UNIVERSITY OF TWENTE.

Master thesis
Health Sciences

Creating a fair workload for nurses in the Acute Medical Unit of Rijnstate Arnhem

An intensity of care model for acute patients

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06-10-2017

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Summary

Rijnstate Hospital Arnhem has an Acute Medical Unit (AMU). The AMU is a department for patients who were transferred from the emergency room or the outpatient clinic. The patients can be admitted to several medical specialties. A patient stays maximum 48 hours in the department, whereafter the patient is transferred to the specialty department or discharged to home. The patients in the AMU have different levels of fitness.

Research problem

The Acute Medical Unit in Rijnstate is noticing several problems having an impact on the nursing workload, namely an unpredictable fluctuation in the acuity of patients, as well as an increased number of patients in the geriatric unit or with psychiatric problems. One way to create a balanced workload is the use of an intensity of care model. Therefore the research objective of this thesis is: *To improve the alignment of the workload for nurses in the Acute Medical Unit, by taking into account the optimal 'nurse-intensity of care' ratio for acute patients.* An intensity of care model is used to create a tool that can establish a more balanced workload for the nurses. Moreover, the tool can be used to schedule nurses in advance and to consider whether the department is in need of a float nurse.

Approach

The study has been divided into two parts; in the first part the model is developed, and in the second part the model is tested. The context analysis, observation, literature study and benchmark lead to the model 'Jones Dependency Tool' for the intensity of care. In this tool, the nurse classified the patients in four categories based on 12 variables in six domains. The results from this model are used to determine a relationship between the patients' intensity of care and the nurses' workload. First was tried to make a multiple linear regression model for the decision of the need for a float nurse. The workload can depend on intensity of care, number of admissions, number of discharges, number of patients with a length of stay over 48 hours and number of medical specialties involved in a shift. When there was not a possible regression model, the analysis of the workload was further expanded for making a nurse staffing advice.

Results

The results of the intensity of care model shows two relationships. The nurses' estimated and the calculated intensity of care matched (correlation of 0.718) and the intensity of care categories of the patients who were classified multiple times (correlation of 0.606). In the measurement period, the intensity of care was mostly low (category 1 or 2). Though the relationships in the measurement period

are not as how they were experienced in practice. There were more patients with a high intensity of care in the department during the measurement period, and the workload was also higher than was measured.

For the nurse staffing was it not achievable to make a multiple linear regression model with the independent variables. The workload was further analysed. The results from this analyses were a high workload for the medical specialty Pulmonology. A significant finding was that half of the nurses always have a lower or higher workload than the average workload in that shift. This finding can be a possible explanation why a regression model cannot be built. The nurse staffing was finally based on solving problems in the system around the AMU to create a fair workload for nurses. Solutions on long term can be a relocation of the AMU near the ER, not exceed the LOS of 48 hours, create career paths for new nurses and use an app or scanner for the double check instead of a second nurse.

Conclusion

The intensity of care model is useful on the AMU, despite the fact that no relationship has been found with the workload. The workload can reduce if the solution are implemented in the AMU.

An important issue in this study is that the period wherein the intensity of care and workload was measured, was not ideal. The nurses filled in less scoring cards than the number of patients who stayed in the department. The reason was the high workload caused by staff shortage.

Samenvatting

Het ziekenhuis Rijnstate in Arnhem heeft een Acute Opname Afdeling (AOA) tot de beschikking. Deze afdeling is voor patiënten die via de spoedeisende hulp of polikliniek opgenomen dienen te worden in het ziekenhuis. De patiënten kunnen voor verschillende specialismes zijn opgenomen. Een patiënt mag maximum 48 uur op de afdeling verblijven waarna de patiënt overgeplaatst wordt naar de specialisme afdeling of ontslagen naar huis. De patiënten in de AOA hebben verschillende levels van zorg nodig.

Onderzoeksprobleem

De Acute Opname Afdeling in Rijnstate heeft verschillende problemen opgemerkt die van invloed zijn op de werkdruk van de verpleging, namelijk de onvoorspelbare fluctuatie in de zorgzwaarte van patiënten, toenemend aantal patiënten voor de Geriatrie of met psychische problemen. Om een eerlijk verdeelde werkdruk te creëren op de afdeling kan het gebruik van een zorgzwaartemodel uitkomst bieden. Daarom is het onderzoeksdoel van deze thesis: *Het verbeteren van de werkdruk voor verpleging in de Acute Opname Afdeling bij het in acht nemen van een optimaal verpleging-zorgzwaarte ratio voor de acute patiënten.* Een zorgzwaartemodel wordt gebruikt als hulpmiddel om een eerlijk verdeelde werkdruk tot stand te brengen. Bovendien, kan dit hulpmiddel worden gebruikt om van tevoren de verpleging in te roosteren en te beslissen of een flexibele verpleegkundige nodig is.

Aanpak

Dit onderzoek is in twee gedeeltes verdeeld; in het eerste deel wordt een model ontworpen en in het tweede deel wordt dat model getest. De analyse van de huidige situatie, observatie, literatuurstudie en benchmark heeft geleid tot het zorgzwaartemodel 'Jones Dependency Tool'. Met deze tool kunnen verpleegkundige patiënten classificeren in vier categorieën, gebaseerd op 12 variabelen in zes domeinen. De resultaten van dit model worden gebruikt om een relatie te bepalen tussen de intensiteit van patiënten en de werkdruk van verpleging. Eerst was geprobeerd om een meervoudige lineaire regressie model te maken voor de besluitvorming van een flexibele verpleegkundige. De werkdruk kan afhangen van de volgende onafhankelijke variabelen: zorgzwaarte van patiënten, aantal opgenomen en ontslagen patiënten in de dienst, aantal patiënten met een langere ligduur dan 48 uur en het aantal specialismes. Als er geen regressie model mogelijk is, zal de analyse van de werkdruk verder worden uitgebreid om toch een advies te geven over verpleegkundige inzet.

Resultaten

De resultaten van het zorgzwaarte model laat twee relaties zien. De ingeschatte zorgzwaarte van de

verpleging en de zorgzwaarte van het model kwamen goed overeen (een correlatie van 0.718) net als de zorgzwaartes van patiënten die meerdere keren waren geclassificeerd (correlatie van 0.606). In de testfase was de zorgzwaarte van de patiënten laag (categorie 1 of 2). Echter de relaties die gevonden zijn in de pilot fase zijn niet zoals in de praktijk wordt ervaren. Tijdens de pilot fase waren er meer patiënten die een hoge zorgzwaarte hadden en verpleging met een hoge werkdruk maar zijn deze patiënten niet ingevuld op de scoringsformulier.

Voor de inzet van verpleging was het niet mogelijk om een meervoudige lineaire regressie model te maken met de onafhankelijke variabelen. Daarom was de werkdruk verder geanalyseerd. De resultaten van deze analyse was dat een hoge werkdruk waren ontstaan op de dinsdagen en voor specialismes was dat voor de longgeneeskunde patiënten. Een belangrijke bevinding was dat de helft van de verpleging altijd hoger of lager werkdruk heeft dan de gemiddelde werkdruk van die dienst. Deze bevinding kan een mogelijke verklaring zijn waarom een regressie model niet gemaakt kan worden. Het verpleegkundige inzet is gebaseerd op het oplossen van problemen in het systeem rond de AOA en daardoor een goede werkdruk te creëren voor de verpleging. De oplossing op langer termijn kunnen zijn: AOA richting de SEH te verhuizen, de ligduur van 48 uur niet overschrijden, loopbaanpaden creëren voor nieuwe verpleegkundigen en gebruik maken van een app of scanner om de tweede verpleegkundige te kunnen vervangen.

Conclusie

De intensiteit van zorg model is bruikbaar op de AOA, ondanks dat er nog geen relatie is gevonden met de werkdruk. De werkdruk kan worden verlaagd als alle of aantal van de oplossingen worden toegepast in de AOA.

Een belangrijke kwestie voor dit onderzoek was dat de periode waarin de zorgzwaartemodel is getest niet een ideaal moment was. De verpleegkundigen hadden door de hoge werkdruk weinig of geen tijd om de zorgzwaarteformulieren in te vullen. De hoge werkdruk was grotendeels ontstaan door een personeelstekort.

Acronyms

ADL	Activities of Daily Living
AMU	Acute Medical Unit
CLA	Collective Labour Agreement
EHR	Electronic Health Record
FIM	Functional Independence Measure
IV	Intravenous
JDT	Jones Dependency Tool
LPN	Licensed Practical Nurse
LOS	Length of stay
MST	Medisch Spectrum Twente
NA	Nurses' Aides
NPR	Nurse-patient ratio
PCDM	Patient Care Delivery Model
PCS	Patient Classification System
RN	Registered Nurse

Preface

In front of you lays my thesis with the title 'Creating a fair workload for nurses in the Acute Medical Unit of Rijnstate Arnhem'. This thesis completes my Master program Health Sciences at the University of Twente, specialisation Optimising healthcare processes. This research is performed for the Acute Medical Unit in Rijnstate Hospital. I have had the opportunity to investigate the workload of the nurses by using an intensity of care model. It was a great pleasure to perform my research at such a relatively new department of the hospital.

Along these lines, I would like to thank all the nurses of the Acute Medical Unit for completing the scoring cards. I would also like to thank Paul Joustra, my supervisor from Rijnstate for his effort to give me valuable feedback and guidance. Thirdly, I would like to thank Wim van Harten, my first supervisor of the University of Twente and CEO of Rijnstate and Derya Demirtas my second supervisor of University of Twente for all the feedback moments and guidance throughout the entire process of writing this thesis. I want to thank the manager of the AMU Yolanda van der Wal and Jildou Smilde for their effort to give me the insights of the processes in the AMU and to guide me. Last but not least, I would like to thank my family and friends for their wise counsels and kind words.

I hope you will enjoy reading this thesis.

Leeanne Nieuwlaar,
Ommen, 6 October 2017

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1. Introduction

In healthcare, it is important to provide a high quality of care. Considering the changing healthcare system, particularly in view of the rise of new technologies, the ageing population and the complexity of the diseases, it is necessary to pay attention to the provision of effective care. Thus the aim is to improve the quality of care[1]. The quality of care is typically said to depend on six factors, namely safety, effectiveness, efficiency, patient-centredness, timeliness, and equity[2].

In the Netherlands, care is split into two sections: acute care and elective care[3]. In acute care, treatment must commence as soon as possible, while considering the correct diagnosis[3]. In the last decade, professionals in the acute care chain have experienced an increased workload, caused by the ageing population and the changes in the healthcare system[4]. Because of the ageing population, hospitals in the acute care chain have experienced an increase in admissions. Moreover, the patients have more severe diseases than they had in previous decades, they also have more multiple comorbidities[4].

Both acute care and elective care can be described by means of the Patient Care Delivery Model (PCDM). This model illustrates how aspects of care are interrelated[5,6]. It focuses on the input, throughput, output and outcome of care. Examples of aspects that can influence healthcare are the characteristics of the patient, the nurse, and the health care system[5,6]. Patients who for example require complex care increase the workload of nurses. Another example which can negatively influence the workload of the nurses is a significant proportion of low-skilled nurses or outsourced nurses who interrupted the continuity of the department[5,6].

Given that a significant proportion of the healthcare professionals is nursing staff, it is important that the nurses perceive the workload during their shifts as fair. Although many nurses are working in hospitals, a shortage of full-time nursing staff in the Netherlands is expected by 2020[7]. The staff shortage will lead to increased workload of the working nurses.

Nurses typically have a maximum number of patients that they can take care of during a shift. The maximum capacity depends on the patients' needs for care and the hospital. The aim is to schedule nurses by the correct nurse-to-patient ratio (NPR)[8], so that costs are as low as possible, yet quality is guaranteed. It is essential to determine the right nurse-patient ratio: a low NPR has proven to lead to a higher mortality rate, a higher chance of complications, errors, and lower job satisfaction[8]. With a low NPR, nurses do not have enough time to take care of the patients properly. Consequently, some

tasks are left unfinished, which can lead to unsafe situations[9]. In turn, unsafe situations lead to a lower quality of care[2]. However, a high NPR is not desirable either. A high NPR leads to an increase in costs for the hospital because more nurses are needed for the same number of patients[10]. Advantages of the higher nurse-patient ratio are a higher quality of care and lower mortality rates[11]. The average NPR for a hospital specialising in acute care is around 1:5 – a ratio of one nurse for five patients[12].

1.1 Rijnstate in the Arnhem

Rijnstate provides top quality clinical care in the regions Arnhem, Rheden and Liemers. It has four hospitals in Arnhem, Zevenaar, Velp, and Arnhem-Zuid. Rijnstate has over 4,000 employees, 287 medical specialists with 28 special fields, and 887 beds. The hospital provides medical care for up to nearly 450,000 residents. Every year around 33,500 admissions, 31,500 day treatments and over half a million outpatient clinic visits take place.

1.2 Acute Medical Unit

Rijnstate Hospital in Arnhem provides top quality clinical care in multiple departments and outpatient clinics. One of the departments is the Acute Medical Unit (AMU), which was established in 2014. The AMU is a unit for patients from the emergency department or outpatient clinic who need acute care for up to a maximum of 48 hours. Some patients are excluded from the AMU, such as pregnant women, children under the age of 18, patients in the intensive care unit, patients requiring coronary care, patients that have suffered a stroke, and psychiatric patients. When the patient has stayed in the AMU for 48 hours of care, the patient is either discharged to a subsequent department for follow-up care or is sent home.

The AMU department has 56 beds and a capacity of 26 nurses per day on a weekday (ten nurses on a day shift, ten nurses on a late shift, and six nurses on a night shift). The number of nurses on weekend shifts is lower. For the late shifts on Saturday and Sunday and the day shifts on Sunday and Monday, nine nurses are available. This number of nurses was established by using historical data from the department. The patterns of patients' admissions and discharges were taken into account in the calculation. However, the exact number of patients and the patients' intensity of care has not been taken into account. In comparison to other departments, the expected number of patients at the AMU is difficult to predict.

1.3 Research problem

The AMU struggles with several bottlenecks, among others the fluctuation of the patients' intensity of care, which influences the nursing workload. The fluctuation of patients is examined with historical data on patterns. The data are classified into medical specialties and analysed to give insight in the number of patients and nurses. These data allow to display the number of patients for any random day in any random month. As mentioned in section 1.2, not all factors that influence the acute care were taken into account in the analysis of the data. Therefore, it is difficult to foresee the required medical specialties and the patients' intensity of the care.

In the present situation, nurses are assigned to patients according to the required intensity of care at the start of the shift. The standard ratio of nurses to the intensity of care of patients is unknown. However, at the beginning of the nurses' shift the NPR is around the 1:6 for the number of nurses assigned, in relation to the intensity of care of the patients. The nurse in charge of the previous shift assigns the nurses to the patients who are admitted to the department, or who are expected to be admitted during the shift. The unpredictable patients' intensity of care expected to be admitted in the department is problematic.

The number of patients in the medical specialty Geriatrics has increased considerably. These types of patients need more care than patients of other medical specialties[13,14]. This is equally true for acutely ill patients with psychiatric problems. Currently, the need of more care for these types of patients is not being taken into account in the model that assigns nurses to patients. As a result, nurses are confronted with a high workload[13].

The three bottlenecks mentioned in the three paragraphs above lead to the following problems: the unknown number of patients who will be admitted during a shift, the allocation of the float nurses at the beginning of the shift, and the scheduling of nurses in advance. A fair workload is between 1 and 3 on a scale of 5, whereas an unfair workload scores 4 or 5. These bottlenecks and problems of an unfair workload can be placed in the framework developed by Hans et al.[15] on resource capacity planning for tactical and operational levels. The unfair workload and the float nurses lead to problems on operational levels, both offline and online. The scheduling of nurses poses a problem at a tactical level. In the current situation, the decision to establish the need for a float nurse at the beginning of the shift has not yet been implemented.

1.4 Research objective and scope

The problem described in section 1.3 leads to the following main research objective:

To improve the alignment of the workload for nurses in the Acute Medical Unit, by taking into account the optimal 'nurse-intensity of care' ratio for acute patients.

The present situation of patients in the department and their complexity of care is analysed to obtain information about the characteristics of the patients. An intensity of care model is used to create a tool that can establish a more balanced workload for the nurses. Moreover, the tool can be used to schedule nurses in advance and to consider whether the departments are in need of a float nurse. For the tool to be effective, it has to be objective and unambiguous. The tool is thus tested in the AMU. The AMU will be benchmarked with other Acute Medical Units in the Netherlands.

The research objective is supplemented with sub-questions that will be answered in the subsequent chapters. The research question and the sub-questions of each chapter are discussed in section 1.5.

1.5 Research questions

The research objective as formulated in section 1.4 is achieved when the following research questions and the subsequent sub-questions have been answered.

Chapter 2: Context analysis

Research question: What is the current situation of the nurses and the patients in the department?
Sub-questions:

- *What is the skill mix of the nurses in the Acute Medical Unit in Rijnstate Hospital?*
- *How are the nurses scheduled in the department?*
- *How does the department currently handle the fluctuations of the number of patients?*
    - *Are ad hoc decisions made for hiring personnel?*
    - *Are there restrictions on how many staff can be hired?*
- *What was the length of stay (LOS) of patients over the last two years?*
- *What are the requirements and restrictions for the deployment of a float nurse?*

In this chapter, the aspects related to nurses and patients are described. The nurses' skill mix and the manner of scheduling are discussed in detail. The data of patients in the AMU are analysed, in order to establish the basis for the development of the model. In the analysis, the focus lies on the LOS of

patients in different medical specialties over the last two years and on the bed occupancy during that period.

Chapter 3: Literature study

Research question: What models are offered in the literature for the intensity of care and the allocation of nurses to patients? Sub-questions:

- *What is the 'standard' nurse-patient ratio for all of the Acute Medical Units?*
- *Which intensity of care models are already known in the literature?*
- *What type of scheduling is used in the models presented in the literature?*
- *Which factors are important to predict the number of acute patients?*

In this chapter, a literature study is conducted in order to establish an overview of the information about the intensity of care models in healthcare, and the manner in which the patients are categorised according to the levels of care. Moreover, the literature study serves to collect information about the scheduling of nurses.

Chapter 4: Benchmark

Research question: How does the performance of the Acute Medical Unit in Rijnstate compare to other similar Acute Medical Units in hospitals in the Netherlands?

Sub-questions:

- *Which intensity of care model do other AMUs in hospitals in the Netherlands use?*
- *Which factors are important according to other AMUs for the implementation of an intensity of care model in the department?*

In this chapter, the AMU in Rijnstate is benchmarked with similar hospitals in the Netherlands to establish how the AMU in Rijnstate performs. The benchmark is finalised by considering the steps of benchmarking that have been derived from the reviewed literature.

Chapter 5: Models

Research question: Which intensity of care models are applicable to the AMU?

Sub-questions:

- *How can the model be used to establish a balanced workload for the nurses?*
- *What for nurse staffing models are useful for the AMU?*

This section analyses the models, applicable to the AMU that are proposed in the existing literature.

On the basis of this analysis, the best model is chosen. A model is preferres as the model is be able to create a balanced workload, schedule the nurses in advance, and decide whether there is a need for a float nurse.

Chapter 6: Experimental design

Research question: How does the model perform in the AMU?

Sub-questions:

- *Which approaches can be used to test the model?*
- *How can the model be used to schedule the nurses?*
- *How can the model help to decide whether a float nurse is required at the beginning of a shift?*

In this chapter, the approach to testing the model is explained, followed by the use of the intensity of care model for the decision of a float nurse. The model inputs and the validation of the model are also described.

Chapter 7: Results

Research question: What are the results of the implementation of the Jones Dependency Tool in combination with the nurse staffing model?
Sub-questions:

- *Does the model result in a fair workload for the nurses?*
- *Is the model useful to schedule the nurses in advance?*
- *Does the model help managers to decide on the need for a float nurse at the beginning of a shift?*

The model has to be implemented in the department. This chapter will describe and clarify the results obtained through the implementation of the model with regard to the balanced workload for nurses, the scheduling of nurses in advance and making decisions on the need for a float.

Chapter 8: Conclusion and recommendations

Research question: What is the conclusion of this study with recommendations?

This chapter presents, the conclusion of the study. Moreover, recommendations are formulated for the department with regard to the application of the model in practice, and the manner in which it can be improved.

2. Context analysis

This chapter defines the context of the study at hand. The goal is to obtain more insight into the procedures of the AMU in Rijnstate. The chapter considers the research question: *What is the current situation of the nurses and the patients in the department?*

In order to answer this question, information on both the nurses and patients is discussed. Particular attention is paid to the nurses' skill mix and the manner of scheduling. Moreover, the data of patients in the AMU are analysed, to define a basis for the development of the model. The focus of the analysis is on the LOS of patients in different medical specialties over the past two years and on the bed occupancy during that period.

2.1 General information

The AMU is an extra department for patients from the emergency department or the outpatient clinic. Figure 1 shows a flow chart of the admissions of patients before and with AMU. The AMUs in the Netherlands differ in naming, location (near the emergency department or not), maximum LOS and number of beds, nurses, and physicians. These variations made it difficult to create a common benchmark.

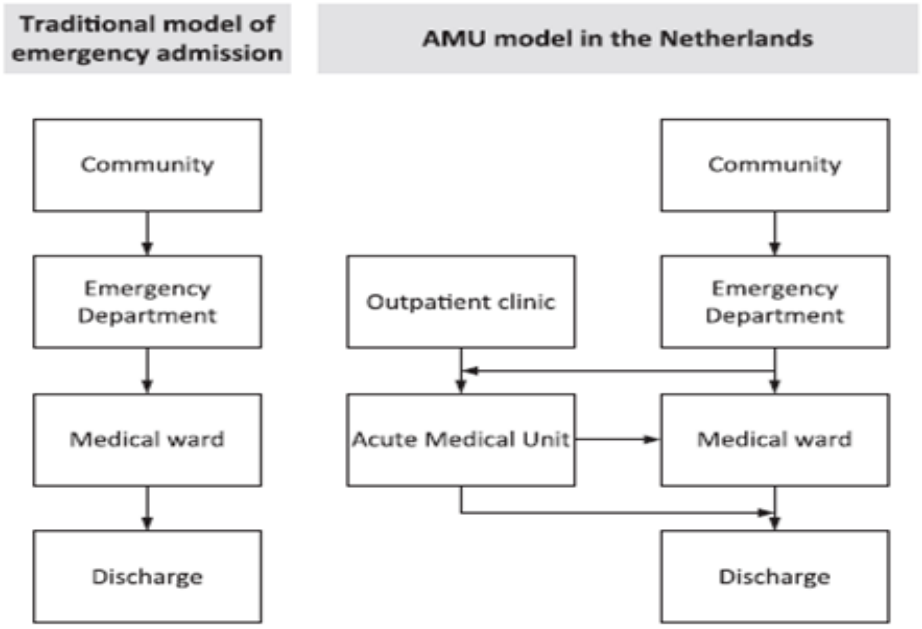

Figure 1. Flow chart admissions for the Acute Medical Unit[16]

In most cases, the emergency physicians are responsible for the department. The personnel of the AMU works in multidisciplinary teams focusing on acute diagnostics and treatments. These teams, consisting of highly educated professionals, can handle a high turnover in patients and yet maintain a high quality of care for the acute patients[16].

2.1.1 Acute Medical Unit in Rijnstate

At the start in April 2014 the AMU had a capacity of 38 beds. In November 2015 the number of beds was increased to 56. The beds are for admitted patients who were discharged from the emergency department or the outpatient clinic. The directive is that patients stay in the AMU department for a maximum of 48 hours. The department is divided into three wards and is located on the seventh floor. The emergency department, radiology and operating theatres are located on the first floor. An ideal AMU is located close to the emergency department. When the AMU is located far from the emergency department, the patient flow from the emergency department to the AMU is smaller, which results in a full emergency department.

The performance of the AMU depends on the hospital as a whole. If the other departments in the hospital are reaching full capacity, the AMU cannot transfer patients to these departments. The patients remain in the AMU, with the result that the AMU reaches full capacity. When the AMU is full, the patients from the emergency department cannot be forwarded to the AMU. These emergency patients were admitted to the specialist departments, but they do not have sufficient personnel to admit patients. Fifteen percent of all patients were directly admitted to the specialist departments. The reasons why patients could not be admitted to the AMU were: a ward of the AMU converted into an influenza ward (patients stay longer and occupy beds for the patients from the emergency room); in summer 2016 the AMU has to close 12 beds for a department that was relocated (the relocated department take this beds over for taking care of their patients); the Pulmonology department has too many patients so patients destined for that department in the AMU could not be transferred to the Pulmonology department (and thus occupied beds for patients from the emergency room).

The department is full when all 56 beds are occupied. In some cases, the manager of the department decides to close some beds during a shift due to the shortage of nurses. During that shift, the nurse in charge may increase the number of available beds if the intensity of care allows it. In the following sub-chapters, the bottlenecks from section 1.3 will be illustrated by means of graphs and tables.

At board level, it was decided that in some cases the AMU must have empty beds for certain patient groups. A consequence of the decision is that the AMU does not have the full capacity to admit

patients. These decisions involved the following periods:

Augustus 2016; 12 beds for relocation of a department

February 17 to April 13, 2015; influenza ward

February 23 to April 8, 2016; influenza ward

December 19, 2016 to March 23, 2017; influenza ward

The patients in the influenza ward stayed longer and thereby occupied beds that would normally have been available to patients from the emergency room or the outpatient department. In the periods in which an influenza ward was in place, the patient flow within the department was lower, and the average LOS was higher.

2.2 Nurses

Information about nurses was acquired from the database of the hospital. The data illustrate a skill mix of the nurses that can be sorted into three categories: registered nurses (RN), licensed practical nurses (LPN) and nurses' aides (NA).

During the past two years, the AMU was party to a total of 116 employment contracts, of which 79 contracts were for nurses and eleven for NAs. The majority of the nurses started with a contract of indefinite duration. Fifteen contracts were zero-hour contracts, with a maximum of 36 hours. There were 23 qualified RNs and 29 LPNs. The nurses and NAs have a contract of 0 to 1 FTE. The data show a total FTE of 68.85. The department needs 39.5 FTE nurses a week.

In total, nurses were absent 140 times in the period between January 1, 2015 and December 31, 2016. The causes can be divided into 'illness', 'illness due to pregnancy', and 'maternity leave'. Table 1 provides an overview of the absences in 2015 and 2016. The high absence due to illness in 2016 was caused by the fact that one nurse was ill three times for a total period of 291 days. When this person is not taken into account, the average number of absent days is 8 in 2016 in comparison to 6.4 in 2015.

Table 1. Absenteeism of employees in 2015 and 2016

Absenteeism	**2015 (cases of sick leave)**	**2015 (number of days)**	**2016 (cases of sick leave)**	**2016 (number of days)**
Ill	58	369	74	861
Ill due to pregnancy	1	158	2	42
Maternity leave	2	230	3	250

Table 2 indicates the absences of the nurses clustered per month for 2015 and 2016. The number of

days was calculated as of the day that the nurse first reported his or her illness. The table shows many days of absence in March. However, the number of reported sick leave cases was low, which illustrates that the nurses were ill for a longer period. The same can be said for April. In November the number of absences was high, with the highest number of reported cases of sick leave for that period. This means that the nurses who were ill were absent for a shorter period than during the other two months. The reason for the high number of days in March is the employee mentioned above, who was absent for 291 days in total. This employee reported the illness in March.

Table 2. Absenteeism per month

Month	Cases of sick leave	Number of days
Jan	21	109
Feb	12	107
Mar	9	325
Apr	9	186
May	10	167
Jun	5	127
Jul	6	157
Aug	11	145
Sep	9	159
Oct	13	101
Nov	14	201
Dec	21	126
Grand total	**140**	**1910**

2.3 Patients

This paragraph discusses the data on patients in the years 2015 and 2016, as derived from the hospital's database. The patterns were analysed in accordance with the following variables[17,18]:

- LOS
- Average number of patients in a day
- Average number of patients per medical specialty in a day
- Mortality rate
- Number of beds
- (Average) number of admitted patients
- Discharge of patients
- Arrival pattern of patients per medical specialty

Before the analysis started, the data file was examined. If one of the following variables was not true, the patient was deleted: department AMU, location Arnhem, is currently admitted. After deleting

these patients, the column with the patient number was deleted, so only the admitted mutation number was left for the patient. Five columns were created in the data file, so a new patient number and the LOS per patient could be determined. In the end, 18,944 patients passed through the AMU in 2015 and 2016. These patients had a total of 40826 admitted mutations, which means that some patients had multiple changes. A change can be a change in bed, medical specialty, or ward. The patient number was established by looking at the mutation number. If the mutation number was the same as above, the patient number remained the same. For every mutation, the LOS was calculated by subtracting the end date and time from the start date and time. Thereafter the LOS per patient number was summed up.

2.3.1 Length of stay

For the purpose of gaining insight into the patients' LOS, data were analysed on the minimum LOS and the maximum LOS of the AMU patients for each of the medical specialty. Table 3 displays the results of this analysis. The medical specialties are categorised into three levels of LOS, based on percentage: where the number of patients accounts for 18% of the total number of patients or more in the AMU, the category is labelled as 'frequent'. Percentages ranging between 5 to 18% are labelled as 'moderate', and percentages of 5% or less are labelled as 'rare'[19]. Table 3 illustrates that the units Internal Medicine, Surgery and Pulmonology have the highest frequency. The patients of these medical specialties account for almost 70% of the total number of patients in the AMU. The remaining 30% is primarily made up of the four medical specialties with a more moderate frequency.

Where the table shows a low minimum LOS, this can be explained by patients changing from one medical specialty to another. Eighty-five patients (0.45% of all patients) were admitted for less than one hour. From these patients, 94% stayed longer in a department in the hospital. The other 6% were discharged from the hospital at the same time that they were discharged from the AMU. The high maximum LOS is the result of patients who were admitted to the ward equipped for influenza patients. These influenza patients were not transferred to other departments until they were cured.

The bed occupancy is calculated by dividing the number of inpatient days by the number of beds over the years of 2015 and 2016. It logically follows that the three medical specialties with the frequency level 'frequent' are responsible for the major part of the bed occupancy. Over the two years, the bed occupancy was lower than the percentage of patients. The reason for this is that not all beds are occupied all the time due to admissions and discharges of the patients.

