion of reducing the LOS for colonoscopies by not performing the preparatory tasks on a bed is seen as a good idea and as soon as possible a trial will be started by the ASW and the OPC together.

Process coordinator of the ASW

She sees the advantages of the possible changes for her department. But after the discussion with the head of the OR she understands that it is difficult to change the OR schedule because of the interdependence with other departments. The positive side is that there is the opportunity for dedicated day surgery ORs which can balance the arrival of patients to the ASW. Also the possibility of a trial for reducing the LOS of colonoscopies in cooperation with the OPC is seen as a positive result.

6.4 Conclusion

Based on the stated requirements for a good implementation of a model in a hospital in § 6.1.1 and applying it to ZGT Almelo in § 6.1.2 it can be said that this thesis partly does not correspond with these requirements; especially regarding the lack of a hard deadline and the availability of data. And the decision maker was not directly involved in the making of the capacity analysis tool but was kept up to date on its progress. However it does comply with the remaining four recommendations. This could mean that the model will not be fully implemented but this is still difficult to predict.

§ 6.2.2 tried to predict what kind of resistance was expected, what tactics could be used and what kind of change the proposed solution was. Based on the reaction of the stakeholders in § 6.3 it can be stated that the kind of resistance was correct since changing even one program in the OR schedule has an effect on all the departments that are affected by the change. The best tactic that is used is difficult to say since this thesis is one part of a larger research project in the hospital and the hospital is waiting for all the results before it will implement large changes in the different departments. But it would probably be negotiation since each department has its own wants and needs.

The hospital already saw that something needed to be changed when they sought the help of consultants and researchers to take a look at the current organization of the hospital and how this can be improved, especially in the light of the link of the different schedules with following departments like the clinical wards and the ASW. However, it is still difficult to predict how all those different departments are going to react based on the culture of these departments. And this has to be foreseen when implementing the changes and what action should be taken to make the changes as smooth as possible with as little resistance as possible.

Both the process coordinator of the OPC and the head of the OR first want to look at what is possible to change within the current OPC and OR schedule before they implement radical changes. One example of this is the reduction of LOS for colonoscopies or the ‘mother’ contracts on Thursdays.

Overall it can be stated that implementation is still an uncertain process with an uncertain outcome at this moment since the hospital is waiting for more results of other studies in ZGT.

7 Conclusion and recommendations

This thesis showed that it is possible to balance the workload on the ambulatory surgery ward by means of moving only a couple of programs in the OR and/or OPC schedule while keeping the same number of beds. This chapter will summarize the thesis and give recommendations based on that.

Several researchers have given suggestions on how the impact of the OR schedule on the number of beds (and other resources) can be reduced. These can be summarized into two solutions:

- Creating a master surgery schedule that takes the impact on the bed occupancy into account (Harris 1985, Beliën et al. 2006, Carter 2002, Beliën et al. 2005, Vissers 1994, De Bruin et al. 2007, Santibanez et al. 2005, Chow et al. 2008)
- Allocate more or lesser beds to a specialty based on the measured need (Vissers 1998, De Bruin et al. 2007, Bekker et al. 2007)

The ZGT Almelo saw that the second solution of adding beds had a limit and this thesis sought a solution based on the first suggestion by researchers. To make this possible more insight into the relations between the OR schedule, the OPC schedule and the resulting capacity problems on the ASW was obtained. The result of this analysis is that the ASW has to conform its scheduling to that of the OR and the OPC. The ASW has to move its patients to other wards if they cannot be fitted into their ward, leading to a possible reduction in patient care and patient friendliness. This interdependence results in a lot of variability in the number of patients on the ASW within a week.

Data has been retrospectively collected and used as an input for a capacity analysis tool that has made it possible to analyze what the effect of an intervention in the OR and/or the OPC has on the number of beds the ASW needs per hour. By implementing the most favorable interventions the variability in a week, measured in coefficient of variation, has increased from 1,8 in the original situation to a coefficient of variation of 6,2. This seems odd but it is caused by a low average and low standard deviation which can explode when the average is close to zero, which is a good thing. Based on the

projection the ASW only needs 27 beds if the OPC and OR schedule is changed based on the proposed interventions.

Based on these results it can be said that a few 'simple' moves is all it takes to alleviate pressure on the busy days and fill up the number of beds on the other days resulting in a more leveled workload for the ASW during the week necessitating fewer or even no moves of patients to other nursing wards.

However, even these small changes result in a ripple effect to other schedules, making even one move in the schedules very difficult. Big changes are only implemented after a bigger study has been concluded; making it difficult to predict what recommendations will be implemented. Only recommendations that can be implemented within the boundaries of the schedules are going to be tried in the near future like reducing the LOS for colonoscopies.

Recommendations

Based on the conclusion several recommendations are made, these are divided into four parts: (1) optimizing planning and scheduling (2) registration and analysis of data, (3) predicting the future and (4) further research.

Optimizing planning and scheduling

Based on the conclusions it should be noted that the creation of the OR schedule should not be used as a blueprint for how the other departments should conform their schedule to it. The schedules at all departments should be created in conjunction with each other making sure that all hospital resources, both human and material, are used efficiently and effectively. One outcome for the ASW could be that it should expand its opening hours to use their beds for more hours in a day i.e. more patients can be treated using the beds more efficiently.

Registration and analysis of data

Registration of data in the hospital information system access to this data should be improved to make analysis easier for lower tiered managers. The data that is in the system is difficult to retrieve and sometimes not accurate at the moment. And the process of extracting the data that is available in the daily schedules of the ASW is too

laborious for one person. Accurate analysis cannot be performed if registration of the data is not improved. This accentuates the need that the nurses of the ASW should have easier access to a computer to register the right time of dismissal of a patient to make careful analysis of length of stay per patient type possible and as a consequence of that the tool and therefore the projections made with the tool could be more accurate.

Predicting the future

Within the discipline of ambulatory surgery, the kinds of procedures and therefore patients continue to grow. If the hospital does not preempt this at an earlier stage it will always have to improvise to solve this instead of taking it head on. In this process, predicting the patient flows could also be a possibility to predict how many beds are needed in a week and what the best way is to divide these over the beds, but also how the OR and/or OPC schedule should be changed to accommodate these patients in the best possible way for all the departments involved.

Further research

There is already a lot of literature concerning hospital bed capacity planning but the authors differentiate between ambulatory surgery and clinical surgery very seldom. However several models that are mentioned can be expanded upon to include this difference and introduce an LOS in hours in addition to an LOS in days. And by this adding to the insight into how efficiently an ambulatory surgery ward could be used by 'doubling' patients.

Another direction for further research is the subject of measuring what the effect is of a certain sequence of surgeries in two situations, namely in a separate OR for ambulatory surgery or in a mix of ambulatory surgery with clinical surgeries, on the number of beds that are needed per hour.

Discussion

The data used in this report is retrospectively collected: the number of patients for one year and the arrival data representing two months. This data is deterministic in nature. No stochastic analysis has been performed on the data but this can be a possibility in the future, for example by fitting a probability distribution on the number of arrivals per

hour per specialty or even more detailed, per specialist. This can be achieved by using the data the OR registers in their computer system.

The averages that are used for the arrivals are a course measure for the number of beds needed (De Bruin et al. 2007). Averages have the disadvantage of the 'flaw of averages'. It states that plans that are based on the assumption that average conditions will occur are usually wrong (Savage 2000). To diminish the effect, deterministic LOS was used instead of an overall average of LOS. However it was not even possible to get an average LOS from the hospital information system since not all patients are dismissed at the time they leave but when the nurse has time to log it into the hospital information system.

This thesis only applies to the effect of a change in the OR schedule and the OPC schedule on the workload of the ASW. However, this can have a negative effect on the workload of the nursing wards regarding the schedules of their own specialties. If these are not timed to their convenience then it can occur that all 'their' patients arrive on one day instead of spread over the week. If ZGT Almelo wants a complete picture it should also look at the patient flows on the nursing wards and include it in a model or expand upon the one described in this thesis.

Terminology & Abbreviations

Ambulatory surgery	Includes both day surgery and outpatient procedure and is defined as treatment for which a patient does not have to stay in the hospital overnight
Ambulatory surgery ward (ASW)	This nursing wards combines patients from both the OPC and the OR
Coefficient of variation	This is a normalized measure of dispersion of a probability distribution. It is defined as the ratio of the standard deviation to the mean. It is a dimensionless number. So when comparing between data sets with different units or wildly different means, one should use it for comparison instead of the standard deviation.
Colonoscopies	This term is a generalization of all kinds of diagnosis that is performed with a scope in any part of the gastrointestinal tract. However all this kinds are performed in the slots described as colonoscopies and diagnosis is performed by an internist.
Day surgery (dagchirurgie)	Includes the observation of the patient by a nurse after surgery for a period of at least 2 hours and a maximum of 24 hours.
Doubling	A term used by the ASW in the ZGT Almelo that means that a bed is used more than once during the day.
DTC	Diagnosis treatment combination, the basis of a new budgeting system for hospitals in the Netherlands that is similar to a DRG-system, but adjusted for the Dutch health care system
Length of stay (LOS)	The number if time a patient spends on a bed. In hospitals this is mostly measured in days, for the ASW it is measured in hours.

Mother contracts	These are contracts favorable for mothers regarding the combination of work and the care for children. This is mainly concerning working hours during school hours. The operations involved are low complex, meaning that most patients are nursed on the ASW.
Occupancy rate	The occupancy rate in the ZGT Almelo is calculated by dividing the number of patients by the number of beds. For the ASW this results in an occupancy rate that is higher than 100%
Outpatient procedure (poliklinische of kleine verrichting)	Includes a period of less than 2 hours under nurse supervision.
Outpatient procedure centre (OPC)	The department where outpatient procedures are performed.
Visual Basic for Applications (VBA)	VBA is a subset of Visual Basic that provides a common language for customizing Microsoft applications. It gives the possibility to automate processes in for example the programs in the Microsoft Office suite which are normally performed with mouse/keyboard actions.

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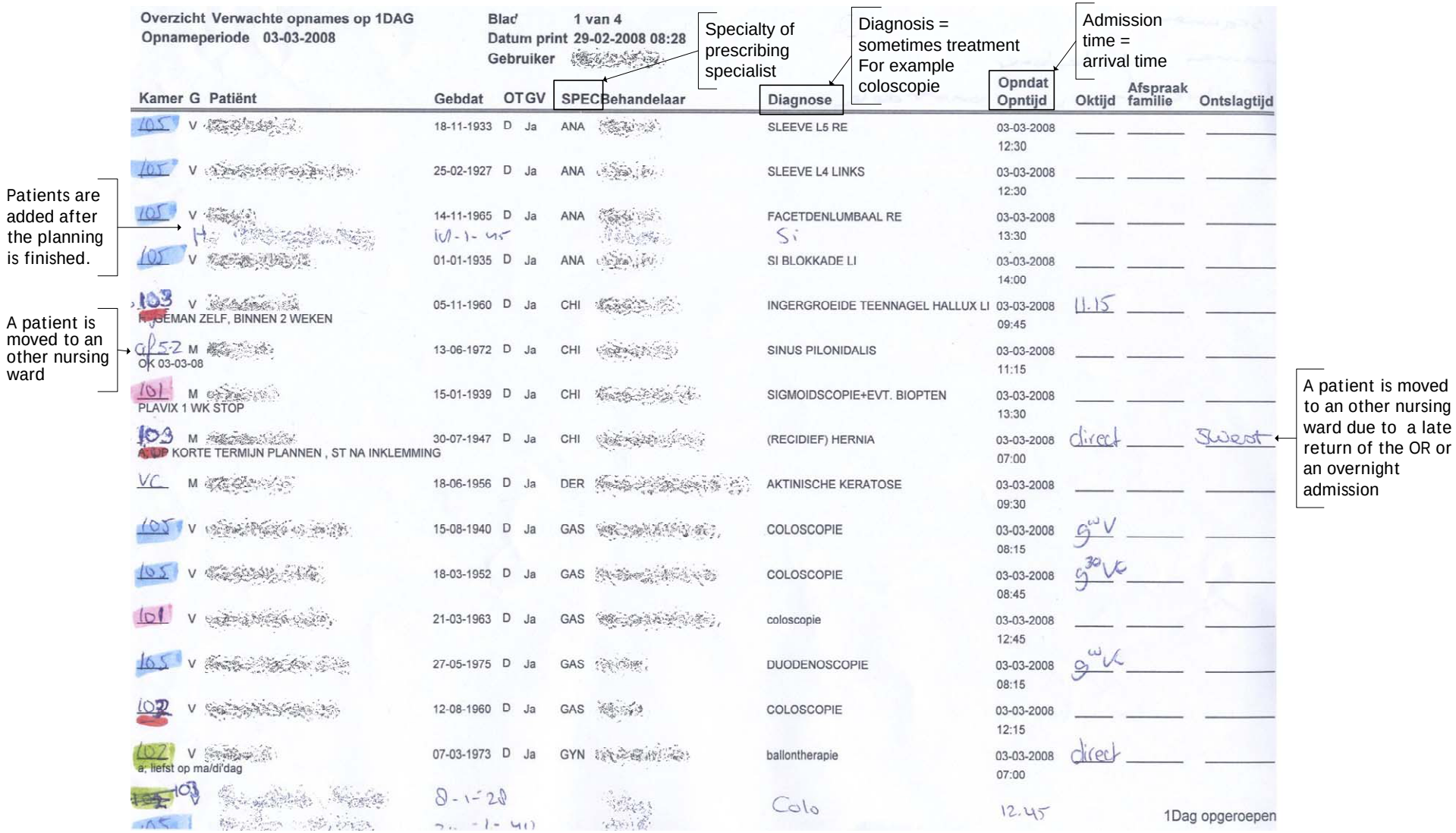
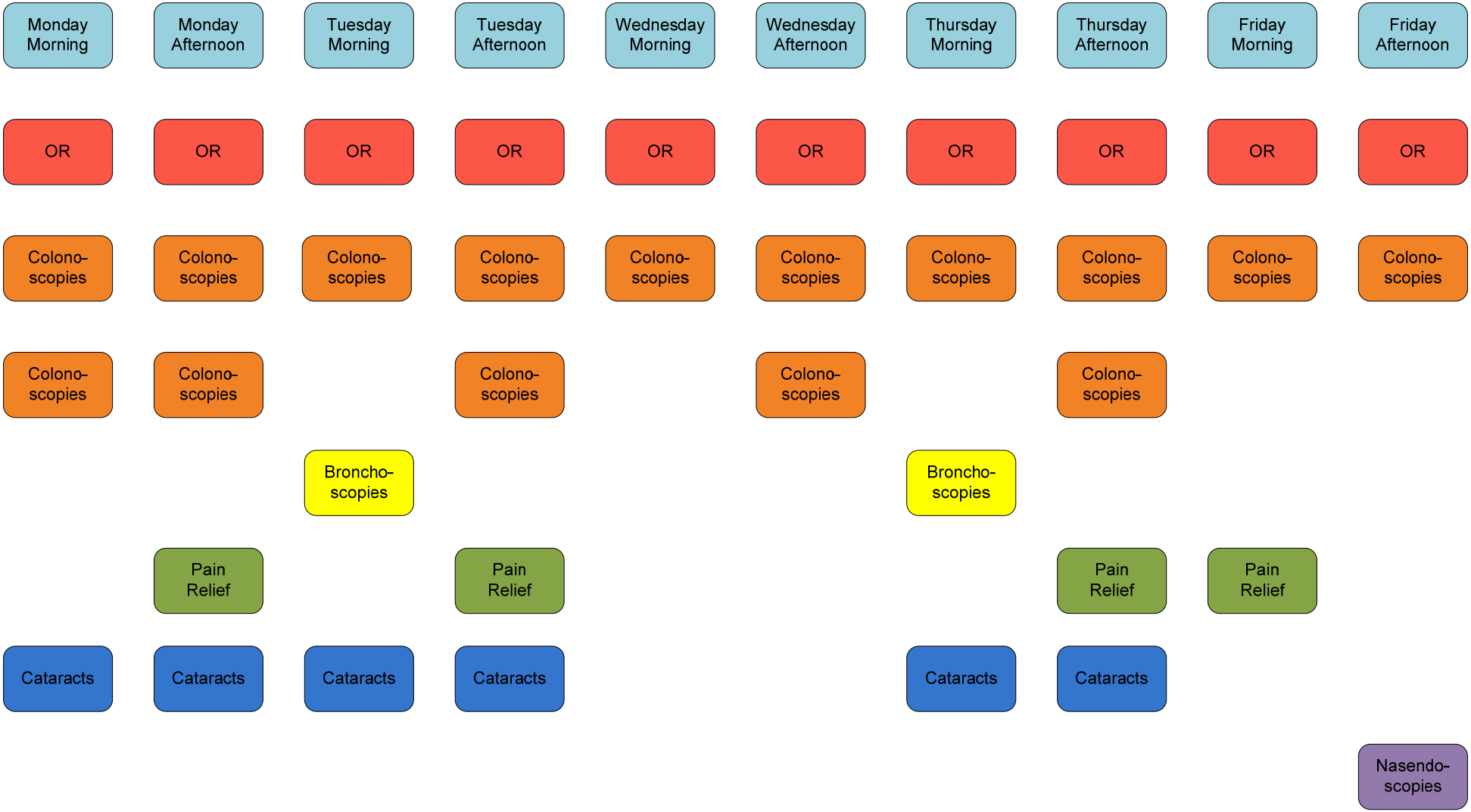
Appendices

Appendix A: Schedule of the ASW

This figure gives an example of how the scheduling on the ASW is done and how its filled in.



Appendix B: Schedule of the OR and the OPC in 2008



Appendix C: The original results

This appendix shows the original settings with the original results in the capacity analysis tool.

The original Control Room settings

Capacity of the ambulatory surgery ward:			
Monday	25		
Tuesday	25		
Wednesday	25		
Thursday	25		
Friday	25		

	Opening time	**Closing time**	
Opening hours ASW	7	18	
Lengths of stay			
Full name	**Abbreviation**	**LOS**	
Gynaecologie	GYN	11	hours
Keel-, neus en oor	KNO	11	hours
Plastische chirurgie	PLA	11	hours
Urologie	URO	11	hours
Kaakchirurgie	MON	11	hours
Orthopedie	ORT	11	hours
Algemene Chirurgie	CHI	11	hours
Bronchoscopieen	Bronchos	2	hours
Cataracten	Catn	2	hours
Coloscopieen	Colos	4	hours
Snurkoscopieen	Snurkos	1	hours
Pijnbestrijding	Pijnb	1	hours
Interne Geneeskunde	Interne	11	hours

The OR schedule

	Monday		Tuesday		Wednesday		Thursday		Friday	
	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime
CHI	8:00	15:30	8:00	15:30	8:00	15:30	8:00	15:30	8:00	15:30
CHI	8:00	15:30	8:00	15:30	8:00	15:30	8:00	15:30	8:00	15:30
GYN	7:45	15:30	13:00	15:30			7:45	15:30	7:45	15:30
MON			8:00	15:30						
KNO	7:45	15:30			7:45	15:30			7:45	12:30
ORT	7:45	15:30	7:45	15:30	7:45	15:30	7:45	15:30	7:45	15:30
ORT	7:45	15:30	7:45	15:30	7:45	15:30	7:45	15:30	7:45	15:30
PLA	8:00	15:30	7:45	15:30	8:00	15:30				
URO	7:45	15:30	7:45	15:30	7:45	15:30	7:45	15:30	8:00	15:30
URO	8:00	15:30								

The OPC schedule

	Monday				Tuesday				Wednesday				Thursday				Friday			
	morning		*afternoon*		*morning*		*afternoon*		*morning*		*afternoon*		*morning*		*afternoon*		*morning*		*afternoon*	
	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime	Starttime	Endtime
Colos	8:15	12:30	13:00	16:15	8:15	12:30	13:00	16:15	8:15	12:30	13:00	16:15	8:15	12:30	13:00	16:15	8:15	12:30	13:00	16:15
Colos	8:15	12:30	13:00	16:15			13:00	16:15			13:00	16:15			13:00	16:15				
Bronchos					8:15	12:30							8:15	12:30						
Catn	8:00	12:30	13:00	16:15	8:00	12:30	13:00	16:15					8:00	12:30	13:00	16:15				
Pijnb			13:00	16:15			13:00	16:15							13:00	16:15	8:15	12:30		
Snurkos																			13:00	16:15

The table with total number of beds per hour per day

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	10,0	10,9	10,4
9	16,9	24,8	14,8	16,8	15,1
10	16,6	27,6	17,4	18,0	18,0
11	18,4	28,1	19,2	18,1	20,6
12	24,0	33,1	22,3	22,2	24,2
13	27,6	35,8	23,7	25,0	25,7
14	28,4	33,8	23,2	24,4	24,6
15	24,9	29,3	23,4	21,9	23,8
16	21,4	27,0	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 8: Sum of the number of beds per hour per day

The measures of improvement

Number of beds on ASW		Maximal difference
Monday	25	3,4
Tuesday	25	10,8
Wednesday	25	-1,3
Thursday	25	0,0
Friday	25	0,7

Measures of improvement	
Average	2,7
Standard deviation	4,8
Coefficient of variation	1,8

The graphs

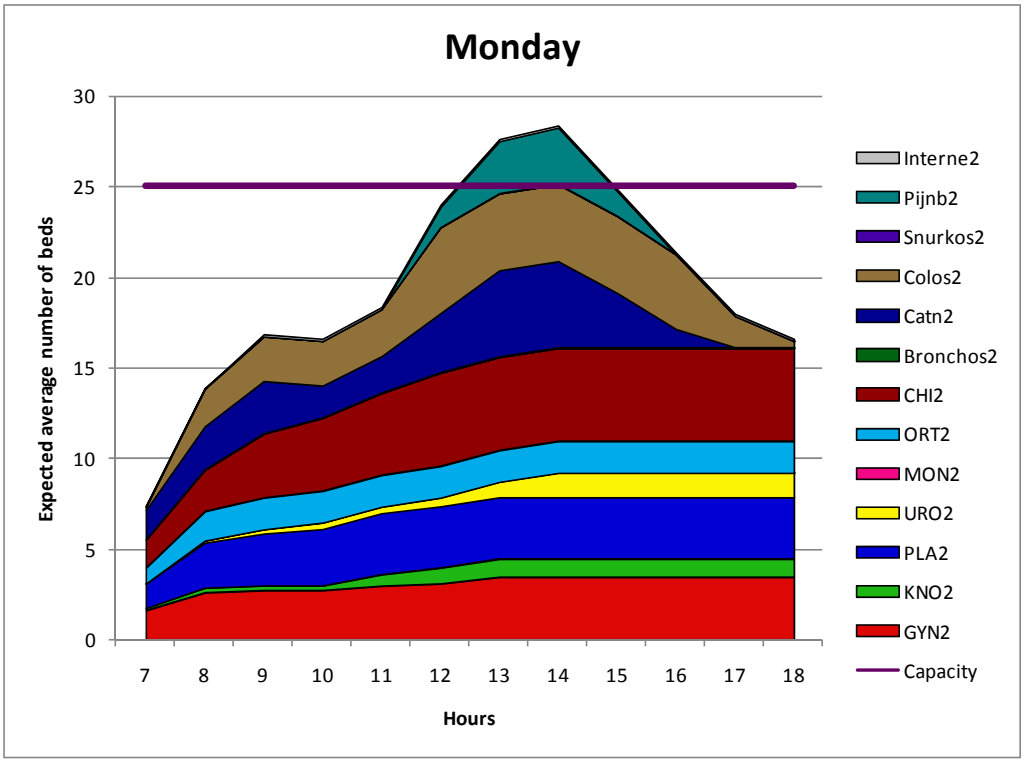


Figure 22: Projection of the expected number of beds on Monday

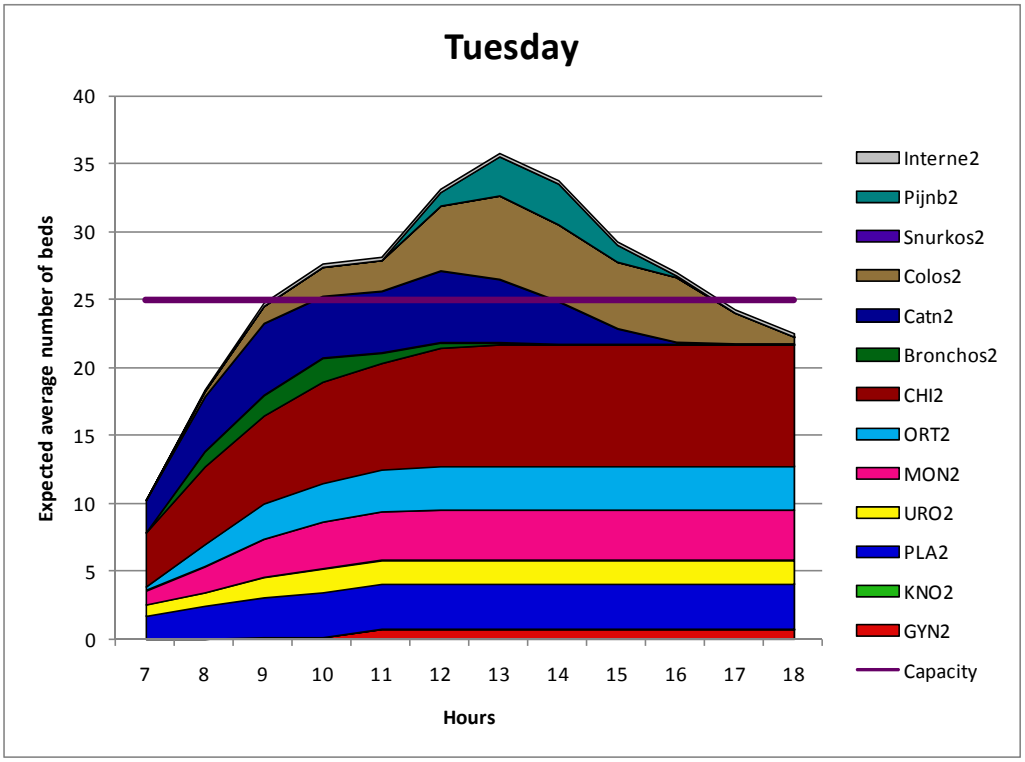


Figure 23: Projection of the expected number of beds on Tuesday

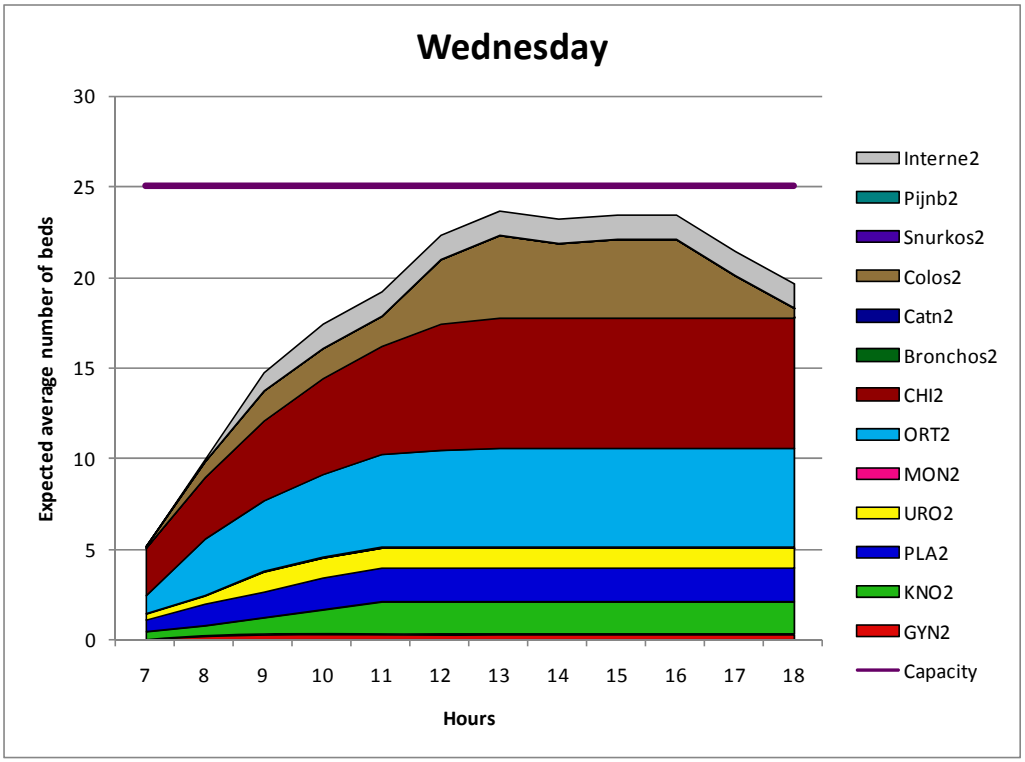


Figure 24: Projection of the expected number of beds on Wednesday

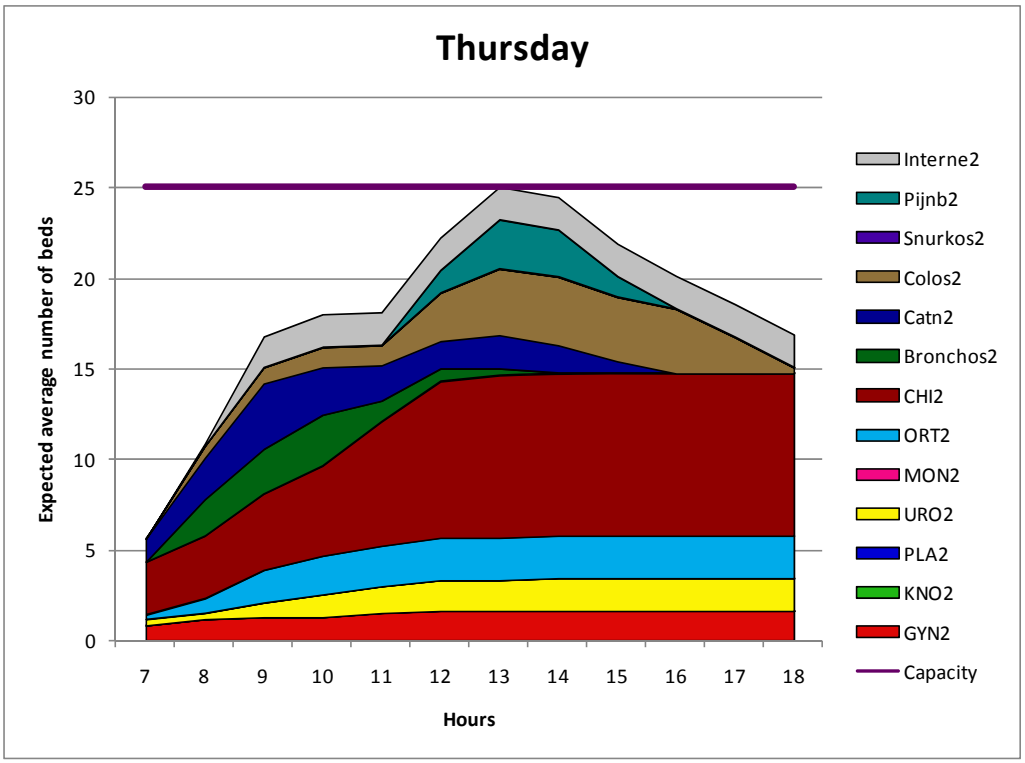


Figure 25: Projection of the expected number of beds on Thursday

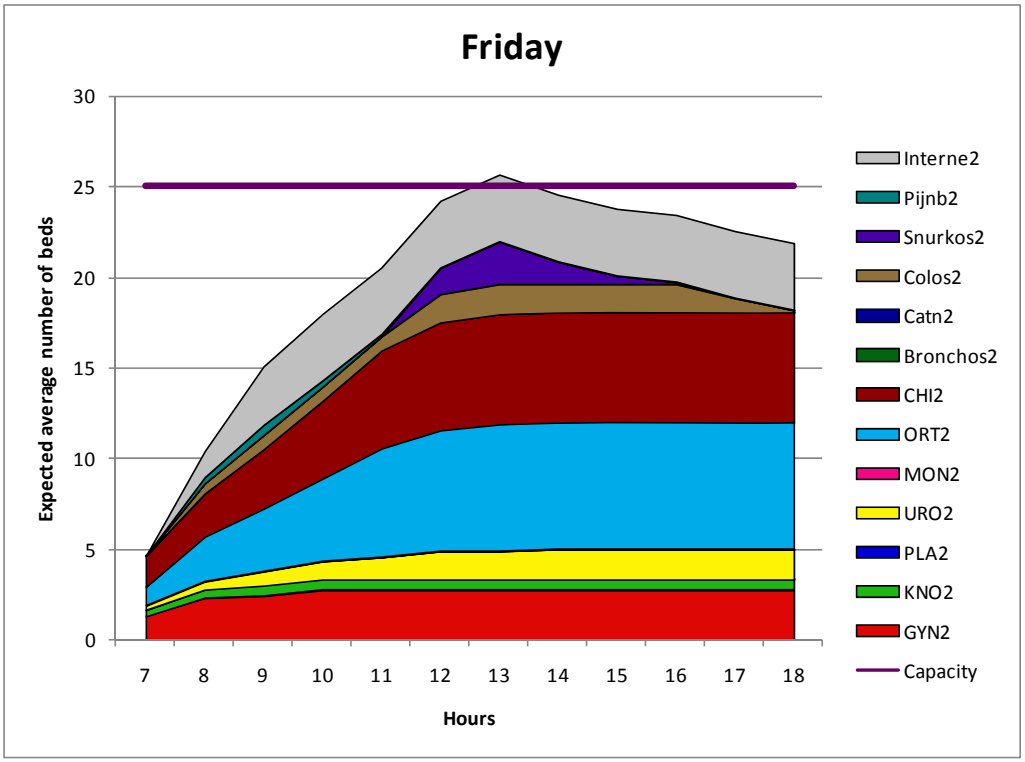


Figure 26: Projection of the expected number of beds on Friday

Appendix D: Results scenarios regarding moves in the OR schedule

This appendix shows the results of all the scenarios mentioned in § 5.1.1. Each result of a scenario will be shown with a table of the total number of beds per hour, a graph of the day were the program has been moved away from and a graph of the day the program has been moved to. Each graph will also show the original situation via a dotted line.

