Tackling the bed blocking problem at the Medical Spectrum of Twente

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Samenvatting

Doordat er een stijgende vraag is naar betere planning, benutting en managing van de gezondheidszorg tracht het Medisch Spectrum Twente (MST) te Enschede, Nederland, de transmurale zorgketen van het MST en drie nazorginstellingen in het adherentiegebied van het MST te optimaliseren. In 2011 kwamen er in totaal 5474 patiënten in aanmerking voor nazorg. 1541 hiervan veroorzaakten in totaal 7810 verkeerde beddagen. Een patiënt veroorzaakt verkeerde beddagen vanaf de dag nadat de patiënt medisch uitbehandeld is tot en met de dag van ontslag uit het ziekenhuis. Bij dit onderzoek zijn enkel patiënten die in aanmerking komen voor nazorg in een verpleeghuis bestudeerd, met uitzondering van heropnames. De groep bestaat uit 1040 patiënten die in totaal 5266 verkeerde beddagen veroorzaakten in 2011. Het doel van dit onderzoek is om de invloed van vijf mogelijke interventies te bepalen op het aantal verkeerde beddagen in het MST, de bezettingsgraad in de nazorg en drie andere indicatoren met behulp van een simulatiemodel. In tegenstelling tot de werkelijke situatie zijn er in het simulatie model enkel twee mogelijke oorzaken voor verkeerde beddagen, namelijk een tekort aan bedden of aan artsen om een opnamegesprek te verzorgen. Alle vijf de interventies zijn onderzocht met n = 101 jaar en een betrouwbaarheidsinterval van 95%. Uit de resultaten blijkt dat het grootste probleem in de transmurale zorgketen een tekort aan artsen om de opnamegesprekken te verzorgen bij de KR/SOM schakelafdelingen en de KR afdelingen is. Dit probleem wordt in twee interventies aangepakt: door het maximale aantal opnamegesprekken per dag bij de KR/SOM schakelafdelingen en de KR afdelingen te verhogen, en door, op het moment dat er een vrij bed is in de nazorg, een patiënt in het MST voorrang geven in plaats van een patiënt op de schakelafdeling zodat het aantal overplaatsingen vermindert en daarmee ook het aantal opnamegesprekken. Het advies aan het MST en de drie nazorginstelling in het adherentiegebied van het MST is om het artsenprobleem op beide mogelijke manieren aan te pakken en om het aantal PG schakelbedden te verhogen van zes naar zeven of om de ligduur van PG patiënten op de schakelafdeling te verlagen van 31 naar 27 dagen. Als alleen het artsenprobleem wordt aangepakt, veroorzaakt dit een afname van 70% van het aantal verkeerde beddagen dat veroorzaakt wordt door een tekort aan bedden of artsen. Echter, in combinatie met een toename van het aantal PG schakelbedden of een afname van de ligduur op de PG schakelafdeling zorgen deze aanpassingen voor een afname van respectievelijk 88% en 87%. Door het stijgende aantal patiënten wordt er aanbevolen om het juiste aantal bedden en artsen opnieuw te bepalen over enkele jaren met nieuwe data.

Summary

On account of a growing demand for better planning, usage and management of health services the Medical Spectrum of Twente (MST) in Enschede, The Netherlands, attempts to optimize the transmural care chain of the MST and the three aftercare institutions in the catchment area of the MST. In 2011 at the MST a total of 5474 patients were notified to be eligible for aftercare. 1541 of these patients caused a total of 7810 bed blocking days. A patient is a bed blocker from the first day after the patient is medically ready up to and including the day of discharge from the hospital. During this research only patients who are eligible for admission to a nursing home, except readmission, have been studied. This group consists of 1040 patients and accounted for a total of 5266 bed blocking days in 2011. The aim of this study is to determine the influence of five possible interventions on the number of bed blocking days at the MST, the occupation rate at the aftercare wards and three other indicators, with the use of a simulation model. Contrary to the actual situation, in the simulation model the only two causes for bed blocking days can be a shortage of either beds or physicians to perform the admission interview. All five interventions have been studied with n = 101 years and a confidence interval of 95%. The results show that the major problem in the transmural care chain is a shortage of

physicians to perform the admission interviews at the BR/SOM ICD and the BR ward. This problem is tackled in two interventions: by increasing the maximum number of admission interviews per day at the BR/SOM ICDs and the BR wards, and, when there is an empty bed at the aftercare institution, give priority to a patient at the MST instead of a patient at the BR/SOM ICD in order to decrease the number of transfers and thereby the number of admission interviews. The advice to the MST and the three aftercare institutions in the catchment area of the MST is to tackle the shortage of physicians in both possible ways and either increase the number of PG beds at the ICD from six to seven or decrease the PG length of stay at the ICD from 31 to 27 days. When only the physician problem is tackled, this causes a decrease in the number of bed blocking days caused by a shortage of either beds of physicians of 70%. However, in combination with an increased number of beds or decreased length of stay of PG patients, the decrease respectively is 88% and 87%. Because of an increasing number of patients due to the aging society, it is recommended to determine the appropriate number of beds and physicians again in a few years with new data.