Table 3. Per medical specialty the number of patients and length of stay

Medical specialties	Number of patients	% of patients	Frequency	Range length of stay (hours)	Bed occupancy
Internal Medicine	5057	27%	Frequent	0:08-406:06	23.0%
Surgery	3983	21%	Frequent	0:02-331:51	13.3%
Pulmonology	3455	18%	Frequent	0:01-481:28	14.1%
Gastroenterology	1768	9%	Moderate	0:07-214:26	5.6%
Geriatrics	1105	6%	Moderate	0:04-430:28	4.8%
Urology	1051	6%	Moderate	0:01-186:32	4.4%
Orthopaedics	1048	6%	Moderate	0:03-189:18	3.2%
Neurology	541	3%	Rare	0:01-309:39	1.7%
Gynaecology	347	2%	Rare	0:12-144:19	1.0%
Otorhinolaryngology	180	1%	Rare	0:53-222:48	0.7%
Plastic surgery	161	1%	Rare	0:08-115:53	0.3%
Rheumatology	116	1%	Rare	3:16-165:44	0.5%
Oral and maxillofacial surgery	94	0%	Rare	1:41-93:32	0.1%
Cardiology	21	0%	Rare	1:10-47:38	0.2%
Dentistry	4	0%	Rare	3:00-19:22	0.0%
Ophthalmology	4	0%	Rare	8:14-31:52	0.0%
Anaesthesiology	3	0%	Rare	4:20-9:40	0.0%
Psychiatric	3	0%	Rare	39:26-50:12	0.0%
Dermatology	1	0%	Rare	21:08-21:08	0.0%
Mental Health Care	1	0%	Rare	0:50-0:50	0.0%
Paediatrics	1	0%	Rare	14:22-14:22	0.0%
Grand total	18944	-	-	0:01-481:28	72.9%

Figure 2 shows a histogram depicting the length of stay for the period of 2015-2016. In 83% of the cases, the patients' stay did not exceed the arranged time of 48 hours. When a patient stays longer than 48 hours, in 45% of the cases the patients' stay in the department was longer than 72 hours. This can be explained by the patients staying in the influenza ward during three extended periods of time in 2015-2016, as mentioned in section 2.1.1.

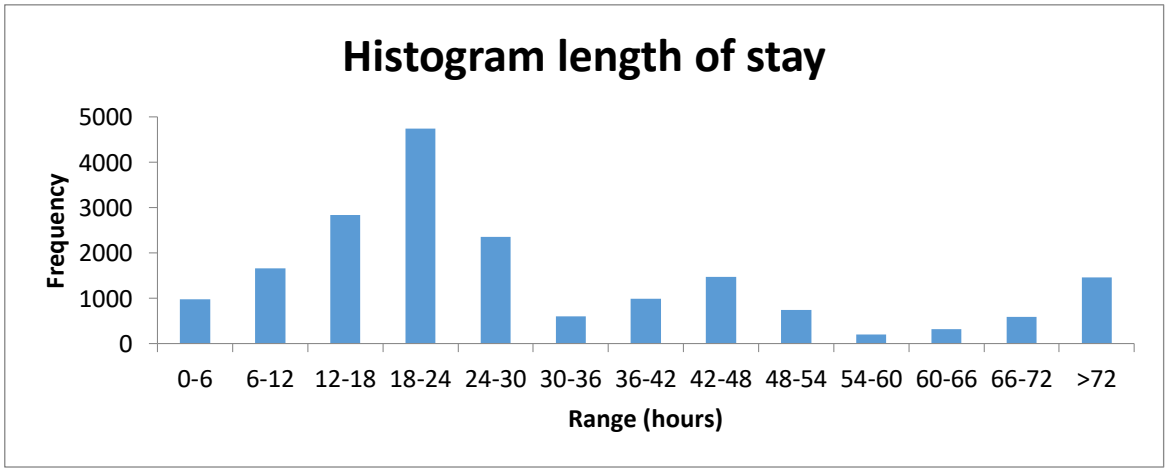

Figure 2. Histogram length of stay with a range of six hours

There are three peaks in the histogram in Figure 2**.** In the first two peaks, the medical specialty Internal Medicine, Pulmonology and Surgery were responsible for around 75% of the patients. In the last peak, 2,078 patients stayed in the AMU for more than 60 hours. That peak is caused by the medical specialties Internal Medicine, Pulmonology and Surgery (83%). Most of the 2,078 patients stayed between 60 and 99 hours (73%).

Figure 3 reflects the LOS clustered per month. The average LOS of every month is around 24 hours. The maximum values fall outside the chart, therefore Table 4 was created. The ranges of LOS are displayed in Table 4, which allows us to identify the maximum LOS. The highest LOS was during the period in which there was an influenza ward. Moreover, the table shows that there was a high LOS in August 2016. This can be explained by high number of patients in the medical specialty Internal Medicine in that month. As a result, the patients staying in the AMU could not be transferred to the department of Internal Medicine and had to prolong their stay in the AMU.

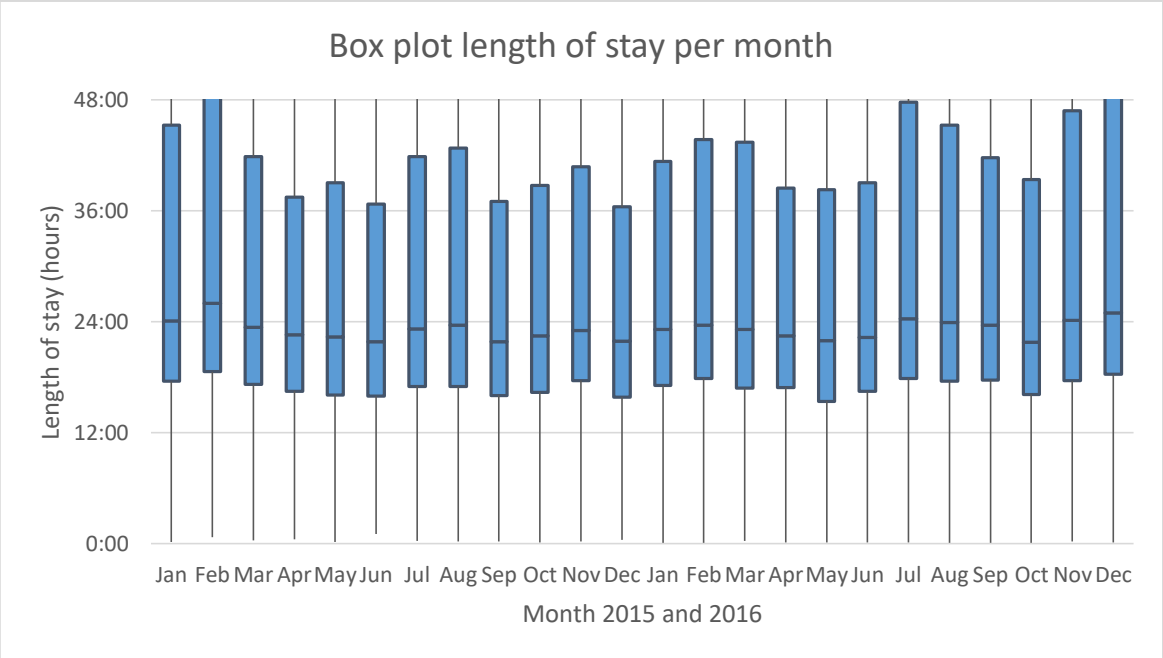

Figure 3. Boxplot length of stay per month

Table 4. Range of length of stay in hours per month per year per patient per medical specialty

Month 2015	Range (min-max LOS in hours)	Month 2016	Range (min-max LOS in hours)
January	0:08-309:39	**January**	0:02-237:23
February	0:42-324:14	**February**	0:03-329:57
March	0:20-481:28	**March**	0:16-274:20
April	0:25-187:40	**April**	0:04-265:36
May	0:08-232:24	**May**	0:05-262:37
June	1:01-203:14	**June**	0:07-256:14
July	0:17-214:26	**July**	0:06-258:31

August	0:14-242:22	**August**	0:01-430:28
September	0:13-219:48	**September**	0:01-241:49
October	0:04-211:37	**October**	0:01-219:12
November	0:14-185:52	**November**	0:13-406:06
December	0:02-237:23	**December**	0:06-260:34

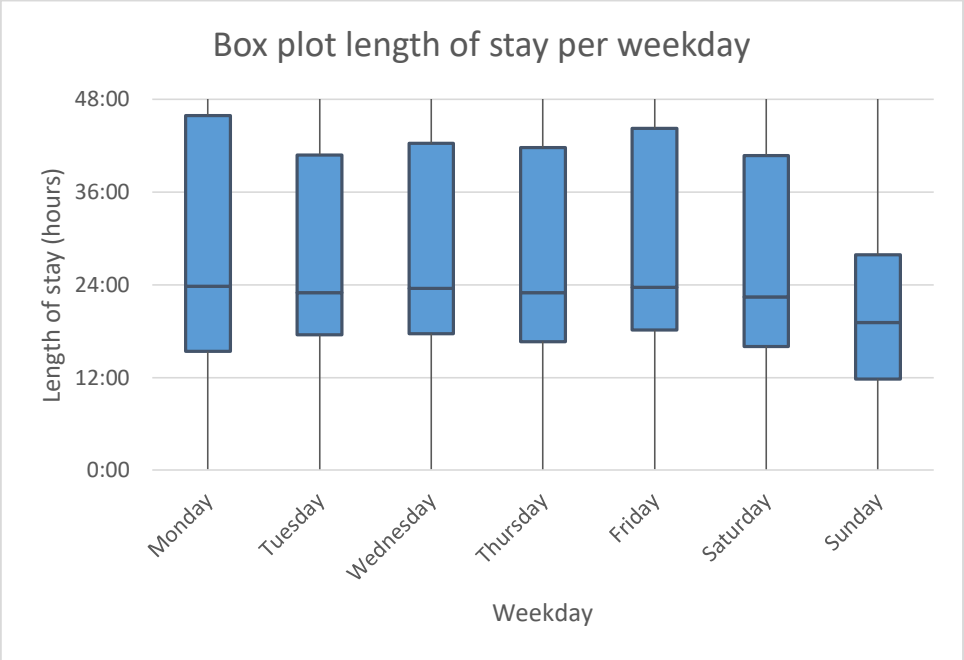

Figure 4. Box plot length of stay per weekday for the day on which a patient is admitted

The boxplot in Figure 4 reflects the LOS per weekday. The boxplot shows that 50% of the patients admitted on a Monday stay in the AMU for 24 hours. When a patient is admitted on a Sunday, their stay in the AMU is shorter as compared to other days. A patient that has been admitted to the AMU on Monday has a 25% chance of staying 48 hours or more in the AMU. On the other days, 75% of the patients were discharged within less than 48 hours.

Table 5 displays the range of the minimal and maximal LOS. The range of maximum hours varies considerably (265-481 hours). The weekends and Mondays saw the shortest stays, whereas the longest stays were noticed on the other weekdays. The patients admitted on Mondays, Thursdays, Saturdays or Sundays were not admitted to the influenza ward or in the summer period. On the other days, the patients were admitted in one of these two periods. The reason for the shorter stays is the same as explained for Table 3. When the patients with an LOS of one hour or lower were excluded, the minimum hours range between 1:01-1:14 hours.

Table 5. The range of length of stay per weekday for the day on which a patient is admitted

Weekday	Range of length of stay (min-max in hours)
Monday	0:06-329:57
Tuesday	0:01-430:28
Wednesday	0:07-406:06
Thursday	0:01-302:13
Friday	0:04-481:28
Saturday	0:01-300:28
Sunday	0:02-265:36

2.3.2 Number of patients

The number of patients is calculated by the Excel function countif. First the number of patients is counted for the date and hour in the column date of admissions. The second step is the same but is counted in the column date of discharge. From the first step, the second step is subtracted to calculate the number of patients for every hour on each day in the years 2015 and 2016.

As shown in Figure 5, the average number of patients on a day varies. The maximum number of beds is 56, yet an average occupancy of 56 beds per day is never reached. This does not mean, however, that the ward was never full. In Figure 6 the maximum number of patients per day is shown. The average number of patients is between 14 and 50, while the maximum number of patients is between 19-56.

The variation in the number of patients is high. Figure 5 and Figure 6 both reflect a wave pattern. In the first months of 2015, the number of beds was lower than in the months that followed. The number of patients changes gradually. When the department has a certain number of admitted patients during a certain period of time, this number varies little during the days that follow.

In 2015, the variation in the number of patients remained stable in comparison to the period between November 2015 and December 2016. Between November 2015 and December 2016 there was a high fluctuation of patients. Large numbers of patients were seen between January 2015 and April 2015, in November 2015, between March 2016 and April 2016, in September 2016 and in December 2016.

As shown in Figure 6, the average bed occupancy per month is between 68% and 109%. The lower bed occupancy rate occurred in 2016 in the months of May, June, and October. In these three months, the average bed occupancy was lower than 70%. The higher bed occupancies were in the periods with an influenza ward or in the summer holidays. The bed occupancy is sometimes higher than 100%; this can be explained by the high turnover in the department. The maximum number of patients is based on the number of patients who are present at a specific hour on a specific day. An example: when a patient

is discharged on 2 January at 14:30, the patient is counted at 14:00, and if a patient is admitted on 2 January at 14:40 the patient is also counted at 14:00 hour. Thus, the patients were counted double but there was only one bed occupied.

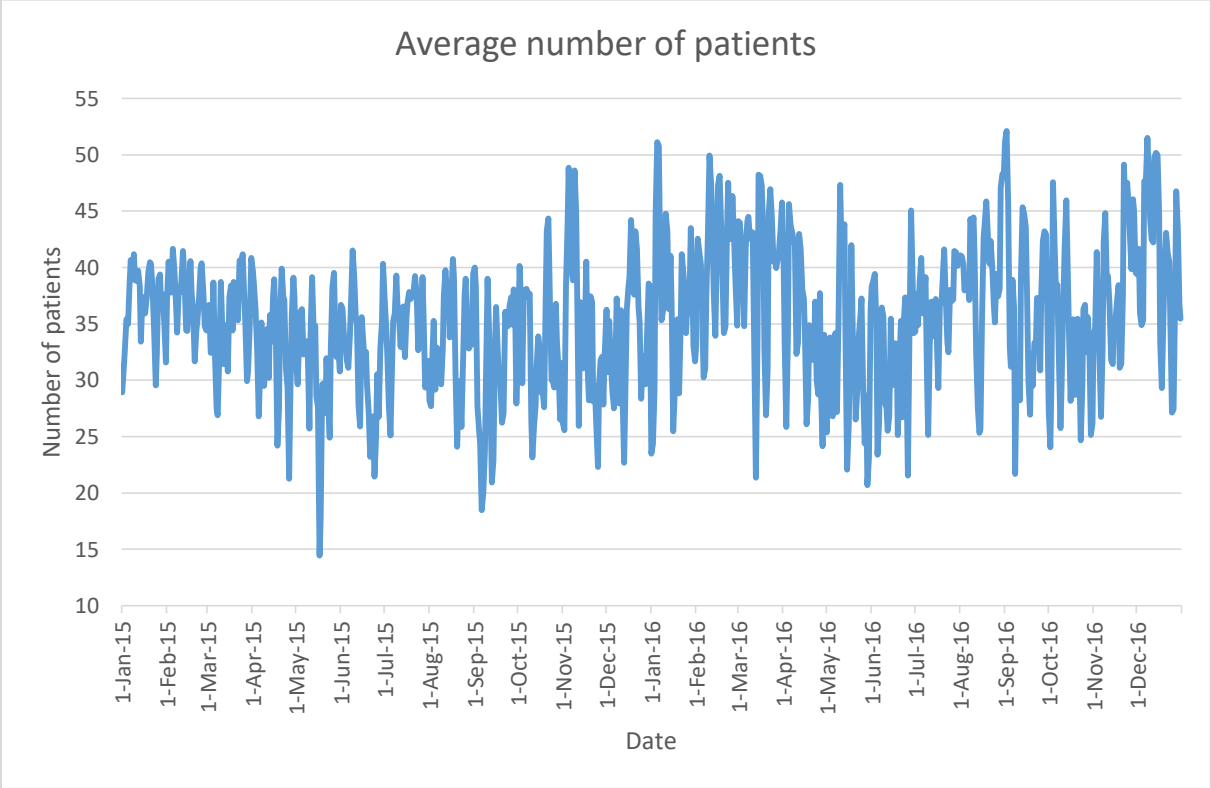

Figure 5. Average number of patients per day

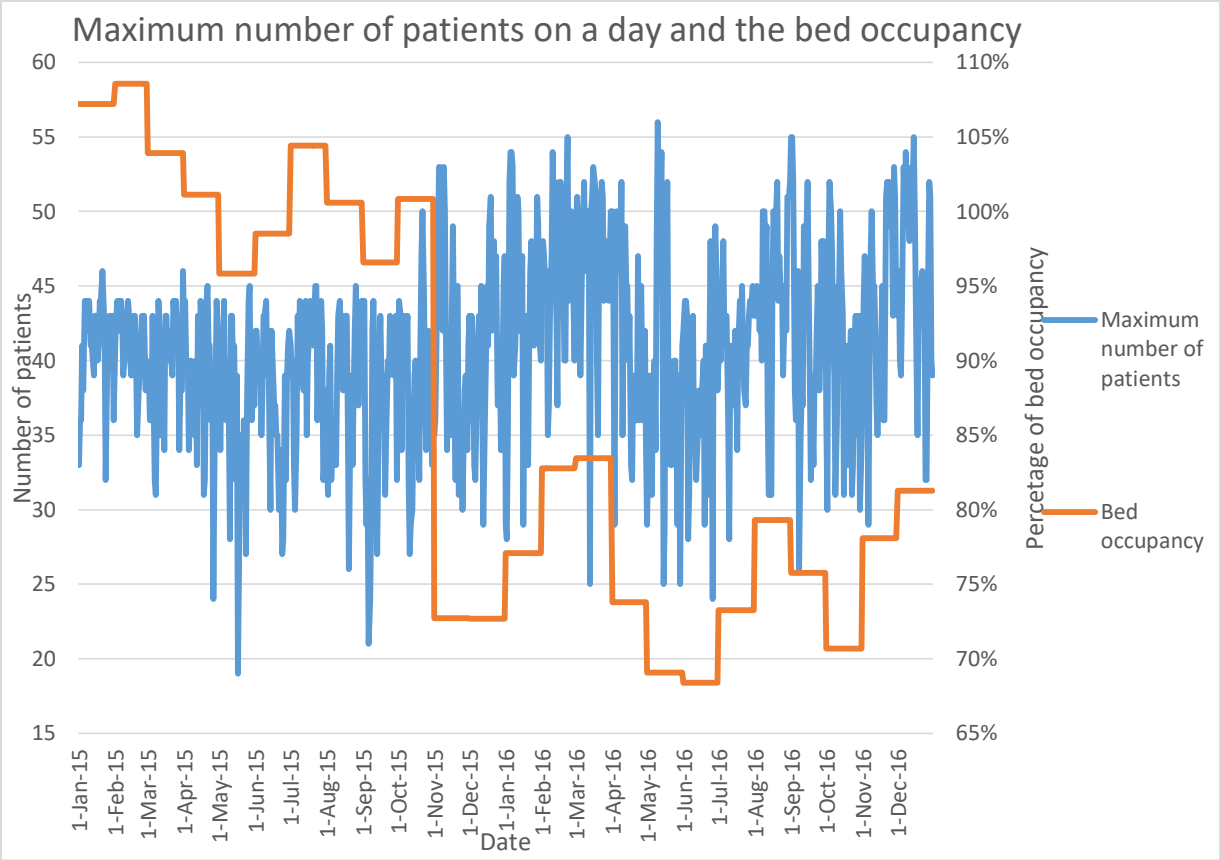

Figure 6. The maximum number of patients a day and the average bed occupancy per month

Figure 7 and Figure 8 show the box plots of the maximum number of patients per month and day of the week. It is remarkable that the months in which the average number of patients was the lowest had the maximum number of patients in a day. Most months reflect a wide range with regard to the maximum number of patients. The median of the months has a range of 38-44.5. In the periods in which there was a low number of patients on average, a high number of patients was measured on some individual days. This explains why the range of the month July is wide and has the highest median of all months.

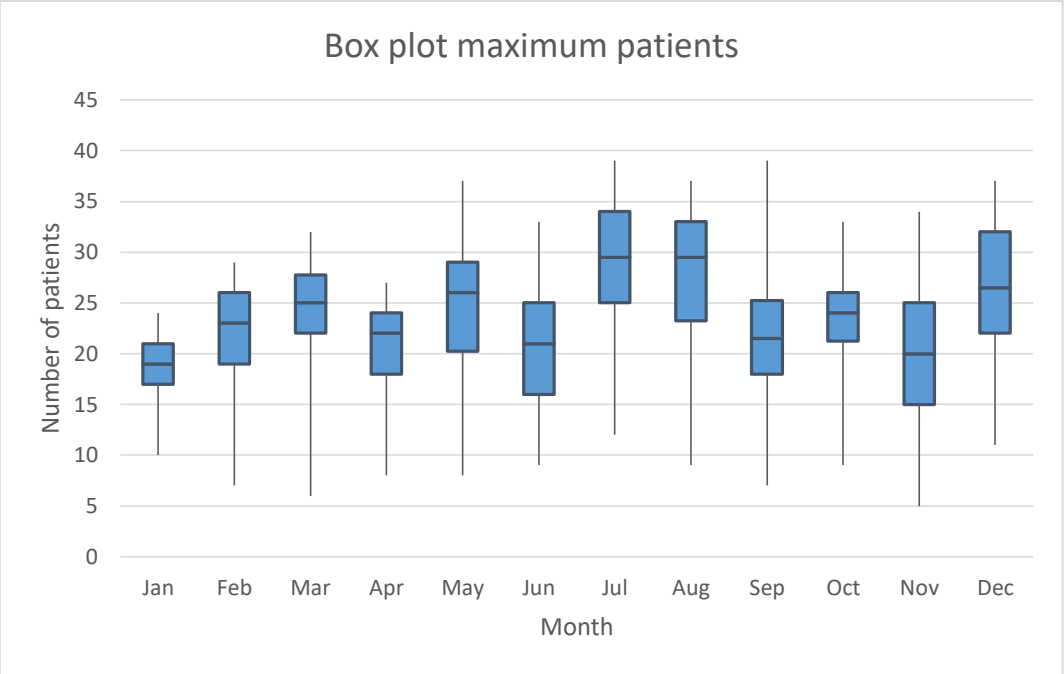

Figure 7. Box plot maximum number of patients clustered per month

Figure 8 shows the box plot depicting the maximum number of patients per weekday. The number of patients is the highest on Tuesdays and Fridays; Sundays and Mondays have the lowest number of patients. The number of patients fluctuates heavily throughout the week. However, the number of nurses does not fluctuate. The number of nurses is scheduled according to a basic shift schedule, which is presented in Table 11.

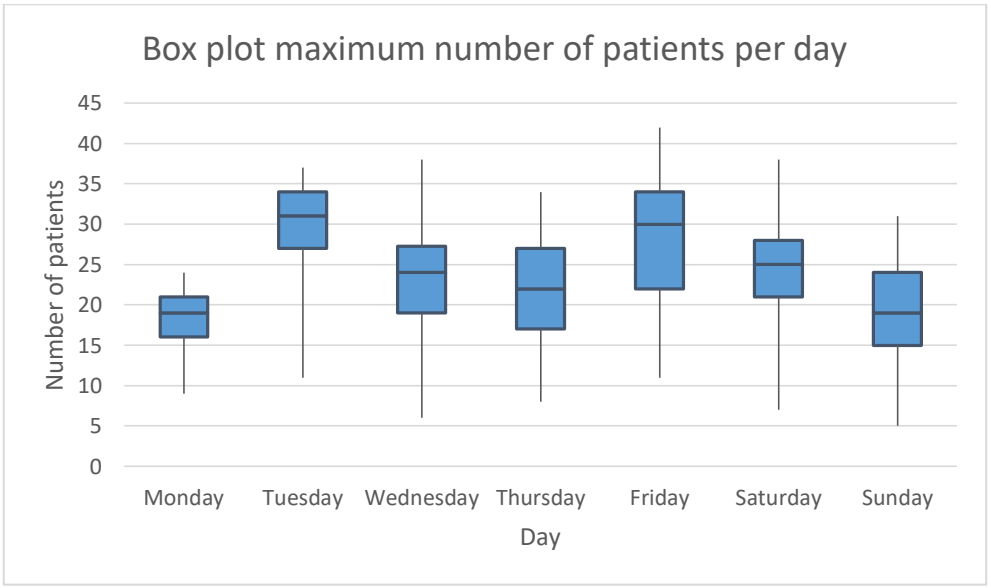

Figure 8. Box plot maximum number of patients clustered per day

For every day and hour of the day, the patterns have been determined. Figure 9 illustrates the number of patients per hour. For every day the highest number of patients on the ward was measured at 11:00. After 11:00, the number of patients decreased, until an increase occurred around 16:00. On Sundays and Mondays, the lowest number of patients was measured between 0:00 and 11:00. This accounts for a difference of approximately 500 patients when compared to the other days. Tuesdays almost consistently had the highest number of patients every hour, compared to the other days of the week. In contrast, on Sunday the number of patients per hour was almost always the lowest.

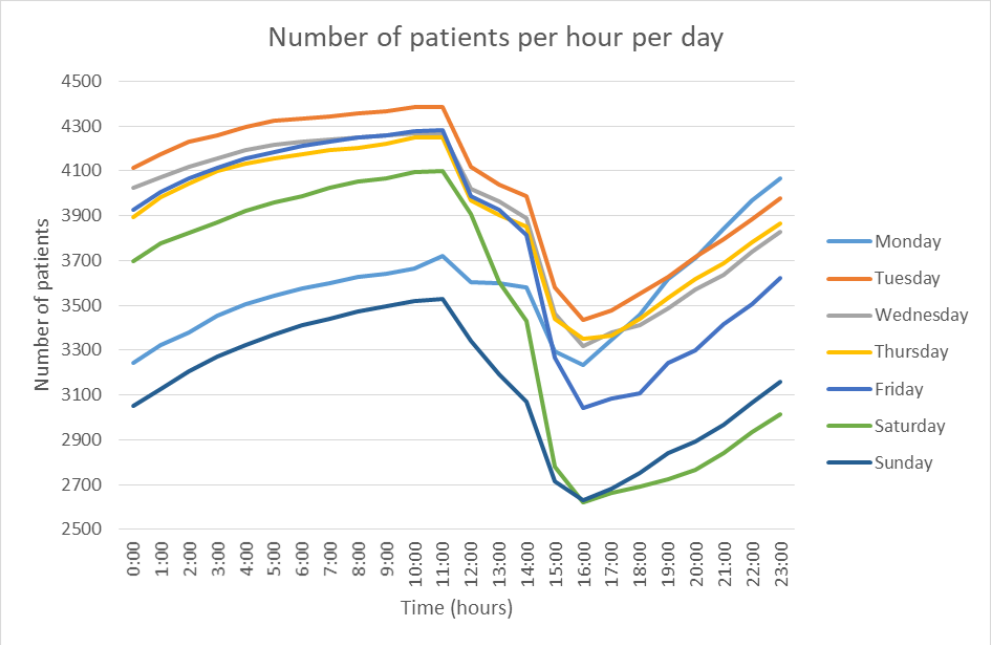

Figure 9. Number of patients per hour per day

Table 6 reflects the daily average number of patients staying in the department per month, divided over the years 2015 and 2016. This number ranges between 34 to 104, with an average of 70 patients on a day. Where the average number of patients is higher than the maximum number of beds, many patients were discharged on the same day. Although the number of beds was lower in 2015, many patients were still discharged. In the winter months, the number of patients was higher than in the other months. The number of patients was lower in summer.

Table 6. Minimum, maximum, and average number of patients on a day in the department per month for two years

Month 2015	Average number of patients (minimum-maximum)	Month 2016	Average number of patients (minimum-maximum)
Jan	72 (52-85)	**Jan**	75 (47-104)
Feb	70 (54-81)	**Feb**	81 (60-101)
Mar	71 (54-86)	**Mar**	81 (47-100)
Apr	68 (47-84)	**Apr**	71 (52-89)
May	64 (34-82)	**May**	67 (38-100)

Jun	66 (46-82)	**Jun**	65 (37-89)
Jul	65 (50-79)	**Jul**	67 (46-87)
Aug	63 (44-86)	**Aug**	71 (44-93)
Sep	63 (38-83)	**Sep**	73 (51-95)
Oct	67 (37-97)	**Oct**	68 (43-92)
Nov	68 (48-99)	**Nov**	72 (50-89)
Dec	70 (52-95)	**Dec**	75 (52-96)
Total	67 (34-99)	**Total**	72 (37-104)

Specialist fields

Table 7 shows the percentage of admitted patients per day, divided by specialist field. The table shows that there is a peak of admitted patients on Fridays, although only for the field of Geriatrics has its highest number of admitted patients of the week on Fridays. With regard to the other specialties, the peak is spread throughout the week.

Table 7. Percentage admitted patients per medical specialty on a day in the week

Medical specialties	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Internal Medicine	31%	28%	29%	29%	30%	28%	26%
Surgery	22%	23%	23%	21%	23%	24%	27%
Pulmonology	21%	21%	20%	20%	18%	20%	18%
Gastroenterology	8%	11%	10%	12%	11%	9%	9%
Geriatrics	6%	7%	6%	6%	7%	6%	5%
Urology	7%	5%	6%	6%	6%	7%	8%
Orthopaedics	5%	5%	6%	6%	6%	6%	6%
Total	**12%**	**15%**	**14%**	**13%**	**25%**	**14%**	**6%**

Mortality rate

The analysed data show that the mortality rate was low during the period between January 1, 2015 and December 31, 2016. On average, the AMU had a mortality rate of 0.45%. This mortality rate does not influence the nurses' workload and, has therefore not been included in the analysis.

Number of beds

Figure 10 shows the maximum number of occupied beds per day. Approximately a third of the days reflect a maximum of 41 to 45 occupied beds. This is followed by an occupancy of 36-40 beds.

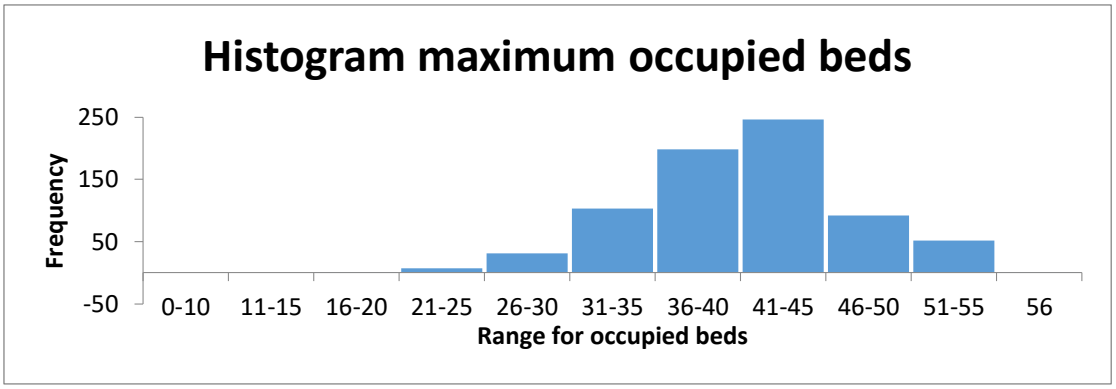

Figure 10. Histogram for the maximum number of occupied beds per day for two years

2.3.3 Admitted patients

The number of admitted patients in 2015 and 2016 was analysed; Figure 11**,** Figure 12 and Figure 13 reflect the results of this analysis. The range of admitted patients in Figure 11 lies between 0 and 77 per day. For both years, the distribution of the admitted number of patients is almost the same. A maximum of four patients more were admitted in 2016 as compared to 2015. The median, first and third quartile reflect a difference of one patient for both years. It can be concluded that, on average, 24 patients were admitted per day on average in both 2015 and 2016.