Scenario 1: Dental surgery from Tuesday to Wednesday

Comments: Figure 27 clearly shows that there is less pressure on Tuesday. Capacity is reached on four hours of the day instead of seven hours in the original graph. Because of the move, the Wednesday graph (Figure 28) has moved over capacity.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	9,3	6,2	5,7	4,7
8	13,9	16,5	11,9	10,9	10,4
9	16,9	22,0	17,5	16,8	15,1
10	16,6	24,3	20,8	18,0	18,0
11	18,4	24,6	22,7	18,1	20,6
12	24,0	29,5	26,0	22,2	24,2
13	27,6	32,1	27,3	25,0	25,7
14	28,4	30,1	26,8	24,4	24,6
15	24,9	25,6	27,1	21,9	23,8
16	21,4	23,4	27,1	20,1	23,4
17	18,0	20,6	25,1	18,6	22,6
18	16,6	18,9	23,3	16,9	21,9

Table 9: Sum of the number of beds per hour per day resulting from a move of Dental surgery from Tuesday to Wednesday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,1	**Average**	2,7
Wednesday	25	2,3	**Standard deviation**	2,8
Thursday	25	0,0	**Coefficient of variation**	1,0
Friday	25	0,7		

Table 10: The maximum difference with capacity per day and measures of improvement for scenario 1

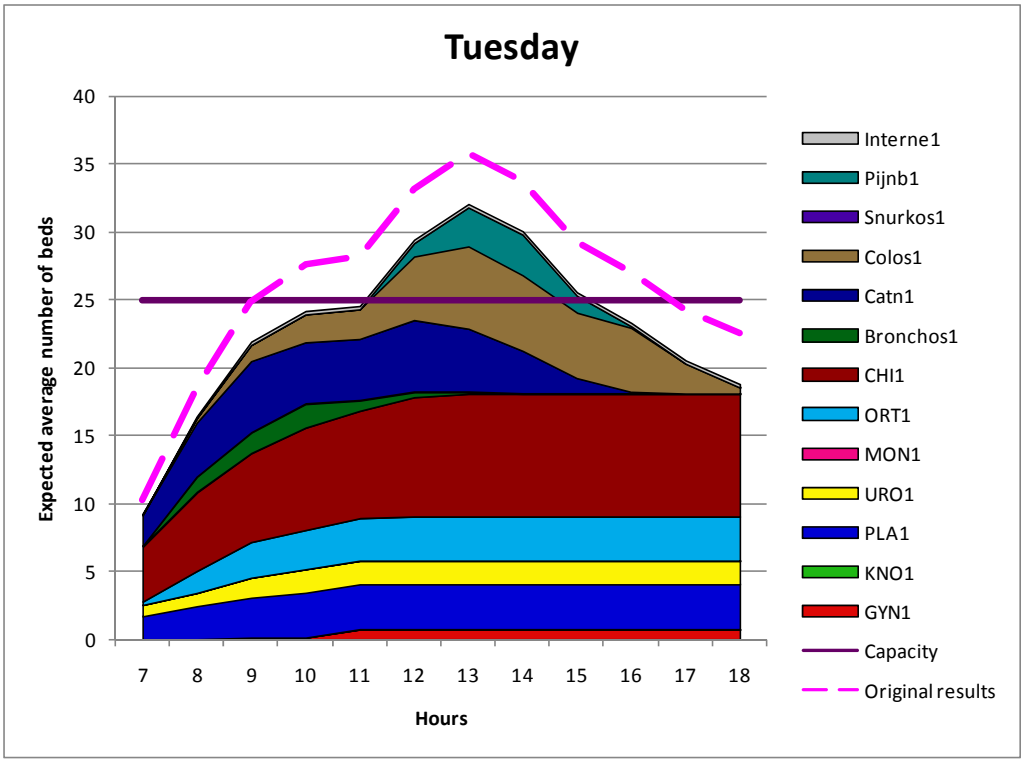


Figure 27: Projection of the expected number of beds on Tuesday resulting from scenario 1

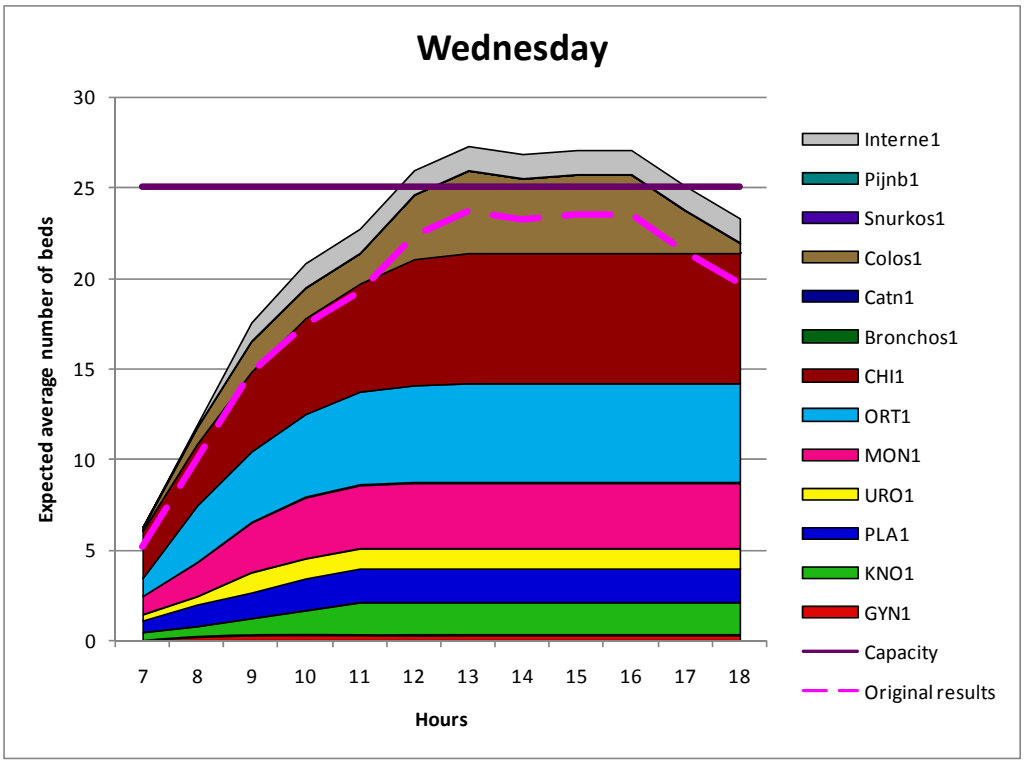


Figure 28: Projection of the number of beds on Wednesday resulting from scenario 1

Scenario 2: Dental surgery from Tuesday to Thursday

Comments: This move shows the graph on Thursday (Figure 30) exceeding capacity on four hours but as with scenario 1, exceeding capacity on Tuesday has reduced by three hours. However, there are two hours less that exceed capacity on Tuesday (see Table 11). But coefficient of variation (CoV) has been reduced by 0,6 compared to the original results.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	9,3	5,2	6,7	4,7
8	13,9	16,5	10,0	12,8	10,4
9	16,9	22,0	14,8	19,5	15,1
10	16,6	24,3	17,4	21,4	18,0
11	18,4	24,6	19,2	21,6	20,6
12	24,0	29,5	22,3	25,8	24,2
13	27,6	32,1	23,7	28,6	25,7
14	28,4	30,1	23,2	28,1	24,6
15	24,9	25,6	23,4	25,5	23,8
16	21,4	23,4	23,4	23,7	23,4
17	18,0	20,6	21,4	22,2	22,6
18	16,6	18,9	19,7	20,5	21,9

Table 11: Sum of the number of beds per hour per day resulting from a move of Dental surgery from Tuesday to Thursday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,1	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	3,2
Thursday	25	3,6	**Coefficient of variation**	1,2
Friday	25	0,7		

Table 12: The maximum difference with capacity per day and measures of improvement for scenario 2

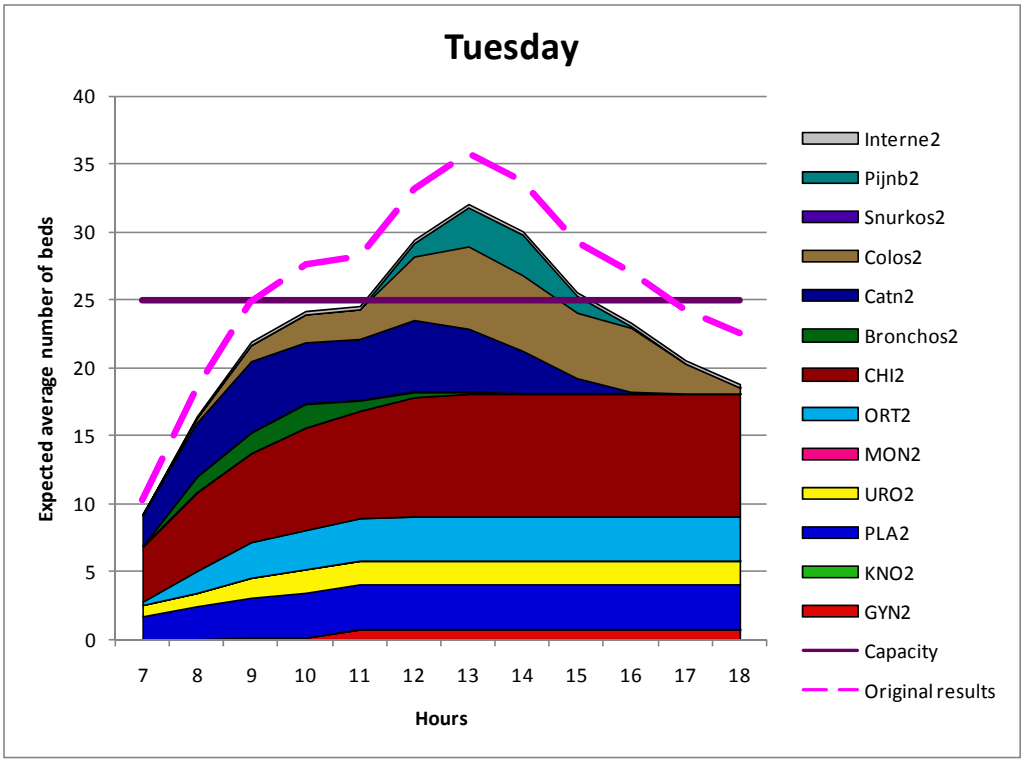


Figure 29: Projection of the expected number of beds on Tuesday resulting from scenario 2

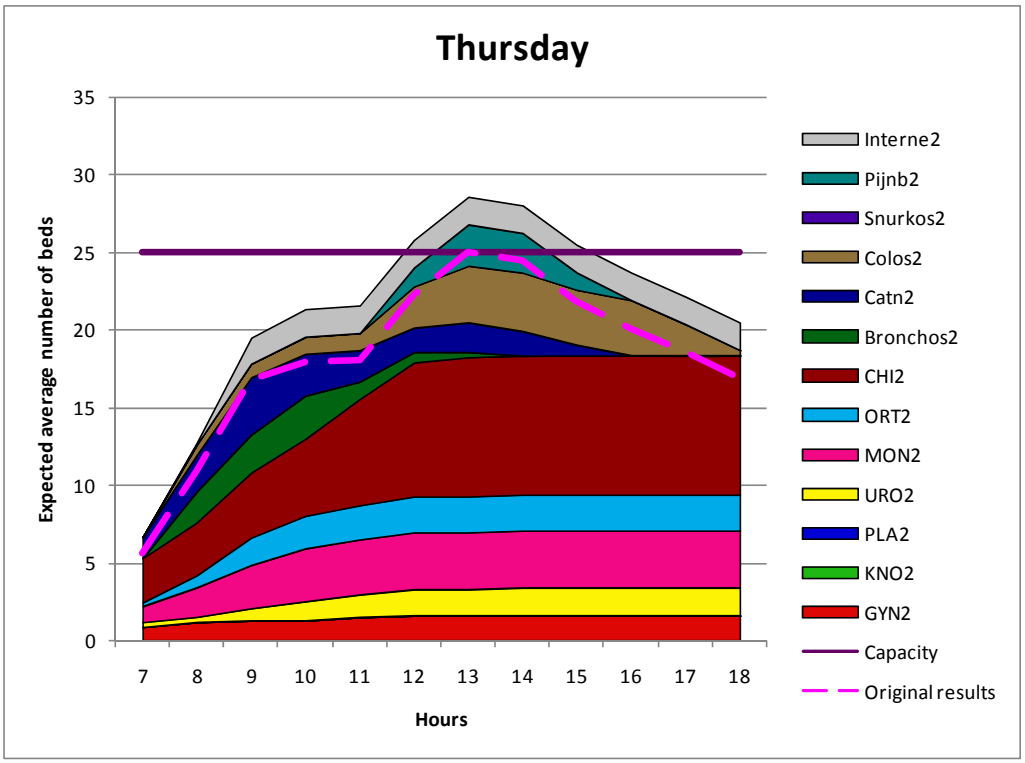


Figure 30: Projection of the expected number of beds on Thursday resulting from scenario 2

Scenario 3: Dental surgery from Tuesday to Friday

Comments: Also Friday shows a graph exceeding capacity (Figure 32), however this one is bigger than the one on Thursday (Figure 30). On Tuesday the same effect can be seen as in the move to Thursday.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	9,3	5,2	5,7	5,7
8	13,9	16,5	10,0	10,9	12,3
9	16,9	22,0	14,8	16,8	17,9
10	16,6	24,3	17,4	18,0	21,4
11	18,4	24,6	19,2	18,1	24,1
12	24,0	29,5	22,3	22,2	27,8
13	27,6	32,1	23,7	25,0	29,3
14	28,4	30,1	23,2	24,4	28,2
15	24,9	25,6	23,4	21,9	27,4
16	21,4	23,4	23,4	20,1	27,1
17	18,0	20,6	21,4	18,6	26,2
18	16,6	18,9	19,7	16,9	25,5

Table 13: Sum of the number of beds per hour per day resulting from a move of Dental surgery from Tuesday to Friday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,1	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	3,4
Thursday	25	0,0	**Coefficient of variation**	1,3
Friday	25	4,3		

Table 14: The maximum difference with capacity per day and measures of improvement for scenario 3

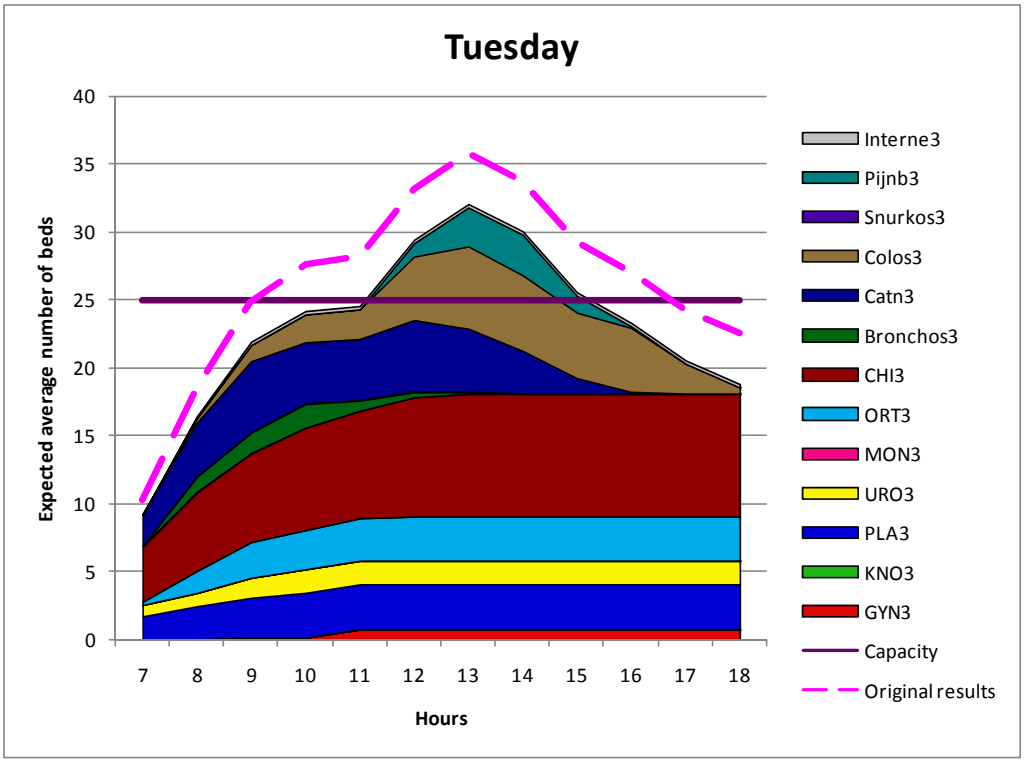


Figure 31: Projection of the expected number of beds on Tuesday resulting from scenario 3

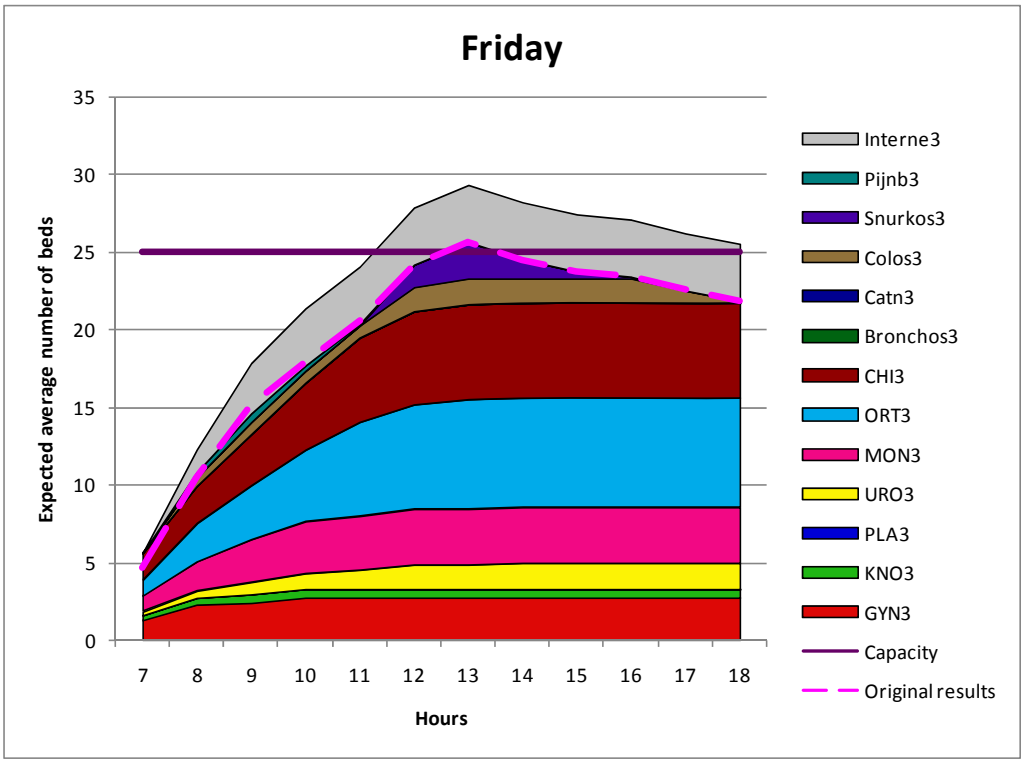


Figure 32: Projection of the expected number of beds on Friday resulting from scenario 3

Scenario 4: Ear, nose, throat surgery from Monday to Thursday

Comments: Since ENT is only a small program, moving the program does not have a big effect on reducing the pressure on Monday (Figure 33 and Table 15). On Thursday (Figure 34) the graph has increased capacity only by a small increment (1,0 maximum).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,3	10,3	5,2	5,8	4,7
8	13,6	18,4	10,0	11,1	10,4
9	16,6	24,8	14,8	17,0	15,1
10	16,4	27,6	17,4	18,3	18,0
11	17,8	28,1	19,2	18,7	20,6
12	23,1	33,1	22,3	23,1	24,2
13	26,6	35,8	23,7	26,0	25,7
14	27,4	33,8	23,2	25,4	24,6
15	23,9	29,3	23,4	22,9	23,8
16	20,4	27,0	23,4	21,1	23,4
17	17,0	24,3	21,4	19,6	22,6
18	15,6	22,5	19,7	17,9	21,9

Table 15: Sum of the number of beds per hour per day resulting from a move of Ear, Nose and Throat from Monday to Thursday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	2,4		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	4,7
Thursday	25	1,0	**Coefficient of variation**	1,7
Friday	25	0,7		

Table 16: The maximum difference with capacity per day and measures of improvement for scenario 4

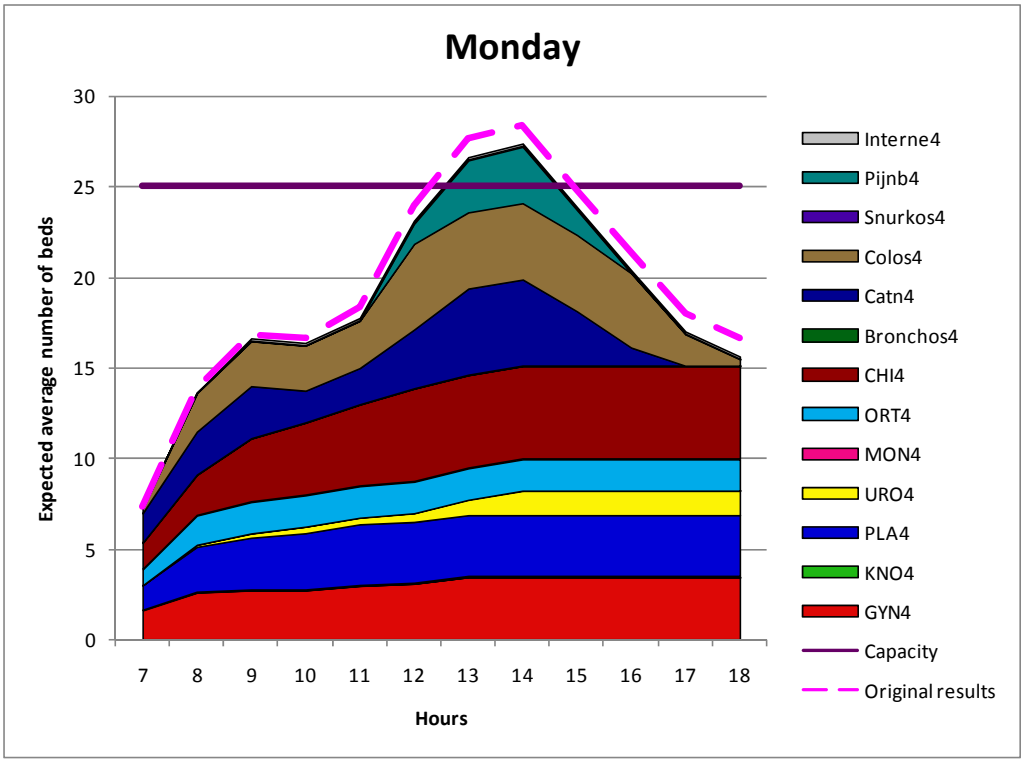


Figure 33: Projection of the expected number of beds on Monday resulting from scenario 4

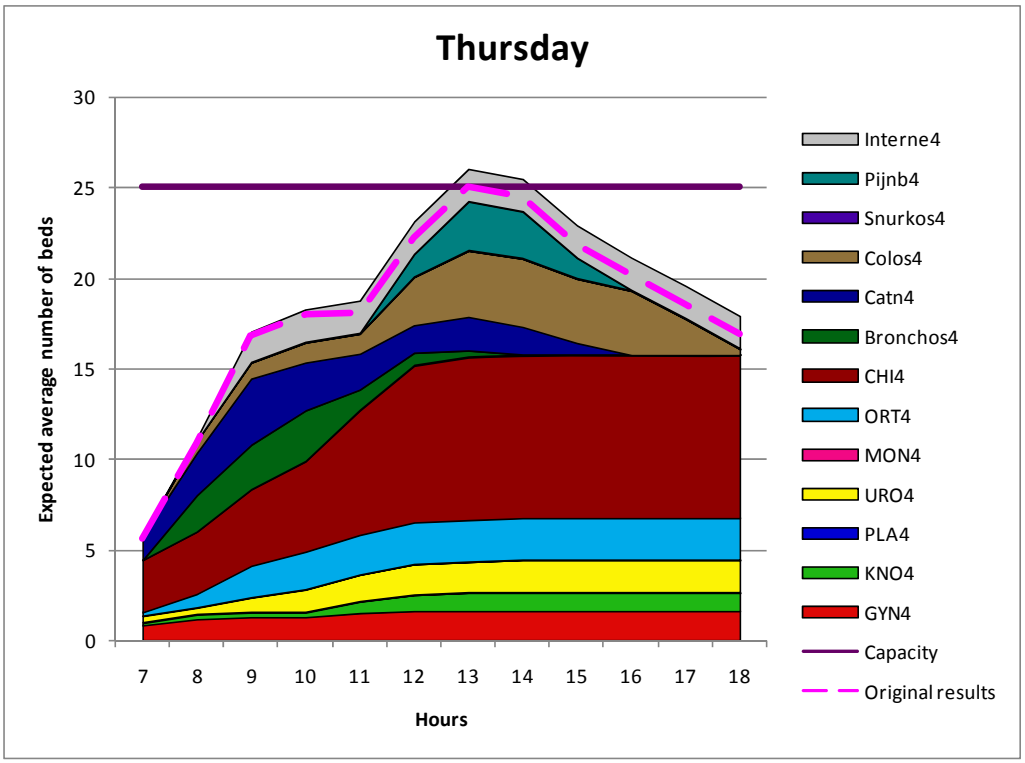


Figure 34: Projection of the expected number of beds on Thursday resulting from scenario 4

Scenario 5: Plastic surgery from Monday to Thursday

Comments: This move results in Figure 36 in a graph that has exceeded capacity and Figure 35 shows that that graph is just under capacity.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	6,0	10,3	5,2	7,0	4,7
8	11,4	18,4	10,0	13,4	10,4
9	14,0	24,8	14,8	19,7	15,1
10	13,5	27,6	17,4	21,1	18,0
11	15,0	28,1	19,2	21,5	20,6
12	20,6	33,1	22,3	25,6	24,2
13	24,3	35,8	23,7	28,4	25,7
14	25,0	33,8	23,2	27,8	24,6
15	21,5	29,3	23,4	25,3	23,8
16	18,0	27,0	23,4	23,5	23,4
17	14,6	24,3	21,4	21,9	22,6
18	13,3	22,5	19,7	20,3	21,9

Table 17: Sum of the number of beds per hour per day resulting from a move of Plastic surgery from Monday to Thursday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,0		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	3,4	**Coefficient of variation**	1,8
Friday	25	0,7		

Table 18: The maximum difference with capacity per day and measures of improvement for scenario 5

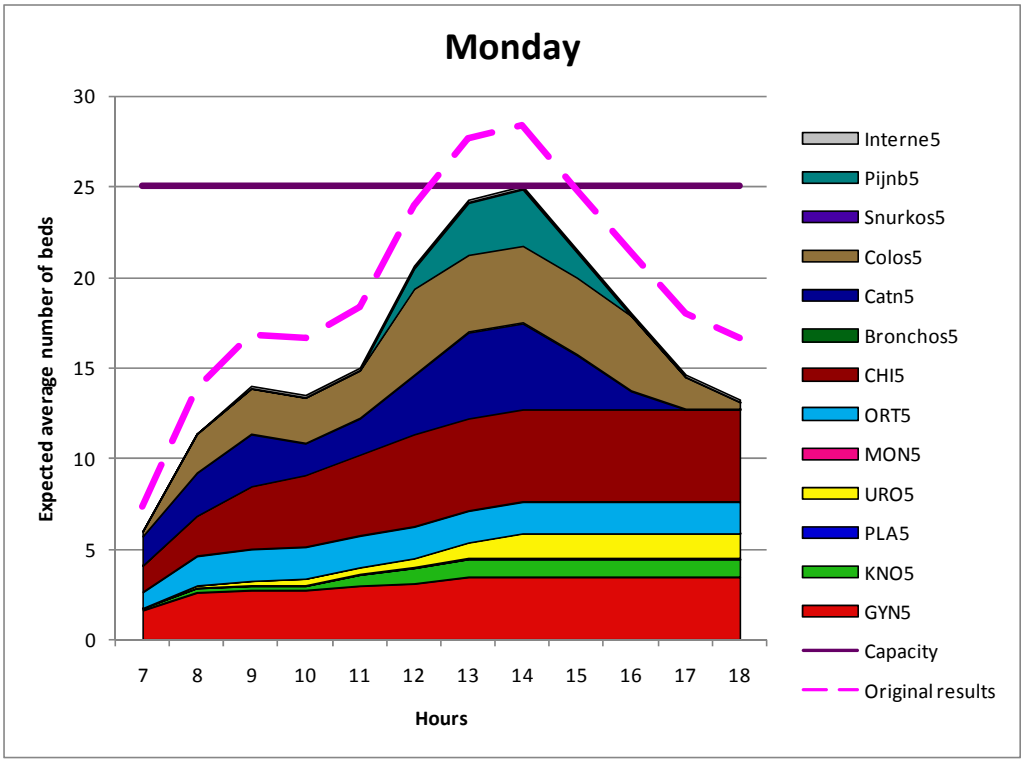


Figure 35: Projection of the expected number of beds on Monday resulting from scenario 5

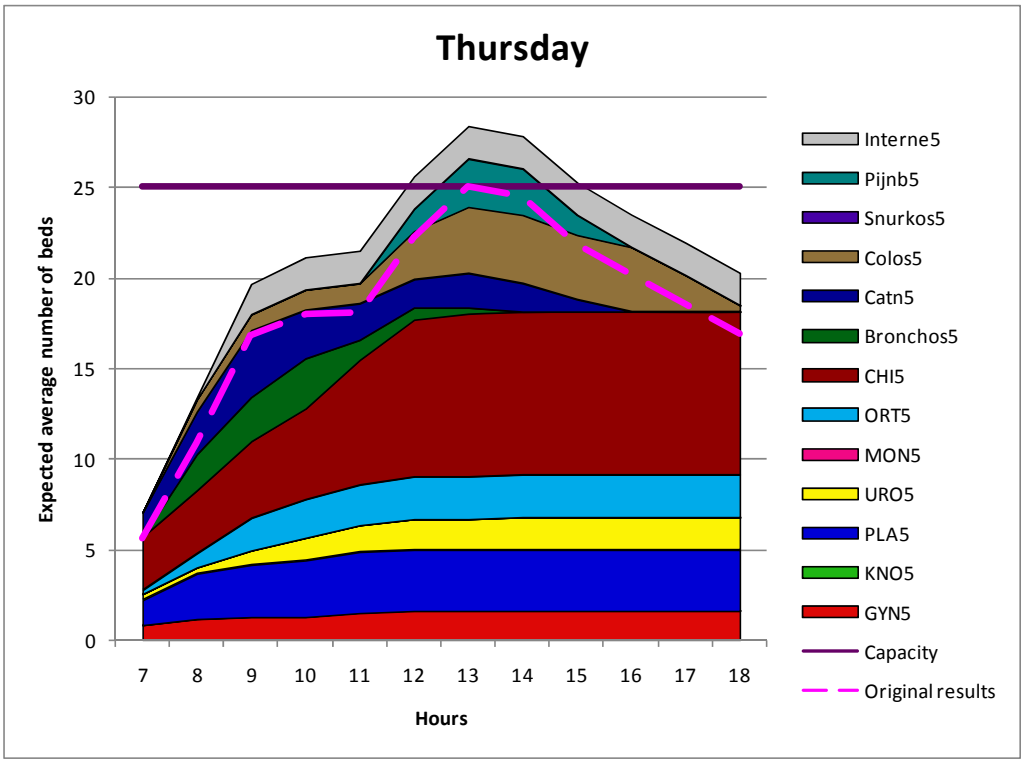


Figure 36: Projection of the expected number of beds on Thursday resulting from scenario 5

Scenario 6: Plastic surgery from Monday to Friday

Comments: Just as with the move from Monday to Thursday, Monday is neatly just under capacity (see Figure 37), however the move to Friday does result in an increase that pushes the graph even more over capacity (Figure 38 and Table 19).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	6,0	10,3	5,2	5,7	6,0
8	11,4	18,4	10,0	10,9	12,9
9	14,0	24,8	14,8	16,8	18,0
10	13,5	27,6	17,4	18,0	21,1
11	15,0	28,1	19,2	18,1	23,9
12	20,6	33,1	22,3	22,2	27,6
13	24,3	35,8	23,7	25,0	29,0
14	25,0	33,8	23,2	24,4	27,9
15	21,5	29,3	23,4	21,9	27,2
16	18,0	27,0	23,4	20,1	26,8
17	14,6	24,3	21,4	18,6	25,9
18	13,3	22,5	19,7	16,9	25,3

Table 19: Sum of the number of beds per hour per day resulting from a move of Plastic surgery from Monday to Friday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,0		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	4,9
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	4,0		

Table 20: The maximum difference with capacity per day and measures of improvement for scenario 6

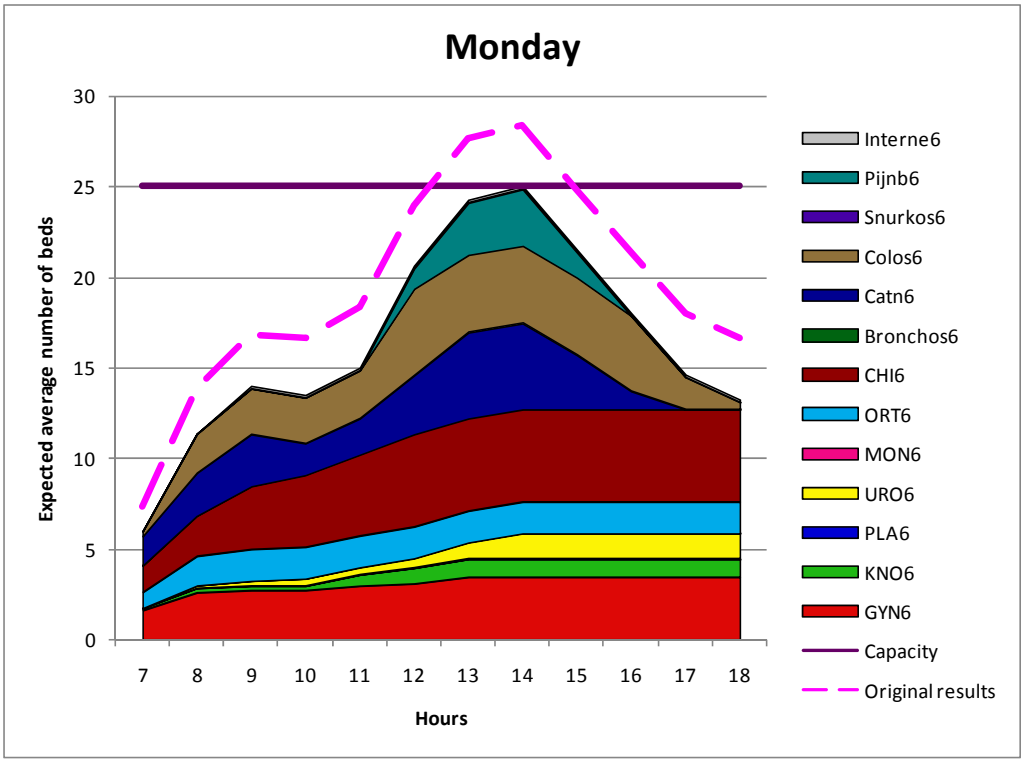


Figure 37: Projection of the expected number of beds on Monday resulting from scenario 6