Keywords
Bed blocking, delayed discharge, transmural care chain, simulation model, capacity planning, control of queues, nursing homes, bed occupancy.

Introduction
The aging society, and therefore the increase in healthcare demand, as well as the increasing pressure on health care costs causes a growing demand for better planning, usage and management of health services [1-3]. Therefore, integrated care chains have been promoted as a means to build a more effective and efficient healthcare system that focuses on one of the six aims of quality improvement: patient centeredness [4-9]. An integrated care chain is a clinical pathway of a patient through different health care organizations [10].

An example of an integrated care chain is the transmural care chain of a hospital and aftercare institutions, consisting of the pathway of patients treated at the hospital followed by a treatment at an aftercare institution or homecare [11]. Transfer mediators at the hospital and the aftercare institutions arrange appropriate aftercare for these patients [12]. However, discharge from the hospital of patients who are medically ready can be delayed, for example because there is no empty bed available at the aftercare institution. This delay is defined as bed blocking. A bed blocker is a patient who has completed treatment in one part of the care chain (e.g. the hospital) and is waiting in this part of the chain for admission to the next part (e.g. an aftercare institution) [10]. Not only in the Netherlands, but also in other countries such as Sweden, England and Austria, hospitals struggle with the bed blocking problem [10].

At macro level, bed blocking impacts health care costs, as an occupied bed in a hospital is more expensive than an occupied bed in a nursing home or, alternatively, providing care at home [10]. At micro level, bed blocking can cause waiting time for new patients and has an adverse effect on the patients' health [9, 10]. The actual revalidation treatment starts when the patient is admitted to the aftercare institution, which means that during the bed blocking period the patient receives no revalidation treatment. The majority of patients develop further complications such as sepsis, increased dependency, social isolation and confusion during the bed blocking period, that further delay their discharge [13]. Besides physical symptoms, frail older patients are anxious about their future during the bed blocking period [14].

A cause of the bed blocking problem can be found in the Dutch funding system. Hospitals are funded based on 'DBC op weg naar transparantie' (DOT) [15], which means that they earn a fixed amount of money per patient. Under DOT-based payment, hospitals have an incentive to increase the number of admissions to ensure a fast patient throughput [16]. Aftercare institutions, on the other hand, are funded based on 'zorgzwaartepakketten' which means that they earn a fixed amount of money per day that a patient is treated [17]. Consequently, hospitals aim for maximum bed availability at aftercare institutions, while aftercare institutions aim at maximizing bed utilization [1, 18, 19]. A high level of utilization of beds in an aftercare institution leads to a dramatic increase in waiting times for patients at the hospital, which leads to the bed blocking problem [18]. Although this is a clear problem, it is too ambitious to try to change the Dutch funding system during this project. Therefore alternative solutions to solve the bed blocking problem have been studied.

In the Netherlands, Intermediate Care Departments (ICD) are used as a buffer for bed blockers [10]. An ICD is a nursing department where the aftercare treatment can already start and that functions as a buffer when all beds at the aftercare institutions are occupied. A patient on an ICD is not a bed blocker seen from a hospital's point of view, because the patient is in the hospital no longer. An ICD is funded based on 'zorgzwaartepakketten' in the same way as aftercare institutions. Van Brakel shows for one specific case that an ICD of five beds with a utilization of 90% ensures a reduce in the number of bed blocking days at the hospital of 50% [19]. Although this solution looks promising, another problem arose with the establishment of ICDs, namely queues for admission to the ICDs. This occurred in more than half of all ICDs in Dutch hospitals, including the Medical Spectrum of Twente (MST) in Enschede, The Netherlands. In essence, the solution (i.e. ICDs) generated the same problem it was meant to solve (i.e. waiting times and bed blocking) [10].

The aim of this study is to determine which modifications to the transmural care chain of the MST and the three aftercare institutions in its catchment area of the MST can cause a decrease in the number of bed blocking days and to determine the magnitude of this decrease in the number of bed blocking days for each modification. Based on the results an advice for the MST and the three aftercare institutions in the catchment area of the MST on modifications to the transmural care chain is given in order to decrease the number of bed blocking days and taking into account an occupation rate at the aftercare which is desired as high as possible.