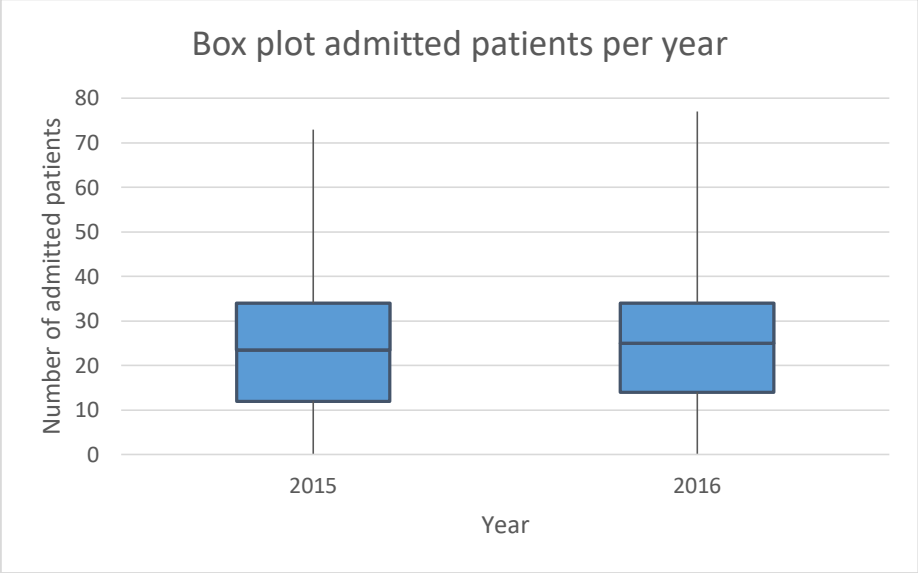

Figure 11. Box plot of the number of admitted patients per year

Figure 12 displays the number of patients admitted per month. The averages of the number of admitted patients on a day per month are close, with a range of 22 to 27 patients. The months of July, August and November reflect the highest average of admitted patients, whereas January, February, May and October account for the lowest number of patients on average. The maximum number of admitted patients were measured for July and August. This is remarkable, because the number of patients during these two months was low, as shown in Figure 5. This implies that both months had a

high turnover.

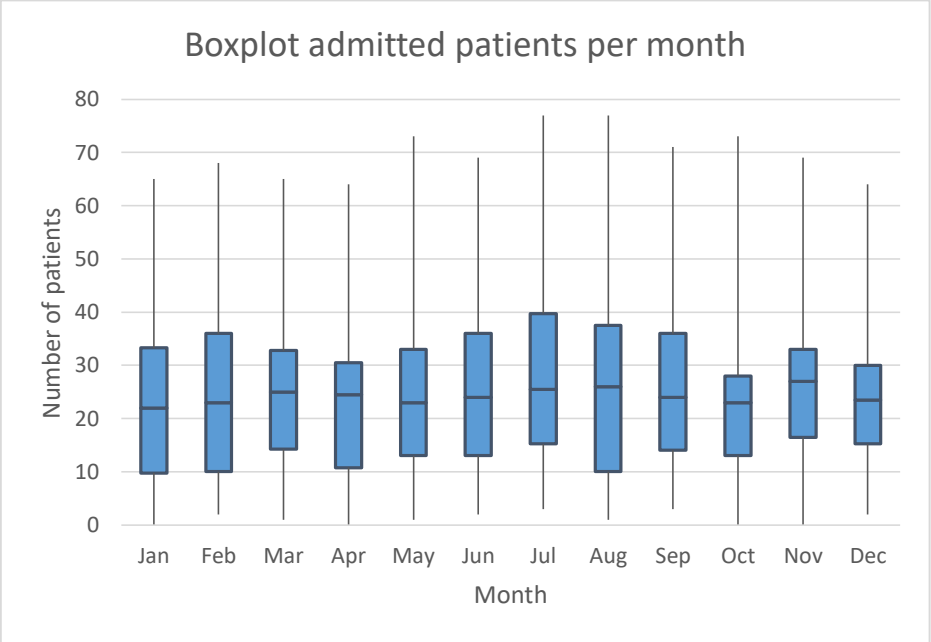

Figure 12. Box plot of the admitted patients per month

Figure 13 illustrates the number of admitted patients per day. The highest number was measured on Thursdays and Fridays. The average number of admitted patients was ranged between 22.5 and 26. It is remarkable that the average number of admitted patients on Sundays was one of the highest. Sundays had the smallest range of admitted patients, from which it can be concluded that the lowest number of patients was admitted on that day. When the number of admitted patients is allocated to the specialist fields surgical and internal medicine, internal medicine always had more patients. The surgical units have received between 43% and 50% of the patients, and internal medicine logically received between 50% and 57% of the patients.

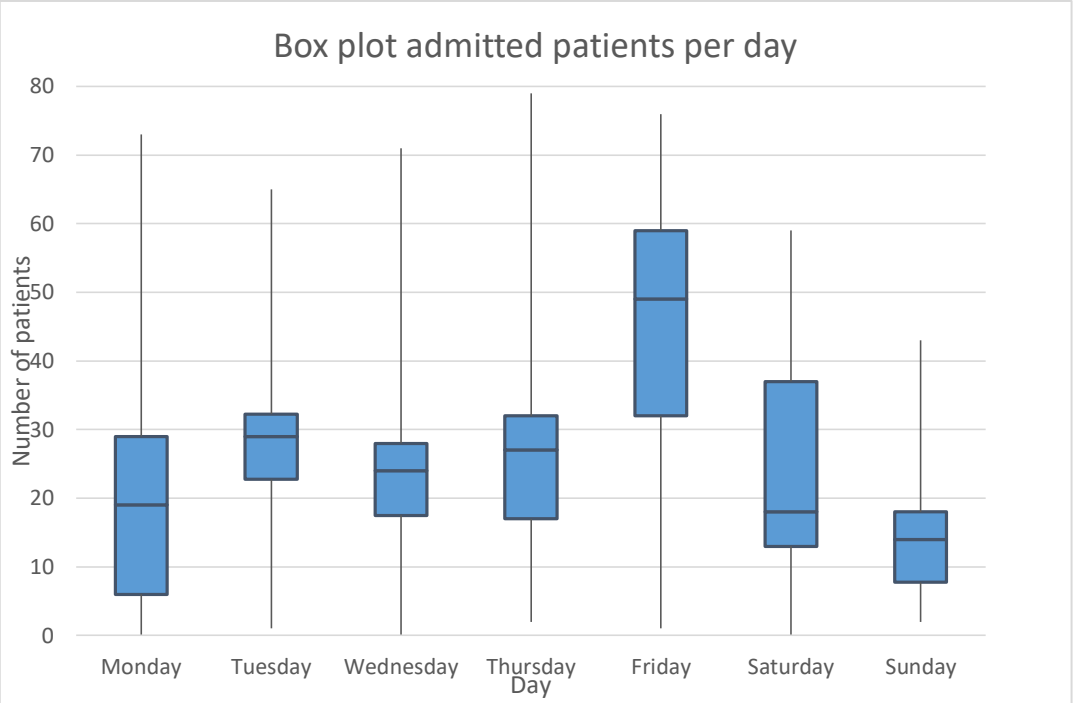

Figure 13. Box plot of admitted patients per day

Table 8 shows where the patients came from, prior to being admitted to the AMU. The majority of the patients was transferred from the emergency department, followed by a much smaller number of patients that came from home and a number of patients coming from an outpatient clinic or other departments in the hospital. The remainder of the prior locations of patients is so small that they have not been included in the analysis.

Table 8. Origin of patients

Origin of the patients	**% of patients**
Emergency department	86.79%
Home	8.91%
Outpatient/department hospital	2.93%
Nursing home	1.11%
General hospital	0.10%
Mental Health Care	0.07%
Rehabilitation centre	0.04%
Academic hospital	0.04%
Other institutions	0.02%

When patients is admitted to the AMU, they most often belong to medical specialty Internal Medicine. The number of admitted patients per medical specialty per month is shown in Table 9. For every medical specialty, the highest number of patients has been highlighted in red. The peaks within the year differ per medical specialty. Internal medicine, Pulmonology, Geriatrics, Urology and

Orthopaedics have the highest number of patients in winter, whereas Surgery and Gastroenterology have the highest number of patients in spring.

Table 9. Admitted number of patients per month for frequent and moderate medical specialties

Month	Internal Medicine	Surgery	Pulmonology	Gastro-enterology	Geriatrics	Urology	Ortho-paedics
Jan	478	300	344	155	103	101	74
Feb	365	277	369	142	85	72	60
Mar	436	346	365	160	90	107	85
Apr	408	332	297	149	122	98	76
May	412	365	262	165	77	92	83
Jun	390	377	243	143	88	88	91
Jul	410	344	189	164	93	84	98
Aug	423	345	198	144	69	63	97
Sep	418	353	233	154	82	90	83
Oct	439	355	290	132	104	104	91
Nov	419	343	292	125	89	68	99
Dec	431	323	322	139	111	73	92
Grand Total	5029	4060	3404	1772	1113	1040	1029

2.3.4 Discharged patients

Figure 14 illustrates the distribution of discharged patients among the total number of patients per day in percent. On 600 of the 731 days the number of discharged patients was higher than 41% of all patients. This implies a high turnover of patients in the department.

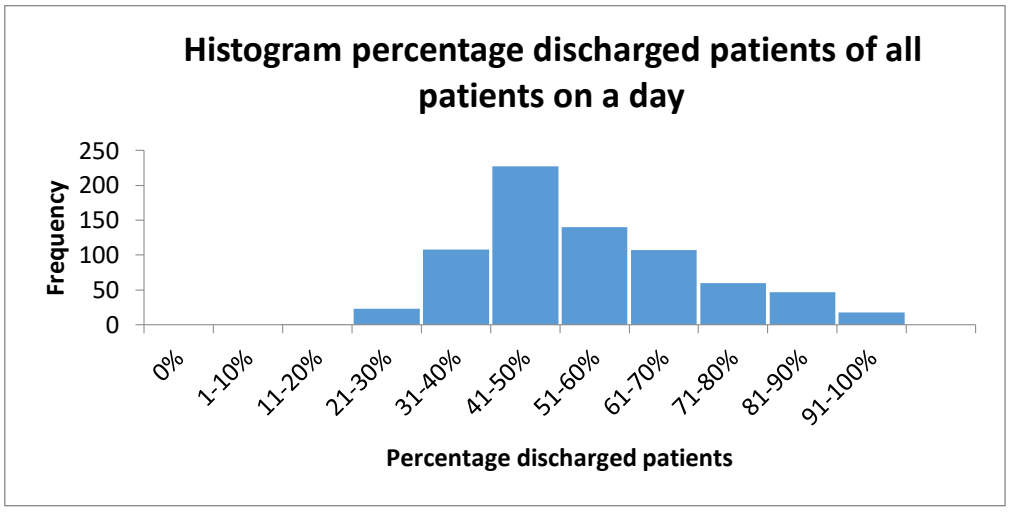

Figure 14. Percentage of discharged patients among all patients on a day

In Table 10 the destination of the patients after discharge from the department is shown per medical specialty. In the majority of the cases, the patients were either transferred to another department in

the hospital or sent home. When a patient is transferred to another department, there is little work for the nurses to do. If, however, the patient goes home and is in need of home care, the nurse is responsible for the arrangement thereof. When a patient has been discharged and goes to another institution or nursing home, it is the nurse's responsibility to arrange for the transport of the patient.

Table 10. Patients' destination after discharge from AMU

Destination after discharge AMU	Surgery patients	Gastro-enterology patients	Geriatrics patients	Internal Medicine patients	Pulmonology patients	Ortho-paedics patients	Urology patients
Department	78.5%	76.4%	84.6%	77.1%	79.8%	85.5%	69.6%
Home	21.0%	23.0%	4.6%	21.6%	19.7%	13.1%	29.4%
Other institution	0.3%	0.3%	5.8%	0.8%	0.3%		0.9%
Nursing home	0.1%	0.1%	4.9%	0.1%	0.1%	0.8%	0.1%
Discharged against advice	0.1%	0.1%		0.1%	0.0%	0.5%	
Adapted home	0.1%		0.1%		0.1%	0.1%	
Passed away		0.1%	0.1%	0.2%	0.1%		

The conclusion that can be drawn based on the analysis of the abovementioned variables is presented in section 2.6.

2.4 Scheduling nurses

The data show that the nurses were commonly scheduled two months in advance. This type of scheduling is done out of tactical considerations. On the operational level, decisions were made with regard to the employment of float nurses, nurses' overtime, and the need for nurses from other departments.

2.4.1 Shifts

There are three shifts for nurses: the day shift, the late shift and the night shift. The number of nurses per shift has changed during the past two years due to the pattern of patients. Table 11 provides an overview of the variation in the number of nurses per shifts in a day. From June 2016 to December 2016, NAs were available to help the nurses with the activities of daily living (ADL) in the morning from 7:30 until 11:30 and in the evening from 18:00 until 22:00. With the deployment of NAs, the number of nurses in a shift can be reduced from 11 to 10. When the AMU has no access to NAs, the number of nurses has to be increased to 12 for the day shift and the late shift. The fact that the number of nurses has been adjusted in accordance with the type of shift and day of the week has led to a decrease to 32

working hours, in comparison to the number of hours that would have been worked if the same number of nurses had been scheduled for all days of the week (10-10-6 nurses).

Table 11. Basic shift schedule

Period	Day	Day shift	Late shift	Night shift
January 2015 until November 2015	Monday-Sunday	7	7	5
December 2015 until May 2016	Monday-Sunday	11	11	6
June 2016 until December 2016	Tuesday-Friday	10	10	6
	Saturday	10	9	6
	Sunday	9	9	6
	Monday	9	10	6

The nurses' schedules are accessible two months in advance. This corresponds to the requirements posed by the Collective Labour Agreement (CLA). These requirements, in combination with long periods of absenteeism and the outflow of nurses, make it difficult to schedule the nurses in such a way that sufficient nurses are available to provide the best quality of care.

The scheduling of the nurses cannot take fluctuations in the number of patients into. Moreover, the number of nurses fluctuates due to illness. Adjusting the number of nurses to the number of patients does not always result in creating a fair workload for the nurses. Nurses' schedules are influenced by patients' intensity of care, the presence of an influenza ward, staff shortages, the system of the AMU, and the location of the AMU in the hospital. The location of the AMU in Rijnstate is not ideal; it is far from the emergency room. Therefore the physicians are delayed in visiting the patients. If the system does not work well, the physicians are delayed or an influenza ward is present, the AMU cannot perform as it should. The AMU may do everything within its power, despite that not be working as it should. This is caused by the rest of the hospital. If the rest of the hospital is not functioning well, the nurses in the AMU experience an increased workload. Due to all influencing factors outside of the AMU, the correct number of nurses is difficult to justify.

The nurses are scheduled based on their experience and not on their education. If possible, there is always a nurse with extensive experience present during in the night shift. Furthermore, a charge nurse is always present during the day and late shifts. Not all nurses are charge nurses; only those capable of coordinating and working as a nurse at the same time are given this title.

2.4.2 Float nurse

In accordance with the CLA for hospitals[20], it is not possible to schedule a float nurse at the start of a shift. The float nurses work in a flex pool, yet they ought to be notified four days in advance. Float nurses are hired from Select, which allows AMU to hire three float nurses at once. Select is an agency

in the hospital that hires out nurses to the departments. The three nurses are scheduled based on their availability and the need of the respective department.

Nurses from other departments can be deployed by the AMU when there is a shortage of nurses on a given shift. The team manager makes this decision. In the majority of the cases it is not possible to deploy nurses from other departments. As mentioned previously, it is also not possible to hire float nurses from Select on such short notice. When the department is confronted with a shortage of nurses, the charge nurse may be employed to take care of the patients. If there are few patients the nurses may take leave from work, in consultation with their colleagues. In a situation where there are few patients, AMU nurses can also be deployed to other departments.

2.5 Observation

This part describes the observation, during which the activities of the nurses were noted. Subsequently, the results of the observation are discussed.

2.5.1 Structure of the observation

The observation was used to decide on the intensity of care[21]. The activities of the nurses and the amount of time accorded thereto were recorded. Furthermore, the nurses were asked which factors and activities contribute to a high workload, and about the workload they experience[22].

Every five minutes the activities of a nurse was observed. In case the nurse performed multiple activities concurrently, every activity was noted as a single activity[17,21,23]. Prior to the start of the observation, an overview of the main activities was entered into a logbook, which was concurrently updated with the additional observed activities[23]. Table 12 provides a description of the main activities. The observation furthermore consisted of retrieving information on the skills and work experience of nurses[24], the time, the shift, the diagnosis codes of the patients in the rooms, the acuity level in every room, the nurse - intensity of care ratio, and the number of occupied beds[17,25].

Table 12. Overview nurses' activities

Code log	Activity	Description of the activity
1	Activities of daily living	Bathing and showering, assisted personal hygiene, assisted dressing
2	Medication	Preparation of medication, application of medication (oral/injection/infusion), documentation of medication
3	Nursing activities	Maintenance of tubes/drains/catheter, inhalation therapy, collecting of specimen for investigation, conversations with patients
4	Observation/monitoring	Measuring vital functions, patient checks

5	Documentation	Documentation in computer to update patient report, to record handover of patient to a physician/colleague and telephone conversations
6	Handover	Handover over a patient to a physician/colleague, telephone conversations
7	Patient flow	Admission, transfer or discharge of a patient
8	Indirect care	Contacting family, making appointments for the patient
9	Pause	To eat, drink or go to the bathroom
10	Waste	Solve errors by colleagues/physicians, supply of equipment

After two days and two late shifts (four observations) a sufficient amount of information was obtained to start with the development of the model on the intensity of care for acute patients. The observations were then brought to an end.

2.5.2 Observation in the department

Appendix A shows the observation log. The data retrieved by means of the observations are reflected in Appendix B. It follows from Table 13 that the most important activities consist of documentation, medication, and handing over the patients. The patient flow is one of the most time-consuming activities. When a patient is admitted to the AMU, the nurses needed approximately half an hour to complete the admission of the patient.

The activities can be divided into two types of care: direct and indirect care. Direct care can concurrently be subdivided into medication, nursing activities, observation/monitoring, and activities of daily living. In total, direct care accounts for a total of 42% of the activities. Indirect care can be subdivided into documentation, handover, contacting family, and patient flow, and accounting for a total of 53% of the activities. Indirect care is an important factor in the high workload of the nurses[26]. Decreasing the amount of time spent on indirect care allows nurses to spend more time on the direct care that patients require. The other 5% of activities is for pauses and waste. The patients who required more care were mostly from the medical specialty Geriatrics and those with psychiatric comorbidity. When a patient needs medication multiple times a day, this influences the intensity of care. Other factors that influence the intensity of care are the patients' dependency on a nurse regarding to mobility or ADL, multiple remeasuring of patients' vital functions, or multiple observations of the patients.

Table 13. Overview activities of the observations

Activities	Average percentage	Percentage range
Documentation	**29.61%**	24-40%
Medication	**15.78%**	13-18%
Handover	**14.32%**	13-17%

Nursing activities	**11.17%**	7-20%
Observation/monitoring	**7.77%**	1-16%
Activities of daily living	**7.28%**	5-9%
Patient flow	**5.10%**	3-8%
Indirect care	**4.13%**	0-10%
Waste	**2.91%**	1-5%
Pause	**1.94%**	1-3%
Grand total	**100%**	

The intensity of care is reflected on a scale of 1-3. At the start of the shift, the patients with three points are first assigned to nurses. The remaining patients concurrently allocated to a nurse. The patients are divided in such a way that all nurses have patients for an equivalent number of points. Table 14 shows the distribution of patients per medical specialty and intensity of care. The estimation of the patients' acuity for one observation was not entirely correct, as that case required a significant amount of documentation and many handovers.

Table 14. Medical specialty during observations

Medical specialty	Number of patients	Percentage of patients	Number of patients with intensity of care 1	Number of patients with intensity of care 2	Number of patients with intensity of care 3
Pulmonology	**9**	**37.50%**	**3**	**4**	**2**
Internal Medicine	**6**	**25.00%**	**2**	**3**	**1**
Surgery	**5**	**20.83%**	**1**	**2**	**2**
Geriatrics	**2**	**8.33%**	**0**	**0**	**2**
Neurology	**2**	**8.33%**	**2**	**0**	**0**
Grand total	**24**	**100.00%**	**8**	**9**	**7**

The majority of the patients belong to the medical specialties Pulmonology, Internal medicine and Surgery. The patients were equally distributed over the scale of acuity. All Geriatrics patients were categorised with 3 on the scale; all Neurology patients were classified with 1.

Experienced workload

During the observation, the nurses indicated that the workload becomes high due to a number of factors: multiple admissions and discharges of patients at the same time, telephone calls, documentation and arrangement for the patients, not being able to help colleagues when they need help, mental problems of the patients, and late visits of physicians. In the morning the NAs assist the nurses with the ADL of the patient so that the nurses have more time to visit the patients. When a patient needs to be in isolation, it is frustrating for the nurses if the stock in that room is not replenished. Other frustration factors are when a physician is not reachable by phone when the nurse

needs to ask something, patients who often unnecessarily call for a nurse, all mobile computers being in use when needed, misplaced equipment and empty stocks. Most of the problems can be easily solved by replenishing the stocks on time and replacing the equipment after use. The mobile computers are not often all in use at the same time. Hence it would not be reasonable to purchase an additional computer for the time when all computers are in use. The other two problems cannot be solved.

During the day shift, the morning (7:00 until 10:00) is a busy period, for this is when the handover takes place, the medication is administered and the patients are bathed. During the late shift, it is particularly busy during the first two hours (15:00 until 17:00) and around 21:00, when the handover and the administration of medication take place.

The nurses experienced the new way of working as pleasant. However, there is one disadvantage to this way of working according to them: because their patients are not clustered in the room, the overview of the patients is lacking.

2.6 Conclusion

The purpose of this section was to determine the context analysis of the department with regard to the number of nurses, number of patients and the observation of nurses. This section has identified that the nurses work in three shifts, with a fixed number of nurses for each shift. Due to a high outflow and long absenteeism of nurses, this scheduling is fraught with problems. Nurses' schedules are influenced by patients' intensity of care, the presence of an influenza ward, staff shortages, the system of the AMU, and the location of the AMU in the hospital.

The second major finding was that in 83% of the cases, the patients stayed in the AMU for less than 48 hours. Sixty-six percent of the admissions were related to the medical specialty Internal medicine, Surgery or Pulmonology. The number of patients was significantly higher in the months between January and April, in September and in December. It was the highest on Tuesdays and Fridays. Between 11:00 and 16:00 there was a decrease in the number of patients, and from 16:00 to 0:00 there was an increase. On average, there were 70 patients per day. This implies that many patients were discharged on the day itself. The number of patients admitted to the internal medicine and pulmonology units, peaked in winter; the peak for surgery took place in spring.

The most obvious finding to emerge from the observation is that the following factors, in order of importance, are vital for the intensity of care: patients with psychiatric comorbidity, number of medications, multiple measuring of patients' vital functions and patient observation, patients' dependency on a nurse regarding mobility or ADL, telephone calls, documentation, arrangements for patients, and geriatric patients. Besides these factors for the intensity of care, other factors also influence the nurses' workload. These factors are multiple admissions/discharges at the same time, and delayed visits by physicians.

3. Literature study

In this chapter, the following research question is answered: *What models are offered in literature for the intensity of care and the allocation of nurses to patients?* In order to answer that question, information is collected about existing models for intensity of care for both elective and acute patients; moreover, the categorization of patients into levels is discussed. Next, a literature study is conducted in order to find information about nurse scheduling and the AMU in the Netherlands. Finally, the key factors for the forecast of the intensity of care of the acute patients are examined.

This literature study focuses on examining models that aim for a fair distribution of work between nurses. These models need to find a basis in the workload of nurses, patient classification into levels of disease severity and the number of nurses related to the intensity of care. The databases of Scopus and Google Scholar were used to search for articles. No limits were set for dates, but the dates were filtered so that the most relevant once appeared first. The abstract was only read if the article met the requirements; articles were only included in the study if one or more of the inclusion criteria were met. Table 15 shows an overview of inclusion and exclusion criteria; Table 16 shows the MeSH search terms in the databases. Useful references in the articles were included in the literature study. Appendix C shows the complete search strategy and the number of hits and obtained articles. Mostly only one to three useful items were found with the search terms. The other hits in the databases were not relevant for this literature study. Reasons to exclude articles were: too complex information, focus on a very specific disease, absence of valid and reliable research on subject, or that the full-text articles were not available on the Internet. In total there were almost 4,500 hits from all search strategies together. Out of these, 34 articles were used in this literature study. The information on elective patients was obtained with multiple search strategies (Appendix C). There were fewer successful search strategies for information on acute patients, which can be explained by the lack of studies relating to the intensity of care of patients.

Table 15. Overview inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Research was for a hospital department	Patients were not included in the study
Workload of nurses and their experiences about the workload	
In the study, the patient classification is described for the model	

Table 16. Overview terms search method per subject with examples

Search terms (MeSH)	
Hospital	Assignment
Nurse	Work pressure
Intensity of care	Emergency
Patient acuity model	Acute
Patient classification systems	Acute medical unit
Development	Allocation
Tool	Length of stay
Nurse to patient	Predict

3.1 General intensity of care model

This subchapter will clarify the model for intensity of care used for elective care in hospitals. Moreover, the workload of the nurses, nurses' allocations to the patients and the length of patients' stay is taken into account. The results can be used as a basis for the model in the AMU.

3.1.1 Patient classification system

The classification of patients in terms of complexity of care plays a major role in the organisation of a hospital[27]. There are several tools to measure the complexity of the care of patients, but there is no uniform method. These models are also known as Patient Classification System (PCS)[7]. A patient classification system has the aim to determine the intensity of both direct and indirect[28] nursing care to a patient. There are two ways of classifying the patients, i.e., with a prototype and with a factor type[28]. The prototype only focuses on the tasks that serve as indicators of the intensity of care, such as bathing or providing medication. This way of classification is subjective. The factor type is an objective classification method. The nurse fills in how much time the patient needs per item on a list of tasks and procedures. The values will be added and the number of points will decide the category of the patient[28]. Intensity of care models are divided into the personal characteristics of a patient, clinical features, characteristics of care, and social features[27]. The model can be applied as a list of all nursing factors in the electronic health record[29]. It is possible to divide patients into three levels of care, distinguishing between patients that do or do not need 24 hours of direct care. The first level, where a patient needs 24 hours of care, varies between high and low care dependency. In this study, the nurses have a minimum of four patients and a maximum of ten patients per shift[8].

Another study applies a model with five adjustable levels of care, in order to make them suitable for a specific department[30]. The key variables for the classification of patients are mental health status, oxygenation, vital functions, independence of mobility/ walk/ eat/ body care/ dress, treatment, the integrity of the skin/ tissue damage[31]. Every variable scores on a scale from 1 to 4 and the scores will be added up to get the total score[31]. An instrument named Functional Independence Measure (FIM)

can be used to assess the patients' ability to perform ADL safely[32] and to determine their intensity of care.

One system that focuses on patient dependency is the RAFAELA system[33–35]. The nurses for each day are assigned to the patients' care needs according to availability. Nursing care differs between units, as the optimal nursing workload is different for each unit[34]. RAFAELA lists the key domains as follows: planning and co-ordination of nursing care; breathing, blood circulation and symptoms of disease; nutrition and medication; personal hygiene and secretion; activity, sleep and rest; teaching, guidance in care and follow-up care, and emotional support[33]. For each subsection, the needs for nursing care are defined separately as A, B, C and D[36]. The nurse has to choose between one of those four alternatives. "A" identifies a patient who manages more or less on his own, "B" identifies a patient who sometimes needs the care of the nurse, "C" identifies a patient who repeatedly needs the care of the nurse and "D" identifies a patient who needs constant care of the nurse[36]. Every letter can be scored, whereby "A" gets 1 point, "B" 2 points, "C" 3 points and "D" 4 points, which results in an end score between 6 and 24. The results are entered into four intensity of care categories: category 1 with minimal need for care (6 to 8 points), category 2 with average need for care (9 to 12 points), category 3 with more than average need for care (13 to 15 points) and category 4 with maximal need for care (16 to 24 points)[35,37].The score per patient is added up for all patients in the unit and divided by the total number of nurses in the unit during the shift[33–35]. The daily nursing care intensity level of the ward can be expressed in the nursing care intensity level points per nurse[37]. This model enables the manager to compare the intensity levels per ward, and gives an idea of the general workload of the scheduled nurses[37]. That workload is optimal when every nurse working in the unit can handle the standard of care for that unit. The tool requires data of patients' care needs and nurses' workload, and can predict the nursing resources on operational and strategic levels[33]. The tool can also show the peaks and valleys of patient admissions related to medical specialties during different periods. Additionally, the tool has another advantage for the charge nurse to achieve optimal workload for the nurses, namely to plan and allocate staff proactively, based on data collected during the previous day or during the most recent period[33].

The last intensity of care model originated in neonatal intensive care. This model focuses on the details for patient assignments. This department developed a detailed system. A group of nurses identified a list with procedures and grouped these procedures into 14 categories[38]. The scoring is based on the number of times a procedure is accomplished within 24 hours. The categories are: respiratory status, lab work, feeding, vital signs, x-rays, weighing, medication, suctioning, chest physiotherapy, wound care, dressing changes, intravenous fluids, miscellaneous (admit/discharge, procedures, nitric oxide or

morgue care) and unstable (to perform unexpected procedures on unstable infants)[38]. The formula for scoring procedures is as follows: 24/frequencies of procedures[38]. When in a group multiple procedures has to perform, then for all procedures the scores were added. The answer after every calculation is the score for that group. It is possible to have a score of zero because patients have not always the procedures in a group. The patients' conditions vary considerably. Therefore it is difficult for the department to ensure a balanced workload for its nurses[38].

PCSs have shortcomings, such as an inadequate forecast of the requirements of nurse staffing or the nursing work, as well as a lack of standardisation of measures; moreover, they are useless in decision-making[39]. An ideal PCS is user-friendly and frugal[39], and considers the characteristics of patient, nurse and organisation. When the indicators of severity of care are graded, the categories of the intensity of care can be determined. The minimum number of points awarded to a patient equals the number of indicators. For example, when there are six indicators, the minimum number of points for a patient is six. The maximum points equal the multiplication of the number of indicators and the number of levels of care[40,41]. Between this range, the points are distributed into levels of intensity of care[40,41].

3.1.2 Assigning nurses to patients

Once the patients have been classified, nurses are allocated to them. The sum of all patient scores divided by the number of patients at that moment in the department, is the average intensity of care for the patients. The nurses are assigned to a number of patients in such a way that all nurses have the same number of patients on all levels[7,29,42]. The patients with the highest acuity score are evenly distributed among the nurses[42]. When possible, nurses will be assigned to the same patients as the day before, so patients know the nurse. A final criterion is the walking distance between patient beds; this should also be equally divided between the nurses[42].

3.1.3 Nurses' workload

Apart from diversity in patients, nurses also have a diverse background, both in respect to experience with and education in nursing specialties[7]. Therefore, after the patient classification, a tool is added to measure the workload as predicted by the nurse based on several indicators in a questionnaire[7]. Table 17 shows examples of indicators and includes explanations[39,43].