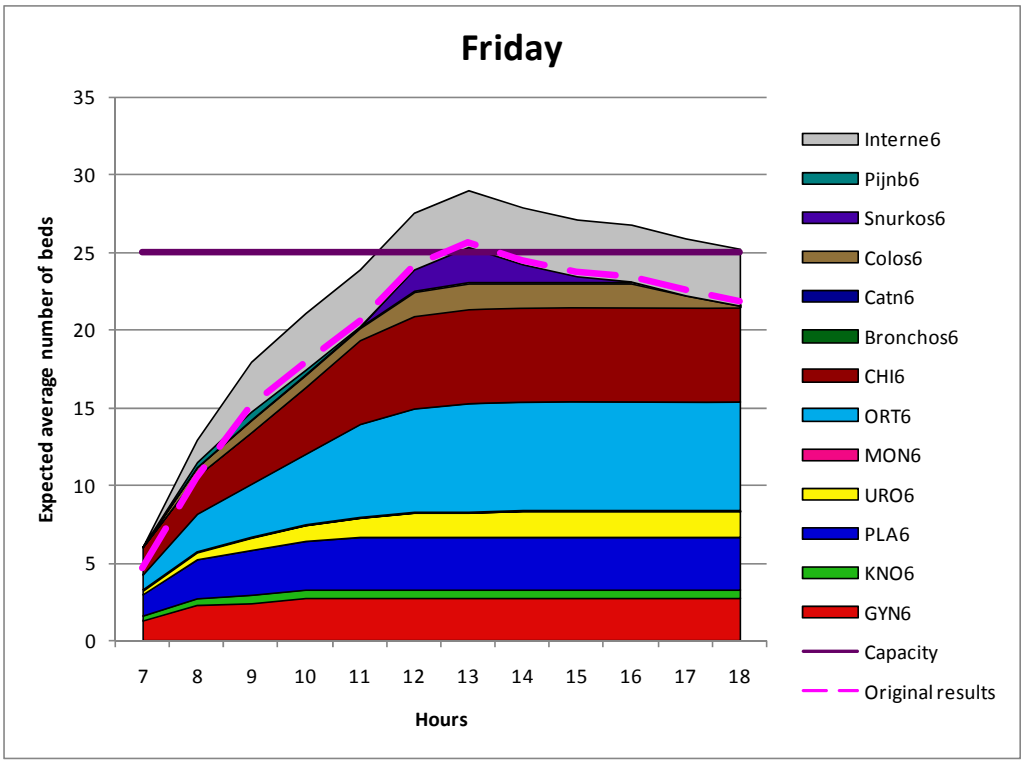


Figure 38: Projection of the expected number of beds on Friday resulting from scenario 6

Scenario 7: Plastic surgery from Tuesday to Thursday

Comments: This move has resulted in fewer patients on Tuesday but has not eliminated exceeding capacity on this day (see Figure 39). Figure 40 shows that the graph has exceeded capacity.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	8,5	5,2	7,4	4,7
8	13,9	15,9	10,0	13,4	10,4
9	16,9	21,8	14,8	19,8	15,1
10	16,6	24,3	17,4	21,4	18,0
11	18,4	24,8	19,2	21,5	20,6
12	24,0	29,8	22,3	25,6	24,2
13	27,6	32,4	23,7	28,4	25,7
14	28,4	30,4	23,2	27,8	24,6
15	24,9	25,9	23,4	25,3	23,8
16	21,4	23,6	23,4	23,5	23,4
17	18,0	20,9	21,4	21,9	22,6
18	16,6	19,1	19,7	20,3	21,9

Table 21: Sum of the number of beds per hour per day resulting from a move of Plastic surgery from Tuesday to Thursday

Number of beds on ASW		Maximal difference
Monday	25	3,4
Tuesday	25	7,4
Wednesday	25	-1,3
Thursday	25	3,4
Friday	25	0,7

Measures of improvement	
Average	2,7
Standard deviation	3,3
Coefficient of variation	1,2

Table 22: The maximum difference with capacity per day and measures of improvement for scenario 7

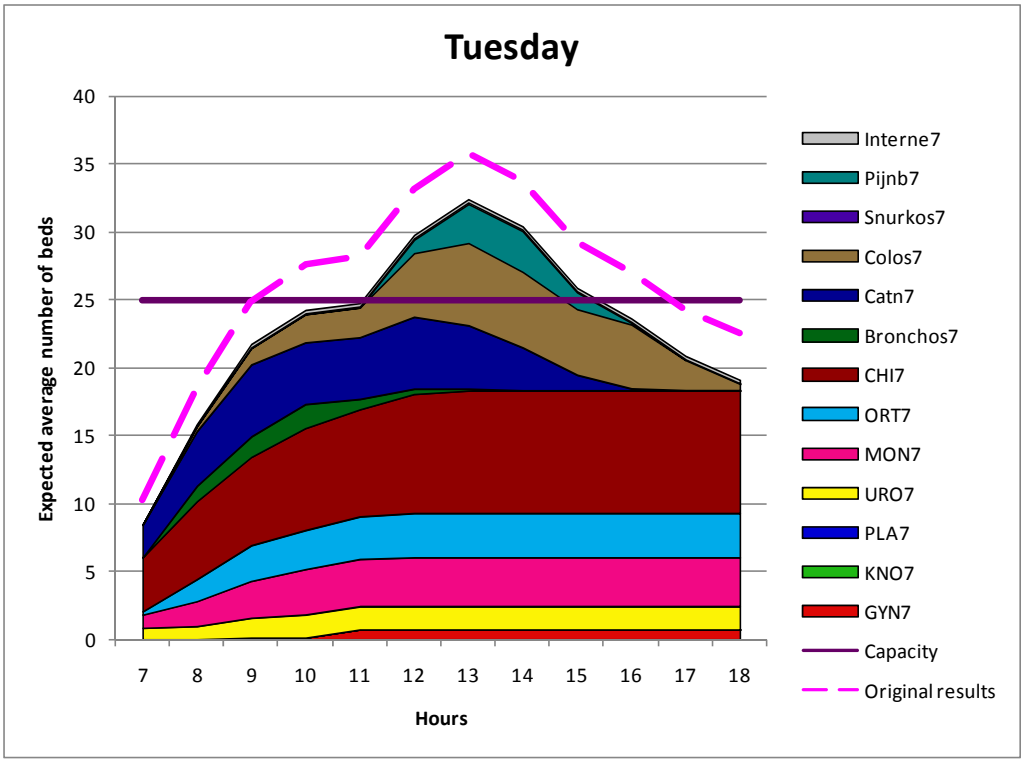


Figure 39: Projection of the expected number of beds on Tuesday resulting from scenario 7

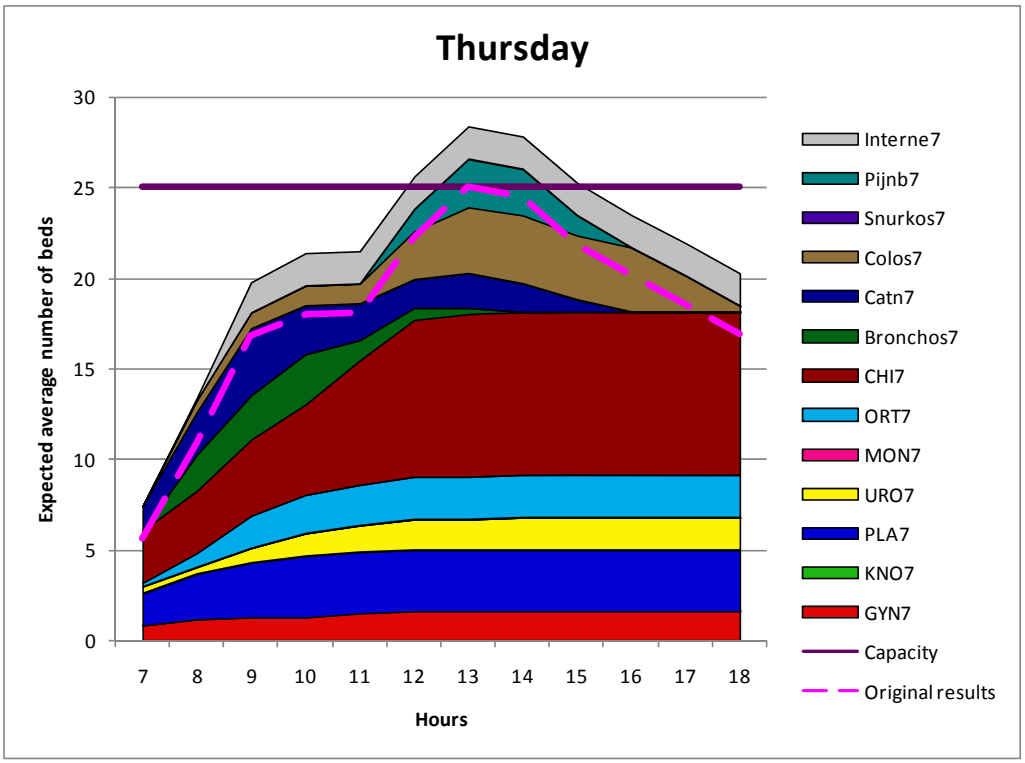


Figure 40: Projection of the expected number of beds on Thursday resulting from scenario 7

Scenario 8: Plastic surgery from Tuesday to Friday

Comments: this move has the same effect on the graph on Tuesday (Figure 41) as can be seen in (Figure 39). However on Friday the graph (Figure 42) goes more over capacity.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	8,5	5,2	5,7	6,4
8	13,9	15,9	10,0	10,9	12,9
9	16,9	21,8	14,8	16,8	18,1
10	16,6	24,3	17,4	18,0	21,4
11	18,4	24,8	19,2	18,1	23,9
12	24,0	29,8	22,3	22,2	27,6
13	27,6	32,4	23,7	25,0	29,0
14	28,4	30,4	23,2	24,4	27,9
15	24,9	25,9	23,4	21,9	27,2
16	21,4	23,6	23,4	20,1	26,8
17	18,0	20,9	21,4	18,6	25,9
18	16,6	19,1	19,7	16,9	25,3

Table 23: Sum of the number of beds per hour per day resulting from a move of Plastic surgery from Tuesday to Friday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,4	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	3,5
Thursday	25	0,0	**Coefficient of variation**	1,3
Friday	25	4,0		

Table 24: The maximum difference with capacity per day and measures of improvement for scenario 8

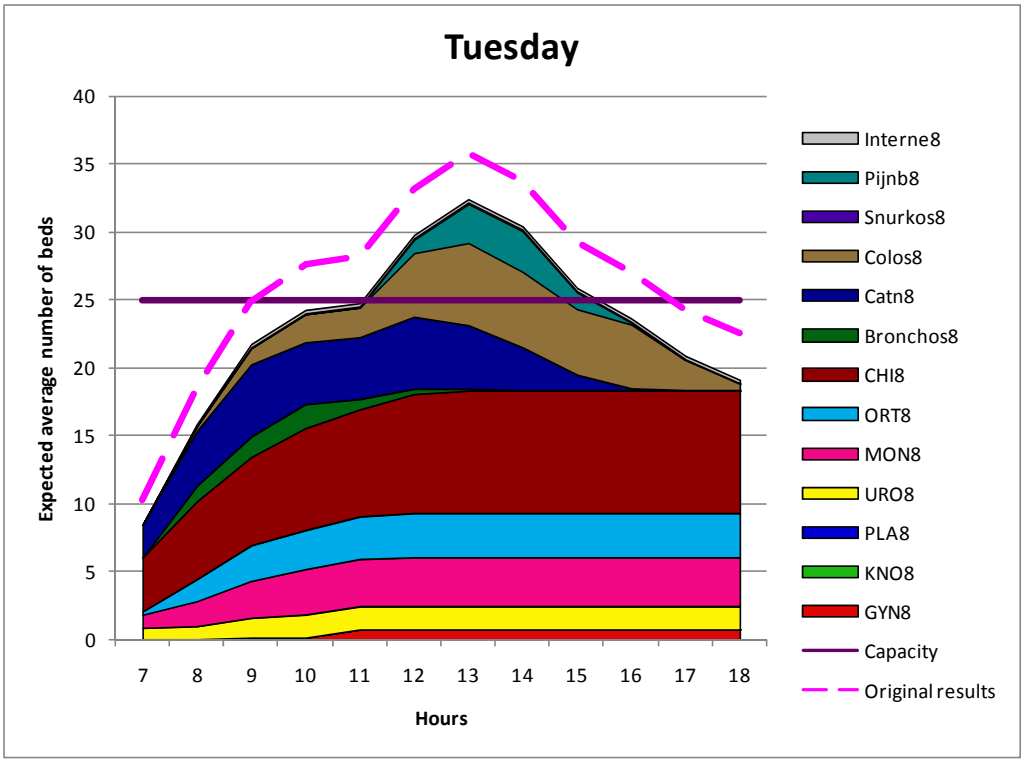


Figure 41: Projection of the expected number of beds on Tuesday resulting from scenario 8

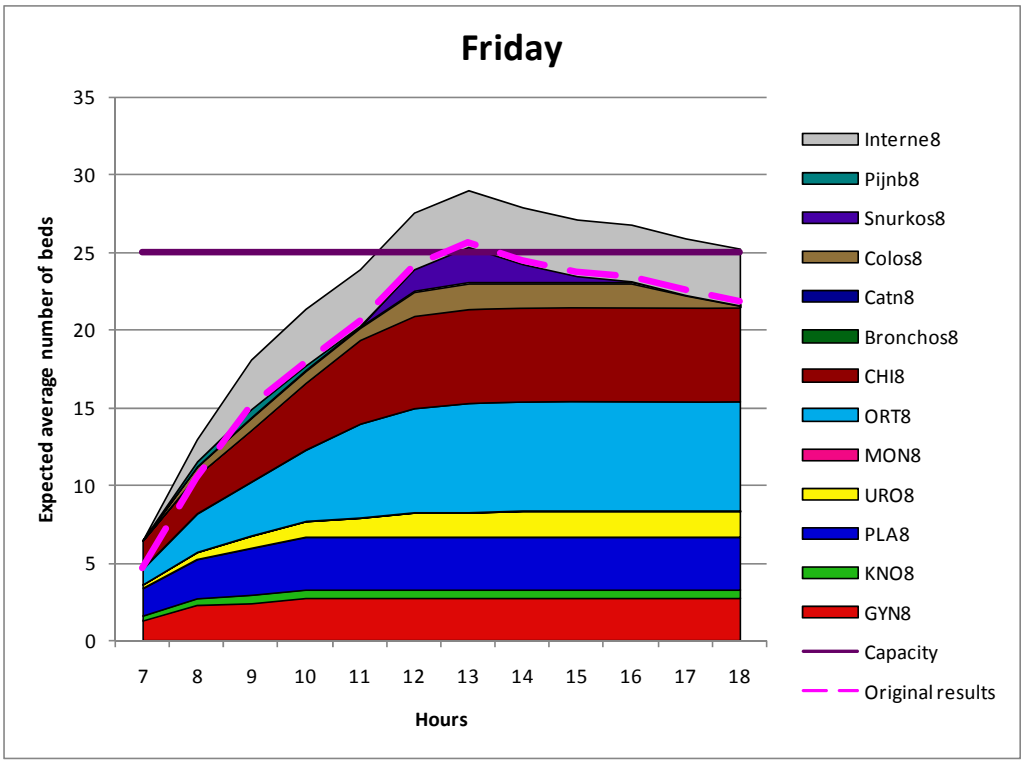


Figure 42: Projection of the expected number of beds on Friday resulting from scenario 8

Scenario 9: Urology from Monday to Wednesday

Comments: The move of one Urology program away from Monday does not seem to have the same effect as the Plastic surgery program has on reducing the expected number of beds. The maximum difference between the maximum for Monday and the maximum in the original results is only 0,7. On Wednesday the difference has been reduced by only 0,4.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,8	18,4	10,1	10,9	10,4
9	16,8	24,8	14,9	16,8	15,1
10	16,4	27,6	17,6	18,0	18,0
11	18,2	28,1	19,4	18,1	20,6
12	23,8	33,1	22,6	22,2	24,2
13	27,2	35,8	24,1	25,0	25,7
14	27,7	33,8	23,9	24,4	24,6
15	24,2	29,3	24,1	21,9	23,8
16	20,7	27,0	24,1	20,1	23,4
17	17,3	24,3	22,1	18,6	22,6
18	15,9	22,5	20,4	16,9	21,9

Table 25: Sum of the number of beds per hour per day resulting from a move of Urology from Monday to Wednesday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	2,7		
Tuesday	25	10,8	**Average**	2,6
Wednesday	25	-0,9	**Standard deviation**	4,7
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	0,7		

Table 26: The maximum difference with capacity per day and measures of improvement for scenario 9

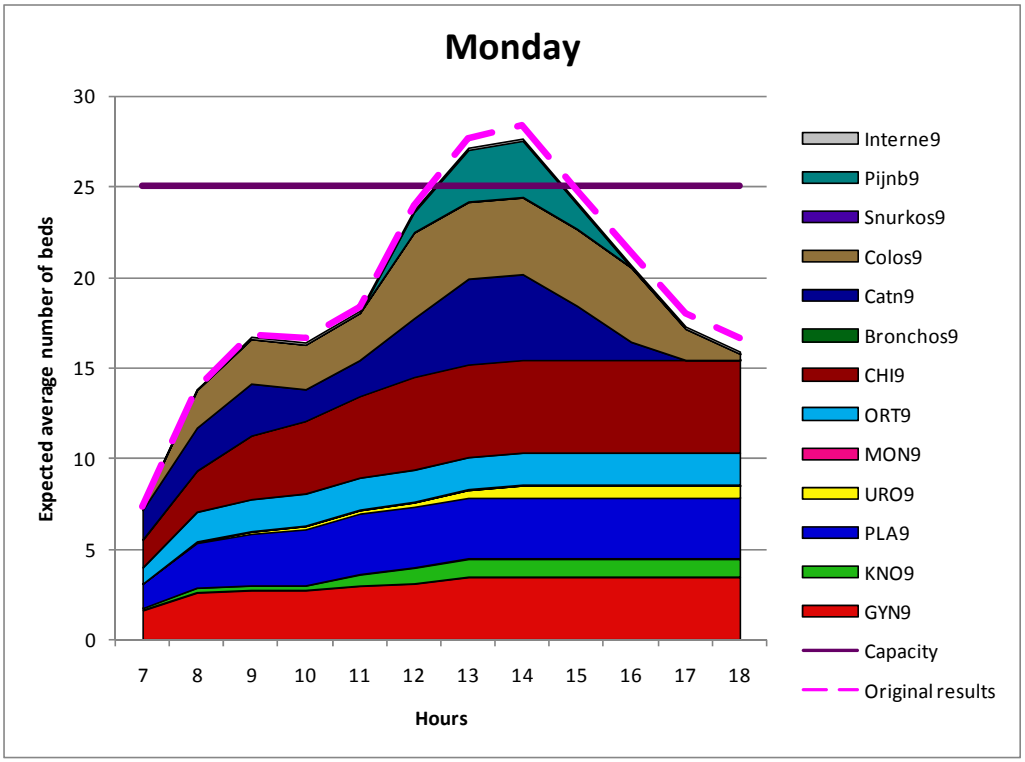


Figure 43: Projection of the expected number of beds on Monday resulting from scenario 9

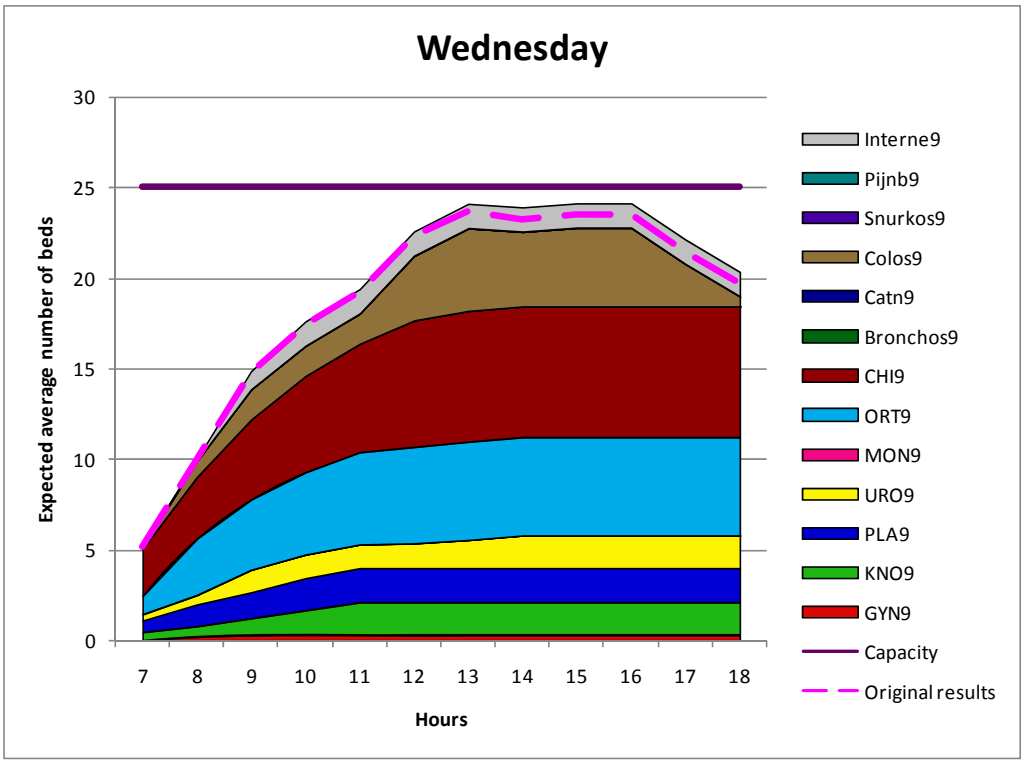


Figure 44: Projection of the expected number of beds on Wednesday resulting from scenario 9

Scenario 10: Urology from Monday to Thursday

Comments: As with scenario 9, this move only reduces the number of beds on Monday (Figure 45) and adds to Thursday (Figure 46) only a little, 0,7 on Monday and 0,4 on Thursday.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,8	18,4	10,0	11,0	10,4
9	16,8	24,8	14,8	16,9	15,1
10	16,4	27,6	17,4	18,2	18,0
11	18,2	28,1	19,2	18,3	20,6
12	23,8	33,1	22,3	22,5	24,2
13	27,2	35,8	23,7	25,4	25,7
14	27,7	33,8	23,2	25,1	24,6
15	24,2	29,3	23,4	22,6	23,8
16	20,7	27,0	23,4	20,8	23,4
17	17,3	24,3	21,4	19,2	22,6
18	15,9	22,5	19,7	17,6	21,9

Table 27: Sum of the number of beds per hour per day resulting from a move of Urology from Monday to Thursday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	2,7		
Tuesday	25	10,8	**Average**	2,6
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	0,4	**Coefficient of variation**	1,8
Friday	25	0,7		

Table 28: The maximum difference with capacity per day and measures of improvement for scenario 10

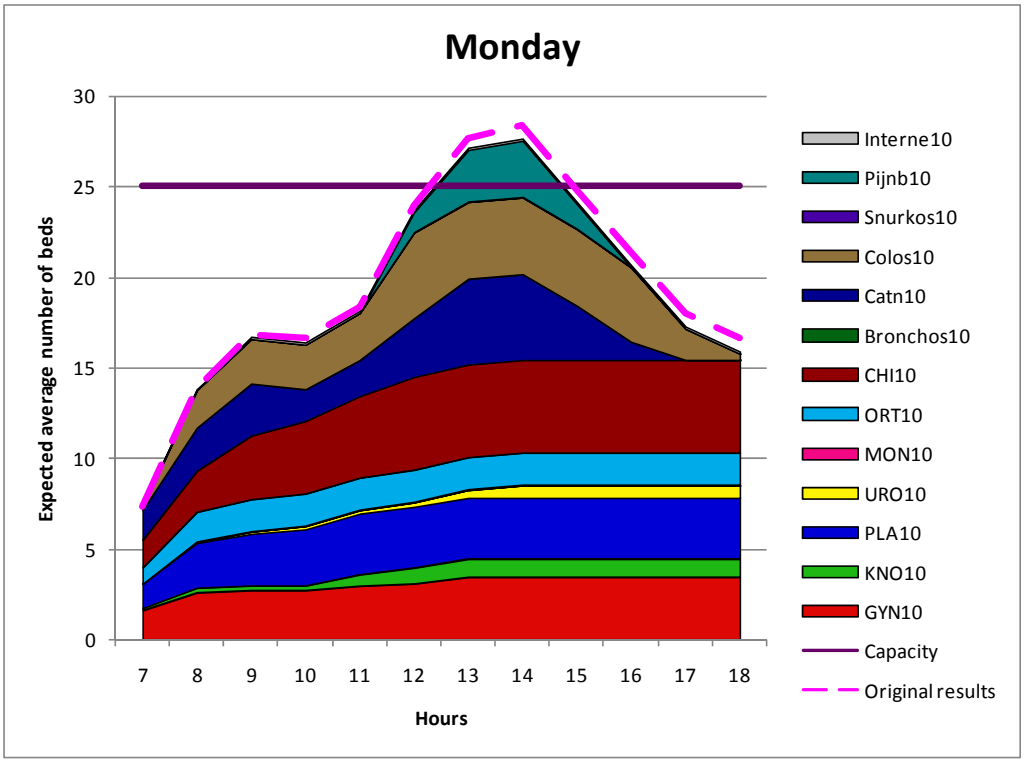


Figure 45: Projection of the expected number of beds on Monday resulting from scenario 10

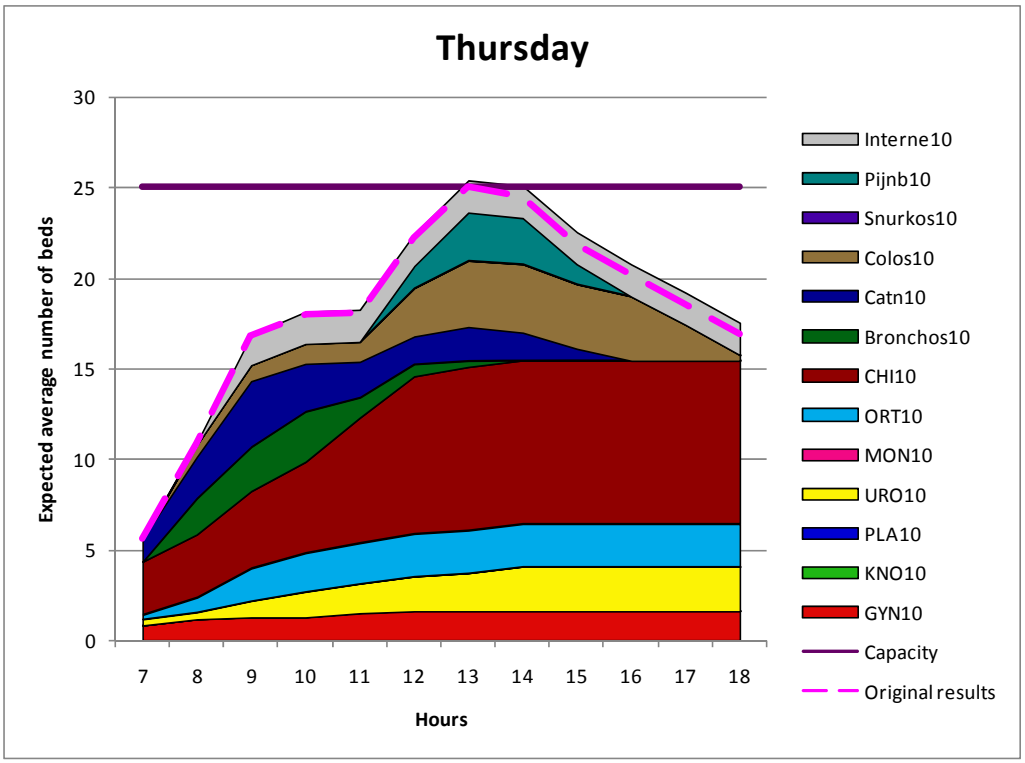


Figure 46: Projection of the expected number of beds on Thursday resulting from scenario 10

Scenario 11: Urology from Monday to Friday

Comments: As with scenario 10 the influence in increasing the graph is only 0,5. Moving one Urology away from Monday does not have the big effects like moving either Plastic surgery or Dental surgery.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,8	18,4	10,0	10,9	10,5
9	16,8	24,8	14,8	16,8	15,2
10	16,4	27,6	17,4	18,0	18,2
11	18,2	28,1	19,2	18,1	20,7
12	23,8	33,1	22,3	22,2	24,5
13	27,2	35,8	23,7	25,0	26,1
14	27,7	33,8	23,2	24,4	25,2
15	24,2	29,3	23,4	21,9	24,5
16	20,7	27,0	23,4	20,1	24,1
17	17,3	24,3	21,4	18,6	23,2
18	15,9	22,5	19,7	16,9	22,6

Table 29: Sum of the number of beds per hour per day resulting from a move of Urology from Monday to Friday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	2,7		
Tuesday	25	10,8	**Average**	2,6
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	1,1		

Table 30: The maximum difference with capacity per day and measures of improvement for scenario 11

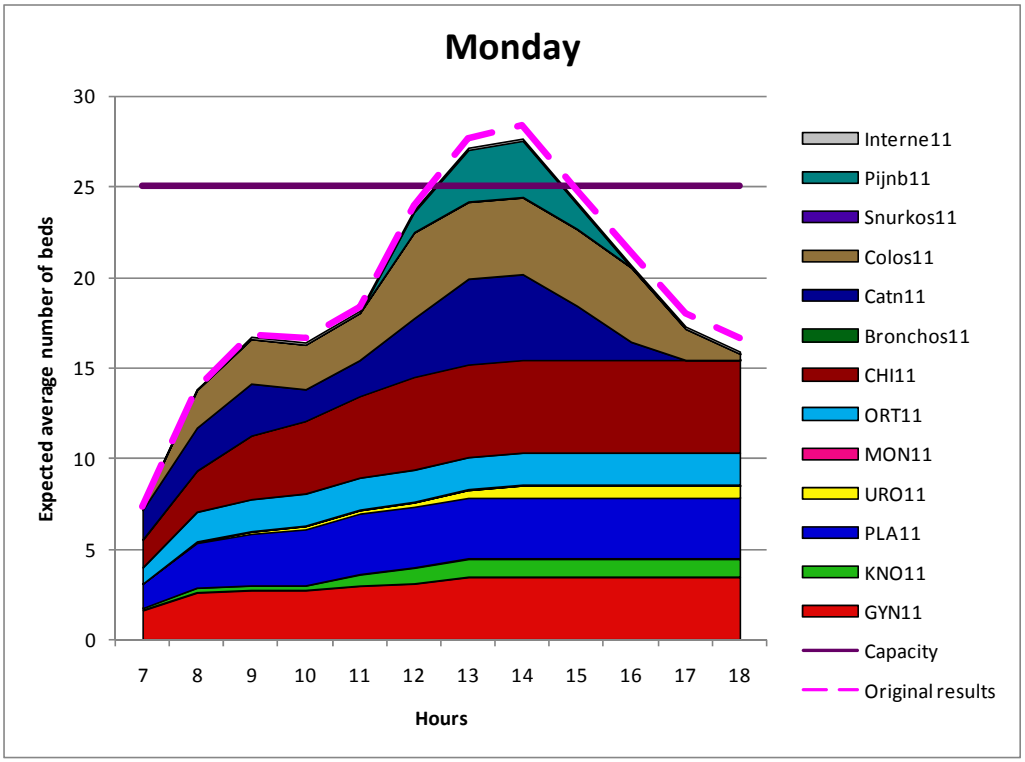


Figure 47: Projection of the expected number of beds on Monday resulting from scenario 11

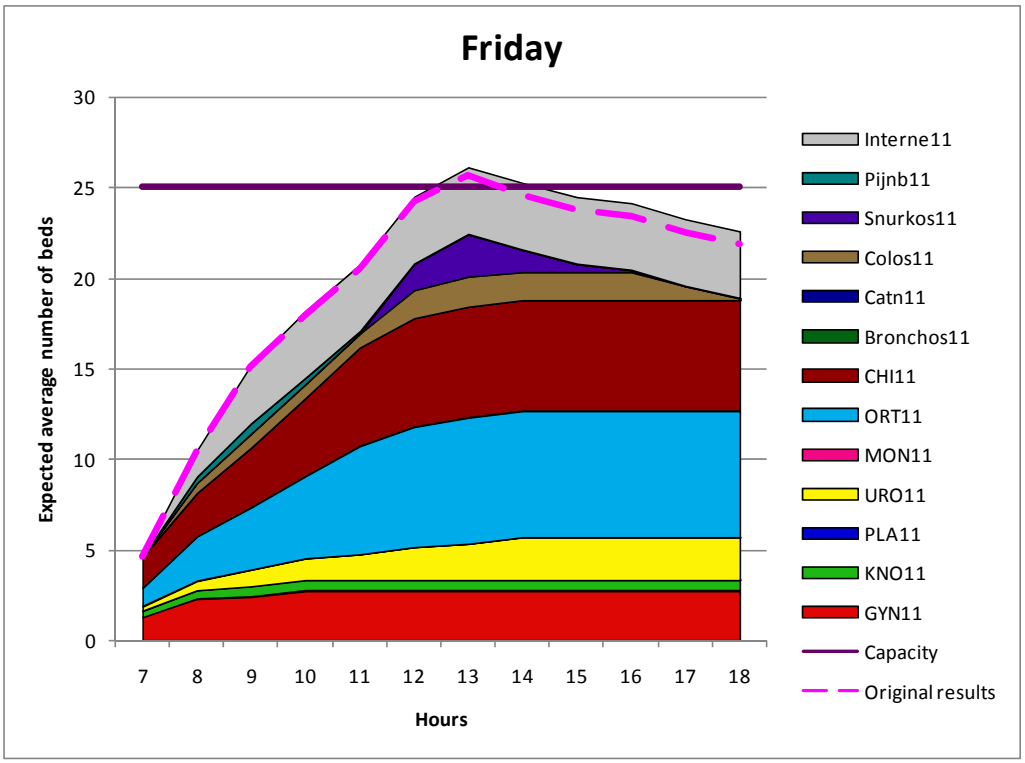


Figure 48: Projection of the expected number of beds on Friday resulting from scenario 11