First, the situation of the bed blocking problem at the MST in 2011 has been mapped out in 'Analysis of the situation at the MST in 2011' together with an analysis of the core problem. Secondly, the assumptions made in the simulation model have been shown in 'Simulation model'. In 'Possible interventions' the five interventions have been explained. The five indicators that are used to determine the performance of the care chain are listed in 'Interventions'. Thereafter, the main 'Results' are shown. In the 'Discussion' an advice is given to the MST and the three aftercare institutions in the catchment area of the MST on which modifications should be implemented in their transmural care chain to ensure a decrease in the number of bed blocking days taking into account the occupation rate at the ICD and aftercare wards, which is desired as high as possible. Finally, several 'Recommendations' for further research have been listed.

Analysis of situation at the MST in 2011

The core business of the MST is to improve the health of the inhabitants of the Twente region in the Netherlands by provision of curative care. Besides basic care, the hospital also offers top clinical care and highly specialized care. The MST accommodates 1070 beds and annually provides 34.000 clinical admissions [20]. At the ward Transfer point, transfer mediators work to help the nurses to arrange aftercare [12]. In 2011 a total of 5474 patients were notified to be eligible for aftercare after their treatment at the MST. 1541 of these patients were bed blockers and caused a total of 7810 bed blocking days. A patient is a bed blocker from the first day after the patient is medically ready up to and including the day of discharge from the hospital.

There are several types of patients that require aftercare. First there are patients who need brief reactivation (BR), which means that they need a temporary admission for revalidation at a nursing home. This patient group consists of patients who are temporary insufficiently self-reliant, for example due to a cerebrovascular accident or a planned or emergency surgery of a knee or a hip. A small part of the BR patients are called complex cases (CC), because they need the revalidation treatment to be in a special room at the nursing home, for example due to the presence of a bacterium such as MSRA. Secondly, there are patients who need a prolonged admission to a nursing home. These patients are divided into two groups: somatic (SOM) which are patients with a physical disability or disorder and psycho geriatric (PG) which are patients with cognitive limitations. The remaining patients are inter alia eligible for home care, go to a home for elderly, need specific rehabilitation care at a specialized rehabilitation institution or go to a hospice for terminal care.

The clinical pathway of patients who need aftercare after their treatment at the MST is given in Figure 1. At the date of admission patients are admitted to the hospital. During the treatment the nurses of the patients' ward notify patients who are eligible for aftercare to the transfer mediators of the hospital. The notified patients are put on separate registration lists in the database of the transfer point based on patient type. Subsequently the transfer mediators gather all necessary information to arrange aftercare. The registration lists are sent to several aftercare institutions every morning on weekdays. Transfer mediators at the aftercare institution notify an available bed at an aftercare institution to the transfer mediators of the MST based on the registration lists. The admission to the aftercare institution and discharge from the hospital is arranged for the day the patients are medically ready. However when there is no bed available on the moment that a patient is medically ready, the patient stays at the hospital and accounts for bed blocking days. Only patients on a waiting list for a nursing home (BR, SOM, PG) are eligible for temporary admission to an ICD. In contrast to all other patients, the aftercare for patients who need specific rehabilitation is arranged by a rehabilitation physician. Therefore the hospital has little influence on the aftercare arrangement of this group of patients.

Patients are discharged from an aftercare institution when their recovery is sufficient to go home. Patients with prolonged admission to an aftercare institution are discharged only when the patient is deceased.

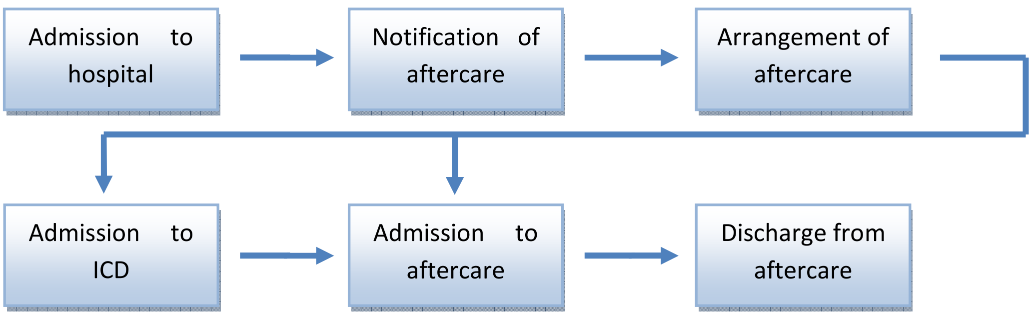

Figure 1: Clinical pathway of patients who need aftercare after treatment at the MST

Based on data from 2011 gathered from the Transfer point MST database is determined whether the bed blocking problem depends on the patient type, the cause of bed blocking or the period of the year in order to find the core problem.