Table 17. Indicators for workload with explanation

Indicator	Explanation
Average LOS	Severe of the disease
Average application of medication a day	Complexity of the patient and time the nurse spends to apply medication
Percentage of patients > 70 years	Displays the need for extra help that elderly patients often need to complete their daily activities
Percentage of patients BMI> 25 kg/ m^2	Patients with a higher BMI will need more care to complete the daily activities
Top three diagnoses of the department	Complexity of the required care per diagnosis
Daily patient turnover (include admissions on the ward, transfer, and discharges)	Measured are the direct care activities and workload associated with these processes of the patients

3.1.4 Length of stay

As described in Table 17, the length of stay can be a factor for the workload. In the past, elderly people already made up a significant portion of acute care. In general, the elderly need a longer stay[44]. In addition, adverse events may occur during hospitalization, such as urinary tract infection or diarrhoea[44].

Length of stay is a definition of the time that passes between the admission and the discharge of a patient in a unit in a hospital[45]. LOS depends on different factors, such as the patient, the nurses and other health professionals, as well as on the care setting[45]. Nurse staffing can decrease the LOS when the staffing is adequate and staff react quickly to symptoms, or the LOS can increase with inadequate staffing where the patient experiences near-misses, errors and adverse events[45]. The relationship between nurse staffing and LOS is not statistically significant for all units in a hospital[45]. Shorter LOS can occur when nurse staffing has a high proportion of RNs[45]. The LOS decreases by an average of 27% when one RN is added per patient per day[45].

3.2 Nurse-intensity of care ratio

Nurse assignments for elective patients can be complicated, as a result of the highly variable duration of stay and intensity of care that the patients require[46]. If a department uses a method that assigns nurses to intensity of care, a detailed intensity of care system is needed[38]. Usually, the charge nurse assigns nurses to patients at the beginning of a shift[46]. Nurses can treat a limited number of patients or points[46]. The maximum points per shift for a nurse depend on the intensity of care levels and scores per indicator[47]. The nurse is scheduled for a maximum of intensity of care points, so the charge nurse can schedule nurses based on the total care points, divided by the maximum points a nurse can handle. The result is the number of nurses needed for the shift[47]. The ratio nurse to intensity of care can vary during shifts. When a patient is admitted or discharged, the intensity of care points of the nurse will be adjusted up or down[38,46,47]. So far, there has been no research into the patterns of nursing to

patients' intensity of care ratio[28].

When the workload for a nurse increases, the chance of absenteeism of the nurse increases as well[48]. A nurse with work overload has 30% more sick leave than a nurse without work overload[48].

3.3 Acute Medical Unit

This paragraph will clarify the model for intensity of care used for Acute Medical Units. The workload of nurses and forecasting of important workload factors are also taken into account.

3.3.1 Intensity of care models

The indicators described in Table 17 are also valid for the AMU[28,42]. However, three reasons make it difficult for the AMU to develop an intensity of care system. First, the flow of patients and the intensity of care vary. Second, patients with the same diagnosis may have different levels of fitness. Third, it is unclear how long the patients will depend on care[28]. A successful patient classification system for acute care is more flexible and has reactive staffing patterns that include the factor of patient dependency[28].

A usable tool for the AMU is the Jones Dependency Tool (JDT). Like RAFAELA in section 3.1.1, the JDT lists six key domains: communication; airways, breathing and circulation (ABC); mobility; activities of daily living; environment, safety health and social needs; and triage[49]. The six key domains can be subdivided into several factors. These factors are represented in Figure 15.

Jones Dependency Tool (JDT)

Component	3	2	1
Communication	☐ Complete impairment* due to either loss of one or more senses*	☐ Impairment* or potential for impairment of one or more senses*	☐ Able to communicate through all senses
	☐ Pain being at the higher range of the visual analogue scale	☐ Pain at the mid range of the visual analogue scale	☐ Pain at the lower range of the visual analogue scale
	☐ Unresponsive	Responding only to verbal/pain stimulation	☐ Alert
	☐ *Language barrier	☐ Difficulty due to *language barrier	☐ No language barrier
	☐ Extensive *behavioural problems	☐ Anxious/tearful/ distressed	☐ Co-operative/relaxed
ABC	☐ Cardiac/respiratory arrest (or risk of arrest)	☐ Risk of impairment to airway breathing or circulation (potential	☐ No ABC problems
	☐ Complete impairment of ABC or shock*	for shock due to condition)	☐ Minor wounds
Mobility	☐ Total immobility	☐ *Partial mobility loss Patient requires trolley/wheelchair	☐ Fully mobile ☐ Minor limb problem
Eating drinking elimination and personal care	☐ Total loss* of bowel/ bladder function and/ or hyperemesis	☐ Partial loss of bowel/ bladder function and/ or vomiting	☐ Normal bowel/ bladder control. No vomiting
	☐ Total loss* of independent self care	☐ Partial loss of independent self care	☐ Able to maintain independent self care
Environmental safety, health and social needs	☐ Demonstrates danger to self or others	☐ Appears unable to fully understand risks	☐ Shows total ability to fully understand risks
	☐ Appears to require extensive social support*	☐ Appears to require some social support*	☐ Does not appear to require social support*
Triage	☐ Red or Orange	☐ Yellow	☐ Green or Blue

*JDT glossary of terms:
Complete impairment – complete loss;
Impairment – some degree of loss;
Senses – any one of the five especially sight, hearing, touch;
Language barrier – inability to speak or because of different language to nurse;
Behavioural problems – psychological or drug related;
Total loss – total inability to control own functions (may be ongoing);
Social support – co-ordination of – relatives/environment/service provision;
Shock – hypovolaemic, cardiogenic, obstructive, distributive requiring immediate intervention;
Mobility loss – relates to loss or partial loss of normal mobility in any limb(s)
Partial mobility loss – has some ability to move limbs but may require help with sitting/standing/personal care.
6–7 = Low dependency; overall score = 0
8–12 = Moderate dependency; overall score = 1
13–15 = High dependency; overall score = 2
16–18 = Total dependency; overall score = 3

Figure 15. Jones Dependency Tool

JDT and RAFAELA differ only in the scale of scores; the JDT uses a three-point scale where one point stands for "fully absent" and three points stand for "fully present". The scores are added up, and the results are categorised in one of the four dependency levels: low (score 6-7), moderate (score 8-12), high (score 13-15) or total (score 16-18)[49]. Nursing care can be tailored to the dependency level. The JDT can be used to improve patient care[50], and can identify patients' specific nursing needs[50]. At the moment, no valid and reliable tools are developed that can predict the workload of the nurses in the AMU[51].

3.3.2 Nurses' workload

The workload of nurses depends on patient dependency and the factors described in Table 17. When patients' acuity and the nurses' workload are measured, the staffing level can be more effective[52].

3.3.3 Forecast acute patients

The number of acute care patients, the intensity of care and the workload can be estimated by linear regression[19] when applied to the forecast of the number of patients, intensity of care or workload for the following day or week. The regression analysis is a valid method to create a representative line for a trend, as represented in Formula a[19].

Formula a: $y = a + bt$

The variables in Formula 1 can be described as below:

- $y =$ the predicted (dependent) variable, in this case the number of patients
- $t =$ the predictor time variable
- $b =$ the slope of the data line
- $a =$ the value of y when t is equal to zero

3.4 Scheduling nurses

The scheduling of nurses is described for the staffing levels and the float nurse; this can be accomplished with different methods.

3.4.1 Staffing levels

For scheduling purposes, budget planning and the capacity of the nurses are taken into account. Linear programming is frequently used to calculate the optimal capacity of nurses at the lowest cost[8]. The planning consists of four phases: 1) determining the budget, 2) scheduling, 3) rescheduling and 4) nurse-patient assignment[8]. The four phases match the framework of Hans et al.[15], where the four phases are strategic, tactical, operational offline and online. At the tactical level, it is decided what number of nurses is effective for the expected patient care. At the operational level, the nurse manager often has no knowledge of how the nurses experience the workload a certain day[7]. In the scheduling the skill mix of the nurses is taken into account, including their job description, qualifications, work experience and responsibilities[53].

The nurses can indicate their shift preferences two weeks in advance, which is entered into the schedule preference. The next step is creating a draft schedule. This will then result in a complete and official schedule. This schedule can be corrected if so required[54].

In the Netherlands the NPR and PCSs are often used, as there is no uniform model, guideline or policy for scheduling nurses[9]. A study suggested a solution, namely to establish an NPR for the day, late and night shifts and to have these modified by the charge nurse of the shift by assigning the nurses to the patients at the operational level[9].

3.4.2 Float nurses

The float nurses are unfamiliar with the department, so for a department, it is profitable if the same float nurses are deployed[55]. Float nurses can indicate their preferences for working in the same way as mentioned in section 3.4.1. In the emergency department it is customary to keep some nurse hours available, so that float nurses can be called when needed on the weekends. In this way, there are enough nurses for the peaks on the weekdays[56].

3.5 Conclusion

There are more common models for intensity of care for elective patients than for acute patients. For acute patients there is one tool, the Jones Dependency Tool. This tool is often implemented in the emergency department, and focuses on other factors that influence the intensity of care than the models for elective patients. The factors in this tool are: communication, ABC, mobility, ADL, environmental safety health and social needs, and triage. This differs from the emergency department and the elective departments.

A good model for elective patients is the RAFAELA system. The factors in this model can be useful for the development of the AMU model (section 5.1). Here the factors are: planning and co-ordination of nursing care, activity, sleep and rest, teaching, guidance in care and follow-up care, and emotional support.

A final good model is the intensity of care model for neonatal intensive care, where it is difficult to create a balanced nurse workload. Due to this model, the workload for nurses has become balanced. In this model the following factors are used: respiratory status, lab work, feedings, vital signs, x-rays, weighing, medications, suctioning, chest physiotherapy, wound care, dressing changes, intravenous fluids, and miscellaneous (admit/discharge, procedures, nitric oxide or morgue care).

According to the literature, the following variables are important to determine the workload: patients older than 70, transfers of patients, average LOS and daily patient turnover (include admissions on the ward, transfer, and discharges).

4. Benchmark

The research question '*How does the performance of the Acute Medical Unit in Rijnstate compare with other similar Acute Medical Units in hospitals in the Netherlands?'* is the focus of this chapter. In order to answer that question, information is collected by researching the subtopics. These subtopics are: the setting of the AMU, the use of intensity of care models, planning systems, scheduling of nurses, and decisions on number of patients per nurse based on the patterns and factors for a high workload. Selected hospitals were contacted to obtain information, ideas about the intensity of care models in the AMU and important factors for implementing such a model. The AMU in Rijnstate is benchmarked with other similar hospitals in the Netherlands in order to investigate how the AMU in Rijnstate performs and ranks.

4.1 Benchmarking process

The benchmarking process is completed in 13 steps, which are described in this subchapter[57,58]. The steps were combined to form three phases.

4.1.1 Planning phase

First the goal of the benchmark must be clarified, i.e., to benchmark the performance of the intensity of care model for the AMU in Rijnstate Hospital with other related AMUs in the Netherlands. Before the model could be benchmarked, the associated AMUs were contacted to gain information, insight and relevant factors about the intensity of care models for acute patients in the AMU.

The team leaders were emailed to obtain information about the characteristics of the nurses and the patients. Besides the team leaders, patients and nurses in the AMU were also stakeholders for the benchmark. The quality of care is increased for patients whose nurse have a workload lower than 4 on the scale of 5.

The benchmarking partners were chosen by using the site of all Acute Medical Units in Netherlands[59]. Only hospitals with the same number of beds and medical specialties were included in the benchmark. The hospitals that were selected and their characteristics are shown in Table 18.

Table 18. Overview department for benchmarking

Hospital, place	Number of beds	Number of medical specialties	Same medical specialties
Isala, Zwolle	62	12	Surgery, Cardiology, Gynaecology, Internal Medicine, Neurology, Psychiatry, Rheumatology, Urology, Gastroenterology, Otorhinolaryngology,

			and Pulmonology
Medisch Spectrum Twente, Enschede	50	15	Surgery, Gastroenterology, Internal Medicine, Neurology, Orthopaedics, Oral and Maxillofacial Surgery, Pulmonology, Plastic Surgery, Urology, Gynaecology, part of Cardiology, Neurology, Rheumatology, and Otorhinolaryngology
The Spaarne Hospital Location South, Harlem	42	8	Surgery, Internal Medicine, Gastroenterology, Neurology, Gynaecology, Otorhinolaryngology, and Geriatric
Admiraal De Ruyter Hospital Location Goes	54	10	Cardiology, Surgery, Gynaecology, Internal Medicine, Otorhinolaryngology, Pulmonology, Gastroenterology, Neurology, Orthopaedics, and Urology
Atrium MC	48	Unknown	Unknown

After contact with the AMUs, the indicators for the benchmark were complemented and improved. The previous chapters have demonstrated the AMU setting and the patient's characteristics. The unpredictability of patients influences the number of nurses during different shifts. A further finding from the previous chapters is the nurses' high workload. Indicators were set up for the above-mentioned elements, to illustrate the performance of the AMUs related to the research question and subproblems of this chapter. Table 19 shows the indicators, outcomes and the explanations for the indicators and outcomes. The indicators' outcomes are described in section 4.1.3.

Table 19. Overview of indicators and outcomes with explanations

Indicator	Outcome	Explanation
Intensity of care model		
Intensity of care model in the department	Yes	By using an intensity of care model, the patients are assigned to nurses based on their need for care. All the nurses in a shift have the same level of intensity of care of patients.
The patients' need for care was used to assign nurses to patients	Yes	The patients are assigned to nurses in two possible manners, either according to their need for care or their total number.
A specific intensity of care model for the AMU	Yes	By developing and implementing an intensity of care model in the AMU, the setting of the AMU and the patients' characteristics are taken into account.
Nurse staffing		
Number of nurses was decided at the beginning of the year	Yes	The number of nurses in a year is determined on a strategic level. The number of nurses can be predetermined for shifts during the weeks or periods. For example, a lower number of nurses in summer and a higher number of nurses in winter.
A fixed number of unoccupied beds at certain moments during a shift	No	When a fixed number of beds is used at certain moments in a shift, the fluctuations of the number of patients is not taken into account. The number of fixed beds is not the same throughout the week or even during the day. It is better to decide the number of unoccupied beds needed based on the number of

		admitted patients from the emergency room, the discharged number from the AMU, and the unoccupied beds at the moment.
Deciding the number of nurses in periods based on historical patterns	Yes	The use of historical data can lead to a decrease in the number of nurses in quiet periods and more nurses in overloaded periods. When using this way of scheduling, the workload for the nurses will be lower than if the same number of nurses were to be scheduled throughout a whole year.
During extremely overloaded periods an extra nurse is deployed	Yes	In extremely overloaded periods, the nurses are no longer able to deliver high quality of care and need help from extra nurses. This can be achieved at all levels (strategic, tactical and operational).
Scheduling decreased number of nurses in quiet periods	Yes	During quiet periods, the number of nurses can be decreased at all levels (strategic, tactical or operational). The nurse can take leave off work.
Setting and AMU patients' characteristics		
Length of stay over 48 hours	Number of patients with LOS over 48 hours per day/numbers of all patients per day (%)	When a patient stays longer than foreseen by the guidelines, this influences the inflow of patients in the AMU and the workload of the nurses. Patients who stay longer have a higher intensity of care. A department with 0% outcome performs well, because there are no patients who stay longer than 48 hours.
Closing beds in a year	Number of days when beds were closed/Number of days in a year (%)	Closing beds means that a department does not have enough personnel to guarantee the quality of care. A department with 0% outcome performs well.
Frequent medical specialties	Internal Medicine, Surgery or Pulmonology	When the AMU treats many different 'frequent' medical specialties in the AMU, the nurses have more visits with physicians.
Average number of admissions a day	Number of average admissions in a day/number of beds (%)	The number of admissions during a day is a significant factor for the workload of the nurses. A low percentage indicates fewer admissions.
Percentages of discharges a day	Number of discharges in a day/ number of beds (%)	With a number of discharges greater than 50%, there is a high turnover.
Increase in geriatric patients	Number of geriatric patients 2016/ number of geriatric patients in 2015 AMU (%)	The higher number of geriatric patients can cause a higher workload for nurses. These patients often stay longer at home without treatment of their ailments and are thus admitted at advance stages of illness.
Increase in patients with psychiatric comorbidity	Number of patients with psychiatric comorbidity in 2016/ Number of patients with psychiatric comorbidity in 2015 (%)	Patients with psychiatric comorbidity require much more care from the nurses.
During shortage of staff: beds closed in the AMU or spread over different departments	Yes (beds closed in the AMU)/No (beds closed spread over different departments)	The AMU can close beds so that there are fewer transfers to other departments, or other departments close beds, in which case the patients stay longer in the AMU.

4.1.2 Deployment phase

In this phase the data for the benchmark were collected. The data of the current situation of the AMU were already collected in Chapter 2. This phase focuses on the performance of the benchmarking

partners. The data were collected through visits to the hospitals. Three hospitals were willing to participate: Isala in Zwolle, Medisch Spectrum Twente (MST) in Enschede and the Spaarne Hospital in Harlem South. Appendix D presents the interview scheme used at the three hospitals. The interview scheme is based on the indicators in Table 19. The performance of the AMUs is described in section 4.13.

The information obtained from the benchmarking partners was compared to the data collected from Rijnstate. Information useful to developing the model will be used in Chapter 5. This section describes all the collected information of the AMUs as relates to important factors from the previous chapters.

Setting AMU

The four AMUs had the same characteristics. These similarities are set out in the list below:

- Patients were acute patients
- Patients were admitted from the emergency department or the outpatient clinic
- The standard length of stay was 48 hours
- Most patients were either from the internal medicine or surgery units
- Patients younger than 18, or admitted to cardiology, intensive care or brain care units were excluded
- Working processes of nurses comprised: handover of patients to colleagues, administration of medication, doctors' visits, measuring vital functions, monitoring and nursing activities.

Not all the AMUs had the same strategy when almost all beds were occupied. In Isala, patients are still admitted until all beds are occupied. When the department is full, the patients from the emergency department go directly to the specialty departments. In Zwolle there should be 30 empty beds at the end of the day shift. The patients already in the AMU are transferred earlier than usual when the department is reaching capacity. Moreover, this manner of working means there are fewer patients transferred in the evening, and patients do not go directly from the emergency department to the right department. These departments were unable to admit patients directly from the emergency department due to the personnel deployment. In MST in Enschede, the decision on how many empty beds are needed is based on the expected number of admissions of patients per hour per day. Nowadays, the emergency room is being watched for how many patients from there still need to be admitted to the AMU. Whether the AMU can still admit patients from the emergency room is decided per shift. When the AMU is reaching capacity, the head of the department must find a solution for the patients who should still be admitted. If there is no solution, a patient stop is announced. In the past, Spaarne Hospital in Harlem had a fixed number of empty beds at the end of the day shift, so patients

from the emergency room could still be admitted when necessary. Nowadays, they use the same way of deciding as in MST in Enschede.

All the departments have a meeting in the morning with team managers from other departments. With these sessions, they clarify for the AMU whether the departments have enough empty beds, so the patients of the AMU can be transferred to the right departments.

Intensity of care models

None of the departments currently have an intensity of care model in place. In Isala, the existence of an intensity of care model is unknown; the hospital works with an NPR instead. The other two AMUs (MST and Spaarne hospital) are in the start-up phase of implementing intensity of care models. In MST, the intensity of care model is being developed in a workgroup, with the intention to create a universal model. The AMU will implement the same model, but the head of the department expects that this model will not work for the AMU. In this model, the patients are scored on paper on different aspects of care according to the following variables: incontinence, transfer (in the department), tube feeding, meals, oxygen, infusion, excretion, cognition, isolation, wounds, bandaging, control/observation, language barrier, conversations, end-of-life care and discharge. The score for every variable is defined. The total score per patient is categorised into the categories of green, orange or red. The admission of the patients to the AMU is not included, and the score differs for every department. A universal model for all the departments in MST is currently not feasible. The Spaarne hospital will implement the system HotFlo for all clinical departments. This system is not a real intensity of care system, but a system where the number of nurses is determined based on the number of patients. There is a base team and a flexible group of nurses. When flexible nurses from one department have fewer patients and a low workload, these nurses are deployed to a department with a higher number of patients and a higher workload. The system creates a profile of a patient based on age, number of diagnoses, number of applications of medication, and number of times the patient needs monitoring. Using this profile, the system calculates the number of patients one nurse can take care of. The characteristics of the departments are taken into account.

The reasons for implementing the models is to create a balanced workload and to reduce the patient stops. Moreover, the model has to generate time profits by making it easy to switch nurses from the same or other departments. However, the model must not become a time-consuming administrative job for the nurses.

Schedule

The number of nurses per day for all hospitals is established at the beginning of the year and this number does not change during the year. In Zwolle, the number of nurses varies between winter and the summer, but is established at the beginning of the year. The number of nurses can change on an operational level due to absences of nurses or extremely busy/quiet shifts.

The nurses in all AMUs were scheduled in the same way. The nurses can indicate their preferences for shifts and days and after that the scheduling is made. The schedule is finished around two months in advance.

A coordinator or secretary organises the admissions and discharges. These persons complete the allocation of patients to beds in the departments. The workload of nurses and how many admissions a nurse has already had are taken into account.

Forecast

At the strategic level, the pattern of the past year is determinative. The busy and quiet periods were clarified. For Spaarne hospital, the upcoming model can predict the number of patients, but the team manager of the AMU thinks it will not work because of AMU's lack of predictability. No hospital has so far started using an intensity of care model, therefore the intensity of care is not predictable. The AMU in MST will forecast the future of the intensity of care when the model is usable in practice. All AMUs have the same problem, namely that it is difficult to predict the number of patients. The AMU in MST forecasts the admissions and discharges based on historical data at both the tactical and operational level. Also, Spaarne hospital forecasts at the tactical level to see what will happen during the days of the week. However, according to the manager of the AMU, it is risky to adjust staff based on the forecast.

Workload

The workload of a nurse is affected by the different care needs of the patients. If a nurse has patients with different medical specialty, he/she has many doctors' visits. The workload ratio between nurses during a shift can be very different when there is no intensity of care model. The patients with psychiatric comorbidity cause more work, as do the number of admitted patients in a shift for one nurse.

4.1.3 Improvement phase

In this phase, the results of the model are compared to the data collected in section 4.1.2.

The indicators were scored for the four hospitals; the outcomes of these indicators are presented in Table 20, Table 21 and Table 22. The outcomes in the tables below provide information on the performance of the AMUs and give insight into the development of an intensity of care model. The tables are divided by subject. Overall, the results indicate that Rijnstate in general performed equally well as compared to the other hospitals.

Table 20. The benchmark indicators for a fair workload

Indicator	Outcome	Rijnstate	Isala	MST	The Spaarne hospital
Intensity of care model in the department	Yes	No	No	No	No
The patients' need of care was used to assign nurses to patients	Yes	Yes	No	No	No
A specific intensity of care model for the AMU	Yes	Not yet	No	Not yet	Not yet

Table 20 presents the outcomes of the fair workload for nurses. Rijnstate is the only hospital that assigns nurses to patients' needs of care. The assignment process is however not based on literature and can be improved. Because no intensity of care model is currently used, these indicators do not affect the benchmark.

Table 21. The benchmark indicators for nurse staffing

Indicator	Outcome	Rijnstate	Isala	MST	The Spaarne hospital
Number of nurses were decided at the beginning of the year	Yes	Yes	Yes	Yes	Yes
A fixed number of unoccupied beds at certain times during a shift	No	No	Yes	No	No
Deciding the number of nurses in periods based on historical patterns	Yes	Yes	Yes	Yes	Yes
During extremely overloaded periods, an extra nurse is deployed	Yes	If there is a nurse available	If there is a nurse available	If there is a nurse available	If there is a nurse available

Scheduling decreased number of nurses in quiet periods	Yes	Yes	Focus on other work	Yes	Focus on other work

Table 21 provides information for the scheduling of nurses. The four AMUs almost use the same approaches concerning the number of nurses at strategic, tactical and operational levels. The different approaches add value for the benchmark. If a hospital chooses to have a fixed number of unoccupied beds, the department does not take into account the fluctuations of the number of patients. For the AMU, it is important to react to these fluctuations. The performance of Isala is lower than the other hospitals due to the fixed number of beds. The other difference relates to the number of nurses during quiet periods. On strategic and tactical levels, the decisions are the same, the number of nurses is lower in a quiet period if the historical data show a decreased number of patients for that period. But on the operational level the approaches differ; Rijnstate and MST decrease the number of nurses. In the quiet periods, the nurses may take time off from work. The other two hospitals keep the nurses in the department, where they can engage in e-learning or work on projects. The idea behind that is when there is a rapid surge in the number of patients, the nurse is at hand. In contrast, if nurses are absent due to taking time off work, the workload of the other nurses increases due to the higher number of patients per nurse.

According to the outcomes from Table 21, Rijnstate achieved the determined outcomes. The decision for the number of nurses in quiet periods is not efficient, because when the nurses take time off work in a shift and the number of patients increases in that shift, the workload increases for the other nurses. Nurses have much over time. When the manager decides to keep nurses in the department during their shifts to work on e-learning or projects, their overtime cannot be consumed.

Table 22. The benchmark indicators for the setting and patient's characteristics of the AMU

Indicator	Outcome	Rijnstate	Isala	MST	The Spaarne hospital
Length of stay over 48 hours	Number of patients with LOS over 48 hours per day/numbers of all patients per day (%)	4%	5%	5%	7%
Closing beds in a year	Number of days when beds were closed/Number of days in a year (%)	0%	0%	0%	1%
Frequent medical specialties	Internal Medicine, Surgery or Pulmonology	Internal Medicine, Surgery and Pulmonology	Internal Medicine, Surgery, Pulmonology	Internal Medicine, Surgery, Pulmonology	Internal Medicine, Surgery, Geriatrics and

			and Gastro-enterology	and Gastro-enterology	Neurology
Average number of admissions a day	Number of average admissions in a day/number of beds (%)	43%	79%	40%	52%
Percentage of discharges a day	Number of discharges in a day/ number of beds (%)	55%	60%	55%	50%
Increase in geriatric patients	Number of geriatric patients 2016/ number of geriatric patients in 2015 AMU (%)	Yes, not substantiated with data	Yes, not substantiated with data	No, not substantiated with data	Yes, not substantiated with data
Increase in patients with psychiatric comorbidity	Number of patients with psychiatric comorbidity in 2016/ Number of patients with psychiatric comorbidity in 2015 (%)	Yes, not substantiated with data	Yes, not substantiated with data	Yes, not substantiated with data	Yes, not substantiated with data
During shortage of personnel: beds closed in the AMU or spread over different departments	Yes (beds closed in the AMU)/No (beds closed spread over different departments)	Yes	No	No	Yes

Table 22 presents the outcomes for the setting and characteristics of the AMU. In cases where Rijnstate does not have the determined outcome, neither do the other hospitals. Rijnstate performs well in comparison with the other three hospitals. First, Rijnstate has the lowest percentage of patients with an LOS in excess of 48 hours. Second, Rijnstate did not close any beds. Third, Rijnstate has fewer medical specialties, therefore the nurses have fewer visits from physicians. Thus, Rijnstate can spend more time on providing care to the patients as compared to hospitals with more medical specialties. For this reason, Rijnstate performs better than the other hospitals. Fourth, Rijnstate is the second-best hospital as regards the percentage of admitted and discharged patients, whereby a lower percentage is better than a higher percentage. Many admissions and discharges create a high turnover, which influences the nurses' workload. The last point of the benchmark is the choice of where to close beds. Rijnstate and Spaarne hospital both close beds in the AMU, which rather than closing beds in different departments, enhances the patient flow.

4.2 Conclusion

From the five selected hospitals, three hospitals were willing to participate, namely: Isala in Zwolle, MST in Enschede and the Spaarne hospital in Harlem South. The number of beds was almost the same as in Rijnstate. The AMU in Rijnstate performed well in comparison to the other hospitals.

One hospital was unaware of the existence of an intensity of care model. The other hospitals all have the same reason for implementing an intensity of care model: to create a fair workload for the nurses. All three departments were in the same phase, namely at the start of implementing an intensity of care model. The following important factors for the intensity of care emerged during the benchmarking exercise were:

- Incontinence
- Transfer (in the department)
- Tube feeding
- Meals
- Oxygen
- Infusion
- Excretion
- Cognition
- Isolation
- Wounds
- Bandaging
- Control/observation
- Language barrier
- Conversations
- End-of-life care
- Discharge
- Age
- Number of diagnoses per patient
- Medication administration frequency
- Monitoring frequency of monitoring

Different factors influence a nurse's workload, namely the number of admitted and discharged patients and the transport of a patient from an examination or operation to the department.

5. Model

In this chapter, the research question w*hich intensity of care models are applicable for the AMU?* will be clarified. The appropriate models from the literature were analysed, and the best model for intensity of care and nurse staffing was developed. The requirements for the models were that a similar workload is created, nurses can be scheduled in advance, and decisions for deploying a float nurse can be made. Furthermore, the fluctuations in the number of patients and the future medical specialties were taken into account to develop the model.

5.1 The collected information for the model

The information in the previous sections 2.5.2, 3.1.1, 3.3.1, 3.4 and 4.1.2 was used as input for this section. During the observation, the nurses were asked what factors influenced the workload in the department. Literature was examined for information on possible intensity of care models for elective and acute patients. Some factors in the intensity of care model for elective patients are necessary for the model in the AMU.

The impact of the variables, or factors, from the observation, literature and benchmark on the patients' intensity of care and the nurses' workload is set out in Table 23. The classification of the variables is based on how often they occur, their relation to the intensity of care or workload, and the AMU nurses' opinions. A model is useful when the model measures variables with a high impact (scale + or ++ in Table 23).

Table 23. Importance of the variables

Scale	Variables observation	Variables literature study	Variables benchmark
- -			
-	Telephone calls		Discharge
+ -	Arrangement for patients Medication	Planning and co-ordination of nursing care Teaching, guidance in care and follow-up care Average applications of medication on a day	Transfer (within the department) Incontinence Tube feeding Oxygen Infusion Excretion Wounds Medication administration frequency per patient Bandaging End-of-life care Number of diagnoses per patient
+	Repeated measuring of vital functions	Activities of daily living Activity, sleep and rest	Meals Monitoring frequency

	Documentation		Control/observation
++	Dependent patient Patient with psychiatric comorbidity	Communication Airway, breathing and circulation (ABC) Mobility Emotional support Environmental safety, health and social needs	Cognition Isolation Language barrier Conversations

For nurse staffing, the patients' intensity of care, the workload, and the fluctuations in number of patients are necessary. A nurse staffing model is most frequently an Excel file with calculations or a mathematical model.

5.2 Intensity of care model in the Acute Medical Unit

This subchapter describes the intensity of care model in the AMU, the important variables from Table 23, and the requirements of the intensity of care model.

5.2.1 Variables

The patients' intensity of care is focused on different aspects, which are all direct care elements and take place by and around the patient. As can be seen in Table 23, the following variables, in order of importance, are crucial: patients with psychiatric comorbidity, communication, ABC, ADL, isolation, mobility, and controls. The variables communication and activities of daily living are too general to measure. Without specifying the variables, the nurses will score them differently. Communication between the nurse and the patient can be divided into mutually understanding each other through communication and the reaction of the patient. The activities of daily living are focused on personal hygiene or bowel functions. For a usable intensity of care model, it is essential that the variables mentioned above can be measured.