Scenario 12: Gynecology from Monday to Wednesday

Comments: Figure 49 shows that the move has resulted in the graph being pushed back to just below capacity. On Wednesday the graph (Figure 50) has been pushed over capacity due to the move.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	5,8	10,3	6,8	5,7	4,7
8	11,3	18,4	12,4	10,9	10,4
9	14,1	24,8	17,2	16,8	15,1
10	13,9	27,6	19,9	18,0	18,0
11	15,4	28,1	21,9	18,1	20,6
12	20,9	33,1	25,1	22,2	24,2
13	24,1	35,8	26,8	25,0	25,7
14	24,9	33,8	26,4	24,4	24,6
15	21,4	29,3	26,6	21,9	23,8
16	17,9	27,0	26,6	20,1	23,4
17	14,5	24,3	24,6	18,6	22,6
18	13,1	22,5	22,8	16,9	21,9

Table 31: Sum of the number of beds per hour per day resulting from a move of Gynecology from Monday to Wednesday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	-0,1		
Tuesday	25	10,8	**Average**	2,6
Wednesday	25	1,8	**Standard deviation**	4,6
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	0,7		

Table 32: The maximum difference with capacity per day and measures of improvement for scenario 12

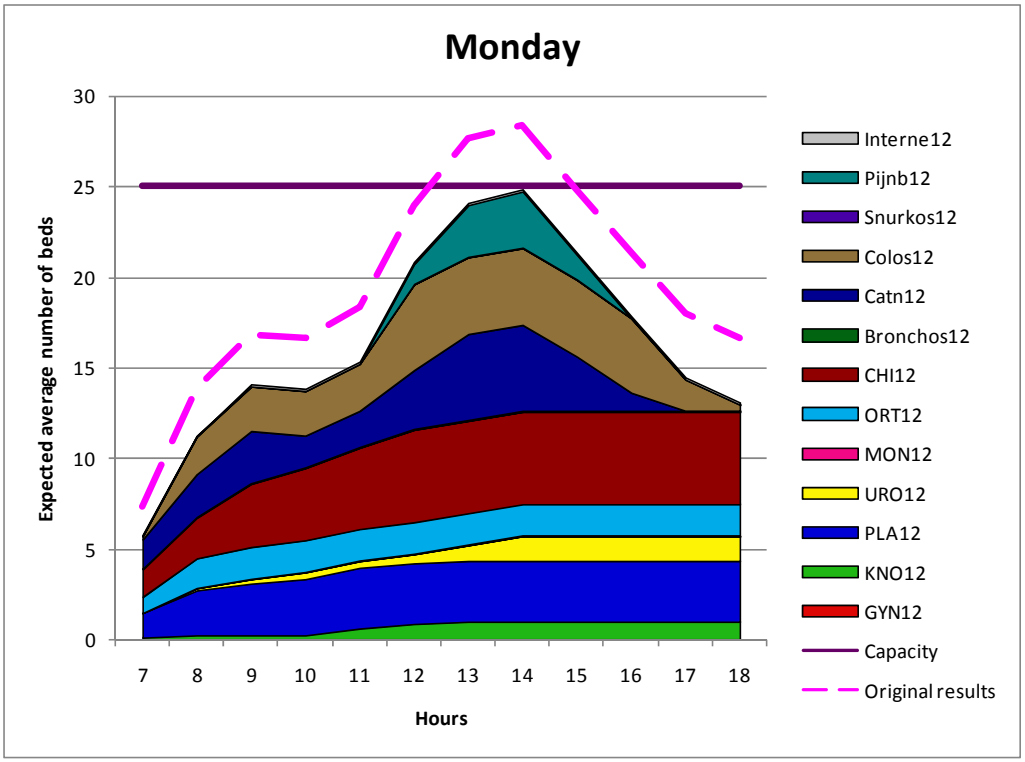


Figure 49: Projection of the expected number of beds on Monday resulting from scenario 12

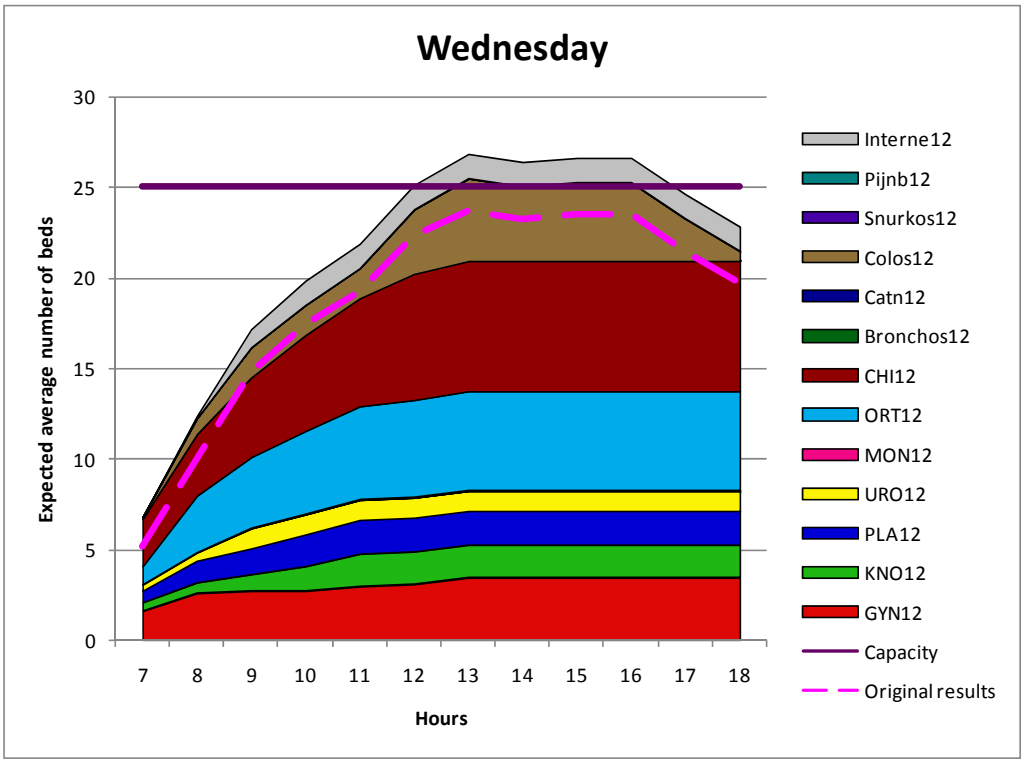


Figure 50: Projection of the expected number of beds on Wednesday resulting from scenario 12

Scenario 13: Gynecology from Tuesday to Wednesday

Comments: Because the Tuesday gynecology program is only an afternoon program with not a lot of patients, the effect of the move to Wednesday is not that significant for both Tuesday, in reducing the number of beds (Figure 51), and on Wednesday (Figure 52) in adding to the number of beds.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	9,8	10,9	10,4
9	16,9	24,6	14,6	16,8	15,1
10	16,6	27,5	17,2	18,0	18,0
11	18,4	27,4	19,6	18,1	20,6
12	24,0	32,4	22,8	22,2	24,2
13	27,6	35,0	24,1	25,0	25,7
14	28,4	33,0	23,6	24,4	24,6
15	24,9	28,5	23,9	21,9	23,8
16	21,4	26,3	23,9	20,1	23,4
17	18,0	23,5	21,9	18,6	22,6
18	16,6	21,8	20,1	16,9	21,9

Table 33: Sum of the number of beds per hour per day resulting from a move of Gynecology from Tuesday to Wednesday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	10,0	**Average**	2,6
Wednesday	25	-0,9	**Standard deviation**	4,4
Thursday	25	0,0	**Coefficient of variation**	1,7
Friday	25	0,7		

Table 34: The maximum difference with capacity per day and measures of improvement for scenario 13

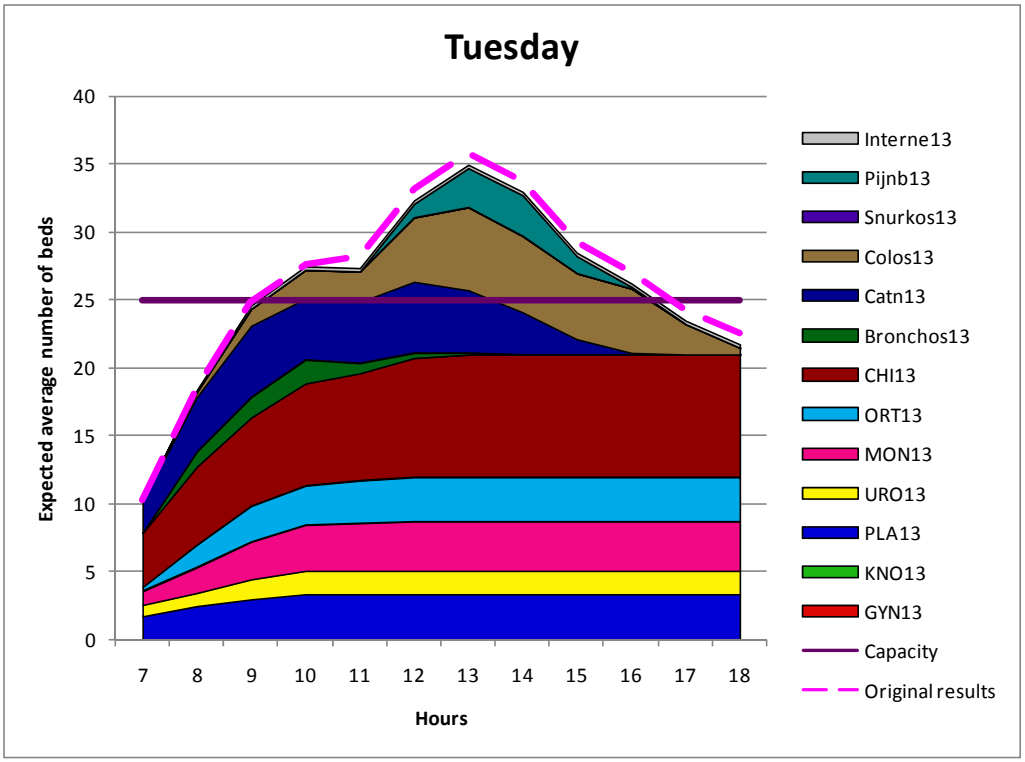


Figure 51: Projection of the expected number of beds on Tuesday resulting from scenario 13

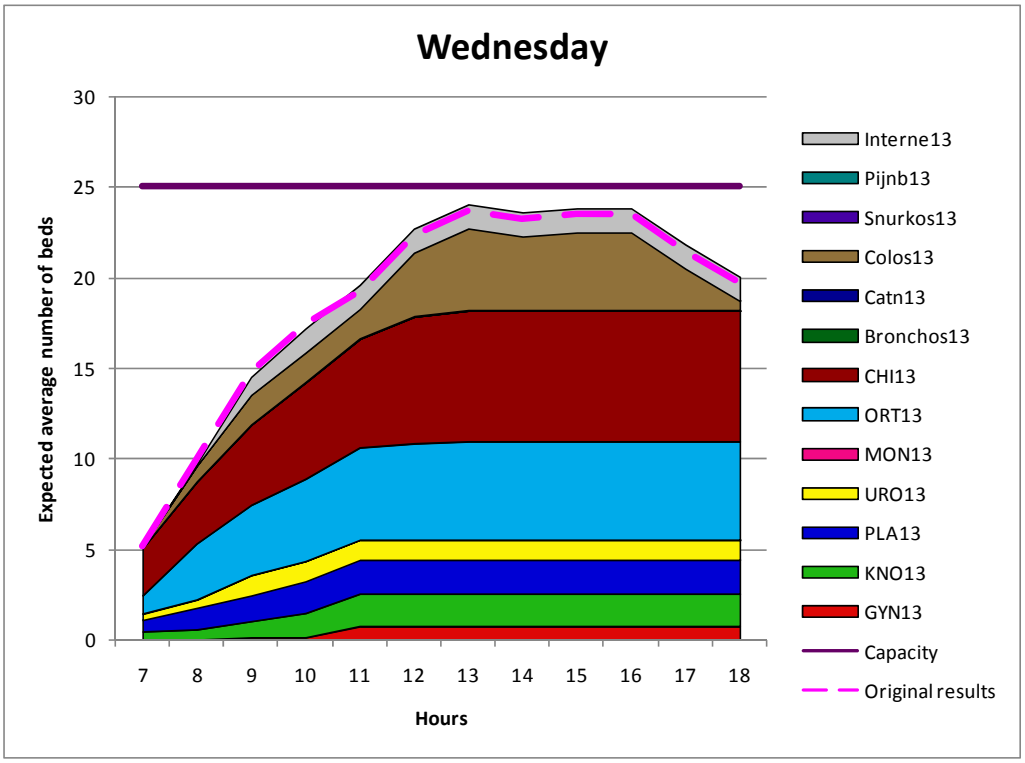


Figure 52: Projection of the expected number of beds on Wednesday resulting from scenario 13

Appendix E: Results scenarios regarding moves in the OPC-schedule

Scenario 14: Pain relief from Monday afternoon to Wednesday morning

Comments: On Monday (Figure 53) the same effect is seen as with the move to Wednesday afternoon. In Figure 54 there is now a small peak in the morning, but this does not push the graph further to capacity. It also neatly precedes the double colonoscopy program in the afternoon, giving the possibility to double beds. Although there are lesser beds needed on Monday and the beds on Wednesday are used more efficiently but the CoV has been increased by 0,6.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	6,3	5,7	4,7
8	13,9	18,4	12,9	10,9	10,4
9	16,9	24,8	17,9	16,8	15,1
10	16,6	27,6	18,8	18,0	18,0
11	18,4	28,1	19,2	18,1	20,6
12	22,9	33,1	22,3	22,2	24,2
13	24,8	35,8	23,7	25,0	25,7
14	25,3	33,8	23,2	24,4	24,6
15	23,5	29,3	23,4	21,9	23,8
16	21,4	27,0	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 35: Sum of the number of beds per hour per day resulting from a move of Pain relief from Monday afternoon to Wednesday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,3		
Tuesday	25	10,8	**Average**	2,1
Wednesday	25	-1,3	**Standard deviation**	4,9
Thursday	25	0,0	**Coefficient of variation**	2,4
Friday	25	0,7		

Table 36: The maximum difference with capacity per day and measures of improvement for scenario 14

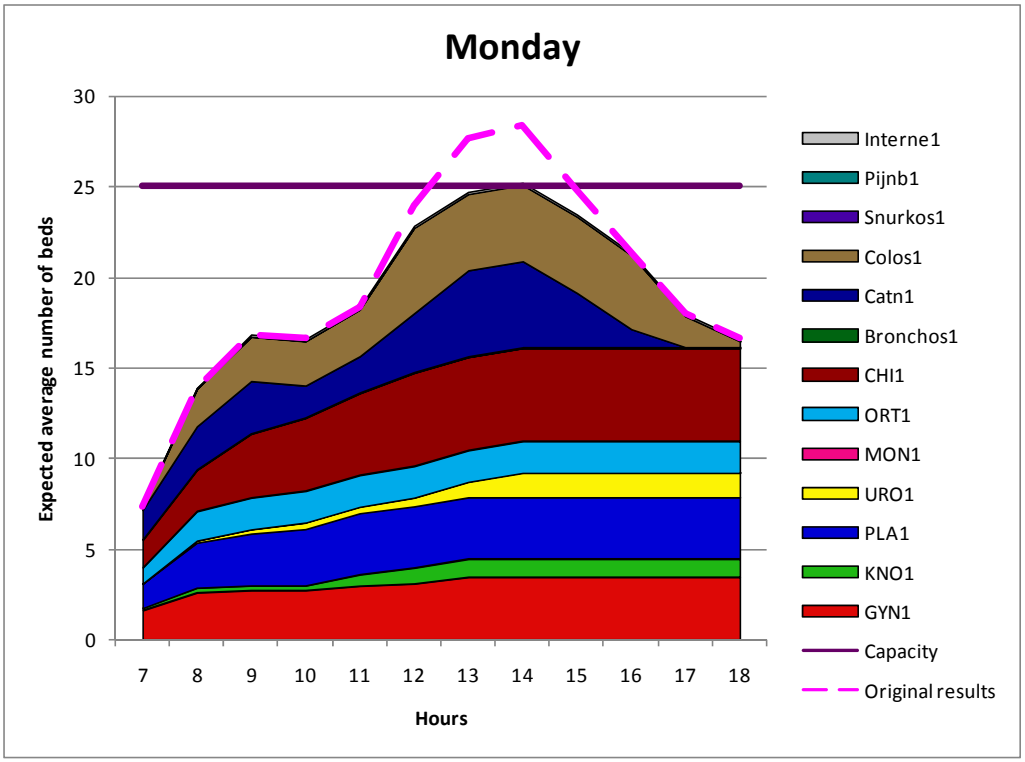


Figure 53: Projection of the expected number of beds on Monday resulting from scenario 14

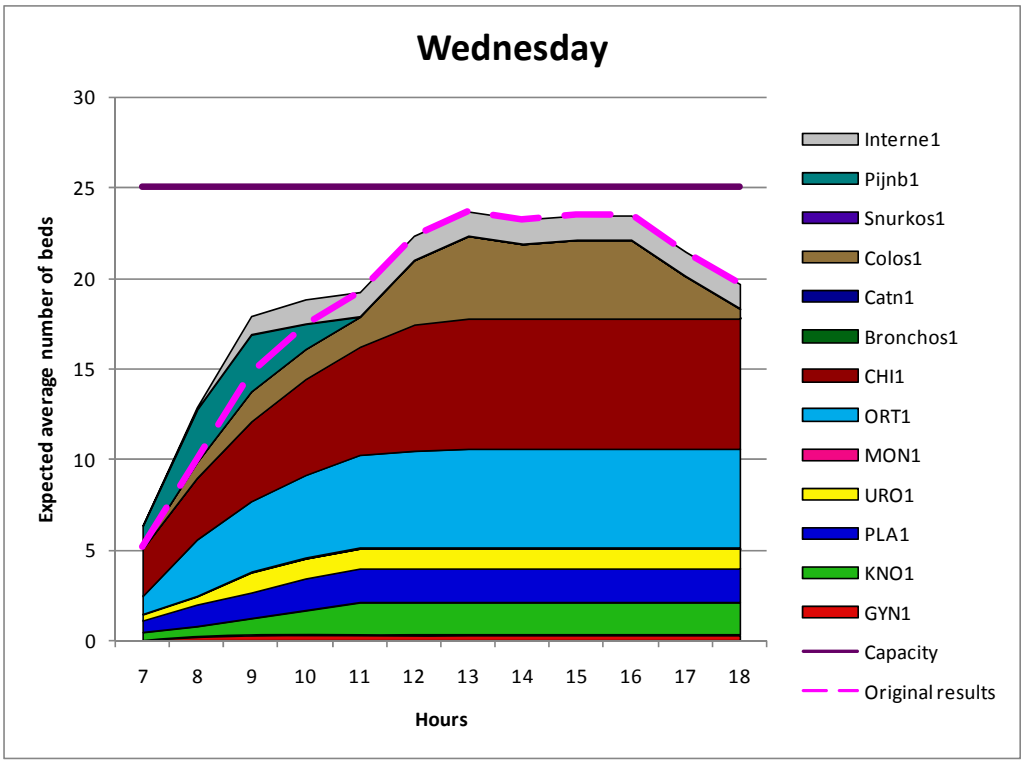


Figure 54: Projection of the number of beds on Wednesday resulting from scenario 14

Scenario 15: Pain relief from Monday afternoon to Wednesday afternoon

Comments: This move has pushed back the peak on Monday (Figure 55) and added 2,9 on Wednesday (Figure 56) and pushed the graph above capacity.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	10,0	10,9	10,4
9	16,9	24,8	14,8	16,8	15,1
10	16,6	27,6	17,4	18,0	18,0
11	18,4	28,1	19,2	18,1	20,6
12	22,9	33,1	23,5	22,2	24,2
13	24,8	35,8	26,5	25,0	25,7
14	25,3	33,8	26,3	24,4	24,6
15	23,5	29,3	24,8	21,9	23,8
16	21,4	27,0	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 37: Sum of the number of beds per hour per day resulting from a move of Pain relief from Monday afternoon to Wednesday afternoon

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,3		
Tuesday	25	10,8	**Average**	2,6
Wednesday	25	1,5	**Standard deviation**	4,6
Thursday	25	0,0	**Coefficient of variation**	1,7
Friday	25	0,7		

Table 38: The maximum difference with capacity per day and measures of improvement for scenario 15

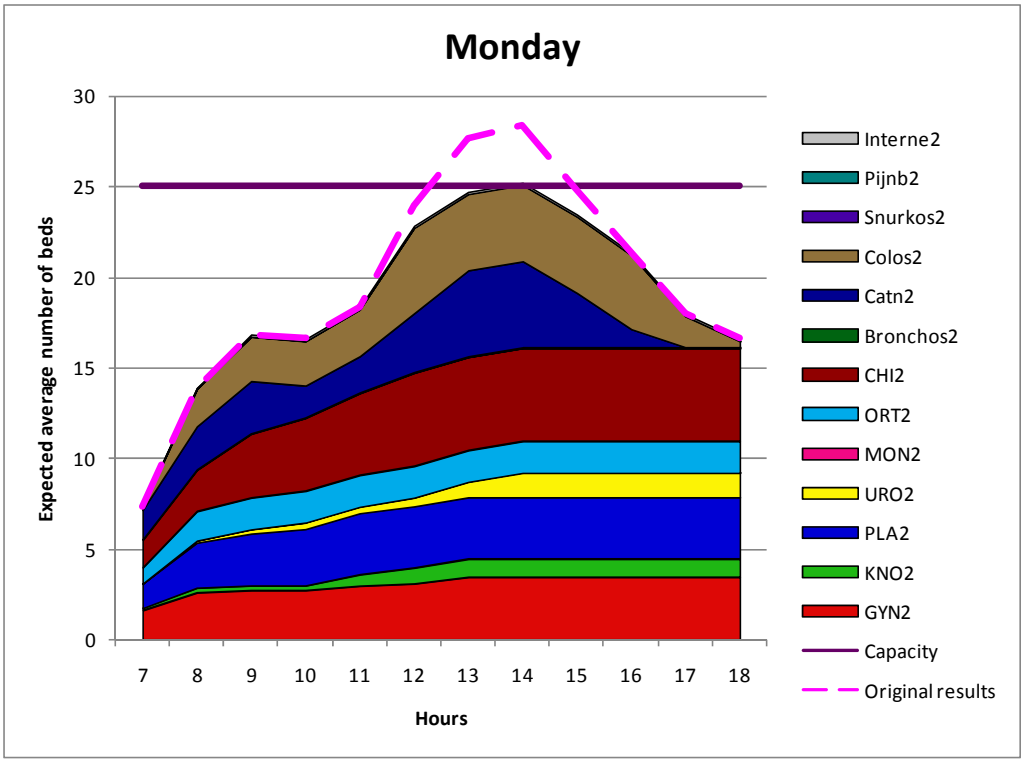


Figure 55: Projection of the expected number of beds on Monday resulting from scenario 15

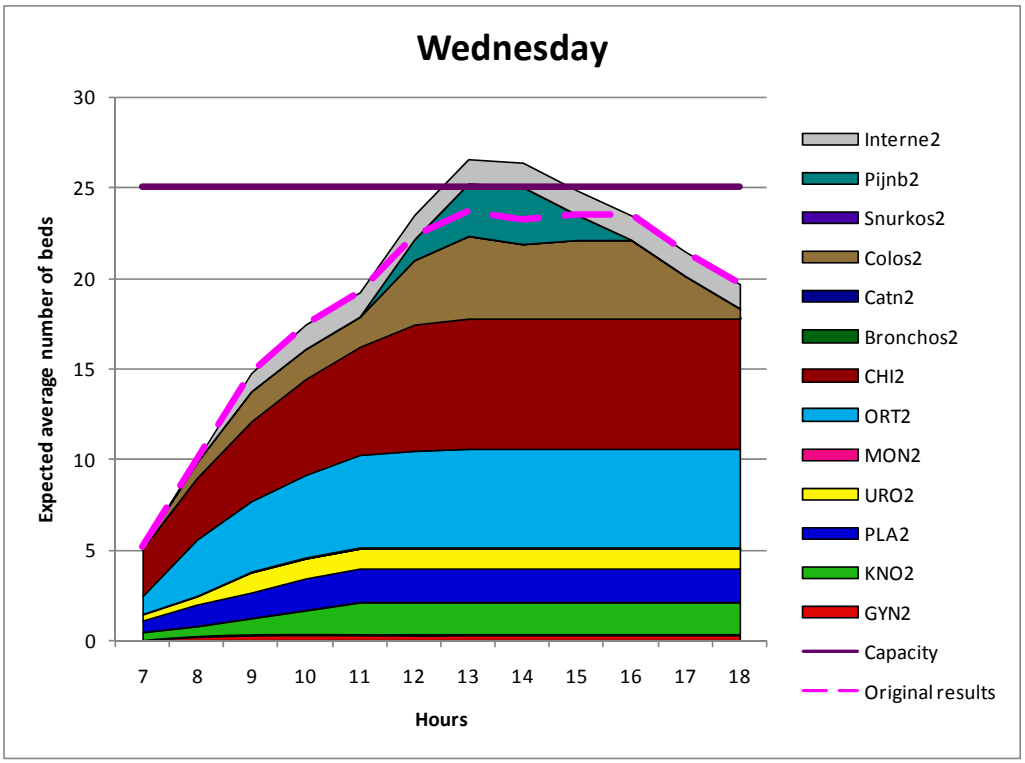


Figure 56: Projection of the expected number of beds on Wednesday resulting from scenario 15

Scenario 16: Pain relief from Tuesday afternoon to Wednesday morning

Comments: On Tuesday the peak has been pushed back (see Figure 57) but not enough to eliminate like the move from Monday afternoon to Wednesday.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	6,2	5,7	4,7
8	13,9	18,4	12,9	10,9	10,4
9	16,9	24,8	17,8	16,8	15,1
10	16,6	27,6	18,7	18,0	18,0
11	18,4	28,1	19,3	18,1	20,6
12	24,0	32,1	22,3	22,2	24,2
13	27,6	32,9	23,7	25,0	25,7
14	28,4	30,8	23,2	24,4	24,6
15	24,9	28,0	23,4	21,9	23,8
16	21,4	26,9	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 39: Sum of the number of beds per hour per day resulting from a move of Pain relief from Tuesday afternoon to Wednesday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,9	**Average**	2,1
Wednesday	25	-1,3	**Standard deviation**	3,6
Thursday	25	0,0	**Coefficient of variation**	1,7
Friday	25	0,7		

Table 40: The maximum difference with capacity per day and measures of improvement for scenario 16

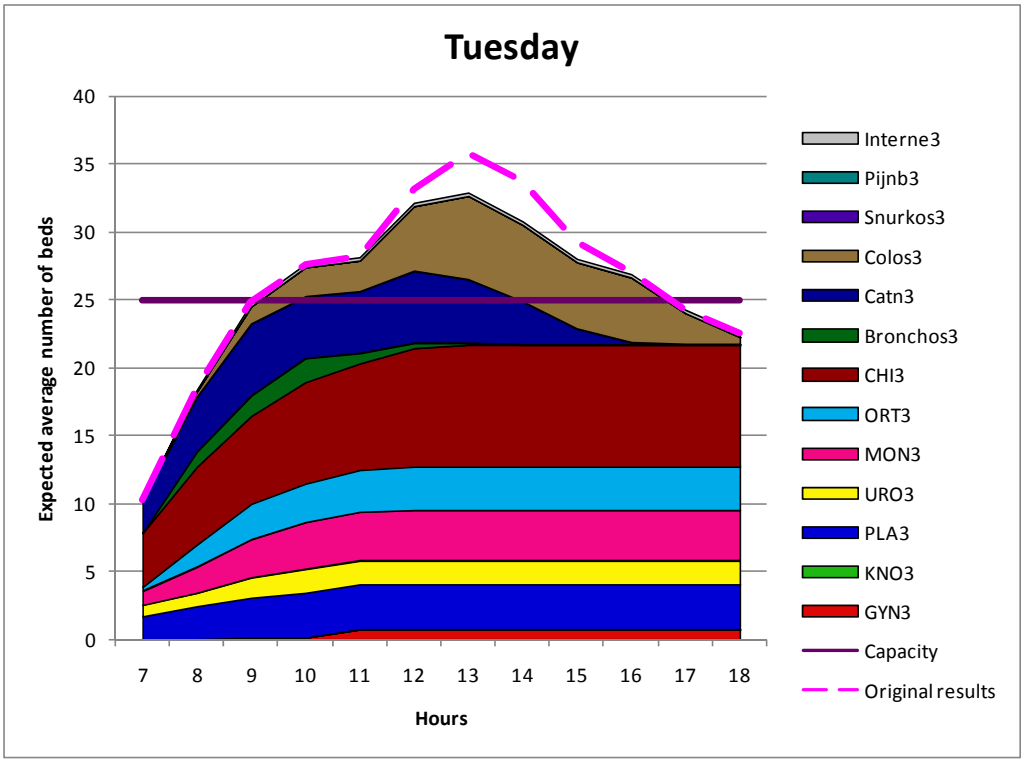


Figure 57: Projection of the expected number of beds on Tuesday resulting from scenario 16

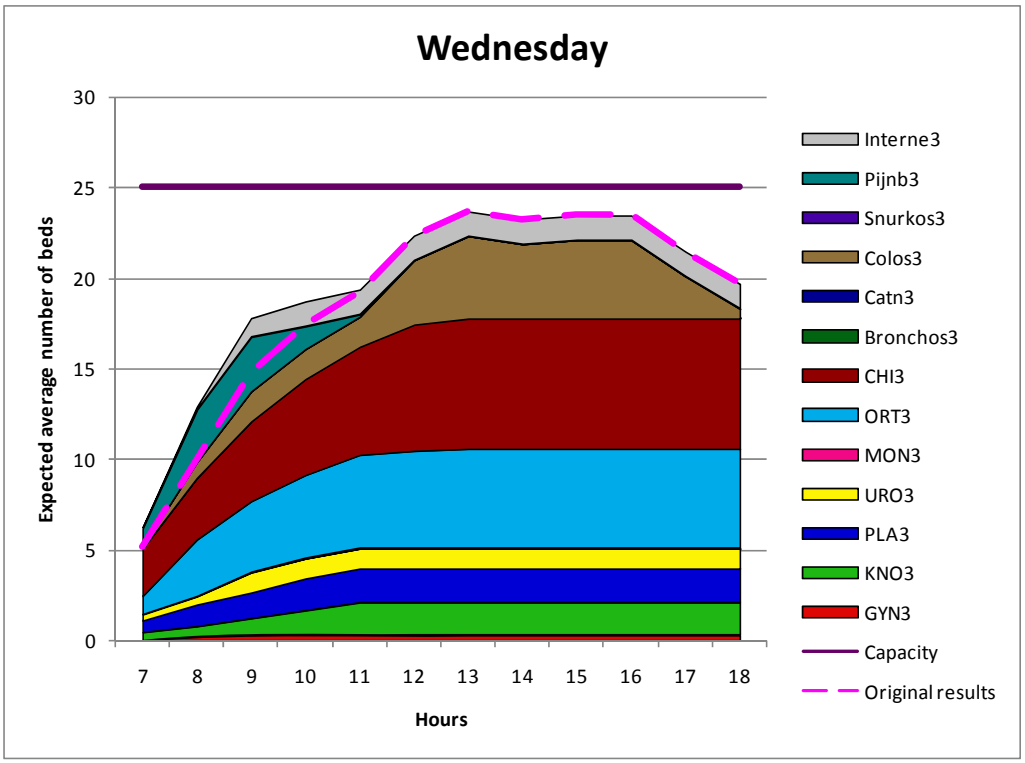


Figure 58: Projection of the expected number of beds on Wednesday resulting from scenario 16

Scenario 17: Pain relief from Tuesday afternoon to Wednesday afternoon

Comments: This move has the same effect as the move from Tuesday to Wednesday morning, except off course for the peak in the graph that pushed the graph over capacity.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	10,0	10,9	10,4
9	16,9	24,8	14,8	16,8	15,1
10	16,6	27,6	17,4	18,0	18,0
11	18,4	28,1	19,2	18,1	20,6
12	24,0	32,1	23,3	22,2	24,2
13	27,6	32,9	26,5	25,0	25,7
14	28,4	30,8	26,2	24,4	24,6
15	24,9	28,0	24,7	21,9	23,8
16	21,4	26,9	23,6	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 41: Sum of the number of beds per hour per day resulting from a move of Pain relief from Tuesday afternoon to Wednesday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,9	**Average**	2,7
Wednesday	25	1,5	**Standard deviation**	3,2
Thursday	25	0,0	**Coefficient of variation**	1,2
Friday	25	0,7		

Table 42: The maximum difference with capacity per day and measures of improvement for scenario 17

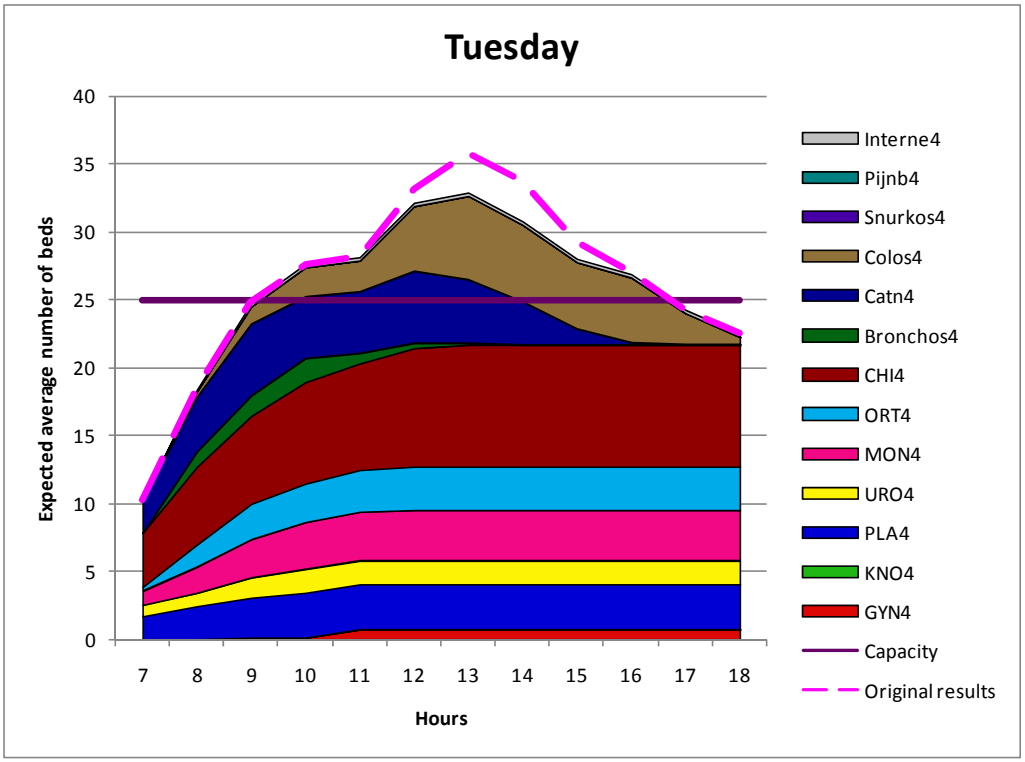


Figure 59: Projection of the expected number of beds on Tuesday resulting from scenario 17

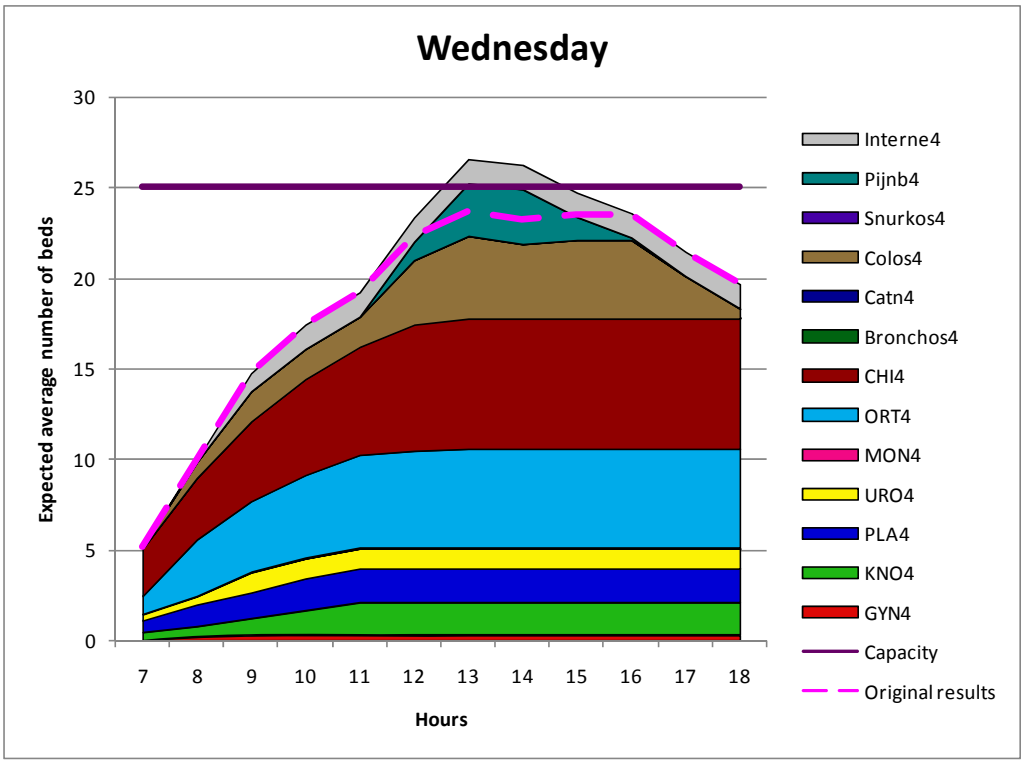


Figure 60: Projection of the expected number of beds on Wednesday resulting from scenario 17

Scenario 18: Colonoscopies from Tuesday afternoon to Tuesday morning, bronchoscopies from Tuesday morning to Tuesday afternoon and pain relief from Tuesday afternoon to Tuesday morning

Comments: these three changes in one day show that even within a day the number of patients per hour can be leveled and reduced the peak on Tuesday (Table 43 and Figure 61). Another advantage is that beds will not be empty in the morning when there is no bronchoscopy program in the morning but there is a pain relief program in the afternoon.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	12,5	5,2	5,7	4,7
8	13,9	22,3	10,0	10,9	10,4
9	16,9	28,6	14,8	16,8	15,1
10	16,6	29,5	17,4	18,0	18,0
11	18,4	29,9	19,2	18,1	20,6
12	24,0	31,6	22,3	22,2	24,2
13	27,6	32,0	23,7	25,0	25,7
14	28,4	30,0	23,2	24,4	24,6
15	24,9	27,4	23,4	21,9	23,8
16	21,4	25,3	23,4	20,1	23,4
17	18,0	23,5	21,4	18,6	22,6
18	16,6	22,4	19,7	16,9	21,9

Table 43: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Tuesday afternoon to Tuesday morning, bronchoscopies from Tuesday morning to Tuesday afternoon and pain relief from Tuesday afternoon to Tuesday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	7,0	**Average**	1,9
Wednesday	25	-1,3	**Standard deviation**	3,3
Thursday	25	0,0	**Coefficient of variation**	1,7
Friday	25	0,7		

Table 44: The maximum difference with capacity per day and measures of improvement for scenario 18

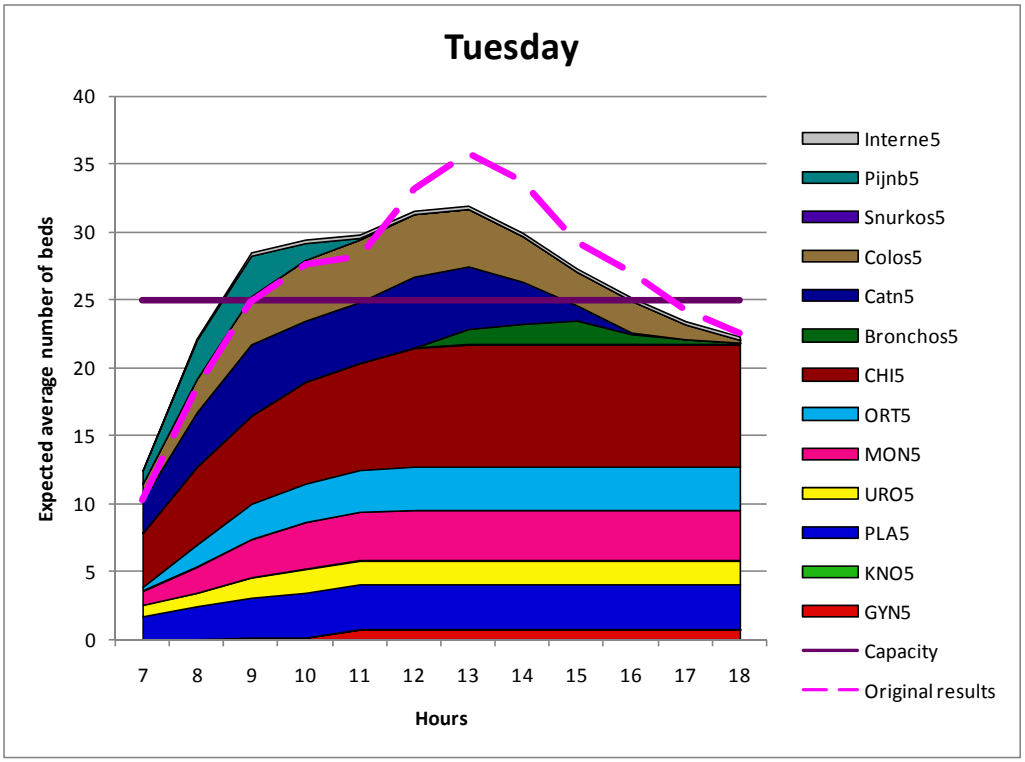


Figure 61: Projection of the expected number of beds on Tuesday resulting from scenario 18

Scenario 19: Colonoscopies from Thursday afternoon to Thursday morning, bronchoscopies from Thursday morning to Thursday afternoon and pain relief from Thursday afternoon to Thursday morning

Comments: Although Thursday, on average, never exceeded capacity. This change in the OPC schedule is similar to scenario 18. The number of patients per hour is leveled throughout the day and the peak during lunch time is less extreme.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	7,7	4,7
8	13,9	18,4	10,0	13,2	10,4
9	16,9	24,8	14,8	18,7	15,1
10	16,6	27,6	17,4	18,1	18,0
11	18,4	28,1	19,2	18,8	20,6
12	24,0	33,1	22,3	20,6	24,2
13	27,6	35,8	23,7	22,6	25,7
14	28,4	33,8	23,2	22,6	24,6
15	24,9	29,3	23,4	21,8	23,8
16	21,4	27,0	23,4	19,4	23,4
17	18,0	24,3	21,4	18,2	22,6
18	16,6	22,5	19,7	17,1	21,9

Table 45: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Thursday afternoon to Thursday morning, bronchoscopies from Thursday morning to Thursday afternoon and pain relief from Thursday afternoon to Thursday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	10,8	**Average**	2,2
Wednesday	25	-1,3	**Standard deviation**	5,3
Thursday	25	-2,4	**Coefficient of variation**	2,4
Friday	25	0,7		

Table 46: The maximum difference with capacity per day and measures of improvement for scenario 19

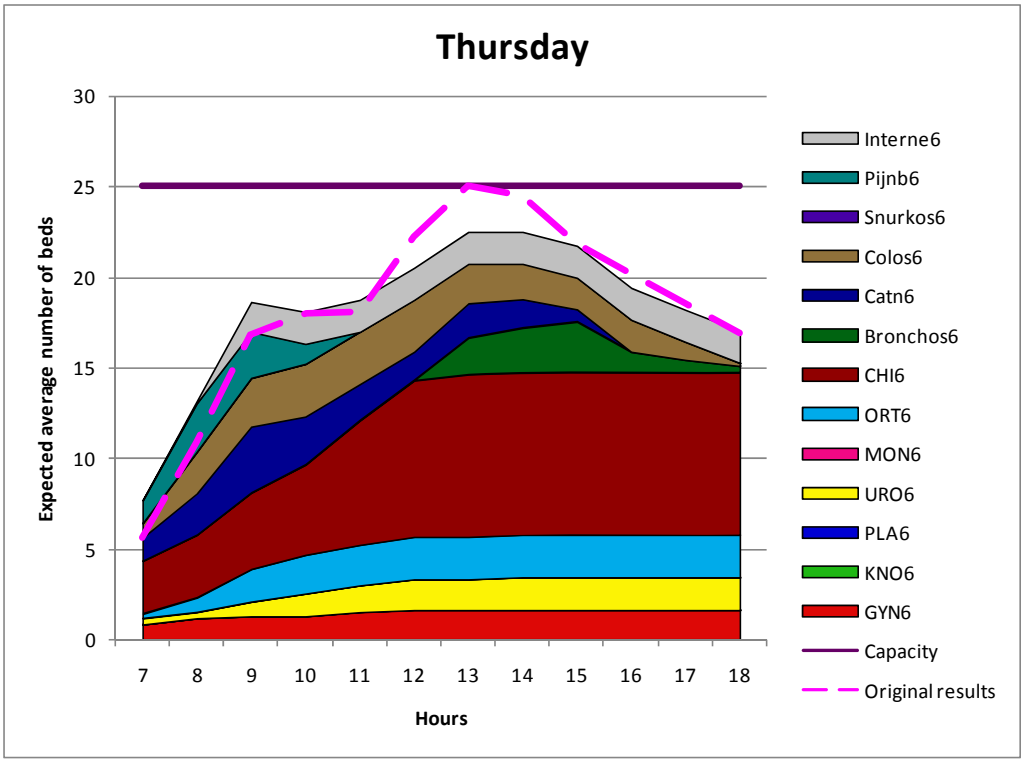


Figure 62: Projection of the expected number of beds on Thursday resulting from scenario 19

Scenario 20: Colonoscopies from Monday morning to Wednesday morning

Comments: The move of a colonoscopy program away from Monday morning (Figure 63) to another day does not have the same effect as the move of a pain relief away from the Monday (Figure 53). The graph on Wednesday has also not changed dramatically (Figure 64).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,3	10,3	5,3	5,7	4,7
8	12,8	18,4	11,1	10,9	10,4
9	15,6	24,8	16,0	16,8	15,1
10	15,4	27,6	18,7	18,0	18,0
11	17,1	28,1	20,5	18,1	20,6
12	22,8	33,1	23,5	22,2	24,2
13	27,4	35,8	23,9	25,0	25,7
14	28,3	33,8	23,3	24,4	24,6
15	24,8	29,3	23,5	21,9	23,8
16	21,4	27,0	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 47: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Monday morning to Wednesday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,3		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,1	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	1,7
Friday	25	0,7		

Table 48: The maximum difference with capacity per day and measures of improvement for scenario 20

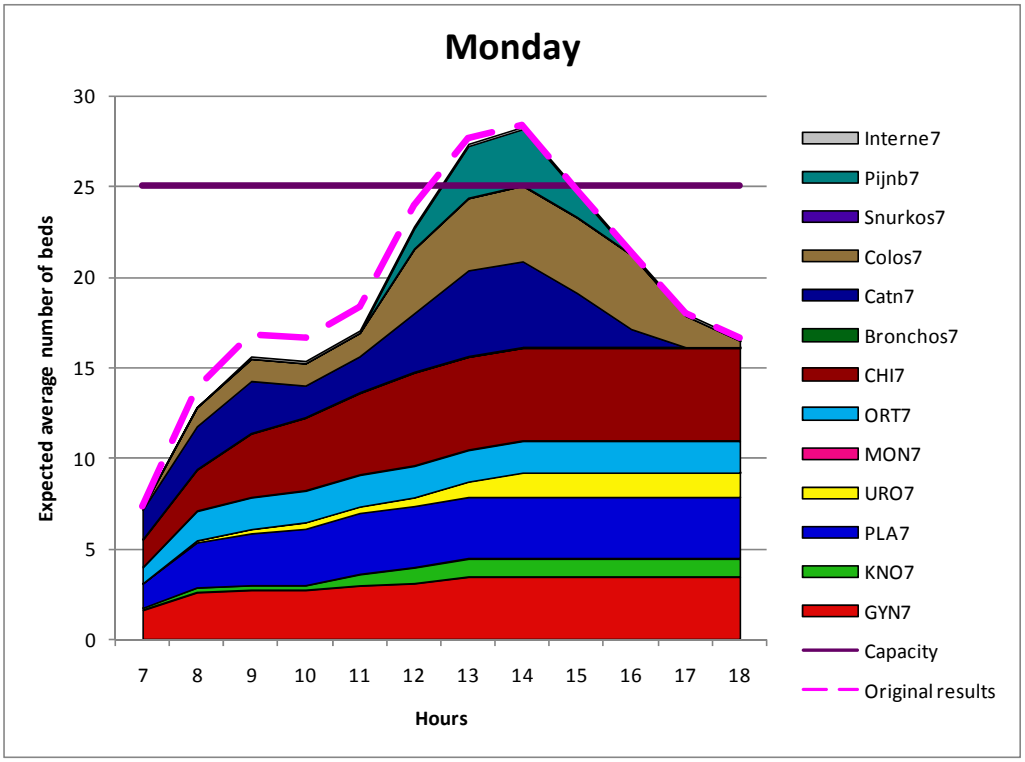


Figure 63: Projection of the expected number of beds on Monday resulting from scenario 20

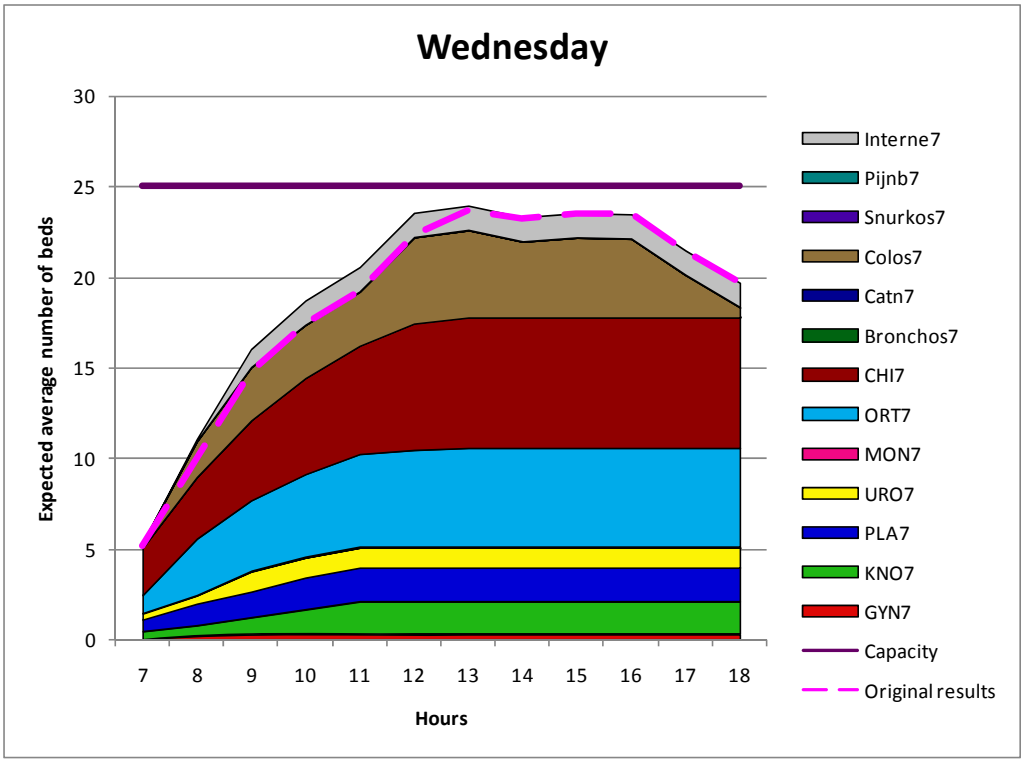


Figure 64: Projection of the expected number of beds on Monday resulting from scenario 20

Scenario 21: Colonoscopies from Monday morning to Friday morning

Comments: the same holds for this scenario as for scenario 20. Moving a colonoscopy program does not have a big effect on pushing down the peak on Monday (see Figure 65).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,3	10,3	5,2	5,7	4,8
8	12,8	18,4	10,0	10,9	11,5
9	15,6	24,8	14,8	16,8	16,4
10	15,4	27,6	17,4	18,0	19,3
11	17,1	28,1	19,2	18,1	21,9
12	22,8	33,1	22,3	22,2	25,4
13	27,4	35,8	23,7	25,0	25,9
14	28,3	33,8	23,2	24,4	24,6
15	24,8	29,3	23,4	21,9	23,8
16	21,4	27,0	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 49: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Monday morning to Friday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,3		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	0,9		

Table 50: The maximum difference with capacity per day and measures of improvement for scenario 21

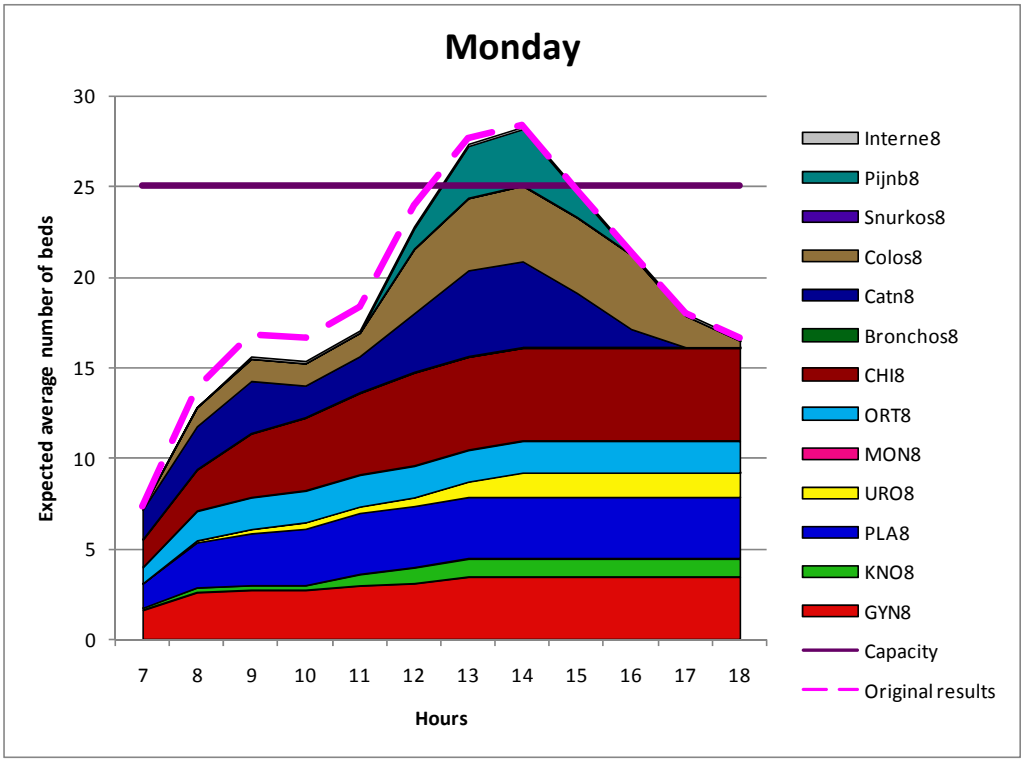


Figure 65: Projection of the expected number of beds on Monday resulting from scenario 21

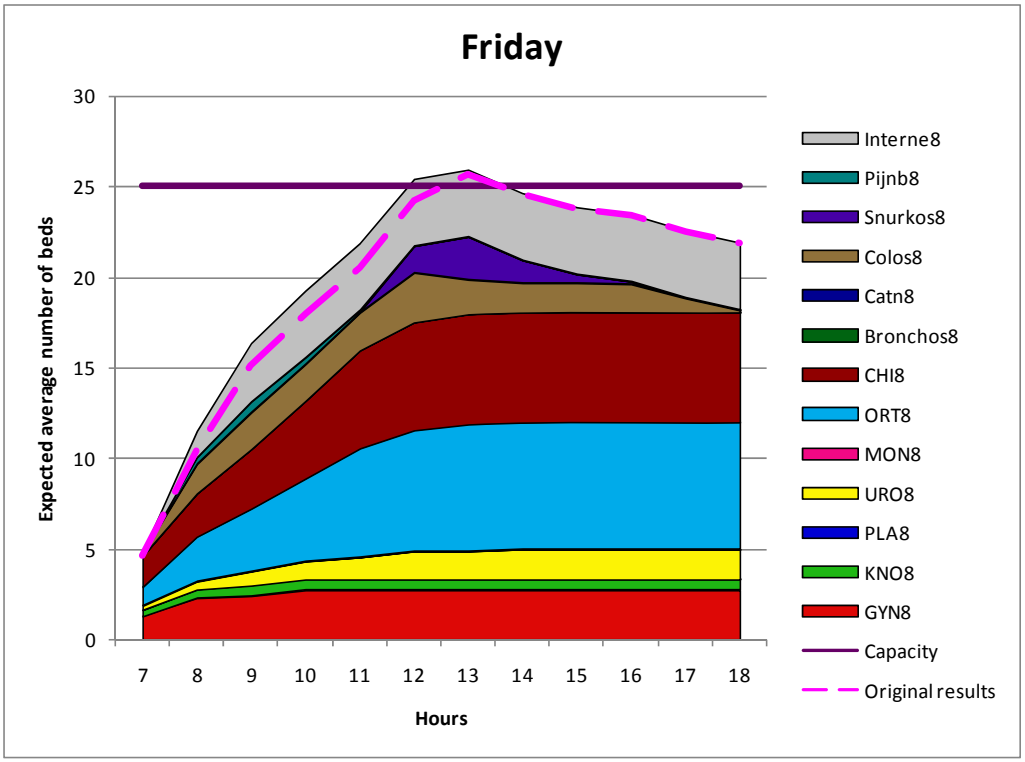


Figure 66: Projection of the expected number of beds on Friday resulting from scenario 21

Scenario 22: Colonoscopies from Monday morning to Friday afternoon

Comments: As with the previous two scenarios the same conclusion is valid for this scenario.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,3	10,3	5,2	5,7	4,7
8	12,8	18,4	10,0	10,9	10,4
9	15,6	24,8	14,8	16,8	15,1
10	15,4	27,6	17,4	18,0	18,0
11	17,1	28,1	19,2	18,1	20,6
12	22,8	33,1	22,3	22,2	24,3
13	27,4	35,8	23,7	25,0	26,7
14	28,3	33,8	23,2	24,4	25,8
15	24,8	29,3	23,4	21,9	25,0
16	21,4	27,0	23,4	20,1	24,8
17	18,0	24,3	21,4	18,6	23,7
18	16,6	22,5	19,7	16,9	22,1

Table 51: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Monday morning to Friday afternoon

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,3		
Tuesday	25	10,8	**Average**	2,9
Wednesday	25	-1,3	**Standard deviation**	4,7
Thursday	25	0,0	**Coefficient of variation**	1,6
Friday	25	1,7		

Table 52: The maximum difference with capacity per day and measures of improvement for scenario 22

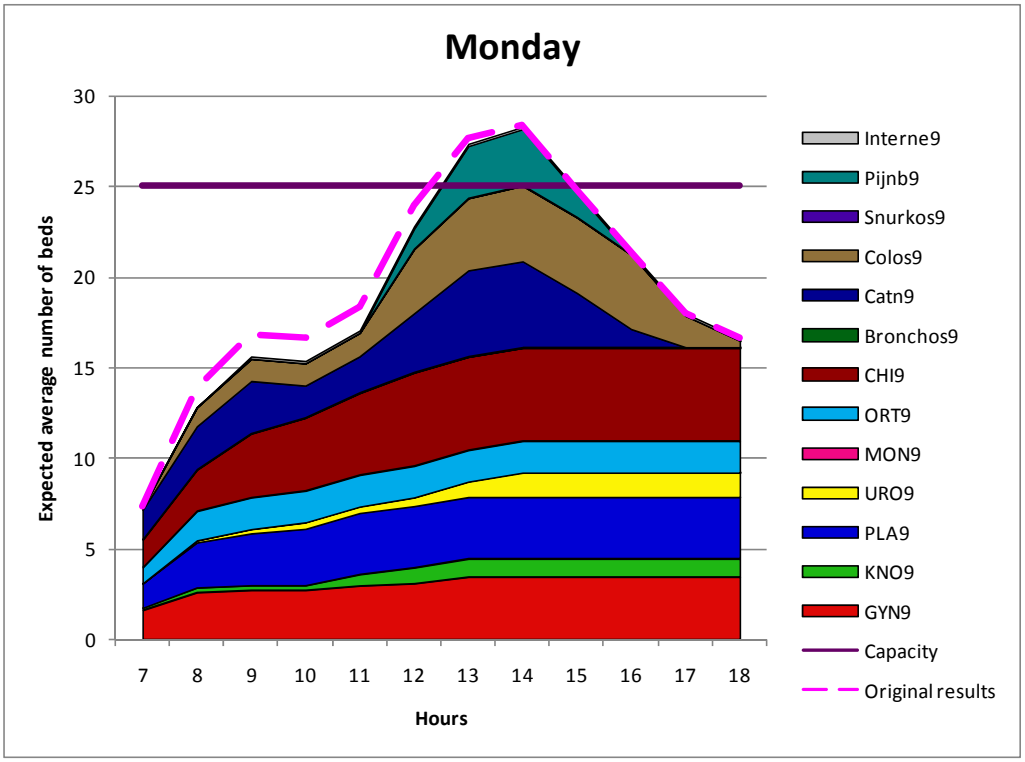


Figure 67: Projection of the expected number of beds on Monday resulting from scenario 22

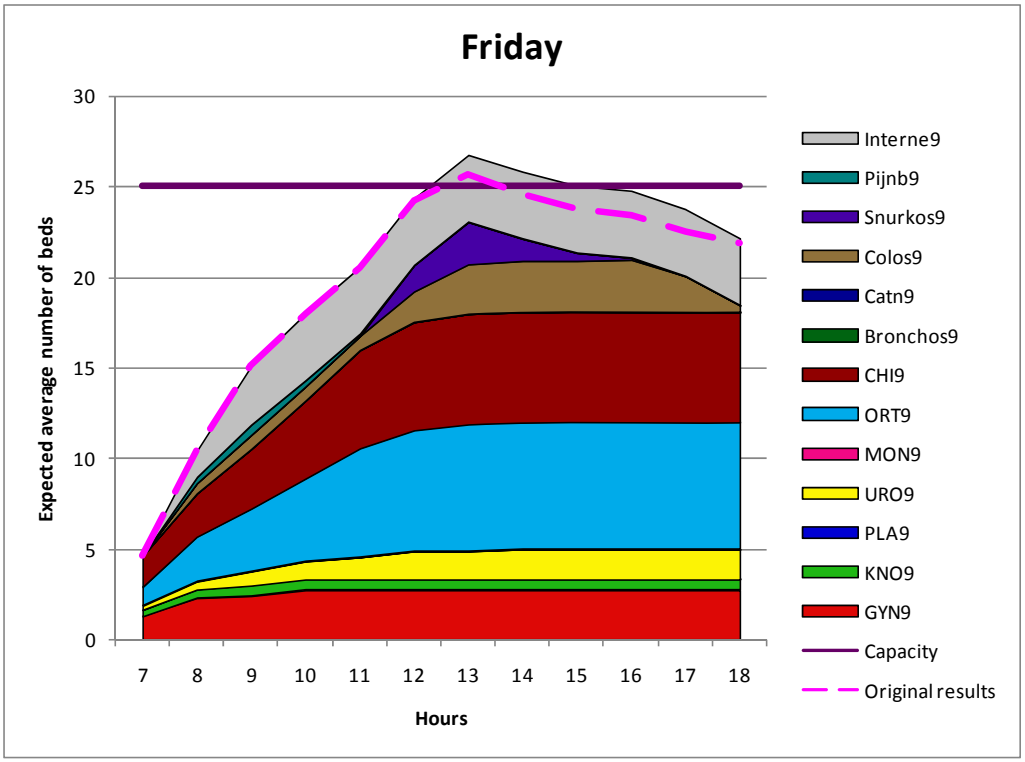


Figure 68: Projection of the expected number of beds on Friday resulting from scenario 22

Scenario 23: Colonoscopies from Monday afternoon to Wednesday morning

Comments: Moving a colonoscopy program from Monday afternoon to another day has a more profound effect then scenarios 20-22 because it reduces the lunch peak on Monday (see Figure 69) but again not as significant as scenarios 14 and 15.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	6,4	5,7	4,7
8	13,9	18,4	11,9	10,9	10,4
9	16,9	24,8	16,8	16,8	15,1
10	16,6	27,6	19,5	18,0	18,0
11	18,4	28,1	21,3	18,1	20,6
12	22,8	33,1	23,2	22,2	24,2
13	25,8	35,8	23,9	25,0	25,7
14	26,3	33,8	23,2	24,4	24,6
15	22,8	29,3	23,4	21,9	23,8
16	19,3	27,0	23,4	20,1	23,4
17	17,1	24,3	21,4	18,6	22,6
18	16,4	22,5	19,7	16,9	21,9

Table 53: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Monday afternoon to Wednesday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	1,3		
Tuesday	25	10,8	**Average**	2,3
Wednesday	25	-1,1	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	2,1
Friday	25	0,7		

Table 54: The maximum difference with capacity per day and measures of improvement for scenario 23

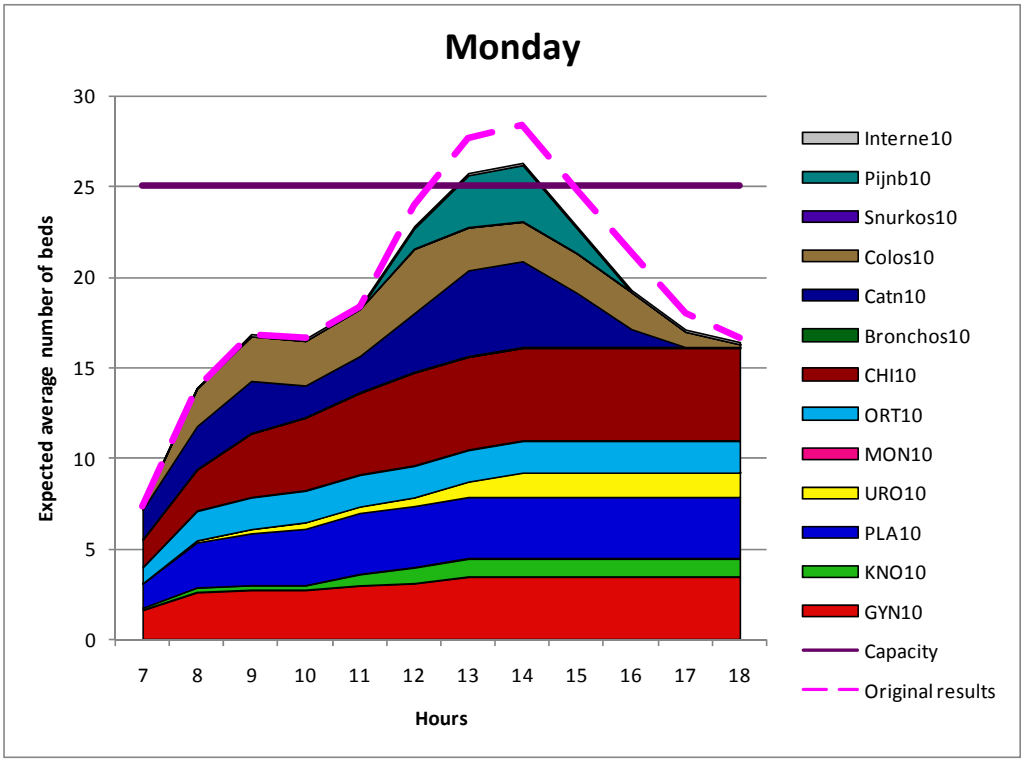


Figure 69: Projection of the expected number of beds on Monday resulting from scenario 23