5.2.2 Requirements of the model

The fluctuation in the number of patients in the AMU is an important factor that has to be included in the model. Not all variables for the intensity of care in Table 23 are applicable in the AMU, but for the elective departments. It is important that the model only implements the variables that are appropriate for the AMU. A model that is a time-consuming activity for the nurses is not suitable for the AMU. Furthermore, the model should be easy to understand. The classification of the patients has to be simple, and not exceed six levels and four categories in order to be insightful for the nurses. In a category that can be scored on more variables, the average is the score for that category.

5.2.3 Models from literature

Three models of interest to the AMU were identified from the literature. Some of their advantages and disadvantages are described below.

The RAFAELA system has the following advantages and disadvantages:

Advantages	Disadvantages
- The system is validate	- The six domains are too abstract
- Focus on intensity of care	- No checklist for the six domains
- Factors based on the views of professionals on nursing care, psychological or emotional care	- A manual for the domains exists, but not yet online
- All factors apply to the AMU	- Time-consuming training
	- A same kind of model is currently in use in the AMU, but not the best model for the purpose

The advantages and disadvantages of the neonatal acuity system are described below. This model is originally intended for the neonatal intensive care unit, but the characteristics in patient diversity of the AMU are equal to that unit. Therefore, this model may be implemented in the department.

Advantages	Disadvantages
- Patients can be scored in many categories	- Classification of the patients is unknown
- Related to the intensity of care	- Requires many calculations to decide the score
- The patient group can be compared with the patients in the AMU	- Maybe too many variables where the nurse has to score the patient, as a result a time-consuming activity for the nurse
- The following factors are applicable for the AMU: respiratory status, feeding, vital signs, medications, wound care, dressing changes and intravenous fluids	- The variable 'patients with psychiatric comorbidity' is missing

Jones Dependency Tool has other advantages and disadvantages, as follows:

Advantages	Disadvantages
- Focus on the emergency department and therefore on a high turnover of patients - For every category, the options are clarified what is present and absent by the patient - The following categories are suitable for the AMU: communication, ABC, mobility, ADL and environmental safety, health and social needs - Enables the indication of present, partially present or absent variables - Four intensities per patient	- The triage is not suitable for the AMU - The concept of partial needs a precise definition

5.3 Nurse staffing

This subchapter describes the nurse staffing model in the AMU, the important variables from Table 23, and the requirements of the nurse staffing model.

5.3.1 Variables

A large portion of nurses' workload depends on patients' intensity of care, but other factors can also influence the workload of nurses. These factors are presented in Table 23 and are shown in Table 24 in order of importance with an explanation.

Table 24. The variables that influence the workload of the nurse with an explanation

Factor	Explanation
The number of admitted patients in a nurse's shift	When a nurse has multiple admissions of patients in a shift, the care of the other patients is put on hold until the nurse has finished the admissions. The workload will increase.
The different medical specialties where patients of a nurse may be admitted for	When a nurse has patients who were admitted for different medical specialties, the nurse has many physicians who visit the patient, this leading to multiple points of contact for the responsible nurse.
Transfer of patients to another department	The workload increases when a nurse has a high number of patients to be transferred to another department. The nurse has to prepare the transfer by informing the patient about the transfer, updating the electronic patient record, and handing over to the nurse from the other department.
Number of LOS longer than 48 hours in a shift	The longer a patient stays in a department, the more severe is the disease. The LOS is maximum 48 hours for the AMU. When a patient reaches this maximum, the care becomes more intensive.
Transport of a patient from an examination or an operating theatre to	When a nurse is transporting a patient from an examination or operating theatre to the department, the nurse is absent from

the department	the department and cannot take care of the other patients. The patients have to wait until the nurse is back.
Late visits of physicians	The nurses have time in the morning to handover the patients to the physicians. If the physicians visit later than planned, the nurses are busy with other activities.
Patients' age	The older the patient, the more the patient is dependent on a nurse for various activities.
Not being able to help a colleague when he/she needs help	The workload is high if a colleague needs help, but the nurse cannot assist the colleague.

5.3.2 Requirements of the model

The nurses' workload is central in this section of the model. The following factors influence the fluctuations in the nurse staffing (also mentioned in section 2.4.1):

- Periods with low requirements for intensity of care
- Workload

The workload can be subdivided into the intensity of care and the variables in Table 24. In the model, the weights of the variables can be calculated.

The nurse staffing model decides the number of nurses for a shift based on the workload and the related factors from Table 24. For the operational level, the decision is the deployment of a float nurse for a balanced workload. The forecast for the intensity of care is important in this model, so the number of nurses can in- or decreased in advance. An estimate of the unoccupied beds for the following days is an advantage. If the intensity of care can be determined for the next morning, the float nurse can either be deployed or not.

5.4 Final model

This subchapter describes the final model, using the information from section 5.2 and 5.3.

5.4.1 Intensity of care model

The information in section 5.2 has shown that the Jones Dependency Tool is the best model as a basis for an intensity of care model for the AMU. The JDT measures the most important variables for an AMU, which are mentioned in section 5.2.1. The triage is not applicable to the AMU and is changed to isolation, which may create a high intensity of care. The classification of patients in a level is adapted, because in the original classification the highest score in a domain is the score for that domain. In the current model, the score of all variables is counted for the intensity of care. The score per domain is the average of the variables' scores in that domain. The classification of the patients is the same as in the original model. The patients are scored on 12 factors on a scale of 1 to 3, whereby for "1", the factor is fully absent, for "2" the factor is not fully present or absent, and for "3" the factor is fully

present. This scale facilitates the classification of patients into four categories: low (score 6-7); moderate (score 8-12); high (score 13-15) or total (score 16-18). Figure 16 presents an adapted version of the Jones Dependency Tool which is applicable to the AMU.

Domain	3 (fully present)	2 (partially present)	1 (fully absent)
Communication	□ Complete impairment due to loss of either one or more senses	□ Impairment or potential for impairment of one or more senses	□ Able to communicate through all senses
	□ Pain being at the range 8 to 10 of the visual analogue scale	□ Pain being at the range 4 to 7 of the visual analogue scale	□ Pain being at the range 0 to 3 of the visual analogue scale
	□ Unresponsive	□ Responding only to verbal/pain stimulation	□ Alert
	□ Language barrier	□ Difficulty due to language barrier	□ No language barrier
	□ Extensive behavioural problems	□ Anxious/tearful/distressed	Co-operative/relaxed
ABC	□ Complete impairment of ABC or shock	□ Risk of impairment to ABC (potential for shock due to condition)	□ No ABC problems/ minor wounds
Mobility	□ Total immobility	□ Partial mobility loss. Patient requires trolley/wheelchair	□ Fully mobile/minor limb problems
ADL	□ Total loss of bowel/bladder function and/or hyperemesis	□ Partial loss of bowel/bladder function and/or vomiting	□ Normal bowel/ bladder control. No vomiting
	□ Total loss of independent self-care	□ Partial loss of independent self-care	□ Able to maintain independent self-care/ is helped by a nurses' aid
Environmental safety, health and social needs	□ Demonstrates danger to self or others	□ Appears unable to fully understand risks	□ Shows total ability to fully understand risks
	□ Appears to require extensive social support	□ Appears to require some social support	□ Does not appear to require social support
Isolation	□ Droplet isolation	□ Contact isolation	□ No isolation

Figure 16. The intensity of care model for the AMU

Most factors for the score "2" can be interpreted in multiple ways. Therefore, these factors are explained in this paragraph. Partially present is not fully absent or present. Score "2" applies if a patient has problems with his/her senses but does not have complete loss of one or more senses. Anxious/tearful/distressed is when a patient has problems with emotions but does not require much attention from the nurse. The patient gets a score "2" if the patient is not in shock but has a poor condition and the risk for a shock or ABC problems is high. Partial mobility loss is defined as problems with mobility and needing help from the nurse or equipment. The bowel and/or bladder can function abnormally where the patient has the most times control over the bladder and bowel. When patients need help for self-care, but can do things on their own, they are scored "2" for the independence of

self-care. The understanding of risks is scored “2” for the patient if he/she does not understand why treatments are necessary or why rules are imposed. Some social support is defined when a patient needs the support of the nurse for social problems, but the nurse is not constantly present to support the patient.

5.4.2 Nurse staffing

First is tried to make a nurse staffing model in Excel that combines the intensity of care and workload. The workload becomes a regression formula with multiple significant independent variables: intensity of care, number of admissions, number of discharges, number of medical specialties and number of LOS over 48 hours. The intensity of care and the workload are collected in the model in section 5.4.1. The data of the variables: number of admissions, number of discharges and LOS higher than 48 hours are collected by the database of the hospital. The other workload factors mentioned in Table 24 were inapplicable for the AMU or cannot be measured. The model is used to illustrate a relation of the workload predictors. To achieve this relation, a linear regression is accomplished in SPSS.

The workload is measured per nurse per shift, so the reasons why a workload becomes high during a shift or day can be determined. The decision for the number of nurses per ward for the day and late shift is described in Table 25, where three nurses is the standard.

Table 25. Decision on the number of nurses by workload

Workload	Number of nurses
1	2
2	3 (small nurse surplus)
3	3
4	3 (small nurse shortage)
5	4

If the nurse staffing model in Excel is not possible, the problems in the system around the AMU will be determined and how the problems can be solved.

5.4.3 Assumptions

The selection of the model is accomplished in consultation with nurses. The other assumptions for testing the model are:

- Cards are filled in by a nurse
- When something is unclear for the nurses, they contact the researcher
- Despite the summer reduction in the hospital during the pilot phase, the intensity of care will

not be influenced by this reduction

- Data that cannot be provided by the card will be collected from a database
- In three weeks all data are collected
- On a ward, there are standard three nurses in the day and late shifts, this is equal to a normal workload
- For the nursing staffing, the basic shift schedule is used to decide the need for a float nurse
- The data of the pilot phase will be used in the chapters results and conclusion

5.5 Conclusion

In conclusion, an adapted version of the Jones Dependency Tool is used as an intensity of care model. This model will later be processed in Excel so that the department can work with the model. For the nurse staffing, a model is built where the workload and intensity of care are central to decide the number of nurses.

6. Experimental design

The focus during the experimental design was on the following research question: *how does the intensity of care and the nurse staffing model perform in the AMU?* This chapter comprises an explanation of the approach to testing the model, and is followed by a discussion of possible opportunities for the department after the model is implemented. The inputs for the model and its validation are also described.

6.1 Intensity of care

The intensity of care model was tested over a period of six weeks in July and August. During the first four weeks the nurses on one particular ward tested the intensity of the care model, while during the last two weeks this same test was performed by the nurses of the whole department. The wards have the same numbers of patients, and thus it was not significant which ward was chosen for the first four weeks of the pilot test. During these four weeks there were some scoring cards completed, and in order to obtain more data from the nurses a decision was made to expand the population to the whole department. Only the day and the late shifts were included in the measurement period, due to a lack of response from the night shift, which had been anticipated.

6.1.1 Measurement period

During the pilot the nurses completed a scoring card for intensity of care, which is presented in Appendix E. It was completed during the measurement period for the patients, who were already either staying on the AMU or were admitted during the nurses' shifts. In total 420 nurses (6 nurses * 7 days per week * 4 weeks + 18 nurses * 7 days per week * 2 weeks) had an opportunity to complete the scoring card during 84 shifts (6 weeks * 7 days per week * 2 shifts) shifts. During the first four weeks there were 18 beds available for patients, while during the last two weeks 56 beds were available. In the chapter results (Table 28) the final number of nurses who categorised their patients using the intensity of care model is shown. When a nurse was overloaded on a shift, there was no time to complete the scoring card, which is why there were fewer nurses with compete cards.

The nurses estimated the categories of the patients. These estimations were then compared with the outcome categories from the model. Section 5.4.1 defines how the outcome categories were established. The intensity of care analysis was performed using the nurses' estimations. The patients' final category scores ranged from 1 to 4, and the intensity of care points from 6 to 18. The intensity of care points are a result of a sum of the average from all six domains. Both the categories for the intensity of care and the score points are examined in the results section. When there is a small

difference in the patient's categories, then the intensity of care points can provide greater insight. Both the patients' intensity of care and the intensity of care points were used for the nurse staffing model.

The data were checked for normality in cases where the data was normal if the skewness and kurtosis were between -2 and 2. However, because the data were already between these two values, it was clearly already normalised. This model is appropriate for a department in which there is a high positive correlation between the nurses' estimated intensity of care and the intensity of care from the model, and, secondly, in which there is a moderate positive correlation between the intensity of care levels of the patients who were scored on several occasions (Table 26). Because the intensity of care of patients can be changed during admission, the correlation may be lower than that between the nurses' and the model's intensity of care. Once the model was found to be appropriate for the department, the analysis was extended. The relationship between the intensity of care and the shifts, days and medical specialties was determined with a statistical significance of a P-value lower than 0.05. In future it will be possible to forecast the intensity of care if there is a statistical significance for the shifts, days and medical specialties.

Table 26. Size of the correlation coefficient

Size of correlation	Interpretation
0.90 to 1.00 (−0.90 to −1.00)	Very high positive (negative) correlation
0.70 to 0.90 (−0.70 to −0.90)	High positive (negative) correlation
0.50 to 0.70 (−0.50 to −0.70)	Moderate positive (negative) correlation
0.30 to 0.50 (−0.30 to −0.50)	Low positive (negative) correlation
0.00 to 0.30 (0.00 to −0.30)	Negligible correlation

For the extended analysis, the nurses' estimated intensity of care was leading and was controlled with the outcome category from the model. For every category is established how many patients were classified in that category by the nurses and how many patients belong in that category according to the intensity of care model.

The nurses' estimated intensity of care for each category comprises the number of patients displayed per shift, which sheds some insight into which category occurs the most in which shift. The days were analysed through average intensity of care as well as the average intensity of care points per category. This brings more understanding to the question of which days have a higher intensity of care, and which have either higher or lower points in any category. Finally, for the medical specialties, observable high intensity of care (points) were examined. If in one of the three analyses no significant difference

was detected, then this analysis will not take into account the nurse staffing advice.

In the analysis of the intensity of care, the final point shows the number of nurses who classified patients in either a lower or higher category than the model. For every nurse the number of times they classified a patient has been determined. Subsequently, per nurse the differences from the classification of the nurse and the model is calculated and is shown as always lower/higher/extreme higher, never lower/higher/extreme higher, or is different for the classifications.

The intensity of care points for each nurse in a shift was added together and will be called the total intensity of care points. From this data a histogram was made in order to show how often that total intensity of care points occurred.

6.1.2 Validation and reliability of the model

The model will be tested for validation and reliability in order to decide whether the intensity of care model can be implemented in the AMU.

Validation

For the intensity of care the model was tested, and the nurses subjectively examined the model. They verified the various aspects of the model that were related to the intensity of care. When the professional's opinion is used as a validity method, this is called face validity. The model has face validity because the nurses thought that the model covered the measuring of the intensity of care[60]. According to professional opinion, the intensity of care model is suitable for the AMU.

The performance of the intensity of care model was tested by a correlation between the nurses' intensity of care and the calculated intensity of care. The correlation is a statistical analysis that assessed whether there was a relationship between the two outcomes. The strength of the correlation is presented in Table 26[61]. Additionally, as described in 6.1.1, the correlation between the intensity of care levels of the patients who were scored multiple times has been calculated.

Reliability

The internal consistency[49] assessed by Cronbach's alpha is also a useful reliability method. This test calculated whether the scores of the domains measured the intensity of care. A value higher than 0.7 indicates a moderate relationship between the item and the intensity of care, whereas a value lower than 0.3 indicates that this item should be removed in order to improve the reliability of the model[62].

For every shift, day and medical specialty, the intensity of care was examined for significance. The significance results will be used to advise the department what they can expect concerning intensity of care in the future. For the shifts an independent sample T-test in SPSS was used, and for the days and medical specialties a One-way ANOVA. The outcomes of these test are shown in Appendix F.

6.2 Nurse staffing advice

For the next model, the nurse staffing model, the workload was first examined. Based on the workload the number of nurses can be determined. The experienced workload was assessed by using a Likert scale from 1 to 5 on the scoring card of the intensity of care (Appendix E). For each shift the nurses made a note of their workload, which was related to different variables mentioned in section 5.4.2. The data for those variables that could not be collected with the scoring card is included in the database from the hospital (variables include number of patients who were admitted, discharged, or stayed longer than 48 hours). The data was modified for use in an Excel file.

Initially a stepwise multiple linear regression model was developed in SPSS, with the dependent variable workload and the independent variables (intensity of care, number of admissions, discharges, LOS above 48 hours and medical specialties per nurse) during a shift. Steps-by-step, the independent variable with the lowest significance was added to the model. The influence of the previously added independent variables on the regression coefficients was controlled. The model was complete when all significant variables were included. The variables were examined in order to discover whether the assumptions for a multiple linear regression were achieved. The assumptions are described in section 6.2.1, and the graphs of the assumptions are shown in Appendix F. Based on the results from the analysis in section 7.1.2, the multiple linear regression model could not be built without violating the assumptions of linearity. The variables were transformed with a logarithm, square roots and a reciprocal function. These assumptions for linearity are also presented in Appendix F.

With the above variables, the assumptions for the regression model were violated (section 6.2.1). Therefore, some independent variables were converted for a second attempt to build a multiple linear regression model. These converted variables are shown in Table 27. There was no relevant converted variable for the number of admissions per nurse and therefore the variable is not presented in Table 27.

Table 27. Converted variables with explanation

Original variable	Converted variable	Explanation
Intensity of care	Intensity of care points	The intensity of care points are more specific than the intensity of care category.
Number of discharges	The factor for patients who were transferred to the hospital is 1 and for discharge from the hospital it is 2.	If the patient is transferred to a medical specialty department, the nurse has less work for the patient than when the patient is discharged from the hospital.
Number of patients who stayed longer than 48 hours	The average LOS of the patients per nurse per shift	The average LOS gives more insight into how long the patients remained in the department.
Number of medical specialties	Patients who were admitted for frequent medical specialties have a factor of 1.1, the moderate medical specialties a factor of 1.3, and the rare medical specialties a factor of 1.6	The care for patients who were admitted for the frequent and moderate medical specialties is known by the nurses, whereas the care for the rare medical specialties is unknown. Therefore, the patients who were admitted for the rare medical specialities had a higher factor than patients for the frequent or moderate medical specialities.

When the variables in Table 27 are performed – in the same way as the multiple regression above – a multiple linear regression again required. The assumptions were checked but were found to be invalid, as the scatter plots in Appendix F show. The transformation of the variables was completed and a multiple linear regression model was built with a transformation function of the logarithm, square roots and reciprocal.

For all regression models an R square above 0.5 is a model that fits the correct data. If the R square is lower than 0.5 then the model is not the best one for the dataset.

For the above-mentioned multiple linear regression models there was no model that validated the assumptions. Therefore a nonlinear regression model was attempted. For every independent variable related to the workload a scatter plot was created, in which an examination was made of the following aspects of the models' suitability: logarithmic, inverse, quadratic, cubic, power, compound, S, logistic, growth or exponential. If one of the independent variables fitted one of the models, it was placed in the nonlinear regression model. A model was deemed to fit if there was an R square of 0.3 or higher.

If the above attempts to create a multiple regression model did not result in a regression model, then the workload data was analysed further. The shifts were examined to discover any statistical significance, and also to determine on which shift, if any, there was a chance of a low or a high workload. The days were analysed to find the average workload, and also for understanding why some days had higher or lower workloads. Finally, for the medical specialties the observable high and low workloads were examined. If, in one of the three analyses, there was no significant difference

detected, then it was not taken into account for nurse staffing.

The workload for each nurse was compared to the average workload of a shift. For every nurse a lower or higher workload was determined. They were further examined concerning the maximum number of care points that the nurses could handle in a shift. These results are significant for the department because they offer some insight into how to arrange staff if one of the nurses with always higher or lower workload works.

Finally, the nurse staffing is based on the problems in the systems around the AMU. The problems are described in section 2.1. The problems are indirect related to the workload of the nurses. If the problems can be solved, the workload will be better for the nurses.

6.2.1 Validation and reliability of the nurse staffing model

This part of the chapter describes the performance of the nurse staffing model, divided into validation and reliability.

Validation

This model was validated in the course of the model development, starting with approval for applicability by the team manager[60]. The conclusion was that the model is appropriate if the manager can decide on the number of nurses.

Furthermore, the nurse staffing model can be validated by the R square and the graphical residual analysis. The R square is measured by how successful the regression is in explaining the dependent variable. A correlation above 0.5 represents a strong relation. The graphical methods can illustrate complex aspects of the relationship between the model and the data[63].

Reliability

The minimum number of observations for the model is based on the effect size (0.15), statistical power (0.8), the number of predictors (5) and the probability level (0.05). To obtain a reliable regression a minimum sample size of 91 observations is required. The regression model is reliable when the following assumptions apply[64]:

Assumption 1: The dependent variable is an interval or ratio variable.

Assumption 2: There are two or more independent variables that can be nominal, ordinal, interval or ratio.

Assumption 3: The independence of observations can be checked by using the Durbin-Watson statistic.

Assumption 4: There is a linear relationship between the dependent variable and the independent variables as groups and as individuals. The relationships can be achieved by creating scatter plots and partial regression plots and inspecting these plots for linearity.
Assumption 5: The data show homoscedasticity.
Assumption 6: The data do not show multicollinearity; this occurs when two independent variables are correlated.
Assumption 7: There are no unusual observations (significant outliers) in the data set.
Assumption 8: The residuals (errors) are normally distributed.

For every shift, day and medical specialty the significance of the workload is gauged, where a P-value lower than 0.05 is significant. This significance is used to clarify the shifts, days and medical specialties, which require either less or more attention concerning nurse staffing.

6.3 Conclusion

During the experimental design the data were collected for the intensity of the care model and the nurse staffing advice. A paper scoring card was used for this purpose. The hospital database was also used to complement the nursing staff data. The intensity of care was analysed for shifts, days and medical specialties. The nurse staffing model could not be built with a regression model, and therefore the workload was examined further for relationships in shifts, days and medical specialties, which was useful for the department.

7. Results

This chapter describes and explains the results obtained from implementing the intensity of care model, which was similar to the nurses' workloads, as well as the advance nurse scheduling and decisions about a float nurse. The research question is: *what are the results of the implementation of the Jones Dependency Tool in combination with the nurse staffing model?* This question is discussed in this chapter.

7.1 Results from the models

During the measurement period, there were 704 patients in the department, which can be found in Table 28. Of these, 392 patients were excluded because either they were admitted and discharged during the same night shift (n=5), or the nurses did not have time to complete the scoring card (n=387). Some of the patients were multiple categorised by nurses; this leads to a total of 570 categorised patients. The results in this section are therefore not based on all patients in the department, and some relevant information on the intensity of care or the workload may be missing. Important data is missing for the shifts with a high workload and patients with a high intensity of care category. Table 28 shows the characteristics of the pilot phase. On average, 6.6 patients were admitted and 7 were discharged during a shift. The patients staying on average less than one day in the department. The standard deviations were high, therefore a large distribution of values was measured. The nurses had a low to average workload (2.38) with a small standard deviation. The intensity of care of patients was 1.67, and the patients were scored with an average of 8.06 intensity of care points. The points vary more than the intensity of care as the standard deviations show. During the measurement period all the intensity of care categories were measured, and the intensity of care points were measured between 6 and 16. The workload was from low to high.

Table 28. Characteristics of the AMU during the measurement period

Number of days	**42**
Number of patients in the department	704
Number of patients in the model	570
Number of nurses who categorised patients	128
Average number of admitted patients per shift	6.6 (SD 4.4)
Average number of discharged/transferred patients per shift	7 (SD 4.8)
Number of medical specialties	12
Average LOS	20:28 hour (SD 12:57 hour)
Average intensity of care	1.67 (SD: 0.806)
Average points for intensity of care	8.06 (SD: 2.135)
Average workload per nurse	2.38 (SD 0.94)

7.1.1 Intensity of care

The model was appropriate for the department because a high positive correlation was found between the nurses' estimated intensity of care and the intensity of care from the model (r_s= 0.718). A moderate positive correlation was also found between the intensity of care categories of those patients who were classified multiple times (r_s= 0.606). In addition to the correlation, the internal consistency was also checked before the data was analysed. The internal consistency had a Cronbach's alpha of 0.812, which means that the domains measured the intensity of care. Due to the results of the correlation and the alpha, the model measured what it was required to measure.

For the next intensity of care results, and for more detailed insight, not only were the categories studied, but also the score points for intensity of care. First, the patient's estimated intensity of care by nurses was compared with the calculated intensity of care from the model. What stands out in Table 29 is the number of patients who were categorised by nurses in the same category from the model, and were also mentioned as the correctly categorised patients. It is apparent from this table that few patients were estimated at category 4, although none of the patients were allocated to category 4 as an outcome of the model. The model categorises patients with a nurses' estimated high intensity of care (categories 3 and 4) in lower categories. Because the nurses estimated the patients in a higher category, it is possible that in the model the indicators are missing for a high intensity of care. In total 70% of the patients were estimated to be in the same category as allocated by the model. Most patients were categorised in the first two categories. The table shows the number of nurses who classified patients. A nurse classified on average 9 patients in category 1, while an average of 5 patients per nurse was placed in category 2. In category 3 there were an average of 2.5 patients per nurse, and in category 4 an average of 1.5 patients per nurse.

Table 29. Number of patients in the intensity of care categories

Intensity of care estimated by nurses	Number of patients who were categorised in the intensity of care category	Number of patients who were correctly categorised	Percentage of correctly categorised patients	Number of nurses who categorised patients
1	293	250	85%	34
2	187	141	75%	36
3	74	9	12%	29
4	16	0	0%	11
Grand total	**570**	**400**	**70%**	**110**

Shifts

Most patients in the day and late shift, had an intensity of care of 1, followed by category 2, as shown in Table 30. The average intensity of care was 1.62 and 1.72 for respectively the day and the late shift.

There was a small difference between the two intensities of care (P-value 0.142), in which the difference between the average points is larger (P-value 0.95). The differences between the average intensity of care, or the average intensity of care points in the two shifts, are not statistically significant. For both shifts there is a levelling effect in intensity of care and intensity of care points. The chances of patients being placed in categories 2 or 3 is higher during the late than during the day shift. No significant differences between the shifts in the measurement period are likely due to chance. The relationships for the shifts are not experienced in practice and can be explained by the missing data from shifts with a high workload. The founded relationships are not useful for the AMU.

From the 84 shifts in the measurement period, there were completed scoring cards in 25 day and late shifts. The intensity of care in the day shift has a larger standard deviation with a lower average intensity of care. This can be clarified by the high amount of intensity of care category 1 in comparison with the amount of other intensity of care categories for the day shift. In the late shift, there is a small difference of the number of patients with intensity of care in category 1 and 2.

Table 30. Number of patients per intensity of care per shift

Intensity of care / Shift	1	2	3	4	Average intensity of care (SD)	Average intensity of care points (SD)
Day	156	79	33	9	1.62 (0.82)	7.90 (2.13)
Late	137	108	41	7	1.72 (0.79)	8.20 (2.13)
Grand total	293	187	74	16	1.67 (0.81)	8.06 (2.13)

Days

To depict the patients' intensity of care per day, Figure 17 has been created. On Tuesdays most patients were assessed, and therefore there was an increase in patients in all categories on Tuesdays. The number of patients in category 1 compared with the other categories is significant for Mondays and Sundays. Also it is notable that, when considering Table 31**,** the highest intensity of care was measured on Saturdays, although the intensity of care points were higher on Fridays. Patients in category 1 had the most intensity of care points on Sundays, and for those in categories 2 and 3 the most points were on Fridays. For those in category 4 the most points were on Wednesdays. The differences between the different days for intensity of care is not significant (P-value 0.580), but for the intensity of care points there is a statistical significance (P-value 0.011). This statistical significance has no practical significance. When the pilot phase is compared with the data from the current situation (chapter 2), it appears that the pattern of the number of patients is different. In the current situation is the most number of patients on Tuesdays whereafter the number of patients decreased, with an increase on Fridays with a decrease till Mondays. In the measurement period is the most number of patients also

on Tuesdays, but Sundays on the second day with the highest number of patients. This contradicts with the current situation where Sundays have the lowest number of patients. Given this contradiction, it is not realistic to assume that the intensity of care from the pilot phase is the same as the experience in practice. In the measurement period, the missing scoring cards were not completed because the care for patients is the most important task for the nurses. The patients need for care was high in the missing days and shifts, and therefore the nurse had no time to complete the scoring card.

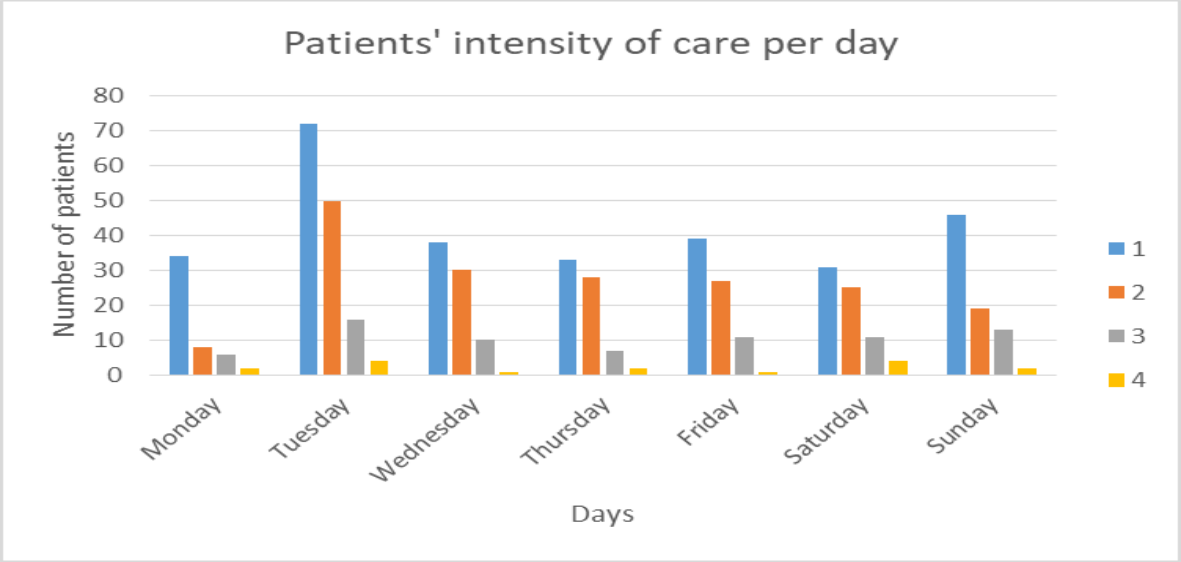

Figure 17. The number of patients per intensity of care per day

Table 31. Per day the intensity of care and the points per day per category

Day	Total number of patients	Average intensity of care (SD)	Average intensity of care points category 1 (SD)	Average intensity of care points category 2 (SD)	Average intensity of care points category 3 (SD)	Average intensity of care points category 4 (SD)	Average intensity of care points(SD)
Monday	50	1.52 (0.86)	6.29 (0.68)	8.88 (1.36)	11.33 (1.63)	13.00 (1.41)	7.58 (2.29)
Tuesday	142	1.66 (0.79)	6.54 (0.77)	8.20 (1.65)	11.13 (1.82)	11.50 (1.29)	7.78 (2.04)
Wednesday	79	1.67 (0.75)	6.42 (0.68)	7.90 (1.16)	10.50 (1.27)	16.00 (-)	7.62 (1.90)
Thursday	70	1.69 (0.77)	6.70 (0.92)	9.25 (1.35)	11.14 (1.77)	12.00 (2.83)	8.31 (2.07)
Friday	78	1.67 (0.77)	7.03 (1.11)	9.56 (1.53)	11.55 (1.44)	14.00 (-)	8.63 (2.20)
Saturday	71	1.83 (0.89)	6.71 (1.22)	8.44 (1.39)	10.82 (1.60)	12.75 (0.96)	8.30 (2.23)
Sunday	80	1.64 (0.85)	7.04 (1.40)	8.95 (1.65)	11.00 (1.29)	13.00 (1.41)	8.29 (2.19)

Medical specialties

Table 32 lists the average points and the categories for intensity of care for medical specialties. A statistical significance was found concerning the differences between the medical specialties and intensity of care (P-value 0.010), and between the medical specialties and the intensity of care points (P-value 0.000). What is apparent from Table 32 is that the highest points for intensity of care of 11.12 belong to the medical specialty of Geriatrics. However, there were only 17 patients admitted for this medical specialty. The patients for Oral and maxillofacial surgery and Otorhinolaryngology have the lowest intensity of care. For the 'frequent' and 'moderate' medical specialties (section 2.3.1), Pulmonology has the lowest intensity of care points. The average intensity of care points for these medical specialties have a range of 7.07-11.12. For all medical specialties the average points range is 6.00-11.12, in which the range for the average intensity of care is 1-2.41. The maximum range for intensity of care points is 6-18 and for intensity of care 1-4. The average points are more detailed. As in the above tables, there is also a levelling effect in the intensity of care for the medical specialties.