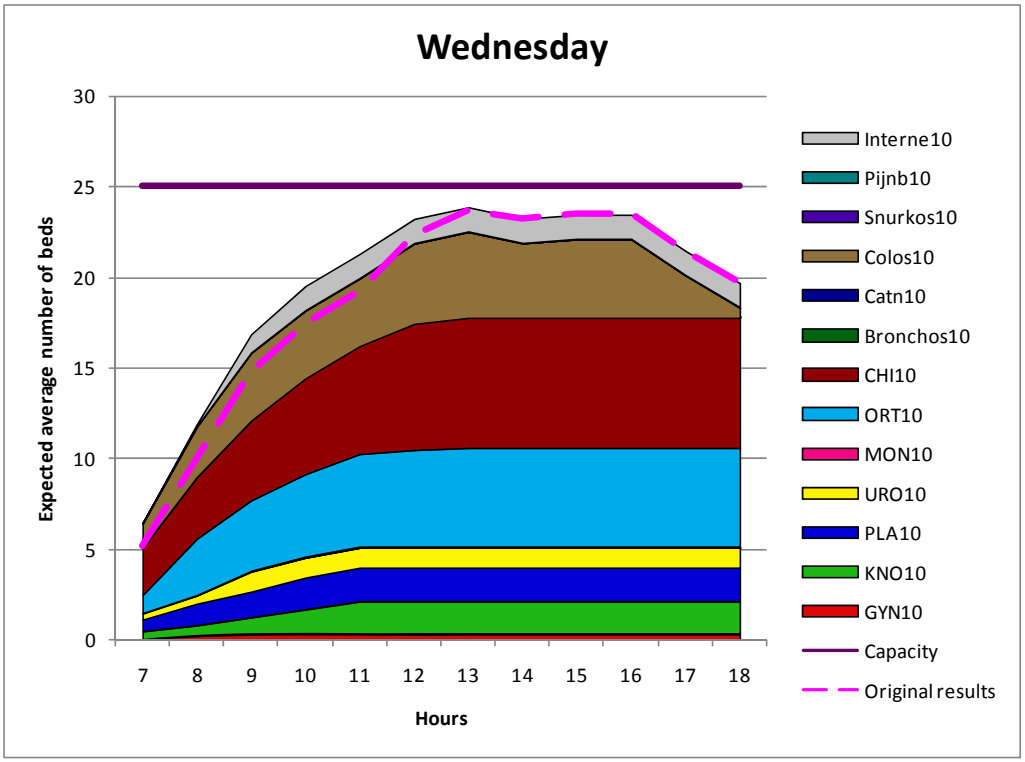


Figure 70: Projection of the expected number of beds on Wednesday resulting from scenario 23

Scenario 24: Colonoscopies from Monday afternoon to Friday morning

Comments: the same comments hold for this scenario as for scenario 23.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	5,9
8	13,9	18,4	10,0	10,9	12,3
9	16,9	24,8	14,8	16,8	17,2
10	16,6	27,6	17,4	18,0	20,1
11	18,4	28,1	19,2	18,1	22,6
12	22,8	33,1	22,3	22,2	25,1
13	25,8	35,8	23,7	25,0	25,9
14	26,3	33,8	23,2	24,4	24,6
15	22,8	29,3	23,4	21,9	23,8
16	19,3	27,0	23,4	20,1	23,4
17	17,1	24,3	21,4	18,6	22,6
18	16,4	22,5	19,7	16,9	21,9

Table 55: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Monday afternoon to Friday morning

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	1,3		
Tuesday	25	10,8	**Average**	2,3
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	2,1
Friday	25	0,9		

Table 56: The maximum difference with capacity per day and measures of improvement for scenario 24

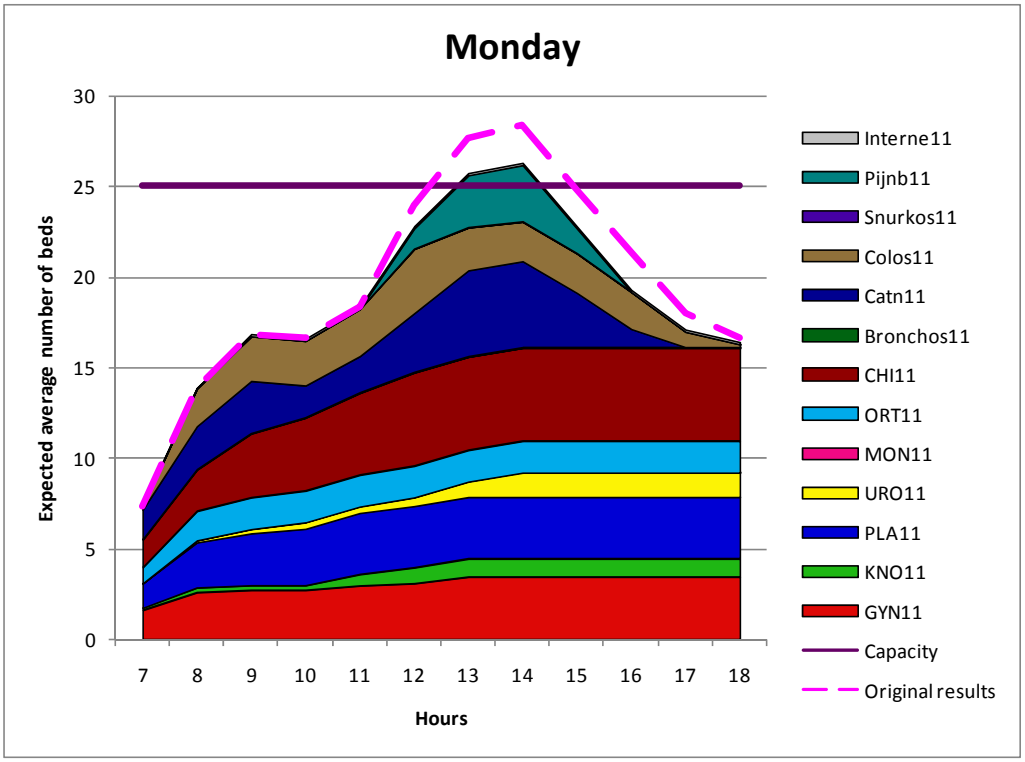


Figure 71: Projection of the expected number of beds on Monday resulting from scenario 24

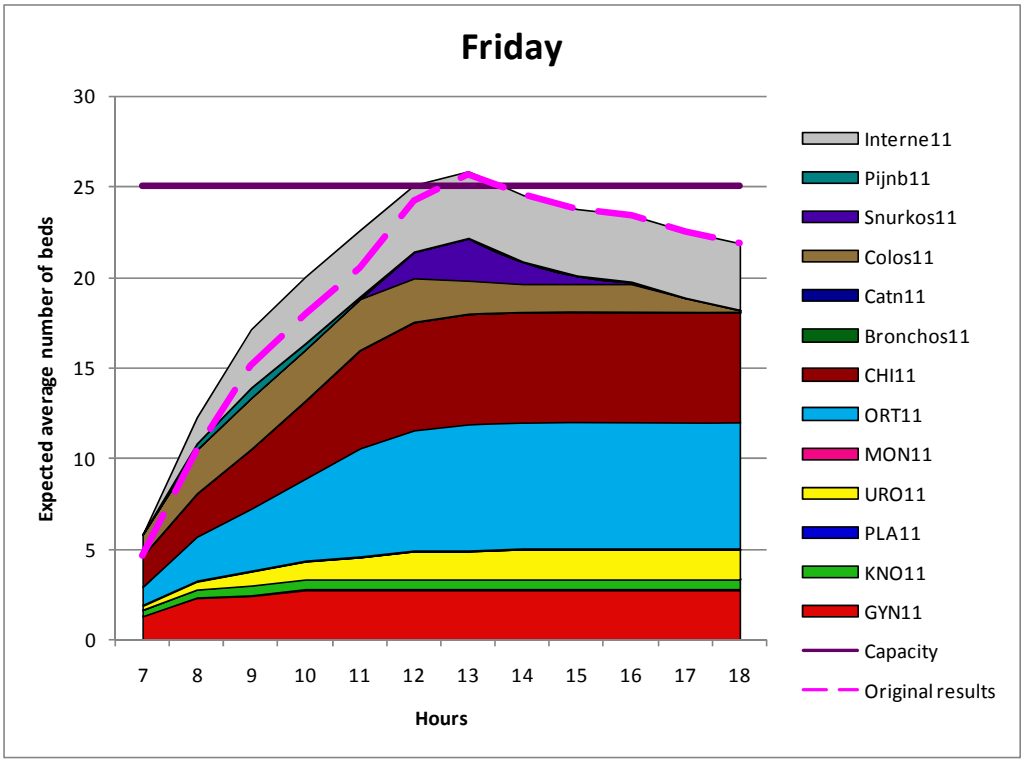


Figure 72: Projection of the expected number of beds on Friday resulting from scenario 24

Scenario 25: Colonoscopies from Monday afternoon to Friday afternoon

Comments: the same comments hold for this scenario as for scenario 23.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	10,0	10,9	10,4
9	16,9	24,8	14,8	16,8	15,1
10	16,6	27,6	17,4	18,0	18,0
11	18,4	28,1	19,2	18,1	20,6
12	22,8	33,1	22,3	22,2	25,4
13	25,8	35,8	23,7	25,0	27,5
14	26,3	33,8	23,2	24,4	26,6
15	22,8	29,3	23,4	21,9	25,8
16	19,3	27,0	23,4	20,1	25,5
17	17,1	24,3	21,4	18,6	23,4
18	16,4	22,5	19,7	16,9	22,1

Table 57: Sum of the number of beds per hour per day resulting from a move of colonoscopies from Monday afternoon to Friday afternoon

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	1,3		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	2,5		

Table 58: The maximum difference with capacity per day and measures of improvement for scenario 25

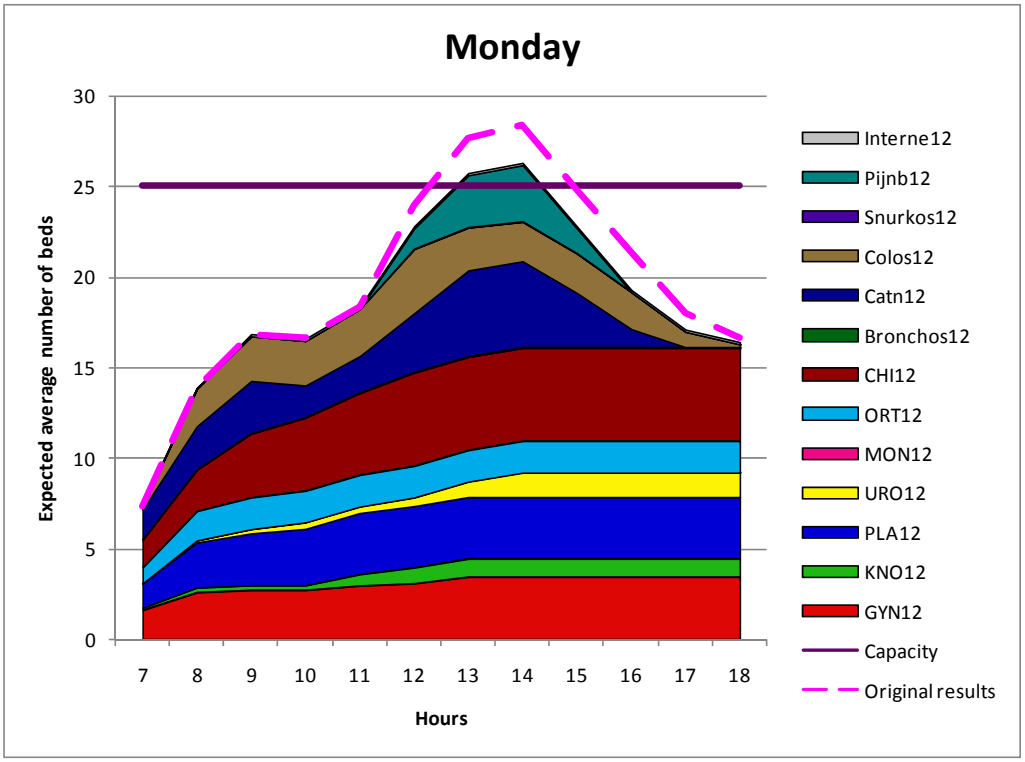


Figure 73: Projection of the expected number of beds on Monday resulting from scenario 25

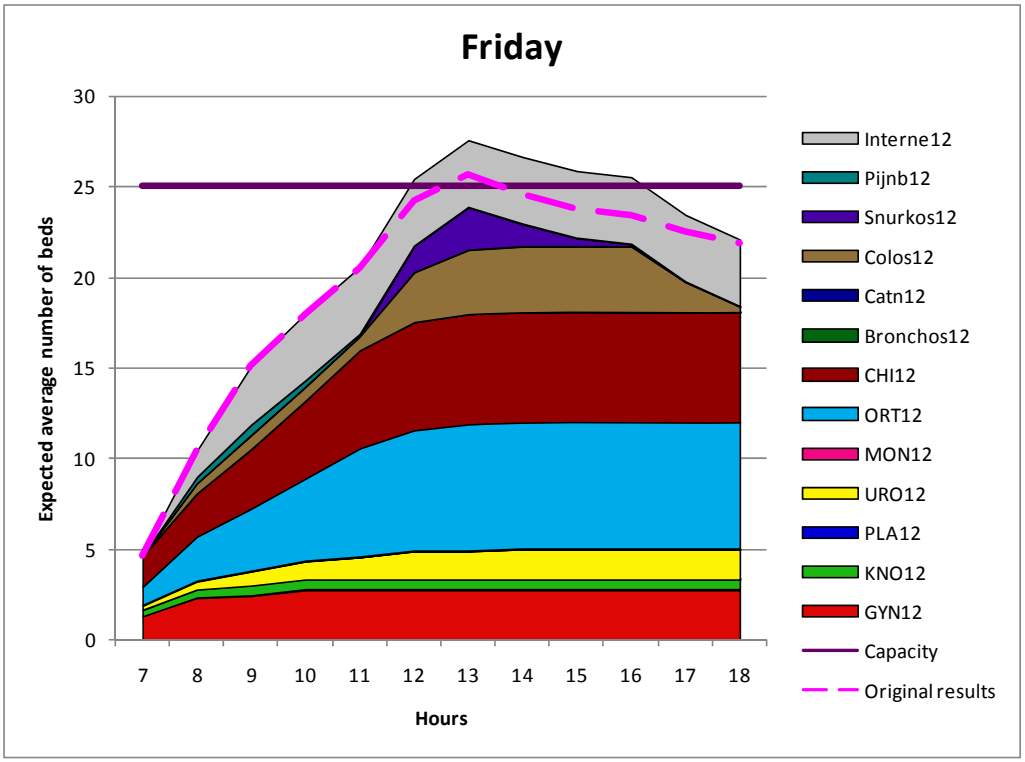


Figure 74: Projection of the expected number of beds on Friday resulting from scenario 25

Scenario 26: Cataracts from Monday to Wednesday

Comments: Moving cataracts away from Monday has a big effect on the number of patients per hour (see Figure 75). It has pushed the graph further below capacity than either scenario 14 and 15 and has filled up the graph on Wednesday over capacity (Figure 76).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	5,8	10,3	6,8	5,7	4,7
8	11,5	18,4	12,4	10,9	10,4
9	14,0	24,8	17,7	16,8	15,1
10	14,9	27,6	19,2	18,0	18,0
11	16,4	28,1	21,2	18,1	20,6
12	20,8	33,1	25,6	22,2	24,2
13	22,9	35,8	28,4	25,0	25,7
14	23,6	33,8	28,0	24,4	24,6
15	21,9	29,3	26,4	21,9	23,8
16	20,4	27,0	24,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 59: Sum of the number of beds per hour per day resulting from a move of cataracts from Monday to Wednesday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	-1,4		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	3,4	**Standard deviation**	4,8
Thursday	25	0,0	**Coefficient of variation**	1,8
Friday	25	0,7		

Table 60: The maximum difference with capacity per day and measures of improvement for scenario 26

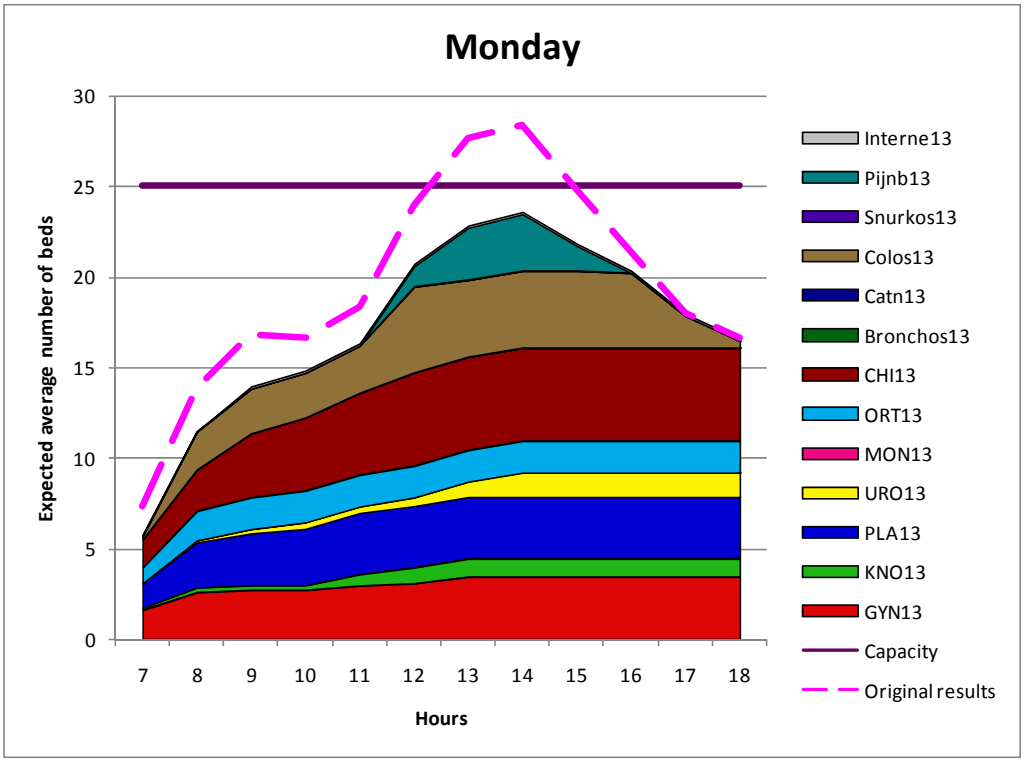


Figure 75: Projection of the expected number of beds on Monday resulting from scenario 26

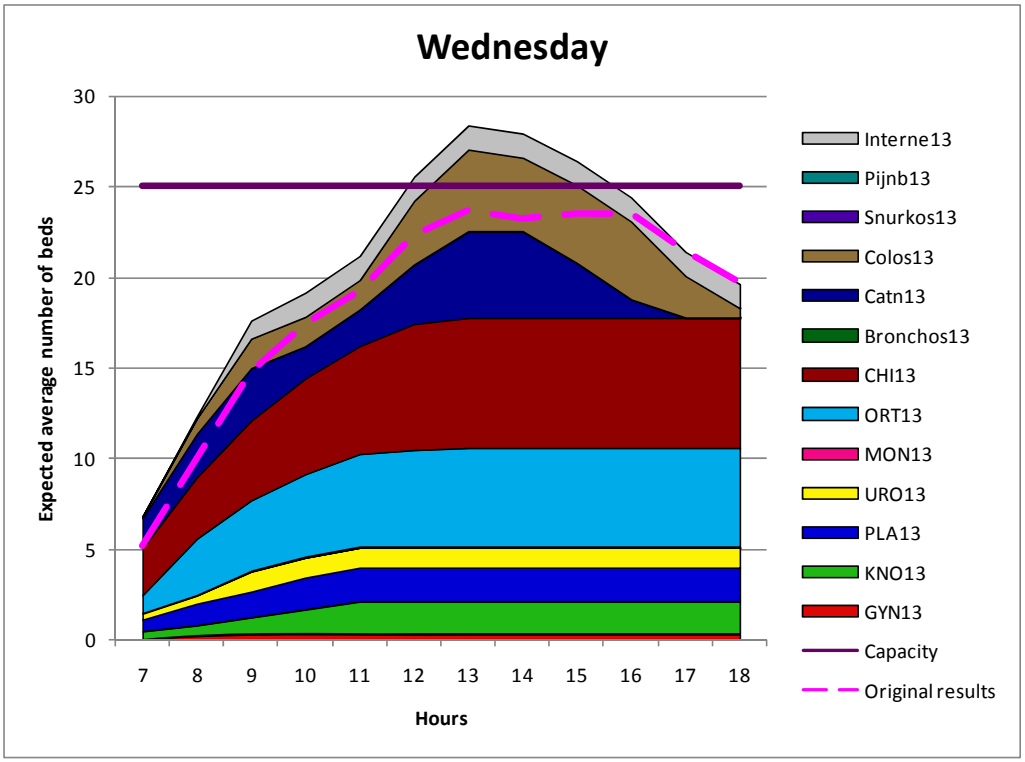


Figure 76: Projection of the expected number of beds on Wednesday resulting from scenario 26

Scenario 27: Cataracts from Monday to Friday

Comments: This move has the same effect on Monday as scenario 26 and has pushed the graph on Friday over capacity by 5,4 (Table 61).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	5,8	10,3	5,2	5,7	6,3
8	11,5	18,4	10,0	10,9	12,8
9	14,0	24,8	14,8	16,8	18,0
10	14,9	27,6	17,4	18,0	19,8
11	16,4	28,1	19,2	18,1	22,6
12	20,8	33,1	22,3	22,2	27,5
13	22,9	35,8	23,7	25,0	30,4
14	23,6	33,8	23,2	24,4	29,3
15	21,9	29,3	23,4	21,9	26,8
16	20,4	27,0	23,4	20,1	24,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 61: Sum of the number of beds per hour per day resulting from a move of cataracts from Monday to Friday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	-1,4		
Tuesday	25	10,8	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	5,3
Thursday	25	0,0	**Coefficient of variation**	2,0
Friday	25	5,4		

Table 62: The maximum difference with capacity per day and measures of improvement for scenario 27

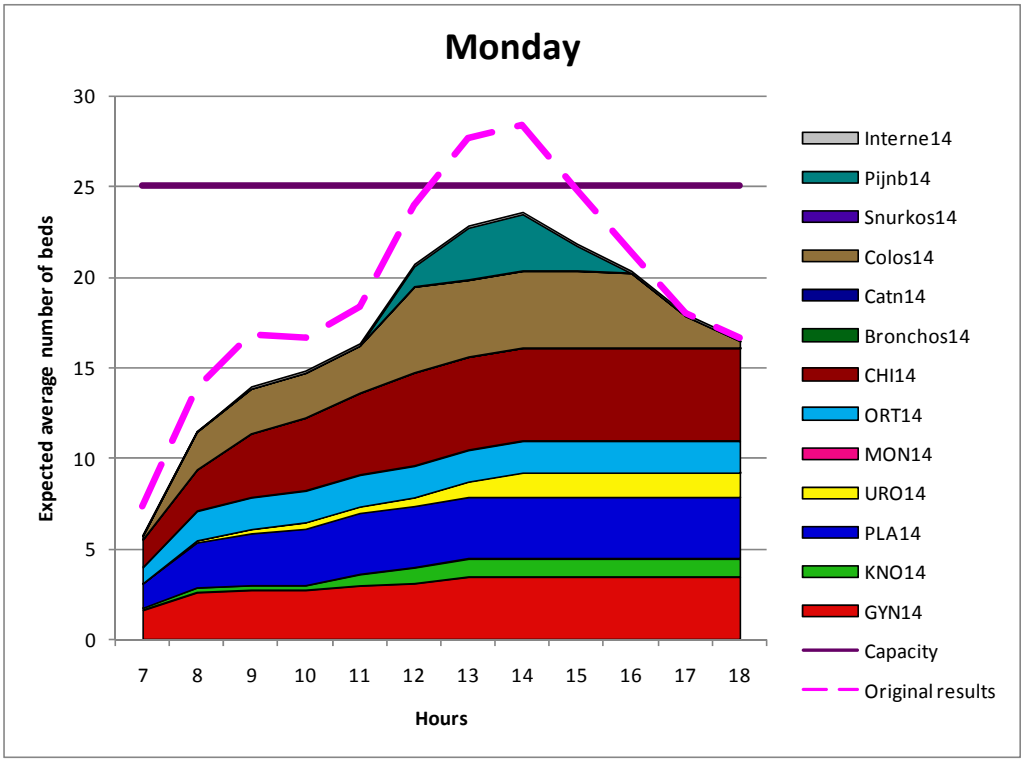


Figure 77: Projection of the expected number of beds on Monday resulting from scenario 27

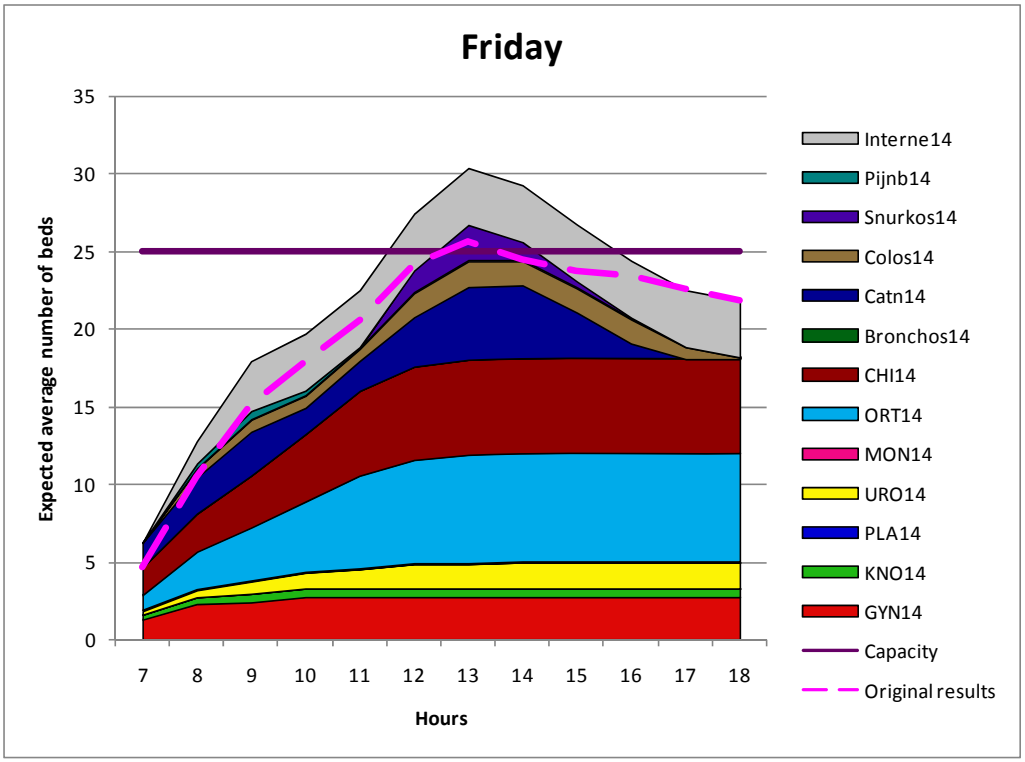


Figure 78: Projection of the expected number of beds on Friday resulting from scenario 27

Scenario 28: Cataracts from Tuesday to Wednesday

Comments: This move also has a big effect (Figure 79), however the effect is seen over the whole day and not just in the morning or the afternoon as with the other OPC programs. On Wednesday the graph has been pushed more over capacity (Figure 80).

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	7,9	7,6	5,7	4,7
8	13,9	14,4	14,0	10,9	10,4
9	16,9	19,5	20,0	16,8	15,1
10	16,6	23,1	21,9	18,0	18,0
11	18,4	23,6	23,7	18,1	20,6
12	24,0	27,9	27,6	22,2	24,2
13	27,6	31,1	28,3	25,0	25,7
14	28,4	30,6	26,3	24,4	24,6
15	24,9	28,1	24,6	21,9	23,8
16	21,4	26,9	23,6	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 63: Sum of the number of beds per hour per day resulting from a move of cataracts from Tuesday to Wednesday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	6,1	**Average**	2,7
Wednesday	25	3,3	**Standard deviation**	2,4
Thursday	25	0,0	**Coefficient of variation**	0,9
Friday	25	0,7		

Table 64: The maximum difference with capacity per day and measures of improvement for scenario 28

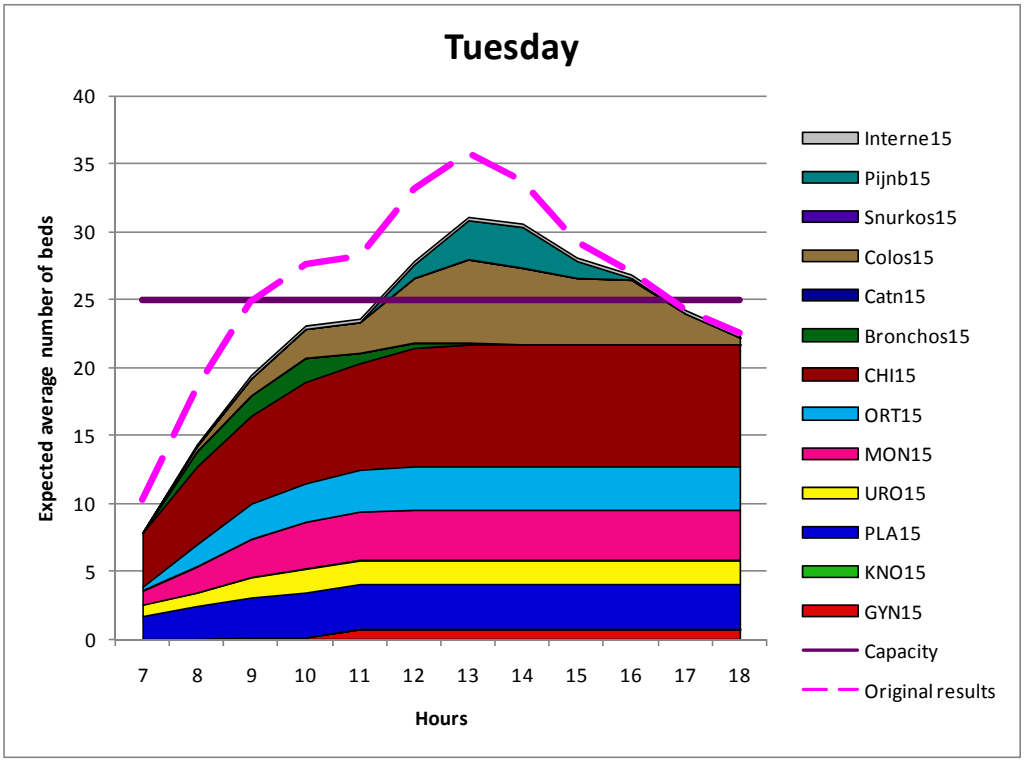


Figure 79: Projection of the expected number of beds on Tuesday resulting from scenario 28

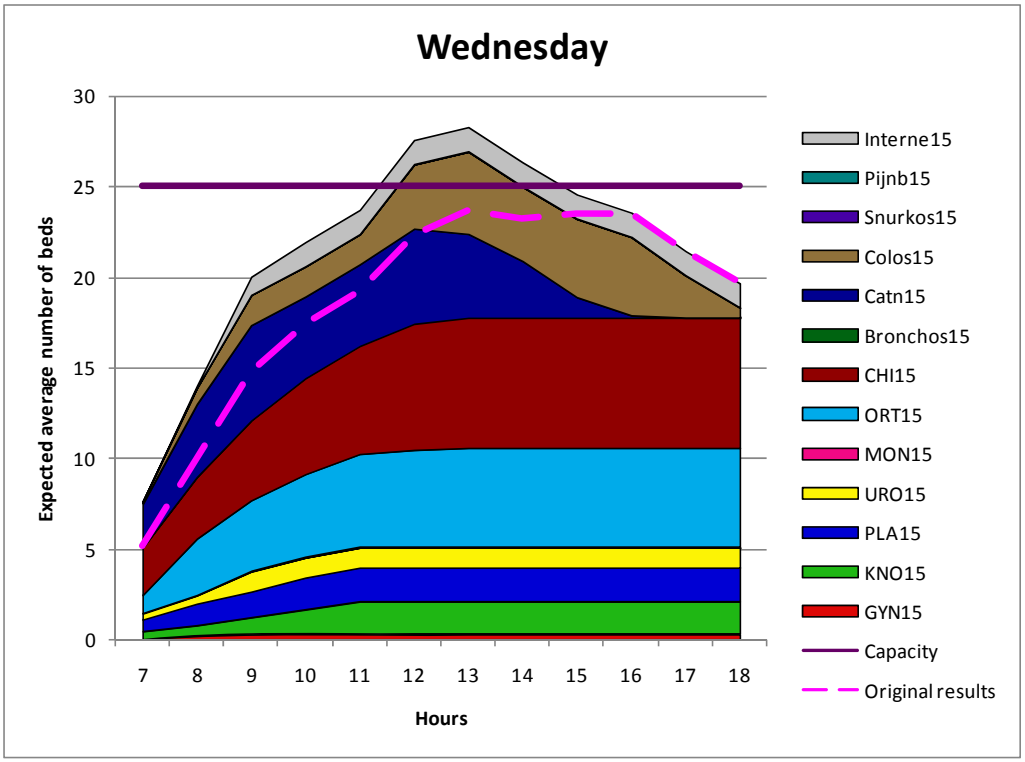


Figure 80: Projection of the expected number of beds on Wednesday resulting from scenario 28

Scenario 29: Cataracts from Tuesday to Friday

Comments: This move pushes the graph on Friday only 0,1 less over capacity than scenario 27 (see Table 65). The effect on Tuesday is of course the same as in scenario 28.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	7,9	5,2	5,7	7,0
8	13,9	14,4	10,0	10,9	14,4
9	16,9	19,5	14,8	16,8	20,4
10	16,6	23,1	17,4	18,0	22,5
11	18,4	23,6	19,2	18,1	25,1
12	24,0	27,9	22,3	22,2	29,5
13	27,6	31,1	23,7	25,0	30,3
14	28,4	30,6	23,2	24,4	27,7
15	24,9	28,1	23,4	21,9	24,9
16	21,4	26,9	23,4	20,1	23,6
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 65: Sum of the number of beds per hour per day resulting from a move of cataracts from Tuesday to Friday

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	6,1	**Average**	2,7
Wednesday	25	-1,3	**Standard deviation**	3,3
Thursday	25	0,0	**Coefficient of variation**	1,2
Friday	25	5,3		

Table 66: The maximum difference with capacity per day and measures of improvement for scenario 29

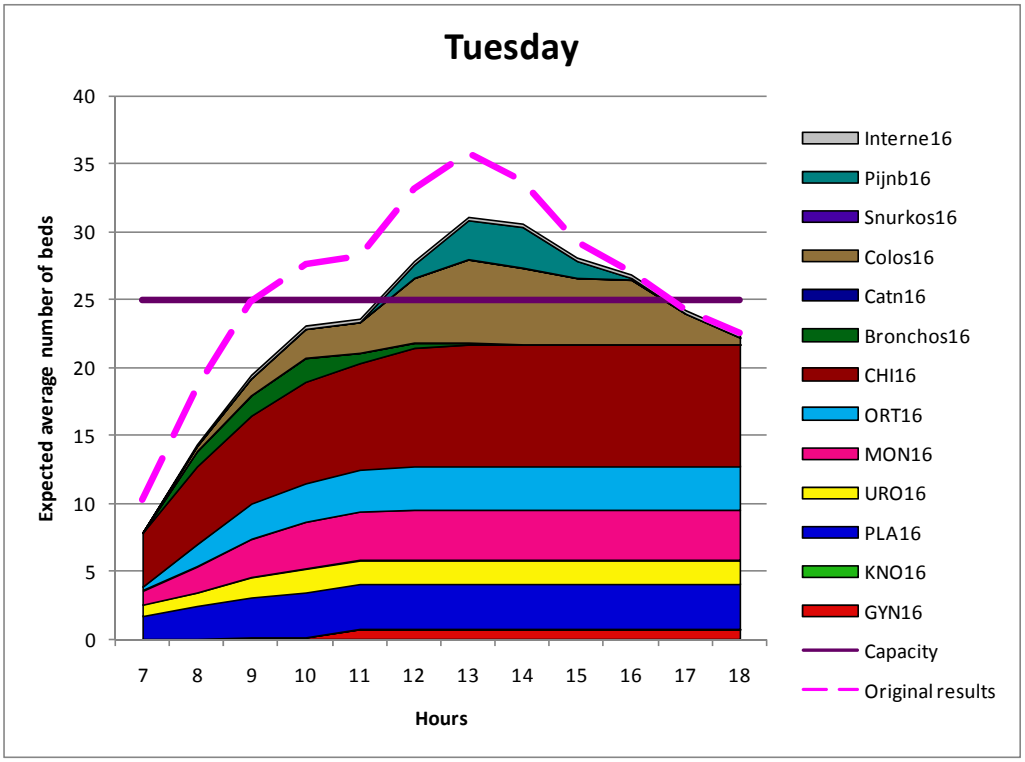


Figure 81: Projection of the expected number of beds on Tuesday resulting from scenario 29

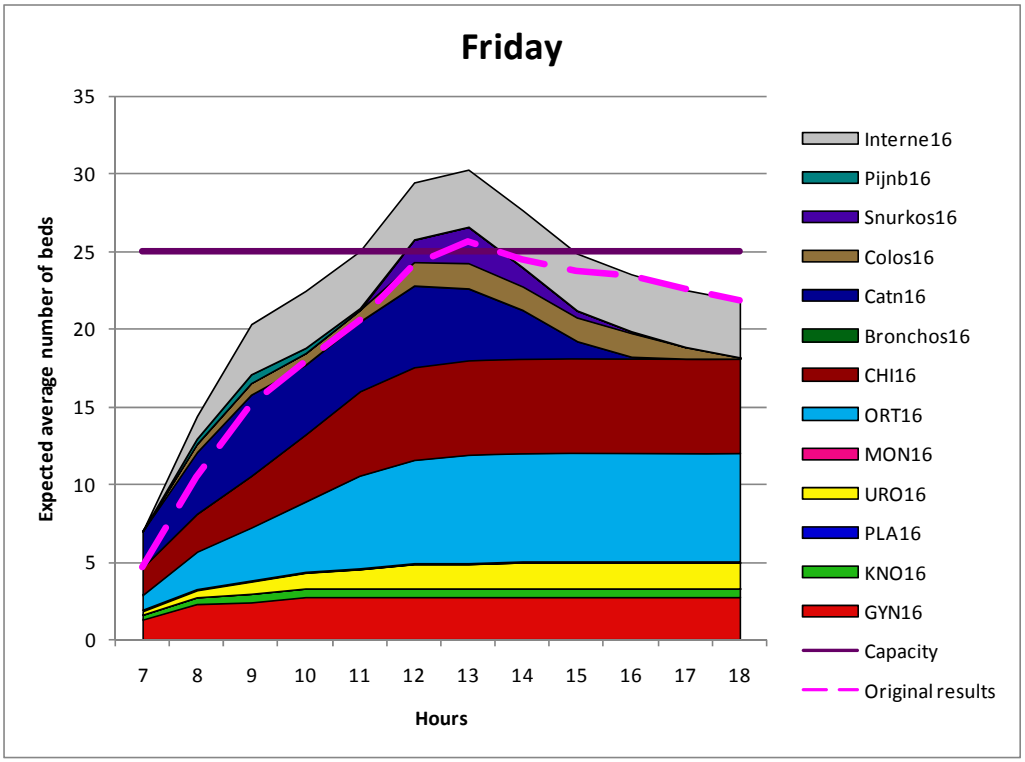


Figure 82: Projection of the expected number of beds on Friday resulting from scenario 29

Appendix F: Changing the length of stay

Scenario 30: Bronchoscopies

Reducing the LOS from two to one hour has no notable effect on the expected number number of beds needed per hour on the ASW. In the graphs you can only see a difference in the morning because bronchoscopies are always morning programs.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	10,0	10,9	10,4
9	16,9	24,8	14,8	16,8	15,1
10	16,6	26,5	17,4	16,0	18,0
11	18,4	27,8	19,2	17,7	20,6
12	24,0	32,9	22,3	21,9	24,2
13	27,6	35,6	23,7	24,7	25,7
14	28,4	33,8	23,2	24,4	24,6
15	24,9	29,3	23,4	21,9	23,8
16	21,4	27,0	23,4	20,1	23,4
17	18,0	24,3	21,4	18,6	22,6
18	16,6	22,5	19,7	16,9	21,9

Table 67: The expected number of beds as a result of a change in LOS for bronchoscopies from 2 to 1 hour.

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,4		
Tuesday	25	10,6	**Average**	2,6
Wednesday	25	-1,3	**Standard deviation**	4,8
Thursday	25	-0,3	**Coefficient of variation**	1,9
Friday	25	0,7		

Table 68: The maximum difference with capacity per day and measures of improvement for scenario 30

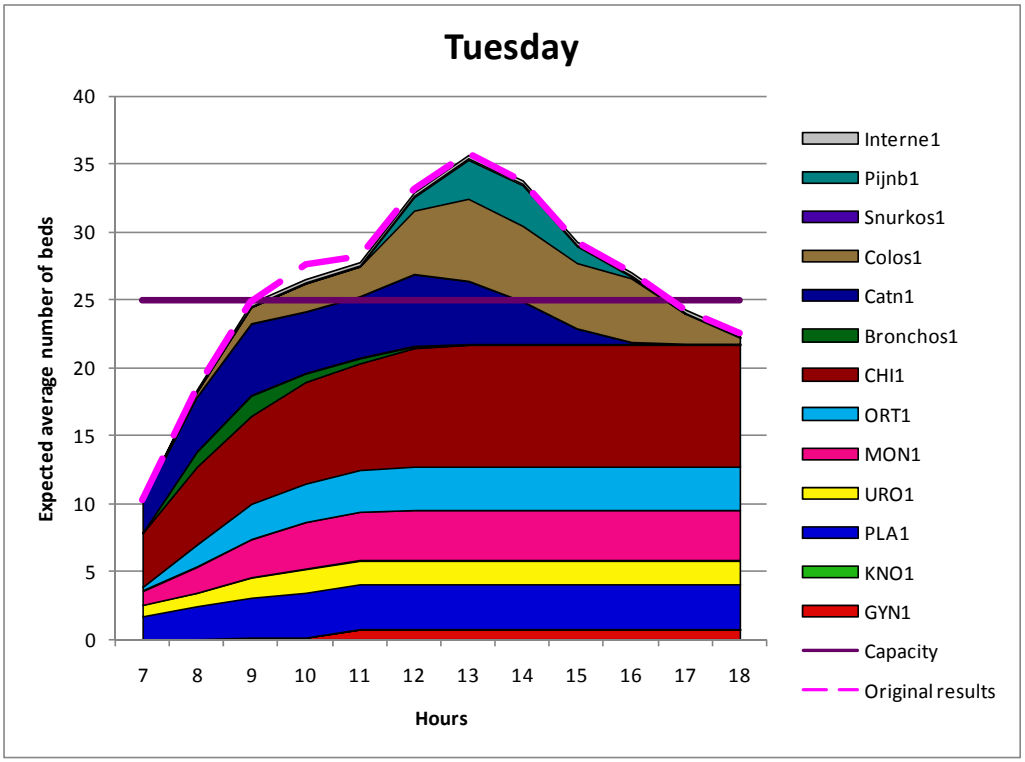


Figure 83: Projection of the expected number of beds resulting from scenario 30

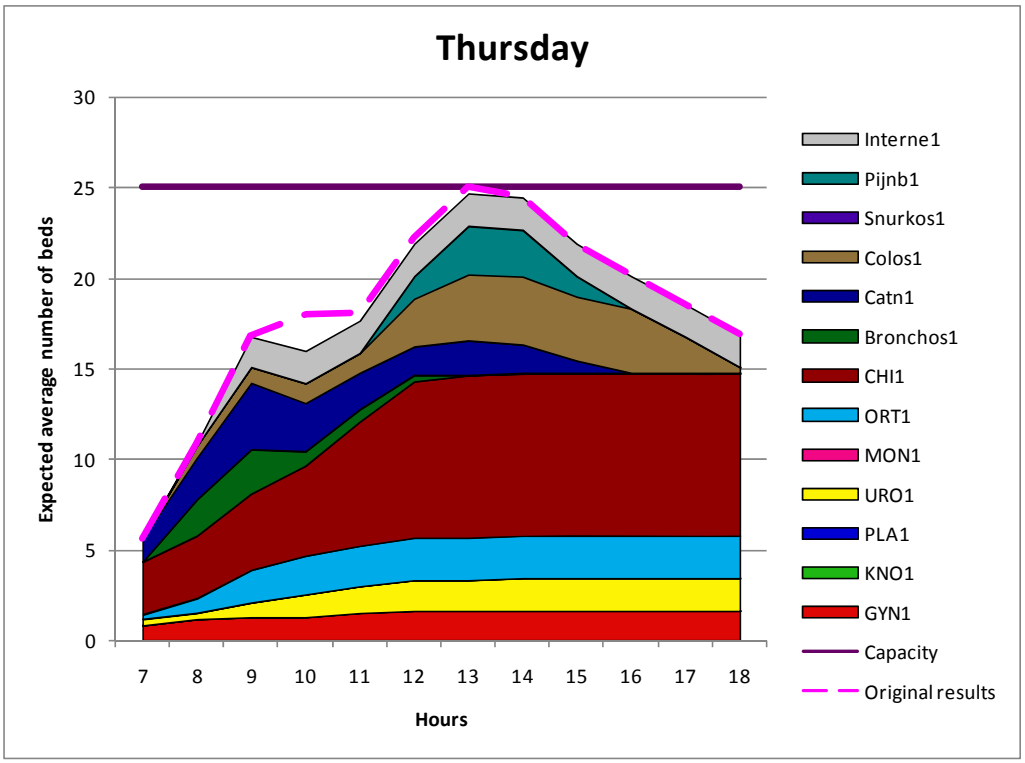


Figure 84: Projection of the expected number of beds resulting from scenario 30

Scenario 31: Colonoscopies

Reducing the LOS from four to two hours has a notable effect on the number of beds needed per hour on the ASW as can be seen in Table 69. The graphs regarding Monday, Thursday and Friday clearly show a more defined break between the morning and afternoon program as a result of the reduction. On Tuesday and Wednesday this effect can be seen but is less defined.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	10,3	5,2	5,7	4,7
8	13,9	18,4	10,0	10,9	10,4
9	16,9	24,8	14,8	16,8	15,1
10	16,4	27,6	17,3	18,0	18,0
11	16,3	27,8	18,3	17,4	20,0
12	21,8	31,9	20,8	21,3	23,4
13	27,3	34,0	22,9	24,6	25,4
14	28,3	32,8	23,2	24,2	24,6
15	22,4	26,6	21,4	20,3	23,0
16	17,6	22,8	19,7	16,9	22,0
17	16,3	22,1	19,3	16,6	21,8
18	16,3	22,0	19,1	16,6	21,8

Table 69: The number of beds as a result of a change in LOS for colonoscopies from 4 to 2 hours.

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	3,3		
Tuesday	25	9,0	**Average**	2,1
Wednesday	25	-1,8	**Standard deviation**	4,3
Thursday	25	-0,4	**Coefficient of variation**	2,0
Friday	25	0,4		

Table 70: The maximum difference with capacity per day and measures of improvement for scenario 31

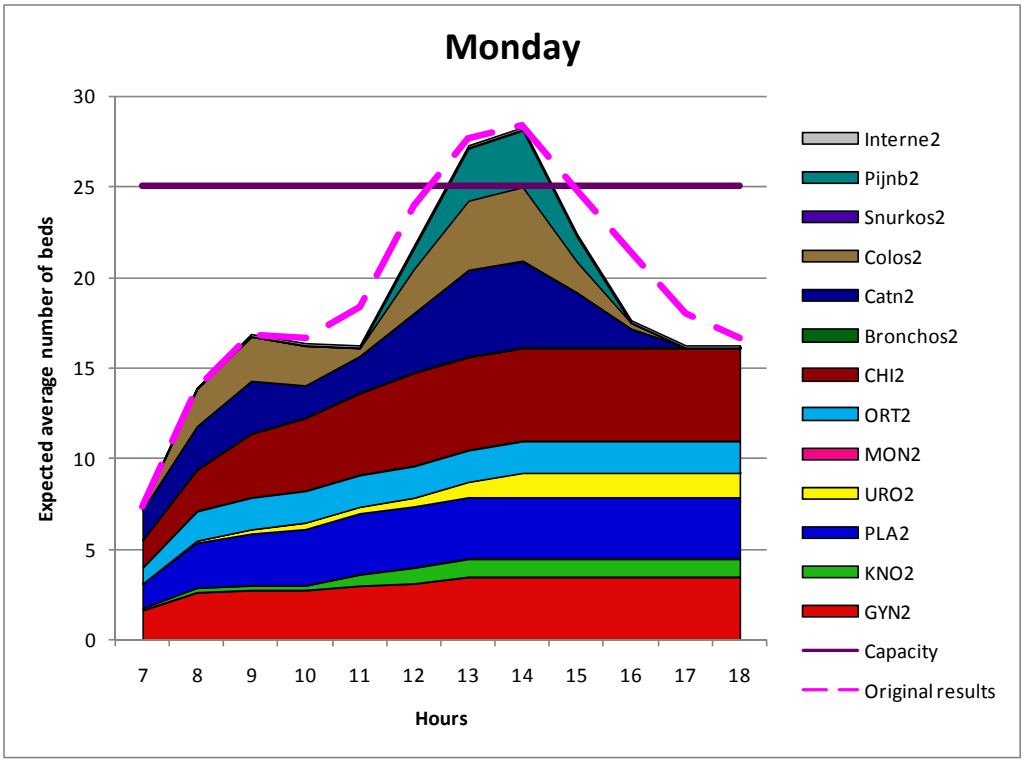


Figure 85: Projection of the expected number of beds on Monday resulting from scenario 31

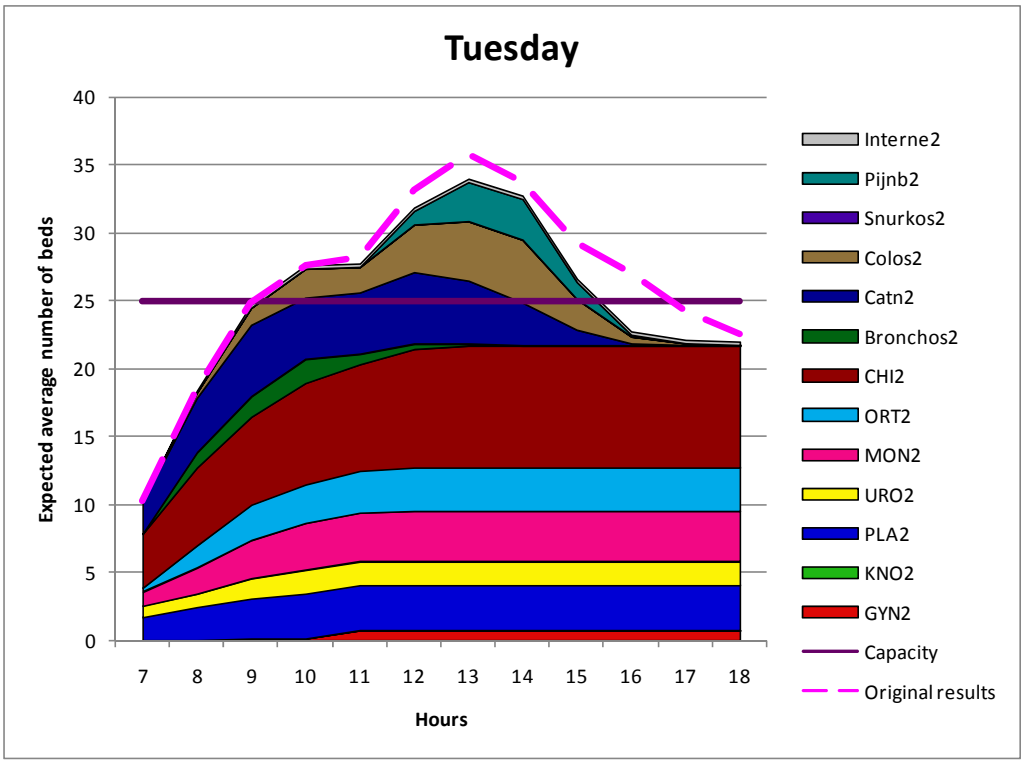


Figure 86: Projection of the expected number of beds on Tuesday resulting from scenario 31

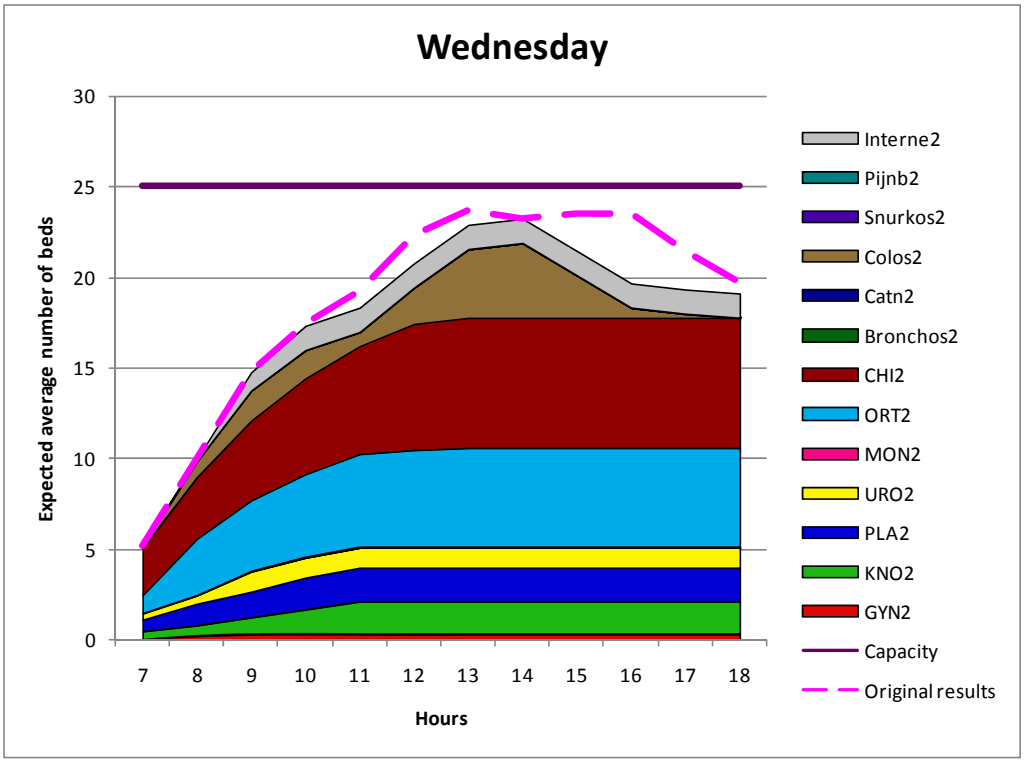


Figure 87: Projection of the expected number of beds on Wednesday resulting from scenario 31

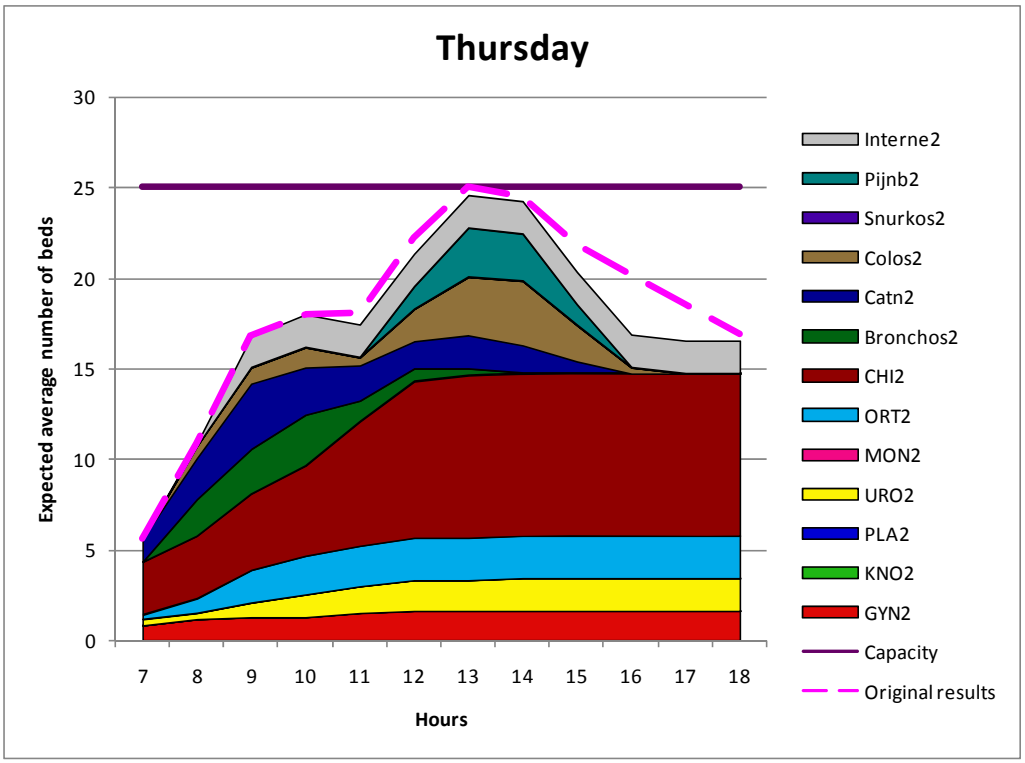


Figure 88: Projection of the expected number of beds on Thursday resulting from scenario 31

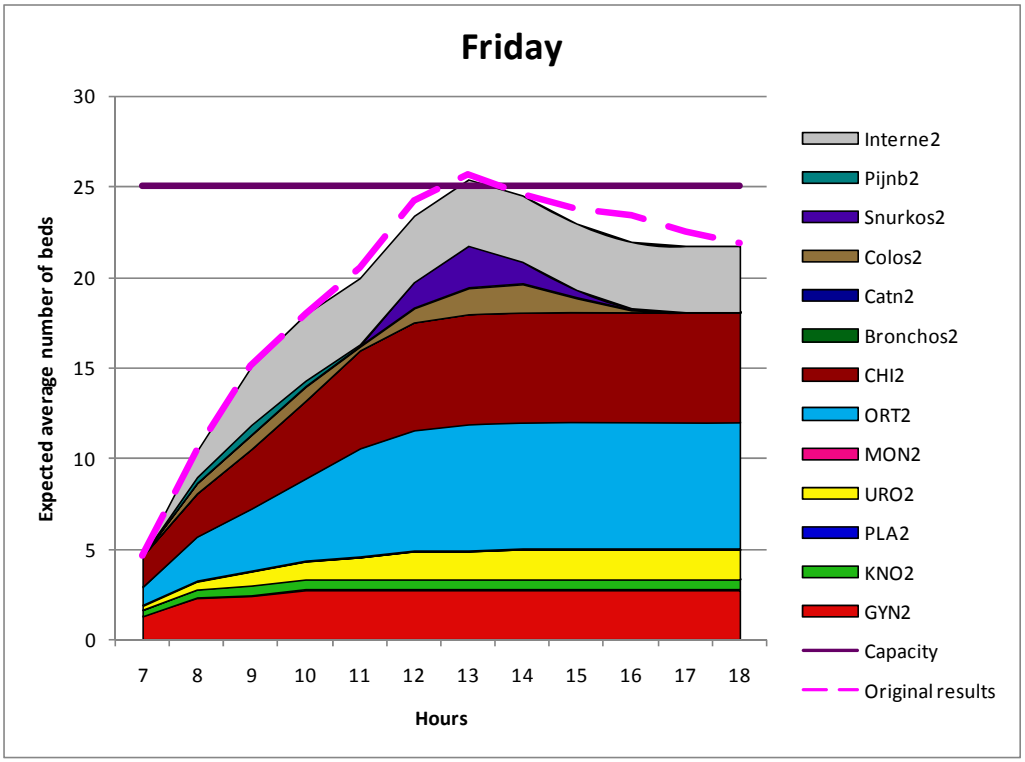


Figure 89: Projection of the expected number of beds on Friday resulting from scenario 31

Appendix G: Results

Part 1: All favorable interventions

The result of implementing scenarios 1, 7, 14, 18, 19, 28 and 31:

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	7,4	9,7	9,4	4,7
8	13,9	13,9	18,8	15,7	10,4
9	16,9	17,6	25,9	21,7	15,1
10	16,4	17,0	26,6	20,7	18,0
11	16,3	16,0	26,3	19,9	20,0
12	20,6	17,1	29,7	22,0	23,4
13	24,4	18,4	31,1	25,3	25,4
14	25,1	18,8	30,0	25,7	24,6
15	21,0	17,9	26,2	24,4	23,0
16	17,6	16,0	23,4	21,2	22,0
17	16,3	15,4	23,0	20,6	21,8
18	16,3	15,1	22,7	20,3	21,8

Table 71: The number of beds as a result of all the interventions

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,1		
Tuesday	25	-6,2	**Average**	0,2
Wednesday	25	6,1	**Standard deviation**	4,4
Thursday	25	0,7	**Coefficient of variation**	17,8
Friday	25	0,4		

Table 72: The maximum difference with capacity per day and measures of improvement for implementing scenarios 1, 7, 14, 18, 19, 28 and 31

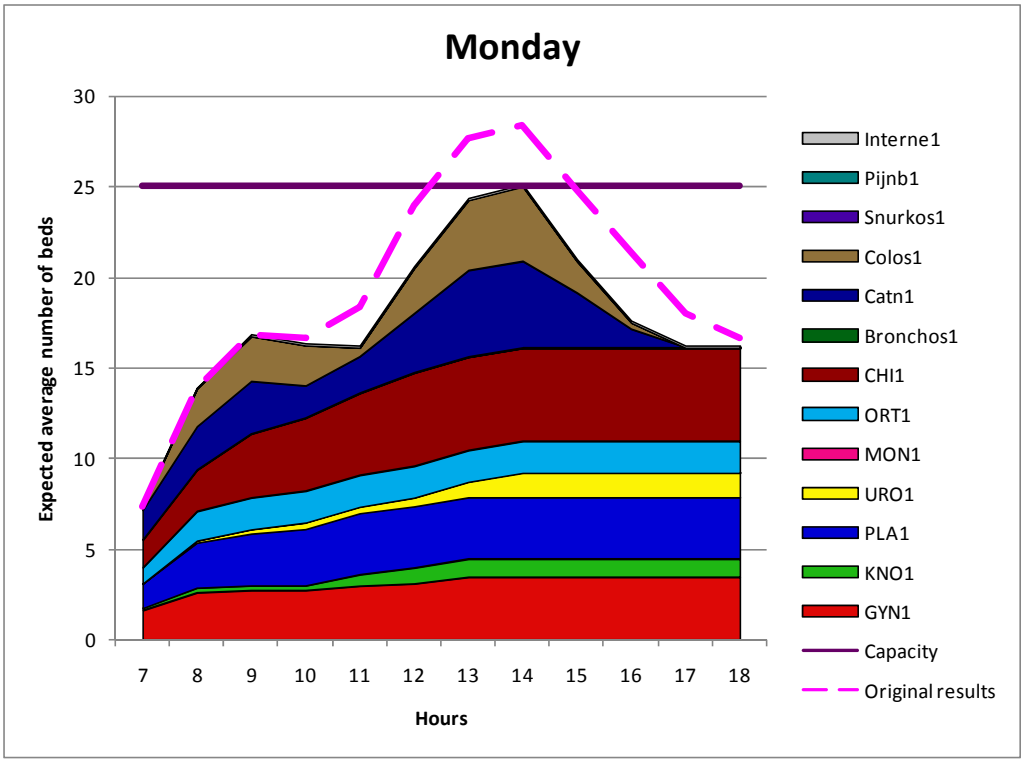


Figure 90: Projection of the expected number of beds on Monday resulting from implementing scenarios 1, 7, 14, 18, 19, 28 and 31

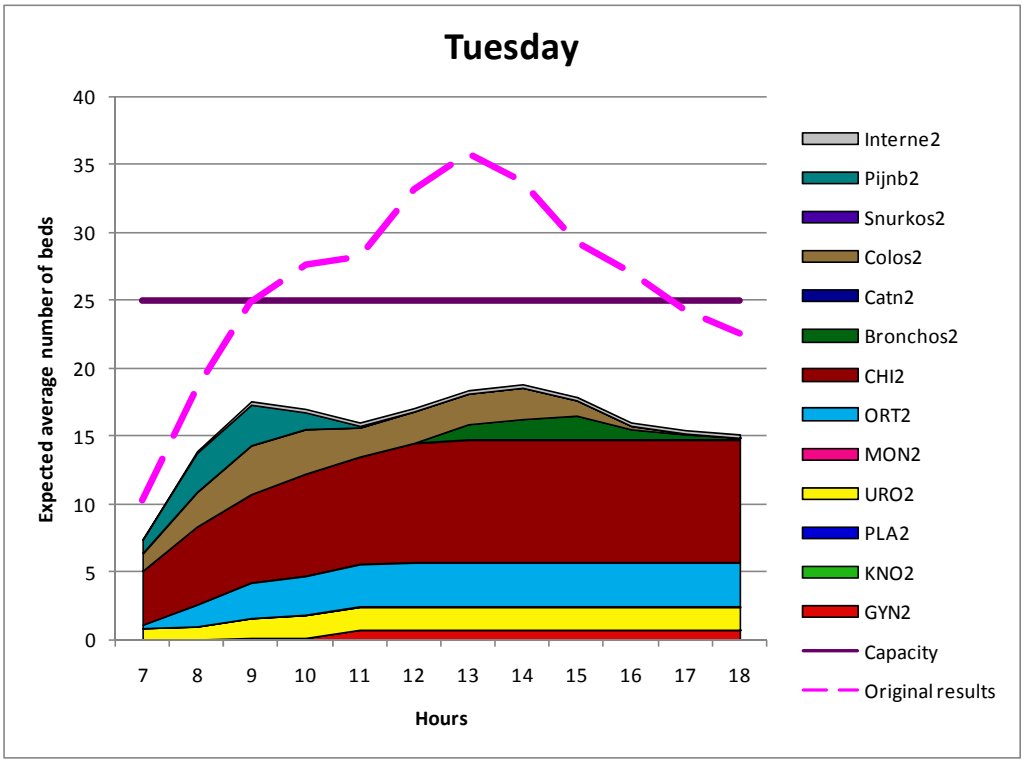


Figure 91: Projection of the expected number of beds on Tuesday resulting from implementing scenarios 1, 7, 14, 18, 19, 28 and 31

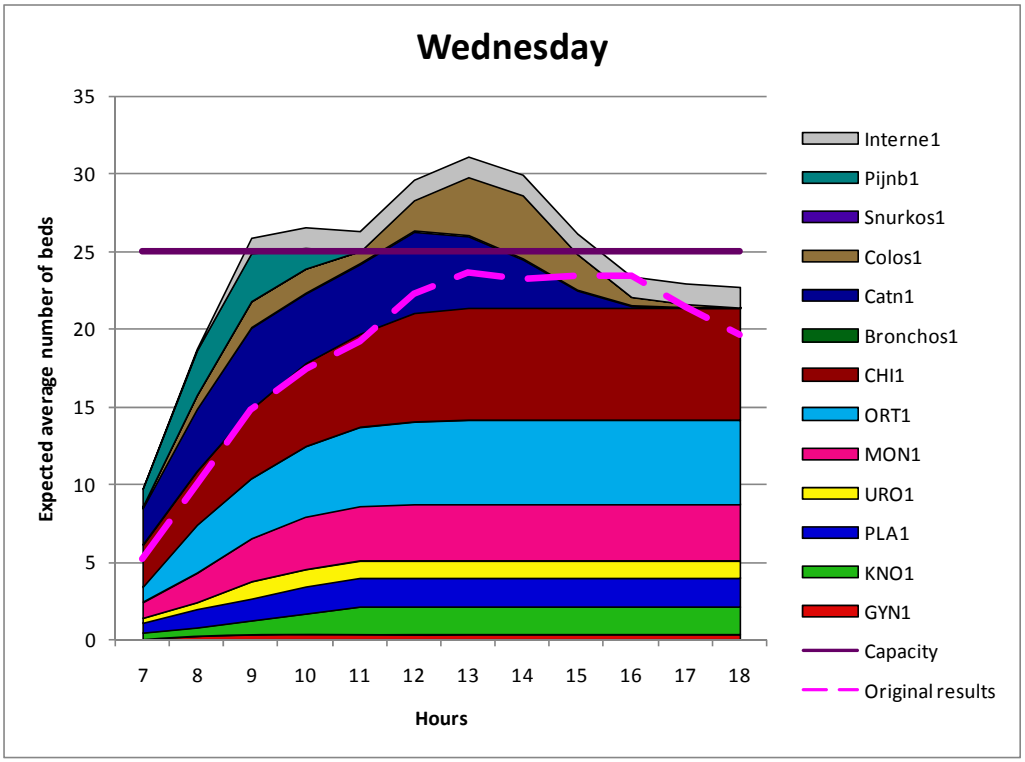


Figure 92: Projection of the expected number of beds on Wednesday resulting from implementing scenarios 1, 7, 14, 18, 19, 28 and 31