The similarity between the current situation and the pilot phase is the significantly higher number of patients for the medical specialties Internal Medicine, Surgery, Pulmonology and Urology than the other medical specialties. The peaks in the current situation per medical specialty on a day are different from the data of the measurement period. Because the peaks in the current situation are the reality, the data of the measurement period are less applicable for the AMU.

Table 32. The average intensity of care and the range per medical specialty

Medical specialties	Average intensity of care points (SD)	Average intensity of care (SD)	Range points (min-max)	Number of patients
Surgery	8.21 (2.11)	1.68 (0.78)	6-14	136
Gastroenterology	7.47 (1.73)	1.50 (0.70)	6-13	70
Geriatrics	11.12 (1.27)	2.41 (0.80)	9-13	17
Gynaecology	7.10 (1.20)	1.20 (0.42)	6-9	10
Internal Medicine	7.97 (2.28)	1.68 (0.81)	6-16	152
Oral and maxillofacial surgery	6.00 (0.00)	1.00 (-)	6-6	3
Otorhinolaryngology	6.67 (1.15)	1.33 (0.58)	6-8	3
Pulmonology	7.07 (1.39)	1.48 (0.68)	6-12	69
Neurology	8.55 (2.16)	1.82 (0.98)	6-13	11
Orthopaedics	9.94 (2.07)	2.33 (0.93)	6-14	36
Rheumatology	10.00 (-)	1.00 (-)	10-10	1
Urology	7.97 (1.86)	1.55 (0.78)	6-14	62

Nurses

The final point to be made concerning the intensity of care analysis is focused on the patients who

were categorised by nurses different than the outcome of the model. The nurses who categorised the patients either consistently lower or higher than the outcome from the model are analysed. They classified patients between one category lower and two categories higher than the model. Table 33 shows how many nurses classified patients differently than the model. For 400 patients (70%) in the care of 38 nurses there is no difference between the nurse's category and that of the model. The other 170 patients were further investigated to discover whether the same nurses classified those patients lower or higher than the model.

Table 33. Difference of nurses' categorising intensity of care with the model

Difference with the model	Number of patients	Number of nurses (% of the 41 nurses)
One lower category	43	17 (41%)
The same category	400	38 (93%)
One higher category	119	36 (88%)
Two higher categories	8	6 (15%)

From the 17 nurses who categorised patients lower than the model, none of them consistently categorised all their patients lower than the model. From the 36 nurses who categorised patients one category higher the model, three nurses consistently classified the patients higher than the model. From the six nurses who categorised patients two categories higher than model, three nurses classified none of the patients lower than the model. All these data are presented in Table 34. It is evident that the model is more likely to categorise patients lower rather than higher compared to the nurses' estimates.

Table 34. Categorizing patients differently than the model

Category from nurses compared with the model	Number of nurses for one lower category	Number of nurses for the same category	Number of nurses for one higher category	Number of nurses for two higher categories	Maximum number of nurses
Always lower	0	-	-	-	0
Always same	-	1	-	-	1
Always higher	-	-	3	-	3
Always extreme higher	-	-	-	0	0
Never lower	-	3	3	3	3
Never higher	4	4	-	-	4
Never extreme higher	10	27	27	-	27
Categorised lower, same and higher	3	3	3	3	3
Grand total	17	38	36	6	41

7.1.2 Workload

The workload is analysed with a regression model and with an exploratory manner. The data and results of the exploratory study will be compared with the data from the analysis in chapter 2.

Regression model

Nurse staffing is based on the workload because if there is a high workload, then the nurses need help in caring adequately for their patients. The workload depends on various factors, as mentioned in section 6.2. In order to examine how these factors influence the workload a regression model was attempted. Before such a model can be built, however, the assumptions mentioned in section 6.2.1 need to be controlled for violation. Neither the scatter plot nor the residual plots showed linearity, and therefore the multiple linear regression model could not be built. The variables were transformed with the logarithm, square roots and reciprocal transformation. The values of the variables were widespread and so it was difficult to find a relationship between the variables and the workload. Therefore the values of the variables were converted, as described in Section 6.2, Table 27. After converting the variables it was found that the multiple linear regression model could not be built, and for the same reason as with the previous model: the transformation of the variables resulted in a violation of the assumptions. Despite the violations of the two regression models, they were run in order to check the fit of the model and the independent variables that predict the workload. Table 35 presents the results for both regression models with and without transformed variables. All the models have little or no fitness with the model (R square from 0 to 0.237). It is remarkable that in most models only the average intensity of care points are equal to the variable for the predicted workload.

Table 35. Overview results regression models

	R square	P-value for the model	Independent variables
Multiple linear regression original variables	0.066	0.006	Average intensity of care
Multiple linear regression original variables transformed with logarithm	0.237	0.040	Number of discharges
Multiple linear regression original variables transformed with square roots	0.107	0.000	Average intensity of care
Multiple linear regression original variables transformed with reciprocal	Error	Error	Error
Multiple linear regression with converted variables	0.082	0.001	Average intensity of care points
Multiple linear regression converted variables transformed with logarithm	0.077	0.002	Average intensity of care points
Multiple linear regression converted variables transformed with square roots	0.080	0.001	Average intensity of care points
Multiple linear regression converted variables transformed with reciprocal	Error	Error	Error

Because the building of the linear regression model was not possible, the possibility of a nonlinear regression model was examined. Scatter plots with the original independent variables were created, although none of the independent variables were an adequate fit with the models. The range of the R square was between 0.000 and 0.115. For the converted variables the range of the R square was 0.000-0.084. These results are lower than the minimum R square of 0.3. A nonlinear regression model therefore does not give any more information than the multiple linear regression models.

Results from exploratory analysis

The analyses of the workload are divided into different aspects, namely per shift, day and medical specialty. The different aspects were examined with the workload related to the length of stay, and the number of admitted and discharged patients.

Workload related to the intensity of care

A relationship between the workload and intensity of care (points) was established by calculating for each workload the average intensity of care (points). These results are shown in Table 36. A higher intensity of care results in a higher workload. This also applies to the intensity of care points except to the workload of 3, in which the points were lower. For this workload the standard deviation is also high, which means that the intensity of care points vary more than by a workload of 1 or 2. The final check was of the workload and the total intensity of care points per nurse. The results indicate that the total points increase with a higher workload, except for a workload of 4. There is also is a high and repeated standard deviation, which results in considerable variation in the total of intensity of care points. For all three averages the difference between a workload of 1 and a workload of 5 is significant. The differences between workloads 2 and 4 are small.

Table 36. The workload and the associated average (points) intensity of care

Workload	Average intensity of care (SD)	Average intensity of care points (SD)	Average total intensity of care points per nurse per shift (SD)	Number of nurses
1	1.44 (0.65)	7.45 (1.57)	30.83 (9.24)	24
2	1.63 (0.79)	7.99 (1.95)	35.05 (10.20)	38
3	1.69 (0.84)	7.79 (1.95)	36.13 (11.97)	47
4	1.91 (0.79)	8.70 (2.19)	35.46 (18.78)	13
5	2.5 (0.86)	9.33 (2.45)	42.00 (12.93)	4

From all patients that are scored, 73% of these patients stayed less than 48 hours in the AMU during a shift of the nurse. The patients who stayed longer than 48 hours in the department, were in the most cases patients for medical specialty Surgery, Internal Medicine or Orthopaedic. These three medical specialties have also in the analysis from chapter 2 a high maximum LOS. Though the workload of the

nurses who had patients in their shift with a longer LOS than 48 hours was in 50% of the shifts low (workload of 1 or 2) and 14% of the shifts high (workload of 4 or 5). When the data is further analysed, most of the patients were categorized with an intensity of care of 1. It is unclear why the patients with a long LOS needs less intensive care.

The low and normal workload occurred the most in the measurement period. Therefore is analysed the low and normal workload related to the number of patients in the different intensity of care categories for a possible relationship between the low and normal workload and the intensity of care. When the workload 1 till 3 was plotting against the intensity of care of 1 till 4, it is remarkable that still more than half of the patients are categorized in an intensity of care category 1 for the low and normal workload. 30% of the patients were categorized in an intensity of care category 2 for the three workloads. It was expected that the percentages with a workload of 1 are high for the intensity of care category 1, the percentages for a workload of 2 are high for the intensity of care categories 1 and 2 and that for a workload of 3 the percentages are high for the intensity of care categories 2 and 3. However, this is not what can be concluded from the data.

Shifts

The nurses did not experience a statistically significant different workload during either the day or the late shifts (P-value 0.607). What is interesting about the data in

Table 37 is that the average workload during the day shift is higher than in the late shift, but the difference is low. In total, workload 3 occurred the most, which means that nurses mainly experience normal shifts. If the shifts are taken apart, then the day shift has the highest chance of having a workload of 3, although a late shift usually has a workload of 2. Because the workload shows no significant difference between the shifts, it can be said that the workload can vary between the shifts. The AMU cannot make decisions of the results.

As mentioned in section 7.1.1 are in total 34 shifts with no measurements of patients' classification or the nurses' workload. Since in the current situation (Figure 9) in the day shift the most patients were discharged, and in the late shifts the most patients were admitted, the expectation is that the workload in the late shift is higher than in the day shift. From the table below it stands out that the opposite of the expectation is measured, but the day shifts have a larger standard deviation. The peak is on the day shift on a workload of 3, and the other workloads are less measured, wherein the late shift the peak is on a workload of 2 with a small difference from the workload of 3. This is the explanation why the day shift has a larger standard deviation. The median for the day and late shift is respectively 3 and 2, which explained the higher average for the day shift.

Table 37. Workload per shift

Workload / Shift	1	2	3	4	5	Average workload (SD)
Day	12 (9.52%)	15 (11.90%)	25 (19.84%)	5 (3.97%)	3 (2.38%)	2.55 (1.07)
Late	12 (9.52%)	23 (18.25%)	22 (17.46%)	8 (6.35%)	1 (0.79%)	2.40 (0.93)
Grand total	**24 (19.05%)**	**38 (30.16%)**	**47 (37.30%)**	**13 (10.32%)**	**4 (3.17%)**	**2.47 (1.00)**

When the workload is only analysed for the shifts wherein patients were admitted, a high workload of 5 is not measured, and the nurses experience in the most shifts a workload of 2. As mentioned above, there were more patients admitted in the late shift than in the day shift (55 patients in late shift and 27 patients in the day shift) (Appendix G, Tables below are analyses of the workload per shift.
Table 46). Admissions of patients take time of the nurses and therefore it was expected that the admissions create a higher workload.

For the LOS is studied the average LOS of the patients and the workload and is shown in Table 38. The average LOS for the day shifts was longer than for the late shift. A longer LOS is in practice related to a higher workload. However, from the analysis, it stands out that the longer LOS does not always create a higher workload.

Table 38. The average LOS in a shift per workload

	Workload					
Shifts	**1**	**2**	**3**	**4**	**5**	**Grand total**
Day	40:29	39:42	48:22	33:34	59:42	43:57
Late	42:46	35:36	38:36	38:14	18:52	37:58
Grand total	**41:37**	**37:13**	**43:41**	**36:26**	**49:29**	**40:48**

The last analysis is the shifts wherein patients were discharged or transferred from the AMU. As mentioned earlier, the most discharges are on the day shifts, and this is measured both in the pilot phase and in the current situation. In 94% of the time that a patient is discharged in a shift, that shift was a shift with a low till normal workload. (Appendix G, Table 47).

In summary, the shifts in relation to the workload is that the lower workload occurred more than a higher workload. This can be caused by the missing data in shifts with a high workload. The expected relationships for the number of admitted or discharged patients and the average LOS for the shifts are not measured in the measurement period.

Days

The workload is statistically and significantly (P-value 0.000) different from the days. Therefore it can be stated that Thursdays and Tuesdays have higher workloads than other days with the data that was collected (Table 39). However, there is missing data and is the relationship not applicable for the AMU. Sundays have lower workloads than in the rest of the week. During the weekends no high workloads were measured. Mondays and Tuesdays have a high variance in the workloads, which means that on these days the workloads can be very different from the average.

Since the number of patients per day not match with the current situation is it plausible that the workload from the measurement period not completely like reality. The average workload was expected higher, especially in the weekends. In the weekends is missing the high workload, and therefore it is now the days with the lowest workload.

Table 39. Workload per day

Day	Average workload (SD)	Range	Number of nurses
Monday	2.70 (1.02)	1-5	11
Tuesday	2.90 (1.01)	1-5	28
Wednesday	2.42 (0.86)	1-4	16
Thursday	2.91 (0.78)	2-4	19
Friday	2.40 (0.90)	1-5	16
Saturday	1.94 (0.79)	1-3	18
Sunday	1.80 (0.97)	1-3	18

If the workload per day is compared with that of the previous day, it is noticeable that Mondays always have a higher workload than Sundays. Wednesdays always have lower workloads than Tuesdays, and Saturdays always lower than Fridays.

After these analysis is the workload per day for only the admitted patients. In the weekends were fewer patients admitted than the rest of the week. The workload is then logically lower than the workload of the rest of the week. When the days in a workweek are examined, the Mondays have a high workload but is a day with the lowest number of admitted patients. From the expectation the Mondays the workload would be lower, or the number of admitted patients would be higher. On Tuesdays are the most number of admitted patients and have almost the highest workload (2.90), which is matched with the expectation of a higher workload with a high number of admitted patients. (Appendix G, Table 48)

The average LOS is analysed per day and workload, where the days with a high workload have a lower

average LOS. The days with lower workload have a higher average LOS. Here too, the relationship that provides a longer LOS for increased workload does not apply. (Appendix G, Table 49)

The last analysis is the number of discharged patients per day and workload. There are 52 patients discharged, with a range of 4 till 11 patients a day. Also for the discharges turn out that with an increased workload that by definition belongs to more number of discharged patients. (Appendix G, Table 50)

Altogether, for days it cannot be said that the workload is increased or decreased by admissions, discharges, or LOS. It can be seen that for the days it is difficult to determine when the high workload can be expected by missing important data of the high workload.

Medical specialties

The workloads for the different medical specialties is statistically significant (P-value 0.018). Patients for the medical specialty of Neurology create the highest workloads for nurses, as shown in Table 40, The workloads for the different medical specialties is statistically significant (P-value 0.018). Patients for the medical specialty of Neurology create the highest workloads for nurses, as shown in Table 14, in which nurses with patients for Otorhinolaryngology can expect a low workload. These patients are not often in the department. For the 'frequent' and 'moderate' medical specialties, the workloads are highest for Pulmonology and are the lowest for Geriatrics.

Table 40. Workload per medical specialty

Medical specialty	Average workload (SD)	Rang workload	Number of patients
Surgery	2.65 (1.03)	1-5	136
Gastroenterology	2.59 (1.03)	1-5	70
Geriatrics	2.18 (0.81)	1-3	17
Gynaecology	2.20 (1.03)	1-4	10
Internal Medicine	2.28 (0.94)	1-5	151
Oral and maxillofacial surgery	2.67 (0.58)	2-3	3
Otorhinolaryngology	1.33 (0.58)	1-2	3
Pulmonology	2.67 (0.95)	1-5	69
Neurology	2.82 (0.87)	2-4	11
Orthopaedic	2.57 (1.14)	1-5	35
Rheumatology	2.00 (-)	2-2	1
Urology	2.31 (1.03)	1-5	62
Average	**2.48 (1.00)**	**1-5**	**568**

For the medical specialties is determined the number of admitted patients and the workload (Appendix

G, Table 51). For the three medical specialties with the most admitted patients (Surgery, Gastroenterology and Internal Medicine) the workload is different. For Surgery is the workload of 2 and 3 measured a lot, for Gastroenterology only workload of 3 and for Internal Medicine only a workload of 2. This is almost the same as the average workload from all nurses. Thus, the number of admitted patients creates not a different workload for the medical specialties. Surprisingly, the medical specialty Pulmonology belongs not to the top three of number of admitted patients.

The LOS per medical specialty and workload is for the 'frequent' medical specialties that the LOS instead of increased decreased by a workload of 3. Further notable findings are that for all medical specialties (except Oral and maxillofacial surgery) the LOS is not linear with the workload, but fluctuate. For Otorhinolaryngology is the highest average LOS measured by a workload of 1. For Urology was the workload of 5 related with the lowest average LOS for that medical specialty. (Appendix G, Table 52)

The number of discharged patients per workload and medical specialty is analysed (Appendix G, Table 53). There are four medical specialties with significant more discharges than the other medical specialties (the 'frequent' medical specialties and Gastroenterology). Also, there is no linearity found with an increased workload and a higher number of discharged patients.

In summary, it is hard to find where the workload is dependent for the medical specialties. The relationships which are found, are not as in reality. Because there was no linearity for workload and the admitted and discharged patients and the average LOS, the AMU cannot make decisions over the workload and the medical specialties.

Nurse

To assess whether the nurse workload is consistently either lower or higher than the average workload per shift, for each nurse in a shift the difference between the actual and the average workload was calculated. The results are shown in Table 41. It is apparent from this table that 12 of the 40 nurses always have a higher workload than average and that nine nurses always have a lower workload. This is half of the nurses. This table clarifies why a regression model is not possible; the nurses experience their workloads very differently.

Table 41. Nurses' workload about the average workload

Difference workloads of nurses with the average workload of the day	Number of nurses
Always lower	9
Always higher	12
Always	5
Workload is different	14

In Table 42,Table 43 andTable 44 the average total intensity of care points, with the average ranges, as well as the average intensity of care with the average ranges and the average number of patients for a workload, are shown. When Table 42 is compared with Table 44, it becomes noticeable that those nurses who always have a lower workload than the average also have, for each workload, lower than average total intensity of care points, as well as a lower number of patients than the general average. For a workload of 2 and 3, there is a higher intensity of care per patient for these nurses. Comparing the data in Table 43 with Table 44**,** it can be seen that nurses with a consistently higher workload have, in workloads 4 and 5, higher than average intensity of care points, and a higher number of patients in a shift. These nurses do not always have the maximum total points per nurse, which means that other nurses reach a maximum of total intensity of care points, and yet do not always have the highest workload. The intensity of care is for the nurses with always lower workload, higher instead of lower. For the nurses with always higher workload is the intensity of care not always higher but sometimes lower.

Table 42. Data from nurses with workload always lower than average

Workload	Average total intensity of care points	Range total care points	Average intensity of care	Range of intensity of care	Average number of patients per nurse in a shift
1	25.83	13-37	1.36	1-3	4.4
2	26.60	15-44	1.71	1-3	4.25
3	20	10-27	2.29	1-4	2.33

Table 43. Data from nurses with workload always higher than average

Workload	Average total intensity of care points	Range total care points	Average intensity of care	Range of intensity of care	Average number of patients per nurse in a shift
2	31.22	16-44	1.79	1-3	6.6
3	33.77	7-51	1.80	1-4	5.4
4	43.2	7-59	1.84	1-3	6.25
5	45.50	42-49	2.56	1-3	9

Table 44. Data from workload of all nurses

Workload	Average total intensity of care points	Range total care points	Average intensity of care	Range of intensity of care	Average number of patients per nurse in a shift
1	30.96	13-45	1.44	1-3	6.75
2	35.23	13-55	1.63	1-4	7.8
3	36.13	7-63	1.69	1-4	8.1
4	35.46	7-59	1.91	1-4	4
5	42.00	24-53	2.50	1-4	6

7.2 Nurse staffing

The intensity of care and the workload are not usable for a mathematical model of nurse staffing, by missing data and the unexpected relationships. There are problems in the system of the AMU, and these are further examined and how these can be solved[65]. In this section is described the possible solutions for creating a fair workload for nurses in the future based on the final report from the AMU[65]. The solutions are indirectly related to the nurse staffing of the model.

Location AMU

The current location of the AMU is far from the emergency room and the radiology department. The current situation has disadvantages for nurses, physicians, and patients. A logical solution is to relocate the AMU nearby the emergency room. The communication between the ER and AMU will be better. The physicians have more overview over the patients when patients were staying nearby the ER. The patient's approach to care currently starts fast. With an AMU nearby the ER and radiology department the patients are earlier for medical examination because the distant between the departments. With the relocation of a department in a hospital, the needs and the capacity of the department has to be described. This solution will indirect influences the nurse staffing of the AMU. The AMU will be more productive if it is placed near the ER. The nurse staffing can be adjust by the higher efficiency of the AMU. The nurses can experience a lower workload, which can result in a lower absenteeism for nurses (only the absenteeism which is created through stress and burn-out).

System of the AMU

The performance of the AMU depends on the whole hospital (section 2.1.1), which means that the nurses of the AMU transfer the patients within the 48 hours. In the past, there were several periods that patients stayed longer in the AMU than the maximal hours. For example, in the AMU were periods with an influenza ward. A second example: the patients who cannot be transferred to the specialty department because of no unoccupied beds, stayed longer in the AMU and created a higher workload

by nurses. Another problem in the system of the AMU is the closing of beds in the hospital. The AMU can transfer fewer patients to the medical specialty departments. A consultation with all the medical specialty departments can result in an overview of where beds are/will be closed and the number of closing beds. The experience from practice is that in the most cases, the patients who stay longer are patients who require a higher intensity of care. Patients were divided into nonsurgical and surgical medical specialties. Sometimes there are difficulties with the transfers of the nonsurgical patients and other times the surgical patients. The flow of the patients can be blocked by different aspects. For example, the ratio of patients (60% nonsurgical and 40% surgical), the reason of the patient's admission, and the capacity of the other departments. When a patient has to be admitted in a one person room, the flow will be limited by the capacity of the one person rooms in the departments. If patients stay longer in the AMU, the preference is that patients stay with lower intensity of care. In the hospital, the different medical specialties have different peaks in the number of patients. These peaks can be forecasted quite accurately. The AMU is working a lot with forecasting, but if the other departments do not forecast their patients, the system around the AMU will not be correct. To motivate the other managers of departments, it is important that these managers know how to forecast and the importance of forecasting. In order to forecast the same level in the same way, an integrated system is recommended. A great advantage for all departments is if the hospital has an integrated system for capacity. The managers have an overview in the number of patients and nurses in their department and other departments. The nurse staffing become flexible if all the departments work with one forecasting system. Once a forecasted peak is coming, the departments can anticipate early on the peak moments by nurses temporarily employ from a department with a low workload to a department with a peak in number of patients.

The AMU is not a department where nurses provide long-term care for patients. Therefore, the AMU is not the department to locate an influenza ward. The clustering of influenza patients has to be somewhere else in the hospital. The patients who have to be admitted in the AMU and do not meet the exclusion criteria can stay in the AMU in the first 48 hours. The nurses provide care for these patients and test the patients on the type of influenza. The flow of the patients with influenza will be better if it is known which influenza type the patient has. When the influenza ward is not in the AMU, the department has the full capacity to function as an AMU.

Shortage nurse staff

The AMU is not the only department in the hospital with a shortage of nursing. The problem with the nurse shortage can be solved if in the whole hospital a new strategy would be implemented. New nurses in Rijnstate will work in departments assigned by team managers and is mentioned as a career

path. The career path for nurses is the new strategy. New nurses will work two periods in a nonsurgical and surgical department, whereafter in the third period the nurse have enough experience to work in the AMU or an IC. After the periods, the nurse can give a preference on what her/his medical specialty will be. With this way of working, departments know that the outflow of nurses will be filled in by nurses from the career path. The AMU will have fewer problems with the nurse shortage with the career path. If all departments contribute with the career path, the implementation will succeed.

Clustering patients in AMU

If the whole system around the AMU is correct, the AMU can cluster patients of the same medical specialties in one room or ward. The nurse has fewer patients in different medical specialties in their shift and will experience a lower workload because the nurse has fewer different doctor visits. An advantage for the physicians is that their patients stay in the same room or in the same ward, whereby the physicians have less contact with different nurses. The clustering of patients is only possible if the AMU has enough capacity. Once the AMU reaches almost full capacity, the patients will be allocated to the unoccupied beds irrespectively for which medical specialty the patient is admitted. The nurses in the AMU know the care for the patients in the most medical specialties, but it is possible that the nurses are better developed in providing care for patients of a certain medical specialty. The knowledge and development can be caused by the previous work experience in the departments. The operational level of nurse staffing can be improved by clustering the patients and assign nurses with more experience in providing care for these medical specialties to these wards than other nurses.

Double check (high risk) medication

In the departments in Rijnstate are prepared and dosed many sorts of medication. For some medicines, a double check is necessary after preparation and after application. A second nurse performs the double check. The second nurse is interrupted from her/his work for his/her patients. A possible solution to replace the double medication check is the use of healthcare medication apps and tools. At this moment these kinds of apps and tools are further developed and improved. These apps and tools decrease the errors in medication application. The apps are available on mobile devices as tablets and smartphones. Through photos, a nurse can remotely verify that the correct medication is administered. Nurses on the department get a notification on their device for a double check. If the nurses are unavailable to check, the notification is sent to a health centre where employees can check the medication. These double checks will be preserved digital and comply with requirements of Health Care Inspectorate. Examples of such apps are Nedap healthcare, Medicatie Controle App, or the company WinVision that healthcare institution provides customized apps. Scanners are also a solution to prevent nurses to double check, where medication is scanned with a scanner or a scanning device.

A scanner can scan a barcode from the medication, and the scanning device recognize the shape, size, thickness, and colour of the pills or capsules. With the scanner, it is necessary that the patients have a barcode on the patient's identification bracelet. The nurses scan the patient's barcode and will be verified in the electronic patient records before the application of the medication. A scanning device which is used in hospitals is MedEye. A nurse put all the patient's medications in a drawer of the scanning device. The prescribed medication in the electronic patient record will be compared with the medication in the drawer of the scanning device for the prescribed time and dose. MedEye has to be installed on a Computer On Wheels. Otherwise, the MedEye is disconnected with the electronic patient records. The company of MedEye is developing an electronic eye for scanning high risk medication, so shortly nurses can administer medication completely independent. The investment in MedEye or medication apps has multiple advantages; the nurses who double checked the medication will not be interrupted in providing care for their patients (workload will be experienced lower), hospital savings in the future on FTE and medication errors decreased.

7.3 Conclusion

The intensity of care model is an appropriate one for the department. In the pilot phase there was a levelling effect in intensity of care points, which can be explained by the fact that during quiet shifts the nurses had time to fill in their scoring cards, while during the busiest shifts they had no time to do so. The department can expect patients between categories 1 and 4 to have between 6 and 15 points. Most patients were allocated to categories 1 or 2. The day and the late shift did not differ statistically or significantly. Therefore the nurses cannot expect a higher intensity of care during the late shift than during the day shift. Based on the data from the measurement period need patients most care on Saturdays and less on Mondays, Geriatric patients required the most care, while nurses have more time for additional duties when attending to Pulmonology patients.

As with the intensity of care, the workload is not significant for the day or for the late shift. The workload is greatest at 3, with second a score at 2. The workloads of 4 and 5 barely occurred during the measurement period. In the measurement period, Thursdays have the highest chance of a high workload. The various medical specialties have almost the same workload. The total points for intensity of care per nurse vary with each workload. When the shifts, days and medical specialties were analysed on the number of admitted and discharged patients and the average LOS, the results are not as expected with the experiences from practice. The missing data could be a reason for the unexpected results.

The following nurse staffing solutions have an effect for the nurses on the long term: relocation of the AMU near the ER, career paths for new nurses, not exceed the maximum LOS of 48 hours for a patient, double check for medication with an app or scanner and clustering patients in the AMU. The nurses can work in a department with a normal workload if the system around the AMU is correct. This can be achieved when the solutions are applied in the AMU and the hospital.

8. Conclusion and recommendation

In this chapter the conclusion to the research question, *what is the conclusion of this study with recommendations?* is given. The recommendations and further research will be described.

8.1 Conclusion

The main goal of this study is to decide upon improvements on the workloads of nurses in the Acute Medical Unit by taking into account the intensity of care for acute patients. The study first identified a potential intensity of care model, in which an adapted version of the Jones Dependency Tool seemed appropriate for the department. The intensity of care in the pilot phase had a levelling effect, which means that the low categories of intensity of care were measured a lot. Besides intensity of care, the intensity of care points for each patient as well as that for the nurses was examined for possible relationships with nurse staffing.

The second aim of this study was to investigate the workload of the nurses and to offer advice on a nurse staffing model. The most important result is that there was no regression model possible with the data from the measurement period. When the workload was further analysed, it seemed that the workload was different for each nurse. Those who always have a lower workload also have fewer patients in their shifts, and not a lower intensity of care than the average, where nurses with a high workload do not have the highest average intensity of care. These findings are conflicting with the expectation. Also there are no linear relationships found between the workload and shifts, days or medical specialties analysed for the number of admitted/discharged patients and average LOS. Advice for a nurse staffing model based on the workload is difficult. The system of the AMU is further analysed. This shows that the nursing on the AMU can work comfortably as the system around the AMU would be improved. To achieve this, the following solutions are conceived: relocate AMU nearby the ER and radiology department, clustering of patients with the same medical specialty in the AMU, implement career paths for nurses in the hospital, double check medication replaced by app on smartphone/tablet or by scanning, and transfer patients within 48 hours. The last point can be achieved by forecasting the peak moments for medical specialties in the whole hospital, and an influenza ward relocates to a department and not located in the AMU.