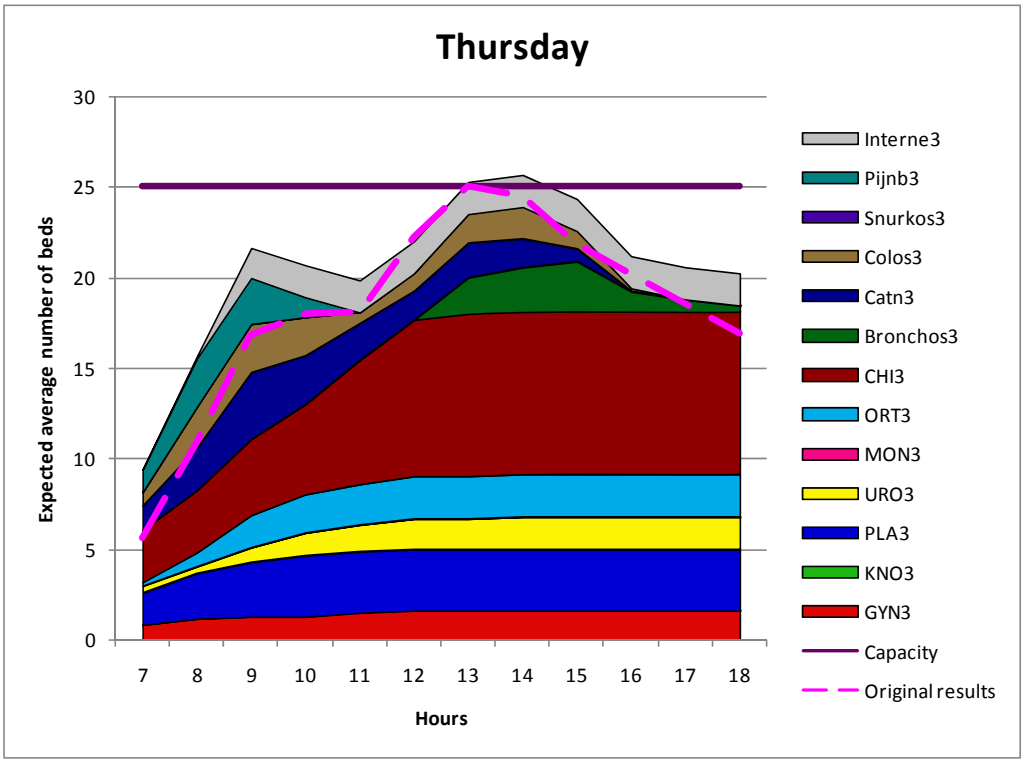


Figure 93: Projection of the expected number of beds on Thursday resulting from implementing scenarios 1, 7, 14, 18, 19, 28 and 31

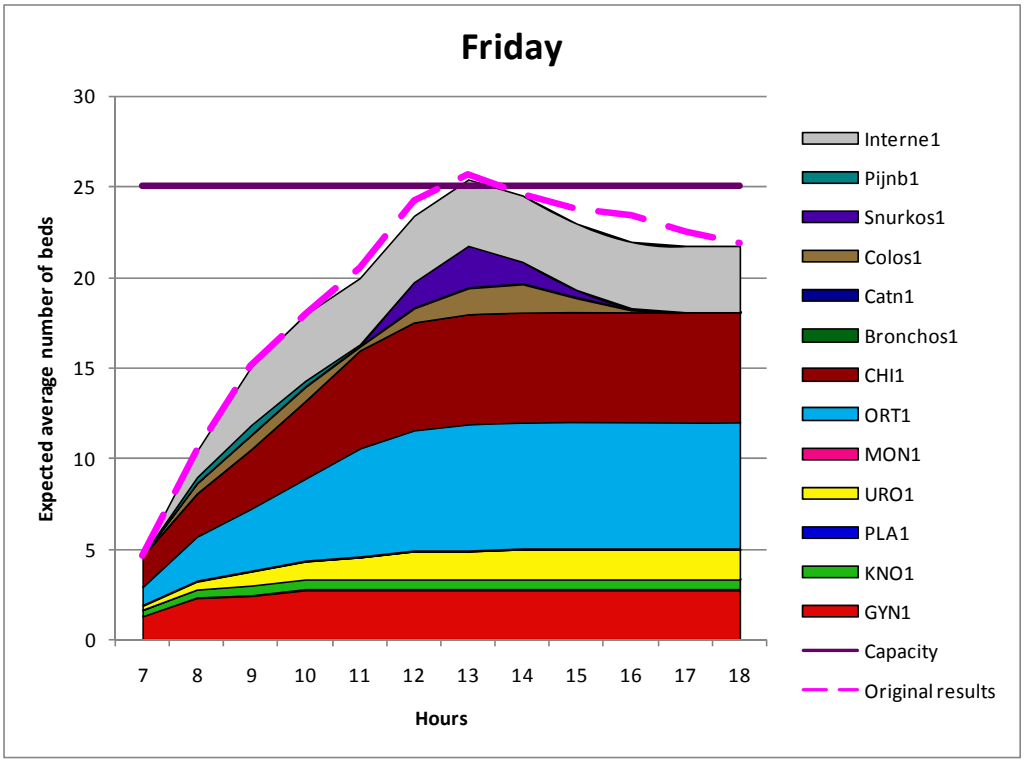


Figure 94: Projection of the expected number of beds on Friday resulting from implementing scenarios 1, 7, 14, 18, 19, 28 and 31

Part 2: All interventions minus scenario 1

The result of implementing scenarios 7, 14, 18, 19, 28 and 31:

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	8,4	8,7	9,4	4,7
8	13,9	15,8	16,9	15,7	10,4
9	16,9	20,3	23,2	21,7	15,1
10	16,4	20,4	23,2	20,7	18,0
11	16,3	19,5	22,8	19,9	20,0
12	20,6	20,7	26,0	22,0	23,4
13	24,4	22,0	27,5	25,3	25,4
14	25,1	22,4	26,3	25,7	24,6
15	21,0	21,5	22,6	24,4	23,0
16	17,6	19,6	19,8	21,2	22,0
17	16,3	19,1	19,3	20,6	21,8
18	16,3	18,8	19,1	20,3	21,8

Table 73: The number of beds as a result of scenarios 7, 14, 18, 19, 28 and 31

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,1		
Tuesday	25	-2,6	**Average**	0,2
Wednesday	25	2,5	**Standard deviation**	1,8
Thursday	25	0,7	**Coefficient of variation**	7,4
Friday	25	0,4		

Table 74: The maximum difference with capacity per day and measures of improvement for implementing scenarios 7, 14, 18, 19, 28 and 31

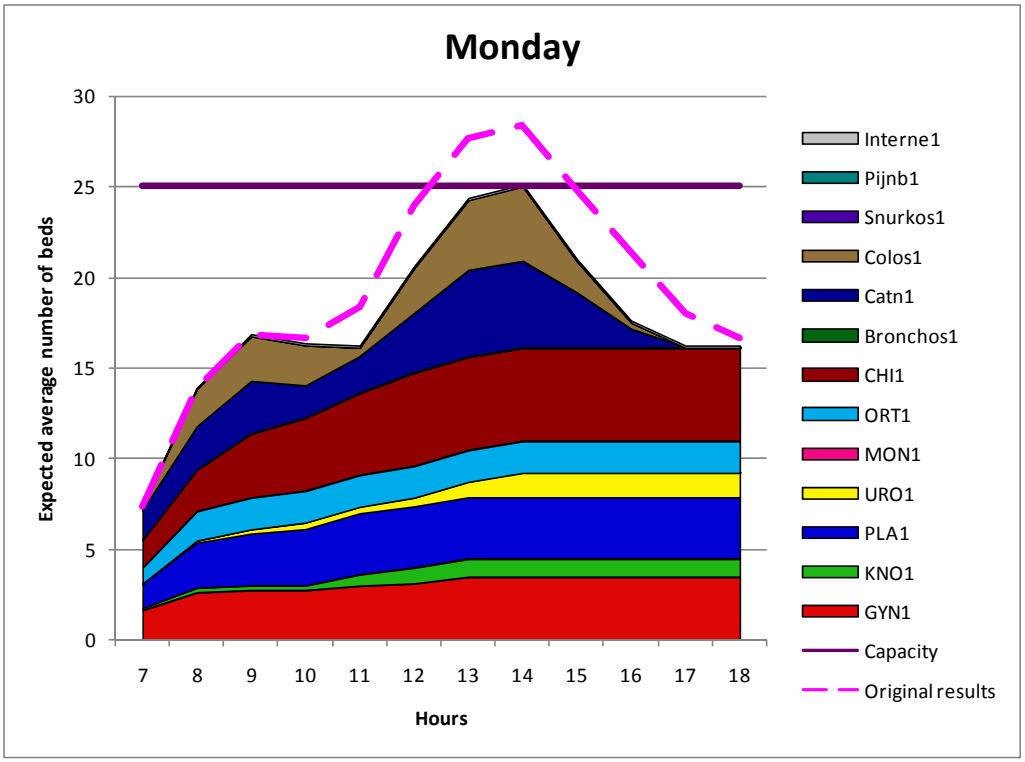


Figure 95: Projection of the expected number of beds on Monday resulting from implementing scenarios 7, 14, 18, 19, 28 and 31

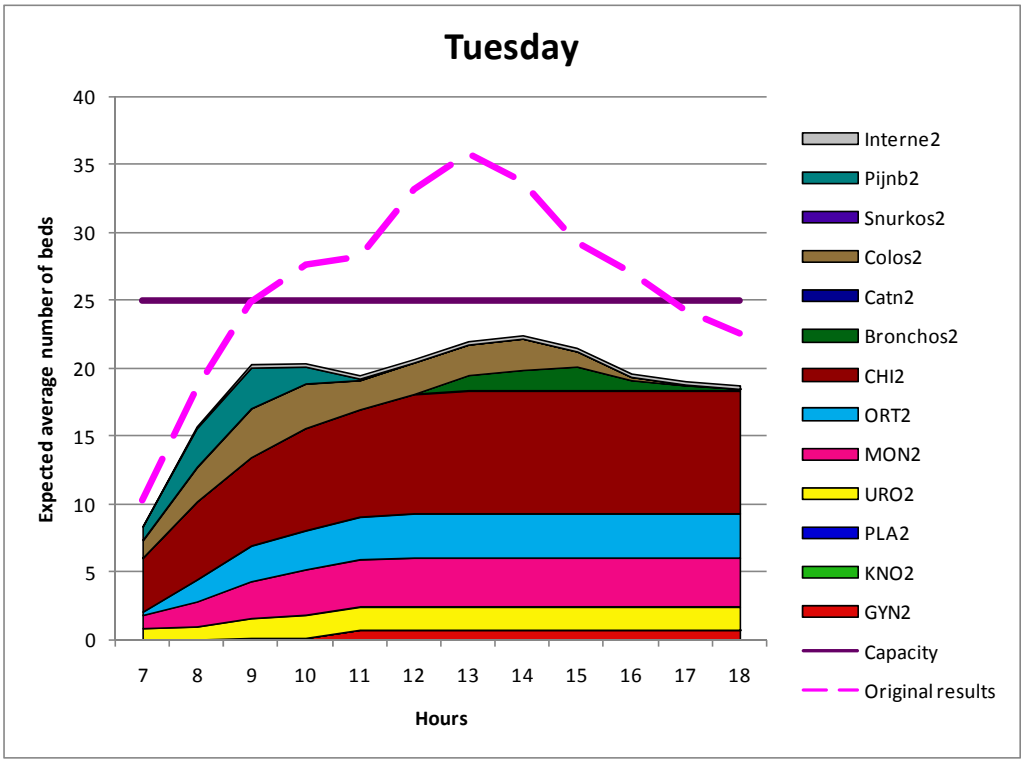


Figure 96: Projection of the expected number of beds on Tuesday resulting from implementing scenarios 7, 14, 18, 19, 28 and 31

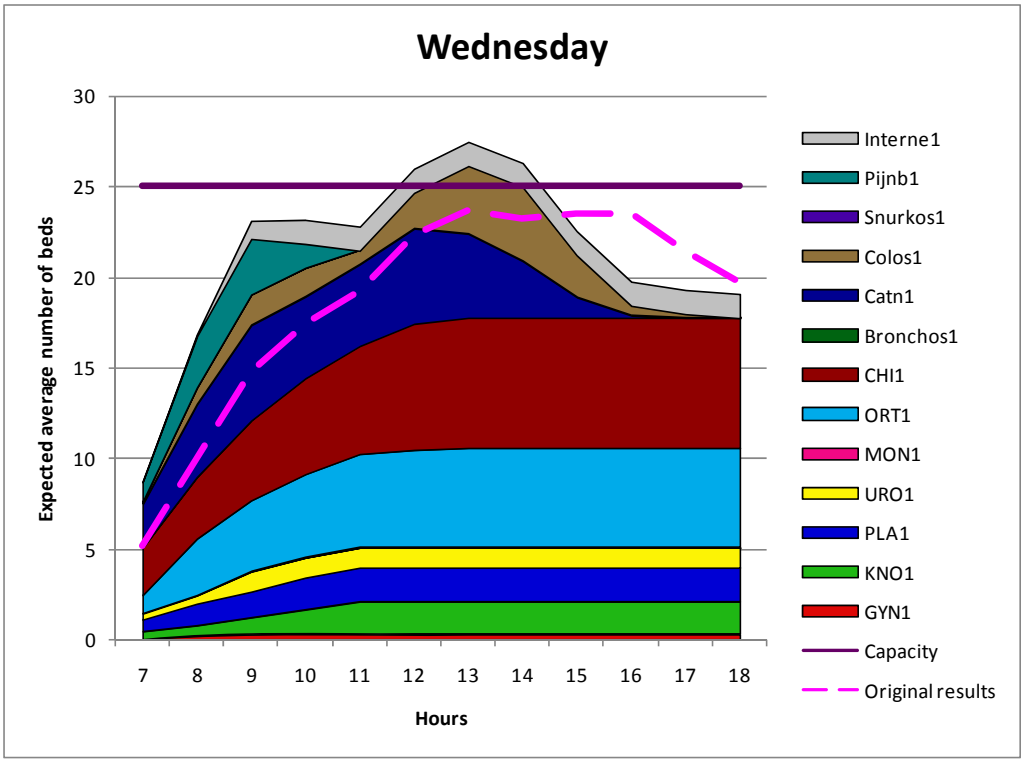


Figure 97: Projection of the expected number of beds on Wednesday resulting from implementing scenarios 7, 14, 18, 19, 28 and 31

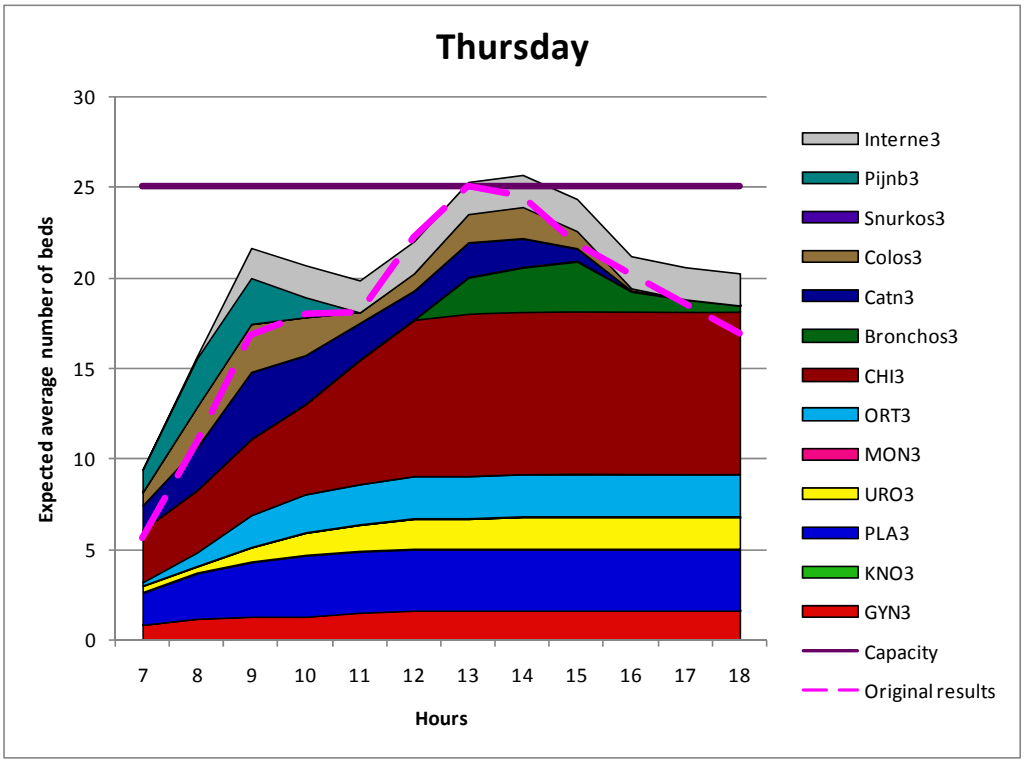


Figure 98: Projection of the expected number of beds on Thursday resulting from implementing scenarios 7, 14, 18, 19, 28 and 31

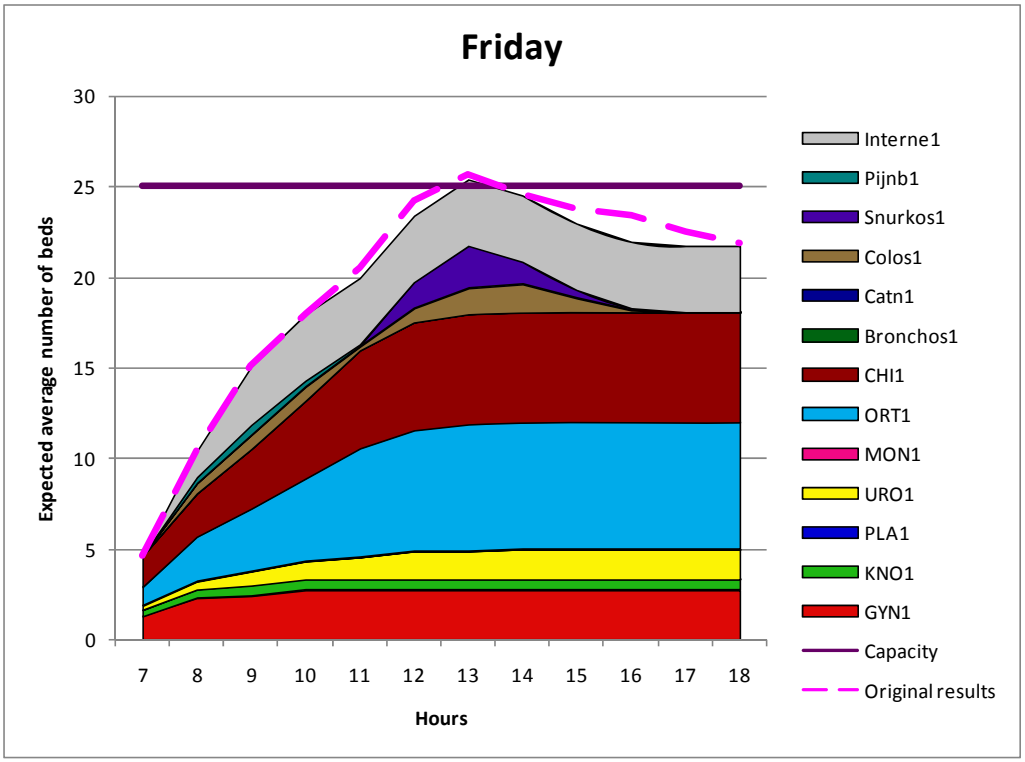


Figure 99: Projection of the expected number of beds on Friday resulting from implementing scenarios 7, 14, 18, 19, 28 and 31

Part 2: All interventions minus scenario 28

The result of implementing scenarios 1, 7, 14, 18, 19 and 31:

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7	7,4	9,8	7,3	9,4	4,7
8	13,9	17,9	14,8	15,7	10,4
9	16,9	22,8	20,7	21,7	15,1
10	16,4	21,5	22,1	20,7	18,0
11	16,3	20,5	21,8	19,9	20,0
12	20,6	22,3	24,4	22,0	23,4
13	24,4	23,0	26,5	25,3	25,4
14	25,1	21,9	26,8	25,7	24,6
15	21,0	19,0	25,1	24,4	23,0
16	17,6	16,1	23,3	21,2	22,0
17	16,3	15,4	23,0	20,6	21,8
18	16,3	15,1	22,7	20,3	21,8

Table 75: The number of beds as a result of scenarios 1, 7, 14, 18, 19 and 31

Number of beds on ASW		Maximal difference	Measures of improvement	
Monday	25	0,1		
Tuesday	25	-2,0	**Average**	0,2
Wednesday	25	1,8	**Standard deviation**	1,4
Thursday	25	0,7	**Coefficient of variation**	6,2
Friday	25	0,4		

Table 76: The maximum difference with capacity per day and measures of improvement for implementing scenarios 1, 7, 14, 18, 19 and 31

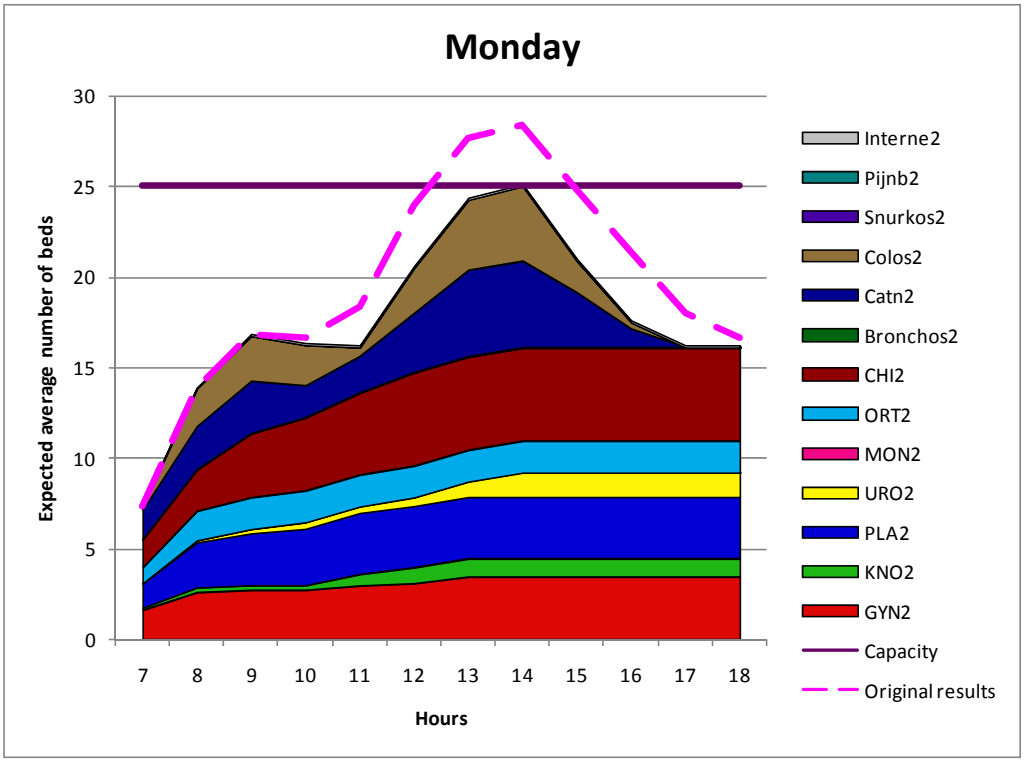


Figure 100: Projection of the expected number of beds on Monday resulting from implementing scenarios 1, 7, 14, 18, 19 and 31

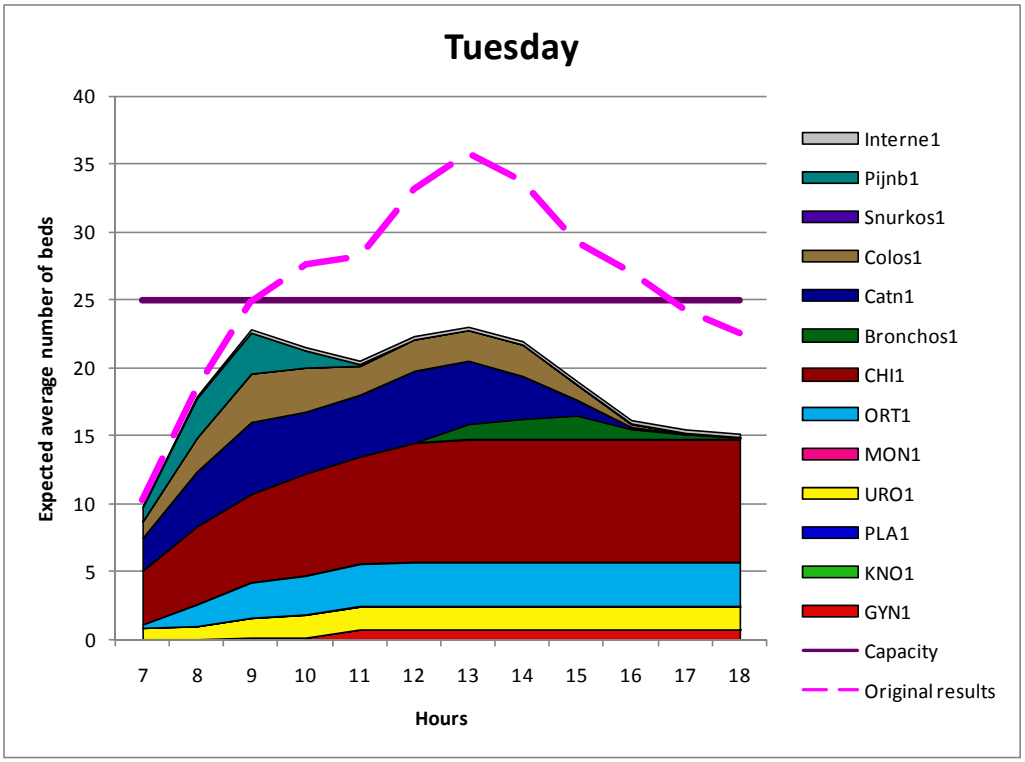


Figure 101: Projection of the expected number of beds on Tuesday resulting from implementing scenarios 1, 7, 14, 18, 19 and 31

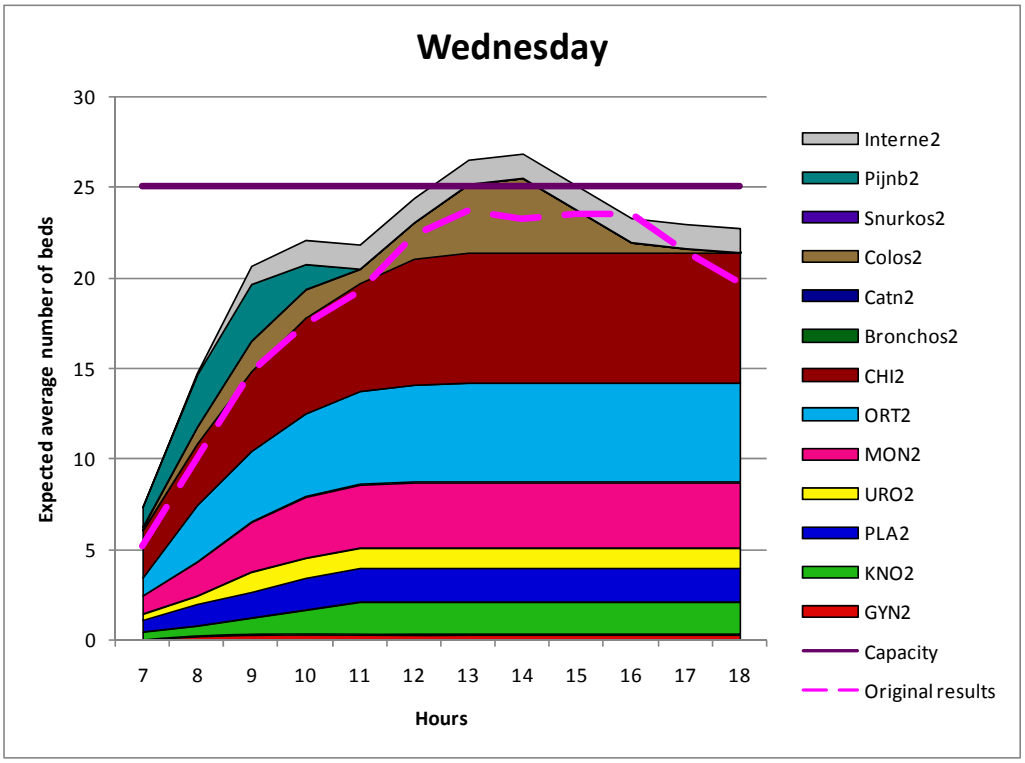


Figure 102: Projection of the expected number of beds on Wednesday resulting from implementing scenarios 1, 7, 14, 18, 19 and 31

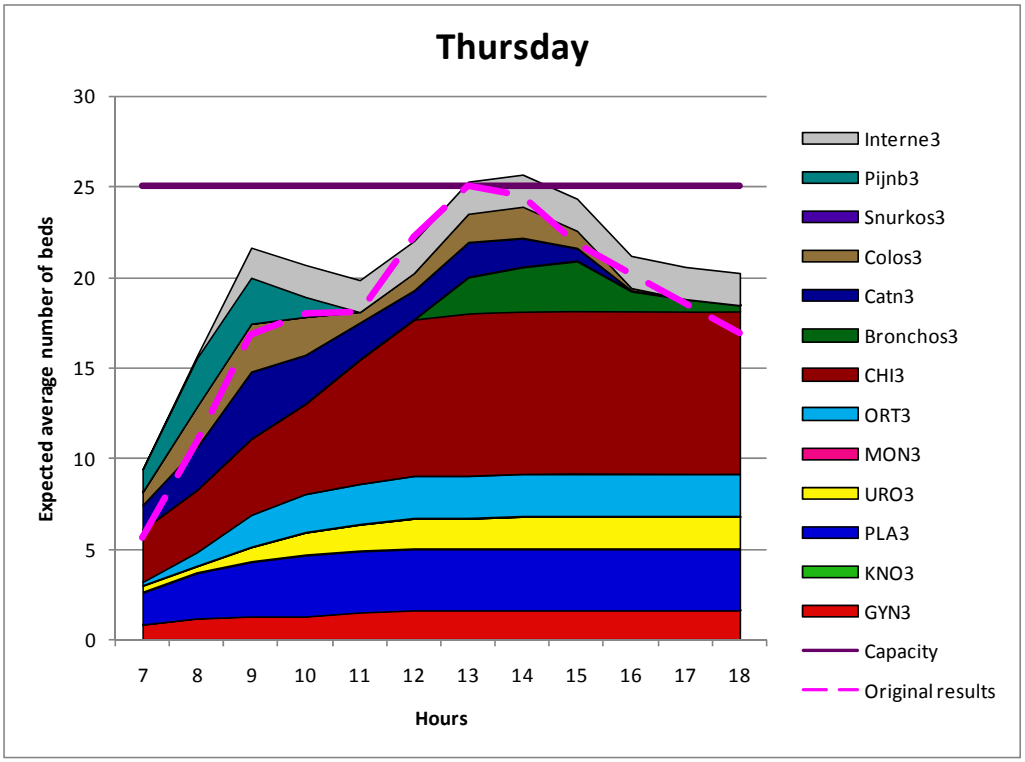


Figure 103: Projection of the expected number of beds on Thursday resulting from implementing scenarios 1, 7, 14, 18, 19 and 31

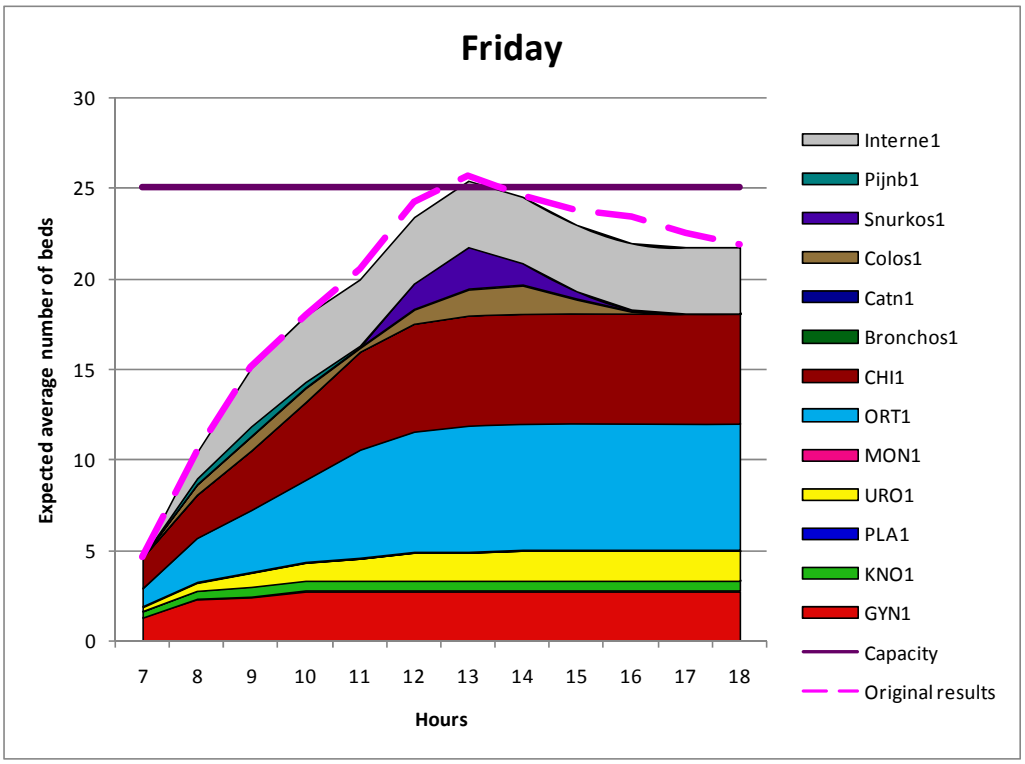


Figure 104: Projection of the expected number of beds on Friday resulting from implementing scenarios 1, 7, 14, 18, 19 and 31

Appendix H: Trends in ambulatory surgery

As in a lot of countries, ambulatory surgery is on the rise in the Netherlands. In the period 2000-2003 there was an average growth of 9,2 % in general hospitals and of 19% in academic hospitals. This growth is combined with a decrease in days of hospitalization from 8,3 days in 2000 to 7,2 days in 2003. This decrease is mainly caused by an increase in ambulatory surgery and due to developments in three fields:

- Medical: the advancement in new, less intervening surgical and anesthesiological techniques and instruments. But also in new drug treatments.
- Organizational: several organizational reforms have been made for cost containment where substitution has taken place from clinical treatment to ambulatory surgery.
- Government: Besides a focus on cost containment, the government has a policy to move cure outside of the hospital. Ambulatory surgery fits in this policy because a part of follow-up care can take place in the home of the patient (NVDK 2007).