8.2 Discussion

The discussion is split into two subsections; in the first the intensity of care model is further discussed, and in the second the workload related to the intensity of care for nurse staffing is discussed. For both subsections the data was collected during a period in the AMU in which there was a staff shortage.

There were also beds became unavailable during this period. There was also a high workload in the AMU caused by these issues.

8.2.1 Intensity of care

A validated and reliable intensity of care model was difficult to find in the literature for elective patients. For acute patients there was even less literature available. For this study the method of choosing the best model from the literature and discussing the appropriateness of the model with the department was chosen as the most suitable.

As mentioned in the conclusion, the intensity of care model is appropriate for the Acute Medical Unit in Rijnstate. A strong relationship between the nurses' estimated intensity of care and that of the model has been reported both in the literature and in this study. Furthermore, this study has also found a moderate relationship between the nurses' estimated intensity of care of patients who had been classified several times. Because some of the nurses estimated the intensity of care differently than the model, there can never be a perfect relationship between the nurses' estimated intensity of care and that of the model outcome. For patients who were classified several times there is another possible explanation for the imperfect relationship: that intensity of care can change during the time the patient is being admitted to the department. One interesting finding concerning intensity of care is that patients with an intensity of care category of 1 were, in 85% of cases, placed in the correct category. The higher the patients' intensity of care, the fewer were categorised in the correct category. During the measurement period many patients were classified in categories 1 and 2. The number of patients in categories 3 and 4 for intensity of care was low. The reasons can be the missing data from the nurses with a high workload or that the nurses may be missing the nursing activities in the model which creates a high intensity of care by patients. The expectations were that in the four intensity of care categories almost the same number of patients were categorised. Contrary to expectations, this study did not have the approximate same number of patients in all categories. A possible explanation for this could be that nurses only filled in the scoring cards when there was a low or a normal workload. Nurses with a low or a normal workload have had, in most shifts, patients in categories 1 or 2 of intensity of care.

The shifts, days and the medical specialties were examined in order to discover whether there was any statistical significance between the different groups and intensity of care, resulting in no difference between the day and late shift. This lack of statistical differences can be explained by the fact that patients were not always categorised during the day for both shifts. For the days there was a statistical significance between the days and the intensity of care points, in which intensity of care did not result

in a significant difference. Based on the data from the measured period, the relationships for the intensity of care points do not differ between the days, but the intensity of care differs too much. It seems possible that these results are due to the levelling effect in the pilot phase, where mostly the intensity of care is measured in the low categories. As the intensity of care has a maximum range of 1 and 4 with a levelling effect, the differences between the types of intensity of care are too small to have any significant importance. The last point for significant difference was examined for the medical specialties and intensity of care points for each medical specialty. For both intensity of care and the intensity of care points the differences were statistically significant. A possible explanation for this could be the unequal distribution of the numbers of patients in the medical specialties (the range of the numbers of patients being 1 to 152). The nurses can assume that from Thursday until Sunday the intensity of care points is higher than during the rest of the week, and also with patients in certain medical specialties, such as Geriatrics and Rheumatology, which create a higher intensity of care level. These assumptions are only based on the data from the measurement periods and are not in accordance with the practical experience.

8.2.2 Nurse staffing

For nurse staffing the relationship between the workload and intensity of care was examined. Surprisingly, no relationship was found between the workload and intensity of care or other related variables. Therefore, to make a nurse staffing model was not possible. Following an expanded analysis of the workload, it was apparent that the workload depends upon each nurse and is subjective, and therefore there was no regression model possible for the workload or related variables.

The shifts, days and the medical specialities were also examined in order to discover whether there was a statistical significance between the groups and the workload, resulting in no difference between the day and the late shift. Based only on the data in the measurement period, for the days and the medical specialties a significant difference was found. Tuesdays and Thursday were days with a higher workload than others, but this can differ from practice. The missing data for the high workload can lead to a different conclusion than when all the scoring cards were completed. During the Tuesdays and Thursdays, there were more scoring cards filled in by nurses. An additional unanticipated finding was that Geriatric patients generally create the lowest workload for the ‘frequent’ and ‘moderate’ medical specialties. Geriatric patients are high for intensity of care, and it was expected that they also create a high workload for nurses. A possible explanation for this could be that they were classified during a period when there were few other patients on a shift. The workload is further analysed on admitted and discharged patients and average LOS. This has resulted in an additional confirmation that the workload during the measurement period cannot be related to variables such as IOC, admitted and

discharged patients or average LOS.

During the pilot phase there were some nurses who consistently had either a lower or higher workload than the average for the particular shift. This is an interesting finding. The expectation was that nurses with a low workload would have patients in categories 1 or 2 of intensity of care or a lower number of patients. Nurses with a high workload were expected to have a high intensity of care with more patients than average. However, the nurses with always a low workload have fewer patients in the shift, but the patients' intensity of care was not lower than the average workload. This means that for these nurses the intensity of care not count heavily on their experience in their workload. Nurses with a constantly high workload had more patients to care for, although not always with a high intensity of care level. For these nurses, they can experience lower intensity of care as an important factor for the workload. Half of the nurses constantly had either lower or higher workloads with different intensity of care categories, and thus the relationship between workload and intensity of care is problematic. This is why no relationship was found between the workloads and the related variables.

The workload is measured in the measurement period by a subjective method. The different nurses experienced the workload different with the same number of patients, intensity of care, LOS or the number of admitted/discharged patients. Because in the measurement period not all factors and variables which can influence the workload were measured, this can be the cause of the bias in the data of the workload. In section 8.4 it is described how the workload can be measured in the future.

The nurse staffing can be improved if the solutions mentioned in section 7.2 are implemented in practice. For example to relocate the AMU nearby the ER and radiology department which is recommended from literature[16,66]. The patients have easy access to the radiology department. When the AMU is not near the ER, it resulted in less productive use of the AMU[66]. The physicians have more overview of the patients if the patients in the AMU are near the ER. Another solution for the nurse staffing is the double check of medication replace by a check via app or scanner[67]. The second nurse is not interrupted in their care for the patients and should have decreased the workload. Also, the first nurse does not have to wait long for another nurse when he/she has time to help the first nurse. The most significant advantage of the double check by scanner or app is the improvement of quality of care because with the application of the medication for the patient with a scanner leads to a decrease in medical errors[67–69]. The workload will be decreased if the nurse shortage problem is solved. A solution is the career paths for nurses[70]. New nurses will then work in two medical specialties and had then enough experience to work in the AMU. By such a system, the managers of the AMU know that there are always new nurses come to work in the AMU. The certainty that the outflow of nursing is filled in

by the nurses of the career paths gives more rest under nursing and the managers. All these solutions will lead to a different nurse staffing approach, from flexible approach to saving on FTEs. The solutions can lead to a lower workload for nurses, and this can result in less absenteeism of nurses (only the absenteeism where stress and burn-out are caused by a high workload[71]).

8.2.3 Limitations

The relationships for the intensity of care or the workload, discussed in the chapter results and sections 8.2.1 and 8.2.2, are not always as expected and experienced in practice. When the AMU will use the relationships for making decisions about nurse staffing, the results and relationships need to be interpreted with caution.

As mentioned in section 8.2, the period during which the pilot phase was performed was not an ideal period to measure. Because the nurses could not always complete the scoring card, the results and the relationships in this and the previous chapter are not completely reliable. The intensity of care in the low categories are reliable because these occurred the most. But for the higher intensity of care categories, there missed too much information. The relationship between intensity of care and the workload for the days and the medical specialties were not experienced in practice. The intensity of care model is still however a good one, although the period and method should be improved.

Intensity of care

The measurement period occurred during a summer period, which did not affect the patients' intensity of care, but did affect the completion of the scoring cards by the nurses. During this period there were some shifts with fewer nurses, resulting in a higher workload and less time to complete the scoring cards. The nurses spent much of the time completing scoring cards for patients with a low intensity of care. In reality there were probably more patients in the higher categories of intensity of care.

During the pilot phase, some nurses missed some nursing activities in the model. Therefore it can be that not all the nurses categorised their patients the same as the model and the correlation between the nurse's estimation and the outcome of the model is not perfect. The patients can be categorised lower or higher than in the pilot phase. The results from these nurses for the intensity of care model can therefore be misleading. Section 8.3 will recommend how to deal with this problem.

Nurse staffing

The workload was to be used to form a nurse staffing model, but this was not achieved. The workload in this study is dependent on each nurse and less dependent on intensity of care. The workload in this

study is very different because the factors in the situation level and the nursing activities besides the intensity of care are not measured, only the opinion of the nurse. Therefore the nurses can experience the workload differently. The nurse staffing is in this study not based on a mathematical model or a nurse- intensity of care ratio but on the problems in the system around the AMU. These problems are indirectly related to the nurse staffing.

8.3 Recommendation

During the pilot phase it emerged that the period during which the intensity of care and the workloads were measured was not an ideal period due to staff shortages and beds becoming unavailable. Nurses filled in fewer scoring cards than the patients who remained the department. In order to gain an accurate overview of the department it is recommended in future to reassess intensity of care together with the nurses' workloads. The scoring cards were not always visible in the department, and they therefore should be placed in a strategic and visible location.

The intensity of care model is recommended, although with adaptions and additional explanations for the nurses. The nursing activities are currently unclear concerning the intensity of care model. It is thus recommended to use the adapted scoring card in Figure 18 during the reassessment. The scoring of this card has been expanded, but it has not been made any longer. The decision concerning intensity of care is the same as before the adaption (described in section 5.4.1). The nursing activities, including the use of catheter/stoma, wound care, vital functions/infusion controls and tube feeding were added to the current scope of the model. Because there can be two variables for each rule that is related to another, it is recommended to cross the highest value in the scoring card.

Domain	3 (fully present)	2 (partial present)	1 (fully absent)
Communication	◻ Complete impairment due to either loss of one or more senses.	◻ Impairment or potential for impairment of one or more senses	◻ Able to communicate through all senses
	◻ Pain being at the range 8 to 10 of the visual analogue scale Vital functions/ infusion controls > 3	◻ Pain being at the range 4 to 7 of the visual analogue scale Vital functions/ infusion controls < 3	◻ Pain being at the range 0 to 3 of the visual analogue scale Vital functions/ infusion controls < 2 times a shift
	◻ Unresponsive	◻ Responding only to verbal/pain stimulation	◻ Alert
	◻ Language barrier	◻ Difficulty due to language barrier	◻ No language barrier
	◻ Extensive behavioural problems	◻ Anxious/tearful/distressed	Co-operative/relaxed
ABC	◻ Complete impairment of ABC or shock Wound care > 15 minutes	◻ Risk of impairment to ABC (potential for shock due to condition) Wound care < 15 minutes	◻ No ABC problems/ minor/no wounds
Mobility	◻ Total immobility	◻ Partial mobility less. Patient requires trolley/wheelchair	◻ Fully mobile/minor limb problems
ADL	◻ Total loss of bowel/bladder function and/or hyperemesis Extensive care of catheter or stoma	◻ Partial loss of bowel/bladder function and/or vomiting Normal care of catheter or stoma	◻ Normal bowel/ bladder control. No vomiting
	◻ Total loss of independent self care Extensive care for tube feeding	◻ Partial loss of independent self care Normal care for tube feeding	◻ Able to maintain independent self care/ is helped by a nurses' aids
Environmental safety, health and social needs	◻ Demonstrates danger to self or others	◻ Appear unable to fully understand risks	◻ Shows total ability to fully understand risks
	◻ Appears to require extensive social support	◻ Appears to require some social support	◻ Does not appear to require social support
Isolation	◻ Droplet isolation	◻ Contact isolation	◻ No isolation

Figure 18. The adapted version of the intensity of care model

Clinical lessons for the nurses is a possible method of raising awareness of the importance of the score cards. The advantages of the intensity of care model can be further clarified. The effect on the nurses is not directly noticeable, but is certainly so after a period of time. By implementing the intensity of care model, the nurses have more overview over the intensity of the patients, which nurse can admit a patient, and the maximum total intensity of care points per nurse can be determined. The added variables can be also be adequately explained.

8.4 Further research

There are important issues to explore for further research. First, how the intensity of care model can be converted to a user-friendly format on the computer. Second, how it can be linked to the electronic health record. The final point is important because all patient records are documented using the same medical terms and all users report in the same area in the electronic health record. As it is also

recommended to replace the double check with an app, it is recommended to investigate whether the intensity or care model can be implemented in a tablet. The nurses have all the information of the patient in one device.

The second issue for further research concerns the question of when in the AMU there is an ideal period for measurements. This can be done by checking the historical data when in the AMU were measurements. When in the future the AMU needs to do measurements, the researchers measured in one time the reality.

The third issue for further research concerns on the measuring of the nurses' workload. Nursing workload measures can be categorized into four levels: (1) unit level, (2) job level, (3) patient level, and (4) situation level[72]. In this study, the patient level is measured and not the situation level. The situation level is the microsystem of the department and measured the following aspects: the physical work environment, supplies not well stocked, many family needs, and ineffective communication among multidisciplinary team members. It explains the impact of a specific performance obstacle or facilitator on nursing workload rather than the overall experience of the nurse. In this level, the distance between the patients' rooms assigned to a nurse is measured (physical workload), the condition of the work environment (light, sounds, hectic) is an influence on the performance of the nurse to do her job. A researcher can identify the characteristics of the microsystem in a department and can then reduce the nursing workload by redesign the system. The whole workload for a nurse depends not only on the situation level but also on the nursing activities. The nursing activities can be measured in different ways, but the category nursing activity intensity of care is the most important. Other activities are administrative tasks and education of the family.

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Appendix A. Observation log

Nurse:
Education:
Work experience AMU:
Shift:
Diagnose codes per room:

Experienced workload:
Number of occupied beds:
Nurse to intensity of care:

Code log	Activity	Description of the activity
1	Activities of daily living	Bathing and showering, assisted personal hygiene, assisted dressing
2	Medication	Preparation of medication, application of medication (oral/injection/infusion), documentation of medication
3	Nursing activities	Maintenance of tubes/drains/catheter, inhalation therapy, collecting of specimen for investigation, conversations with patients
4	Observation/monitoring	Measuring vital functions, patient checks
5	Documentation	Documentation in computer to update of patient report, to record handover of patient to a physician/colleague and telephone conversations
6	Handover	Handover over a patient to a physician/colleague, telephone conversations
7	Patient flow	Admission, transfer or discharge of a patient
8	Indirect care	Contacting family, making appointments for the patient
9	Pause	To eat, drink or go to the bathroom
10	Waste	Solve errors from colleagues/physicians, supply of equipment

Time	Activity	Room	Intensity of care	Comment Patients BMI >25/ mental status / admitted/ discharged

Appendix B. Data of observation

1. Observation 1: Number of times an activity occurs per room

Activities	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	For colleague	For nurse	% per activity
	IOC* 1	IOC 1	IOC 2	IOC 3	IOC 2	IOC 2			
	Int**	Neu**	Pul**	Int**	Pul**	Pul**			
Activities of daily living			**7**		**1**		**1**		**6.62%**
Medication	**4**	**2**	**2**	**6**	**2**	**1**			**12.50%**
Nursing activities	**1**			**4**	**1**	**2**	**2**		**7.35%**
Observation/ monitoring		**1**							**0.74%**
Documentation	**11**	**6**	**9**	**10**	**10**	**8**			**39.71%**
Handover	**4**	**3**	**3**	**4**	**4**	**4**	**1**		**16.91%**
Patient flow		**2**	**1**	**1**					**2.94%**
Indirect care	**1**	**1**	**1**	**5**	**4**	**1**		**1**	**10.29%**
Pause								**3**	**2.21%**
Waste						**1**			**0.74%**
Grand total	**21**	**15**	**23**	**30**	**22**	**17**	**4**	**4**	**100%**
% per room	**15%**	**11%**	**17%**	**22%**	**16%**	**13%**	**3%**	**3%**	**100%**

* IOC= Intensity of care

** Int= Interne Medicine, Neu= Neurology, Pul= Pulmonology

2. Observation 1: Number of times an activity occurs per hour per room

Time (hours)	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	For colleague	For nurse	% per hour
	IOC* 1	IOC 1	IOC 2	IOC 3	IOC 2	IOC 2			
	Int**	Neu**	Pul**	Int**	Pul**	Pul**			
07:00-08:00	**3**	**3**	**5**	**3**	**2**	**3**			**13.97%**
08:00-09:00	**3**	**2**	**3**	**2**	**5**	**3**	**1**		**13.97%**
09:00-10:00	**3**	**1**	**3**	**5**	**3**	**2**		**1**	**13.24%**
10:00-11:00	**3**	**4**	**2**	**4**	**2**	**2**		**1**	**13.24%**

11:00-12:00	**1**	**1**	**5**	**4**	**3**	**2**			**11.76%**
12:00-13:00	**1**		**2**	**3**	**4**	**1**	**1**	**1**	**9.56%**
13:00-14:00	**4**			**4**	**1**	**1**	**2**		**8.82%**
14:00-15:00	**1**		**1**	**3**		**1**		**1**	**5.15%**
15:00-15:30	**2**	**4**	**2**	**2**	**2**	**2**			**10.29%**
Grand total	**21**	**15**	**23**	**30**	**22**	**17**	**4**	**4**	**100%**
% per room	**15%**	**11%**	**17%**	**22%**	**16%**	**13%**	**3%**	**3%**	**100%**

* IOC= Intensity of care

** Int= Interne Medicine, Neu= Neurology, Pul= Pulmonology

3. Observation 2: Number of times an activity occurs per room

Activities	**Room 1**	**Room 2**	**Room 3**	**Room 4**	**Room 5**	**For colleague**	**For nurse**	**Percentage per activity**
	IOC* 3 Ger**	**IOC 1 Pul****	**IOC 1 Neu****	**IOC 1 Sur****	**IOC 3 Sur****			
Activities of daily living	**2**		**1**	**1**	**3**	**1**		**8.70%**
Medication	**2**	**4**	**2**	**5**	**2**	**1**		**17.39%**
Nurse activities	**1**	**2**	**2**	**6**	**5**	**2**		**19.57%**
Observation/monitoring	**2**	**1**	**1**		**1**			**5.43%**
Documentation	**4**	**5**	**7**	**5**	**2**			**25.00%**
Handover	**2**	**3**	**3**	**3**	**1**			**13.04%**
Patient flow	**1**		**1**		**1**	**1**		**4.35%**
Indirect care								**0.00%**
Pause							**3**	**3.26%**
Waste		**1**	**1**		**1**			**3.26%**
Grand total	**14**	**16**	**18**	**20**	**16**	**5**	**3**	**100%**
% per room	**15%**	**17%**	**20%**	**22%**	**17%**	**5%**	**3%**	**100%**

*= Intensity of care

** Ger= Geriatric, Pul= Pulmonology, Neu= Neurology, Sur= Surgery

4. Observation 2: Number of times an activity occur per hour per room

Time (hours)	Room 1	Room 2	Room 3	Room 4	Room 5	For colleague	For nurse	% per activity
	IOC* 3	IOC 1	IOC 1	IOC 1	IOC 3			
	Ger**	Pul**	Neu**	Sur**	Sur**			
07:00-08:00	2	5	2	2			1	13.04%
08:00-09:00	5	3	2	6				17.39%
09:00-10:00	4	1	3	3				11.96%
10:00-11:00	1	2		1	4			8.70%
11:00-12:00	2	1	1	1	3		1	9.78%
12:00-13:00		2	4	2	6			15.22%
13:00-14:00				1	3	2	1	7.61%
14:00-15:00			4	2		2		8.70%
15:00-15:30		2	2	2		1		7.61%
Grand total	14	16	18	20	16	5	3	100%
% per room	15%	17%	20%	22%	17%	5%	3%	100%

*= Intensity of care

** Ger= Geriatric, Pul= Pulmonology, Neu= Neurology, Sur= Surgery

5. Observation 3: Number of times an activity occur per room

Activities	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	For colleague	For nurse	% per activity
	IOC* 1 Int**	IOC 3 Int**	IOC 2 Sur**	IOC 2 Int**	IOC 2 Pul**	IOC 2 Int**			
Activities of daily living	1		2				1		4.60%
Medication	5		3	1	3	4			18.39%
Nursing activities		1		3	2	6	1		14.94%
Observation/monitoring	2		1	2	1	2	2		11.49%
Documentation	4		6	5	2	4			24.14%
Handover	2	2	2	2	2	1			12.64%
Patient flow		1	2		1	2	1		8.05%

Indirect care									**0.00%**
Pause								**2**	**2.30%**
Waste							**1**	**2**	**3.45%**
Grand total	**14**	**4**	**16**	**13**	**11**	**19**	**6**	**4**	**100%**
% per room	**16%**	**5%**	**18%**	**15%**	**13%**	**22%**	**7%**	**5%**	**100%**

*= Intensity of care

** Int= Internal Medicine, Sur= Surgery, Pul= Pulmonolgy

6. Observation 3: Number of times an activity occurs per hour per room

Time (hours)	**Room 1**	**Room 2**	**Room 3**	**Room 4**	**Room 5**	**Room 6**	**For colleague**	**For nurse**	**% per hour**
	IOC* 1 Int**	IOC 3 Int**	IOC 2 Sur**	IOC 2 Int**	IOC 2 Pul**	IOC 2 Int**			
15:00-16:00	**3**		**4**	**4**				**1**	**13.79%**
16:00-17:00	**3**		**5**	**2**		**1**	**1**	**1**	**14.94%**
17:00-18:00						**3**	**3**		**6.90%**
18:00-19:00						**4**	**1**	**1**	**6.90%**
19:00-20:00	**2**		**4**	**2**	**2**	**3**		**1**	**16.09%**
20:00-21:00			**2**	**2**	**2**	**2**			**9.20%**
21:00-22:00	**4**		**1**	**2**	**6**	**3**	**1**		**19.54%**
22:00-23:00	**1**	**3**				**1**			**5.75%**
23:00-23:30	**1**	**1**		**1**	**1**	**2**			**6.90%**
Grand total	**14**	**4**	**16**	**13**	**11**	**19**	**6**	**4**	**100%**
% per room	**16%**	**5%**	**18%**	**15%**	**13%**	**22%**	**7%**	**5%**	**100%**

7. Observation 4: Number of times an activity occur per room

Activities	**Roo**	**Roo**	**Roo**	**Roo**	**Roo**	**Roo**	**Roo**	**For**	**For**	**% per**

	m 1	m 2	m 3	m 4	m 5	m 6	m 7	colleague	nurse	activity
	IOC* 3	IOC 1	IOC 2	IOC 1	IOC 3	IOC 3	IOC 2			
	Pul**	Pul**	Pul**	Pul**	Ger**	Sur**	Sur**			
Activities of daily living	**4**	**2**			**1**			**2**		**9.18%**
Medication	**2**	**3**	**2**	**3**			**2**	**4**		**16.33%**
Nursing activities							**1**	**4**		**5.10%**
Observation/ monitoring	**4**	**4**	**1**	**1**	**1**	**1**	**1**	**3**		**16.33%**
Documentation	**3**	**2**	**3**	**3**	**2**	**6**	**4**	**1**		**24.49%**
Handover	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**1**		**13.27%**
Patient flow		**2**			**1**	**3**				**6.12%**
Indirect care					**1**	**1**	**1**			**3.06%**
Pause									**1**	**1.02%**
Waste									**5**	**5.10%**
Grand total	**14**	**15**	**9**	**9**	**7**	**12**	**11**	**15**	**6**	**100%**
Percentage per room	**14%**	**15%**	**9%**	**9%**	**7%**	**12%**	**11%**	**15%**	**6%**	**100%**

* IOC= Intensity of care

** Pul= Pulmonology, Ger=Geriatric, Sur=Surgery

8. Observation 4: Number of times an activity occurs per hour per room

Time (hours)	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	For colleague	For nurse	% per hour
	IOC* 3	IOC 1	IOC 2	IOC 1	IOC 3	IOC 3	IOC 2			
	Pul**	Pul**	Pul**	Pul**	Ger**	Sur**	Sur**			
15:00-16:00			**4**	**4**		**3**	**3**		**1**	**15.31%**
16:00-17:00			**2**	**2**		**1**	**1**	**5**		**11.22%**
17:00-18:00		**3**				**3**		**1**	**1**	**8.16%**
18:00-19:00	**2**	**3**				**1**		**3**	**1**	**10.20%**
19:00-20:00	**2**					**4**	**5**	**3**	**1**	**15.31%**
20:00-21:00	**3**	**1**	**1**	**1**				**2**		**8.16%**
21:00-22:00	**2**	**1**	**1**	**1**	**1**		**1**		**1**	**8.16%**

22:00-23:00	**2**				**3**			**1**	**1**	**7.14%**
23:00-23:30	**3**	**7**	**1**	**1**	**3**		**1**			**16.33%**
Grand total	**14**	**15**	**9**	**9**	**7**	**12**	**11**	**15**	**6**	**100%**
% per room	**14%**	**15%**	**9%**	**9%**	**7%**	**12%**	**11%**	**15%**	**6%**	**100%**

* IOC= Intensity of care

** Pul= Pulmonology, Ger=Geriatric, Sur=Surgery

Appendix C. Search strategy

General intensity of care model

Description of IOC models

Database: Web of Science	Search strategy	Number of hits	Useful references
	TOPIC: (patient classification systems*) AND TOPIC: (develop)	1,567	[40,41]
Database: Scopus	Search strategy	Number of hits	Useful references
	"patient acuity model"	1	[32]
	(TITLE-ABS-KEY ("intensity of care") AND TITLE-ABS-KEY (tool) AND TITLE-ABS-KEY (hospital OR medicine OR clinical))	22	[27]
	(TITLE-ABS-KEY ("patient classification system") AND TITLE-ABS-KEY (hospital OR clinical OR medical))	373	[28,39]

Workload of nurses

Database: Business Source Elite	Search strategy	Number of hits	Useful references
	(work pressure* or workload) AND nursing	303	[73]
From reference:	Search strategy	Number of hits	Useful references
	[73]	-	[74]
	Other articles	-	[7,39,43]

Nurses allocating to patients

Database: Web of Science	Search strategy	Number of hits	Useful references
	TOPIC: (assignment) AND TOPIC: (Nurse to patient*)	519	[7]
Database: Scopus	Search strategy	Number of hits	Useful references
	(TITLE-ABS-KEY ("allocation nurses") AND TITLE-ABS-KEY (patient))	3	[29]
	(TITLE-ABS-KEY (assignment) AND TITLE-ABS-KEY ("nurse to patient"))	19	[42]

Length of stay

Database:	Search strategy	Number of	Useful

Web of Science		hits	references
	TITLE: (Length of stay) AND TOPIC: (emergency or acute) AND TOPIC: (hospital or clinical or medical) Refined by: WEB OF SCIENCE CATEGORIES: (EMERGENCY MEDICINE)	141	[44]
	TOPIC: ("Length of stay") AND TOPIC: ("acute care hospitals") OR TOPIC: (predict or factors) AND TOPIC: (hospital or clinical or medical) Refined by: WEB OF SCIENCE CATEGORIES: (EMERGENCY MEDICINE)	236	[45]
Database: Scopus	Search strategy	Number of hits	Useful references
	(TITLE-ABS-KEY ("length of stay" AND predict) AND TITLE-ABS-KEY (emergency OR acute) AND TITLE-ABS-KEY (hospital OR clinical OR medical)) AND (EXCLUDE (SUBJAREA , "BIOC") OR EXCLUDE (SUBJAREA , "AGRI") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "PHAR"))	1,001	[44]

Nurse-intensity of care ratio

Nurse to intensity of care ratio

Database: Web of Science	Search strategy	Number of hits	Useful references
	TOPIC: (acuity of patient) AND TOPIC: (nurse assignment)	32	[38,46,47]
Database: Scopus	Search strategy	Number of hits	Useful references
	(TITLE-ABS-KEY ("nurse assignment") AND TITLE-ABS-KEY ("intensity of care" OR "patients' acuity"))	4	[46]

Acute Medical Unit

Intensity of care models for acute patients

Database: Scopus	Search strategy	Number of hits	Useful references
	TITLE-ABS-KEY ("patient classification system") AND TITLE-ABS-KEY ("acute care" OR "acute medical unit" OR "emergency department")	31	[34,51]
From reference:	[34]	-	[33,35,37]
	Jones Dependency tool	523,000	[36,49,50]

Workload of the nurses working with acute patients

Database: Scopus	Search strategy	Number of hits	Useful references
	(TITLE-ABS-KEY ("jones dependency tool") AND TITLE-ABS-KEY ("acute care" OR "acute medical unit" OR "emergency department"))	6	[52]

Scheduling nurses

Staffing levels

Google:	Search strategy	Number of hits	Useful references
	variables analysis nurse staffing	386,000	[45]

Float nurses

Database: Scopus	Search strategy	Number of hits	Useful references
	TITLE-ABS-KEY ("float nurse")	24	[55]
Database: Web of Science	TOPIC: (float nurse)	85	[54,56]

Appendix D. Interview scheme for benchmark

Questions	Questions to ask further
AMU Can you briefly describe the department AMU?	Description department ● Beds ● Medical specialties ● Exclusion patients ● Frequent medical specialties ● Medical specialties to a lesser extent ● Standards LOS
Can you briefly describe how the processes were in the AMU?	
Current planning model How is it determined whether the department can still accommodate enough patients in the coming hours, when the department is almost full and when the department is full?	Description model • Based on patterns • Patient flow • Included the number of nurses
Benchmark Can you tell me about how the AMU performs in general?	Indicators ● Percentage patients' LOS above the standard? ● How often were beds closed on annual basis? ● Frequent medical specialties ● Number of admissions a day ● Number of discharges a day ● Percentage Geriatric patients ● Percentage patients with psychiatric comorbidity ● When there is a personnel shortage, were beds closed in the AMU or spread in the hospital?
And in comparison with other AMUs?	
What are factors that can make a AMU a success?	

Intensity of care model Is the department working with an intensity of care model or is an intensity of care model in development?

If yes

Strategic	
How are nurses scheduled?	Nurse • How far in advance is the schedule known for nurses? • Number of nurses on a day in different shifts by implementing the intensity of care model

	• Number of nurses on a day in different shifts before implementing the intensity of care model • Rules in extreme overloaded periods (number of nurses, deployment of float nurses, closing of beds, admission stop) • Rules in quiet period (number of nurses, nurses deploy on other departments)
What was/is the reason the department needs an intensity of care model?	Intensity of care • Which model? • Requirements model for implemented the model in the department? • Important factors for choosing the correct intensity of care model
Is the intensity of care predicted and if so, how?	Predictions • How to handle the unpredictable patient flow in model? • Admissions/discharges predict?
How is the respond on the patient flow?	Respond on situations • Increasing elderly patients • Patients with psychiatric comorbidity
What system is used to divide patients?	

Tactical	
Are the number of nurses still adjusted for a period of weeks/months?	Nurse • Maximum number of nurses during a shift
What factors cause a work overload by the nurses?	Intensity of care • Factors in consideration in model for weeks/months • Maximum score of a patient
How is the respond on the patient flow?	Respond on situations • Handle the patient flow

Operational	
Are the number of nurses still adjusted at the start of the day?	Nurse • Handle extreme overload periods (number of nurses, deployment of float nurses, closing of beds, admission stop) • Rules in quiet period (number of nurses, nurses deploy on other departments)
What is the score of patients based on?	Intensity of care • When scoring? Who is scoring the patients?

If no

Strategic

How are nurses scheduled?	Nurse • How far in advance is the schedule known for nurses? • Number of nurses on a day in different shifts • Assignment of patient to nurses • Number of patient to one nurse • Rules in extreme overloaded periods (number of nurses, deployment of float nurses, closing of beds, admission stop) • Rules in quiet period (number of nurses, nurses deploy on other departments)
What was/is the reason the department does not need an intensity of care model?	Intensity of care/workload • Is an intensity of care model possible? • Requirements model for implemented the model in the department? • Important factors which influence the intensity of care of a patient
Are you using another model to reduce the workload for nurses?	• Which model • Factors workload
How do you take the unpredictability of patient flow in deciding on the number of nurses for a year?	Predictions • Admissions/discharges predict?
How is the respond on the patient flow?	Respond on situations • Increasing elderly patients • Patients with psychiatric comorbidity

Tactical	
Are the number of nurses still adjusted for a period of weeks/months?	Nurse • Maximum number of patients to one nurse during a shift Workload • Factors in decision number of nurses during shifts • Maximum score of a patient
How is the respond on the patient flow?	Respond on situations • Handle the patient flow

Operational	
Are the number of nurses still adjusted at the start of the day?	Nurse • Rules in extreme overloaded periods (number of nurses, deployment of float nurses, closing of beds, admission stop) • Rules in quiet period (number of nurses, nurses deploy on other departments)
Where is the allocation of the patients to nursing based?	Intensity of care • When assign the patients? • Who divide the patients?

	• Is the assignment changed during a shift?

Appendix E. Scoring card for intensity of care and workload

Scoring card intensity of care			
Patient number	**Medical specialty**	□ **Day shift** □ **Late shift**	**Date:** **Name nurse:**

Domain	**3 (fully present)**	**2 (partially present)**	**1 (fully absent)**
Communication	□ Complete impairment due to loss of either one or more senses	□ Impairment or potential for impairment of one or more senses	□ Able to communicate through all senses
	□ Pain being at the range 8 to 10 of the visual analogue scale	□ Pain being at the range 4 to 7 of the visual analogue scale	□ Pain being at the range 0 to 3 of the visual analogue scale
	□ Unresponsive	□ Responding only to verbal/pain stimulation	□ Alert
	□ Language barrier	□ Difficulty due to language barrier	□ No language barrier
	□ Extensive behavioural problems	□ Anxious/tearful/distressed	Co-operative/relaxed
ABC	□ Complete impairment of ABC or shock	□ Risk of impairment to ABC (potential for shock due to condition)	□ No ABC problems/ minor wounds
Mobility	□ Total immobility	□ Partial mobility loss. Patient requires trolley/wheelchair	□ Fully mobile/minor limb problems
ADL	□ Total loss of bowel/bladder function and/or hyperemesis	□ Partial loss of bowel/bladder function and/or vomiting	□ Normal bowel/ bladder control. No vomiting
	□ Total loss of independent self-care	□ Partial loss of independent self-care	□ Able to maintain independent self-care/ is helped by a nurses' aid
Environmental safety, health and social needs	□ Demonstrates danger to self or others	□ Appears unable to fully understand risks	□ Shows total ability to fully understand risks
	□ Appears to require extensive social support	□ Appears to require some social support	□ Does not appear to require social support
Isolation	□ Droplet isolation	□ Contact isolation	□ No isolation

Self-assessment category intensity of care	□ **4 (Total)**	□ **3 (High)**	□ **2 (Moderate)**	□ **1 (Low)**

Workload 1= low 3= normal 5= high	□ **5**	□ **4**	□ **3**	□ **2**	□ **1**

Appendix F. SPSS results for intensity of care and workload

Intensity of care

The statistical significance for the intensity of care per shift is determined by the independent T-test. The P-value is higher than 0.05 and the (points) intensity of care and shift is not significant difference.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Zorgzwaarte	Equal variances assumed	,546	,460	-1,470	568	,142	-,099	,067	-,232	,033
	Equal variances not assumed			-1,469	563,415	,142	-,099	,068	-,232	,033

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Total intensity of care points	Equal variances assumed	,597	,440	-1,672	568	,095	-,299	,179	-,650	,052
	Equal variances not assumed			-1,672	566,339	,095	-,299	,179	-,650	,052

For the days, the intensity of care and days is not statistical significance, but the points intensity of care has a significant difference with the days as shown in Table below.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Zorgzwaarte	Between Groups	3,075	6	,512	,787	,580
	Within Groups	366,576	563	,651		
	Total	369,651	569			
Total intensity of care points	Between Groups	74,725	6	12,454	2,783	,011
	Within Groups	2519,247	563	4,475		
	Total	2593,972	569			

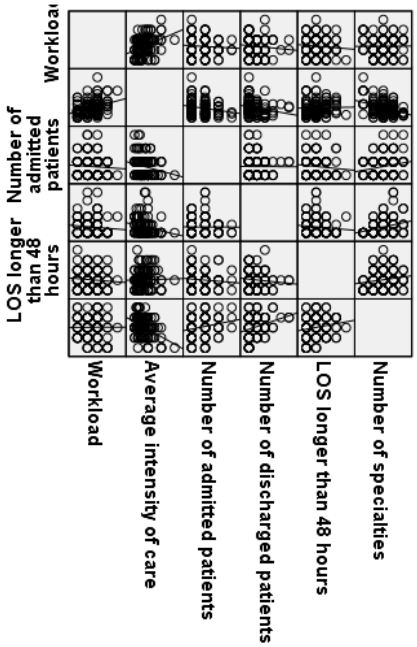
For the medical specialties, there is a statistical significance found for intensity of care and points of intensity of care (table below).

ANOVA

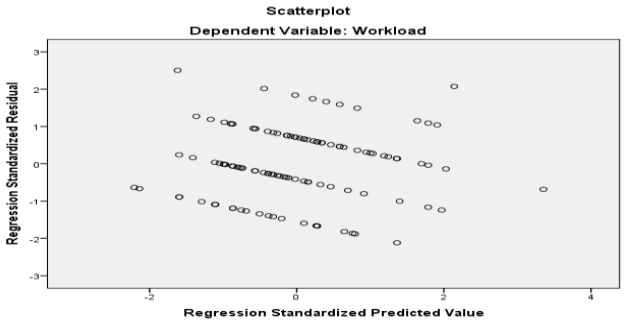
		Sum of Squares	df	Mean Square	F	Sig.
Zorgzwaarte	Between Groups	15,964	11	1,451	2,290	,010
	Within Groups	353,687	558	,634		
	Total	369,651	569			
Total intensity of care points	Between Groups	214,480	11	19,498	4,572	,000
	Within Groups	2379,492	558	4,264		
	Total	2593,972	569			

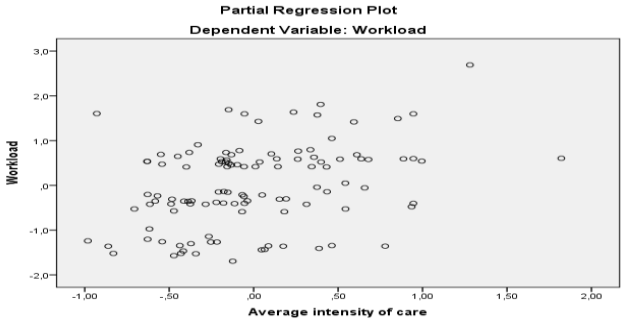
Workload

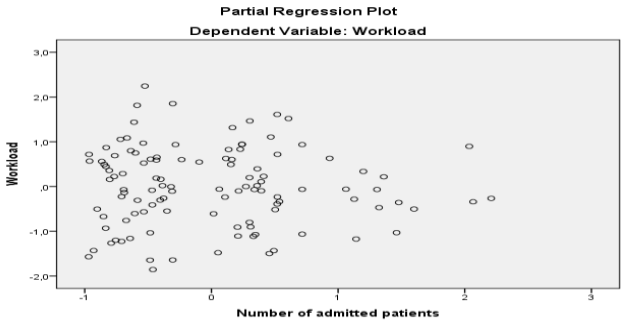
Checking assumptions for the multiple linear regression with the subsequent independent variables: Average intensity of care, number of admitted patients, number of discharged patients, LOS over 48 hours and number of medical specialties. In the figure below, the linearity of the independent variables with the dependent variable is shown and checked. There is no linearity in this figure.

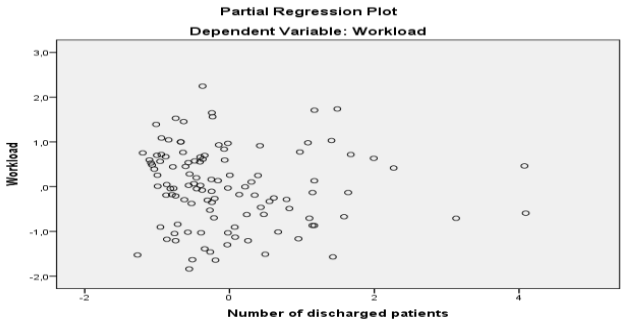


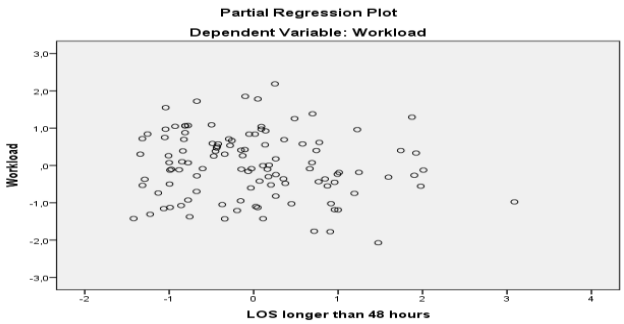
For the residuals of the variables is also checked if there is linearity, and is shown in figure below. The scatterplots displayed not linearity.

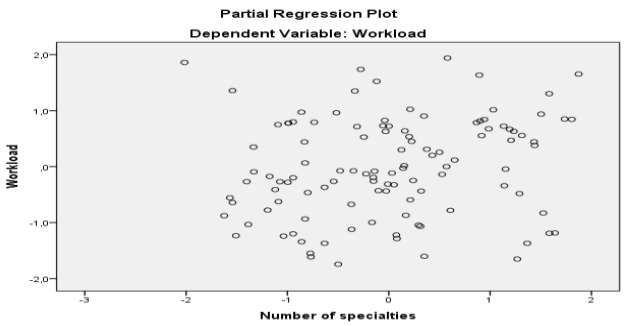

Scatterplot
Dependent Variable: Workload
Regression Standardized Residual
Regression Standardized Predicted Value


Partial Regression Plot
Dependent Variable: Workload
Workload
Average intensity of care

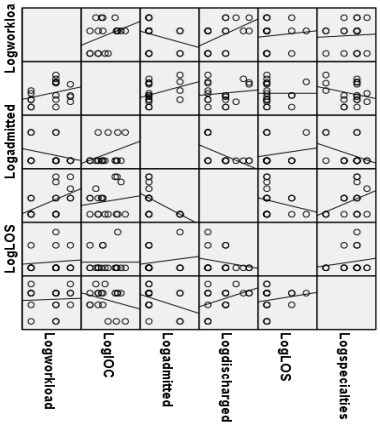

Partial Regression Plot
Dependent Variable: Workload
Workload
Number of admitted patients

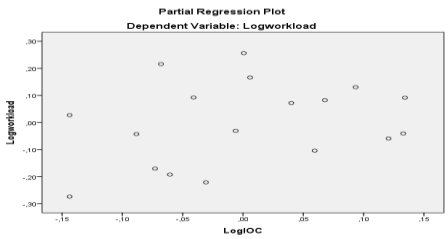

Partial Regression Plot
Dependent Variable: Workload
Workload
Number of discharged patients

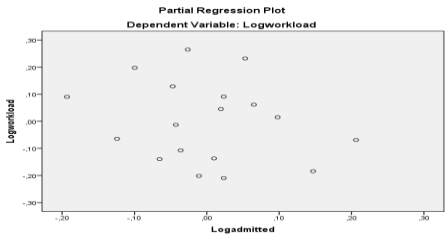

Partial Regression Plot
Dependent Variable: Workload
Workload
LOS longer than 48 hours

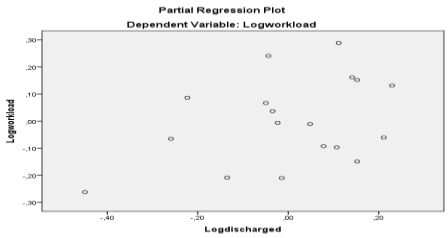

Partial Regression Plot
Dependent Variable: Workload
Workload
Number of specialties

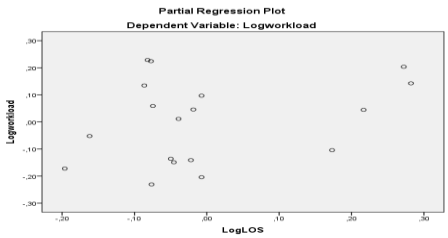
Transformation with a logarithm function results in the scatterplots below, where is no linearity is shown.

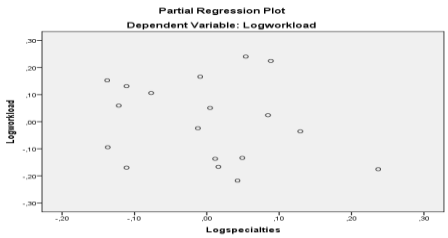




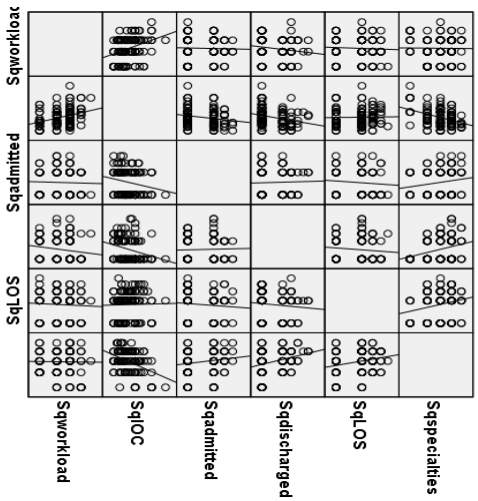


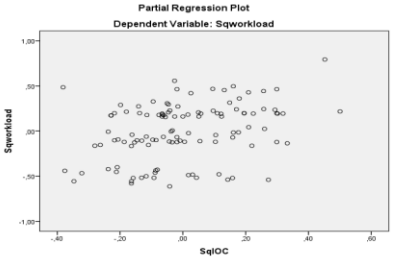


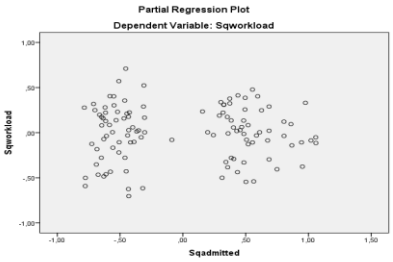


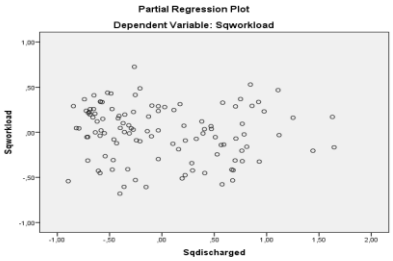


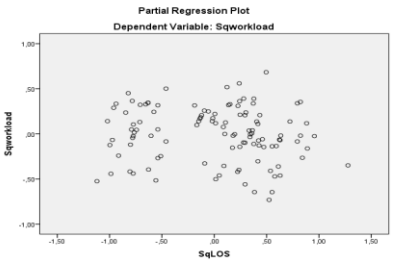
Transformation with a square roots function results in the scatterplots below, where is no linearity is shown.

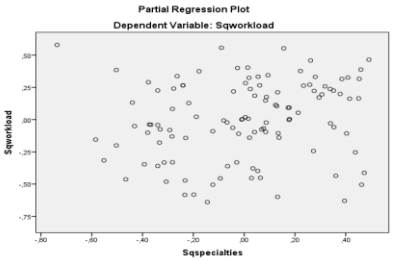




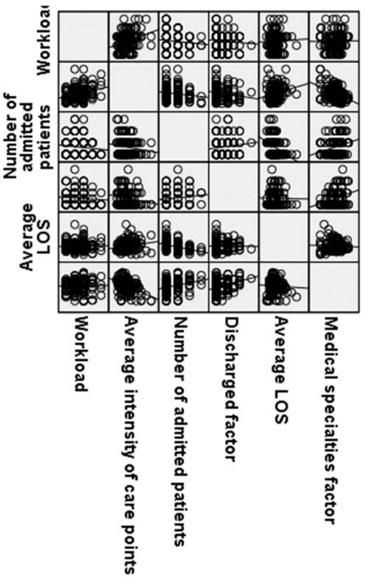


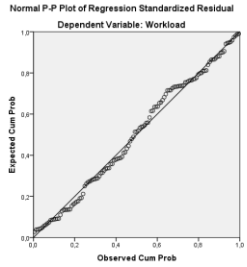


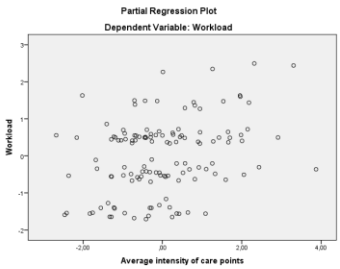


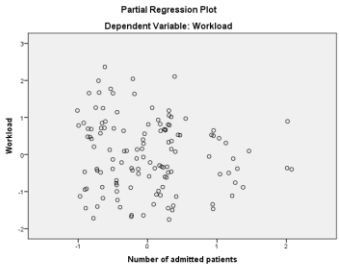


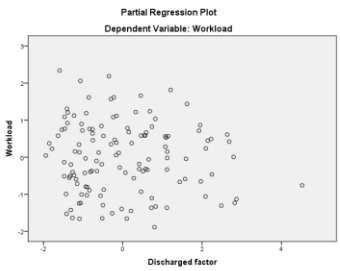
Checking assumptions for the second attempt of a multiple linear regression with the subsequent independent variables: Average points intensity of care, number of admitted patients, discharged factor, average LOS and medical specialties factor. In the figure below is shown the scatterplot with the independent variables with the dependent variables, subsequently the linearity check for residual variables.

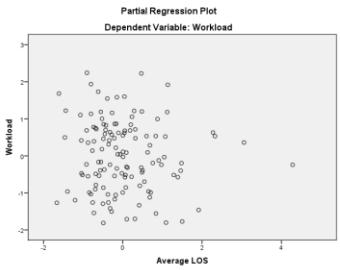

Workload
Number of admitted patients
Average LOS
Workload
Average intensity of care points
Number of admitted patients
Discharged factor
Average LOS
Medical specialties factor

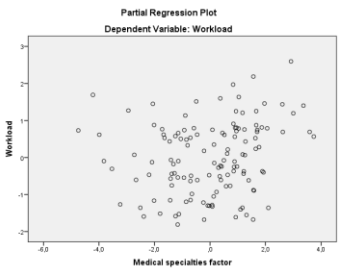




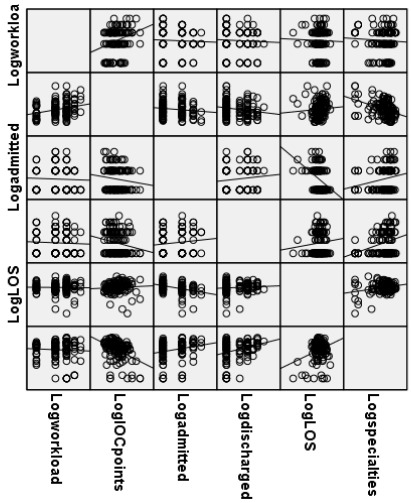


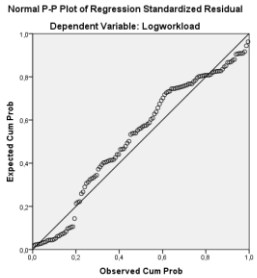


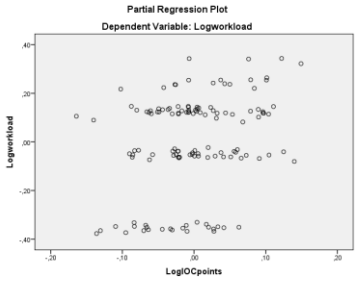


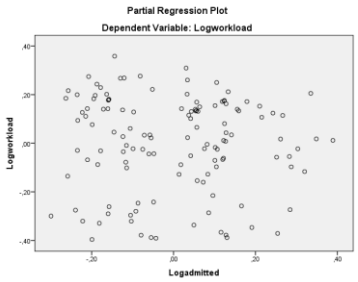


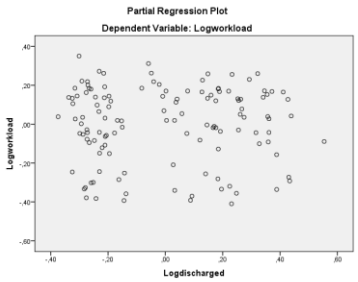
Due to the nonlinearity, the transformation of the variables is performed. In the figures below, the transformation with a logarithm function is shown.

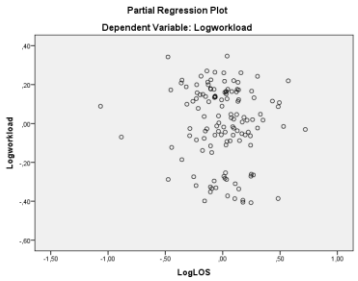

Logworkloa
Logadmitted
LogLOS
Logworkload
LogIOCpoints
Logadmitted
Logdischarged
LogLOS
Logspecialties

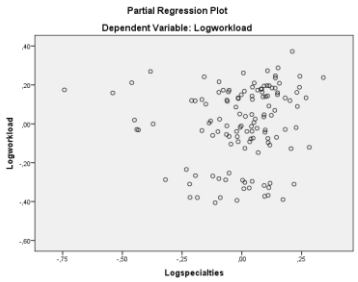




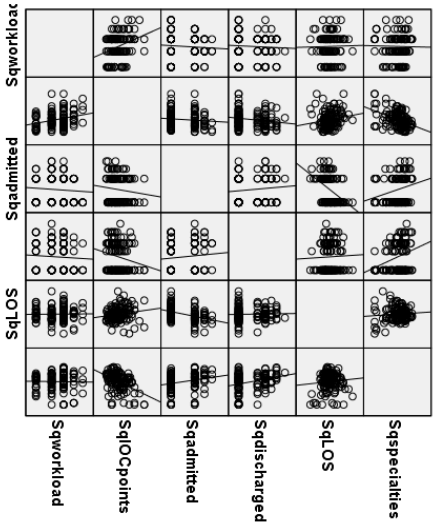


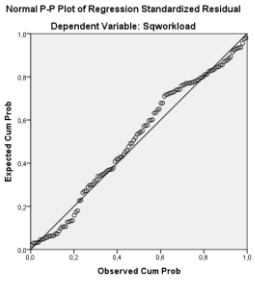


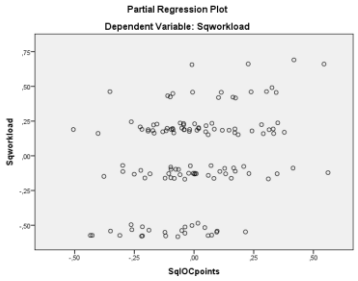


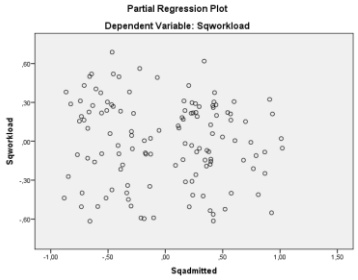


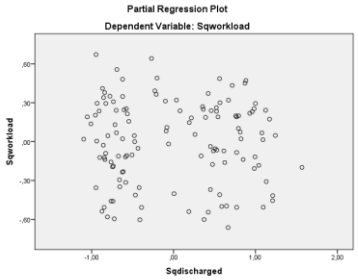
The last transformation is the square root, with the figures as result for the check of linearity.

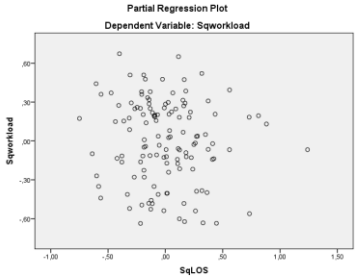

Sqworkloac
Sqadmitted
SqLOS
Sqworkload
SqIOCpoints
Sqadmitted
Sqdischarged
SqLOS
Sqspecialties

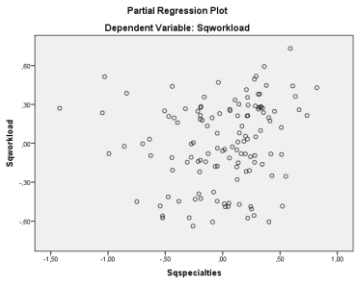

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Sqworkload
Expected Cum Prob
Observed Cum Prob


Partial Regression Plot
Dependent Variable: Sqworkload
Sqworkload
SqIOCpoints


Partial Regression Plot
Dependent Variable: Sqworkload
Sqworkload
Sqadmitted


Partial Regression Plot
Dependent Variable: Sqworkload
Sqworkload
Sqdischarged


Partial Regression Plot
Dependent Variable: Sqworkload
Sqworkload
SqLOS


Partial Regression Plot
Dependent Variable: Sqworkload
Sqworkload
Sqspecialties

Statistical significance workload per shift, day and medical specialties

The significance of the workload per shift is examined with an independent sample T-test. The workload is not significant different in a shift.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Workload	Equal variances assumed	,265	,608	,516	124	,607	,0939	,1821	-,2664	,4543
	Equal variances not assumed			,514	120,103	,608	,0939	,1828	-,2680	,4559

The One-way ANOVA results in a significance difference between the workload and the days.

ANOVA

Werkdruk

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	99,285	6	16,547	19,759	,000
Within Groups	470,645	562	,837		
Total	569,930	568			

Also the workload and medical specialties is statistical significance.

ANOVA

Werkdruk

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22,756	11	2,069	2,106	,018
Within Groups	547,173	557	,982		
Total	569,930	568			

Appendix G. Results analyses intensity of care and workload

Table below is the analysis of the intensity of care and medical specialties per day

Table 45. The medical specialties with percentage of number of patients per day in the pilot phase

Medical Specialty	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Grand total
Internal Medicine	43%	28%	30%	27%	23%	22%	28%	28%
Gastroenterology	17%	11%	14%	21%	11%	9%	10%	13%
Pulmonology	15%	18%	18%	8%	7%	9%	10%	13%
Surgery	15%	30%	24%	26%	25%	28%	22%	25%
Urology	11%	8%	9%	11%	19%	10%	14%	11%
Geriatrics	0%	0%	0%	3%	4%	10%	6%	3%
Orthopaedics	0%	5%	4%	5%	11%	12%	10%	7%
Grand total	**9%**	**25%**	**14%**	**12%**	**13%**	**13%**	**15%**	**100,00%**

Tables below are analyses of the workload per shift.

Table 46. The workload per shifts were nurse has admitted patients

	Workload				
Shifts	**1**	**2**	**3**	**4**	**Grand total**
Day	4	8	9	2	23
Late	5	16	12	4	37
Grand total	**9**	**24**	**21**	**6**	**60**

Table 47. The number of times in a shift patients are discharged per workload

	Workload					
Shifts	**1**	**2**	**3**	**4**	**5**	**Grand total**
Day	8	8	17	1	1	35
Late	5	8	3	1		17
Grand total	**13**	**16**	**20**	**2**	**1**	**52**

Tables below are analyses of the workload per day

Table 48. Workload per day for the nurses who had admitted patients

	Workload				
Day	**1**	**2**	**3**	**4**	**Grand total**
Monday		1	5	1	7
Tuesday	1	5	7	1	14
Wednesday	1	5	2	1	9
Thursday		3	3	3	9
Friday	1	6	2		9
Saturday	3	3	2		8
Sunday	3	1			4
Grand total	**9**	**24**	**21**	**6**	**60**

Table 49. Workload per day and the average LOS in hours

	Workload					
Day	**1**	**2**	**3**	**4**	**5**	**Grand total**
Monday	38:10	38:49	31:08	47:14	18:52	33:28
Tuesday	36:12	33:47	31:31	37:06	71:05	35:56
Wednesday	25:22	37:13	42:47	21:26		35:51
Thursday		45:26	34:29	39:14		39:27
Friday	51:43	29:49	56:00		36:56	42:49
Saturday	37:04	39:03	52:38			41:18
Sunday	50:03	42:25	75:56	36:53		56:41
Grand total	**41:37**	**37:13**	**43:41**	**36:26**	**49:29**	**40:48**

Table 50 Workload per day for nurses who discharged patients in a shift

	Workload					
Days	**1**	**2**	**3**	**4**	**5**	**Grand total**
Monday	1		3			4
Tuesday	2	2	4	1		9
Wednesday	2	4	4	1		11
Thursday		2	5			7
Friday	2	4	3		1	10
Saturday	2	2	1			5
Sunday	4	2				6
Grand total	**13**	**16**	**20**	**2**	**1**	**52**

Tables below are for the workload and the medical specialties

Table 51. Workload per medical specialty for nurses who admitted patients in a shift

	Workload				
Medical specialties	**1**	**2**	**3**	**4**	**Grand total**
Surgery	1	10	11	1	23
Gastroenterology	2	3	6	2	13
Geriatrics	1	1			2
Internal Medicine	7	13	3		23
Pulmonology	1	3	3	2	9
Neurology		1		1	2
Orthopaedics		2			2
Urology	1	2	5		8
Grand total	**13**	**35**	**28**	**6**	**82**

Table 52. Workload per medical specialty and the average LOS in hours

	Workload					
Medical specialties	**1**	**2**	**3**	**4**	**5**	**Grand total**
Surgery	39:57	45:00	42:33	41:45	21:04	41:46
Gastroenterology	26:40	17:58	36:06	27:45	41:18	29:12
Geriatrics	36:11	29:08	37:19			34:10
Gynaecology	29:33	40:58	47:41	27:39		38:13

Internal Medicine	37:51	39:45	34:45	27:15	57:24	37:18
Oral and maxillofacial surgery		12:35	19:40			17:18
Otorhinolaryngology	136:43	21:24				98:16
Pulmonology	33:44	38:03	25:59	37:26	30:24	31:26
Neurology		33:22	42:16	14:25		30:38
Orthopaedics	66:24	30:11	150:38	97:39	252:25	97:37
Rheumatology		23:04				23:04
Urology	36:17	38:35	32:26	41:56	8:44	35:19
Grand total	**39:45**	**37:03**	**41:15**	**40:49**	**56:33**	**40:09**

Table 53. Workload per medical specialty for nurses who discharged patients in a shift

	Workload					
Medical specialties	**1**	**2**	**3**	**4**	**5**	**Grand total**
Surgery	1	7	4	1		13
Gastroenterology	1	4	10	1	1	17
Geriatrics		1				1
Gynaecology		1	2			3
Internal Medicine	8	4	8			20
Pulmonology	3	3	10	2		18
Neurology		1				1
Orthopaedics	2	2	2			6
Rheumatology		1				1
Urology	2	3	3			8
Grand total	**17**	**27**	**39**	**4**	**1**	**88**