The total number of patients per patient type at MST who need aftercare is shown in Figure 2, together with the total number of bed blocking days caused by these patients in 2011. Patients who need BR account for 45% of all bed blocking days. Notable is the major difference in the average number of bed blocking days per patient between different patient types. This average is more than 4 days per patient for patients who need specific rehabilitation or need aftercare at a nursing home (BR, SOM, PG), not including readmission to a nursing home. PG patients have the highest mean number of bed blocking days per patient with 11.9 days. The hospital has little influence on the aftercare arrangement of patients who need specific rehabilitation, therefore during this research only patients who are eligible for admission to a nursing home, except readmission, have been studied. Because these patients account for a relatively large average of bed blocking days per patient and the MST has influence on the arrangement of their aftercare. This group consists of 1040 of the total 5474 patients who are eligible for aftercare and account for 5266 of the total of 7810 bed blocking days.

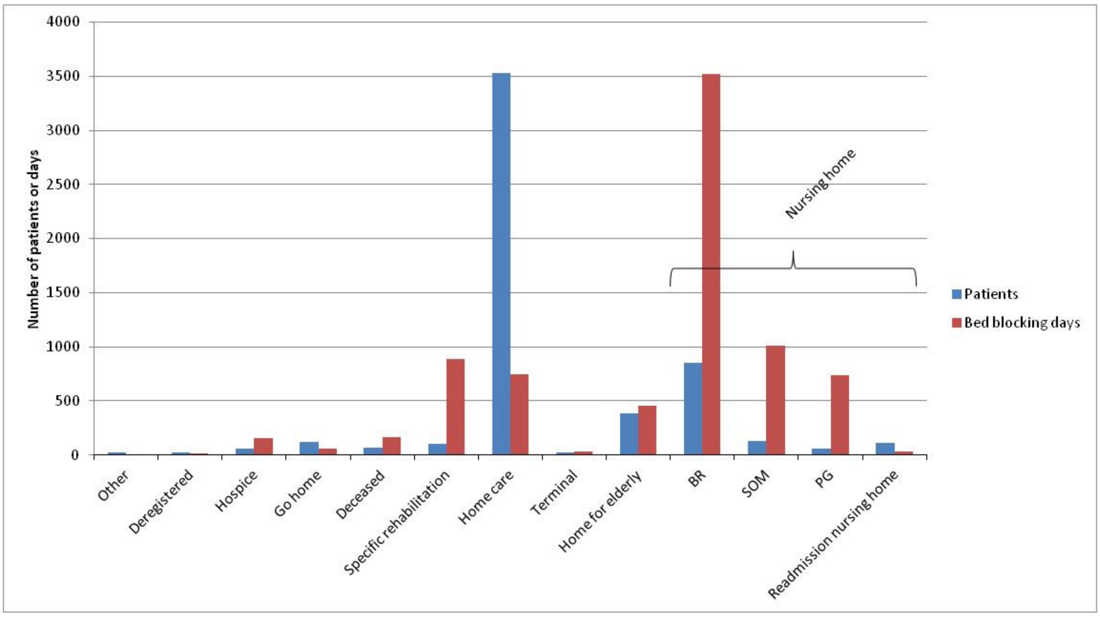

Figure 2: The number of patients and the number of bed blocking days per patient type at MST in 2011

(Source: Database Transfer point MST, Jan-Dec 2011, N=5474)

When a patient blocks a bed at the MST the transfer mediators of the MST often report the cause of bed blocking. Figure 3 shows the total number of patients (BR, SOM and PG) that caused bed blocking days and the total number of bed blocking days at the MST in 2011 divided per reason of bed blocking. Of all 5266 bed blocking days 29% is caused because there is no bed available at the aftercare institution and another 20% is also partially caused by this reason. This part of the bed blocking problem is tackled during this research. Complex cases (CC), which is a small subgroup of BR patients, caused an average of 17 bed blocking days per patient, which is the highest average of a patient group. Therefore and also because this subgroup of patients needs special beds at a BR ward in a nursing home, during this research CC patients have been studied in a separate group next to BR, SOM and PG.

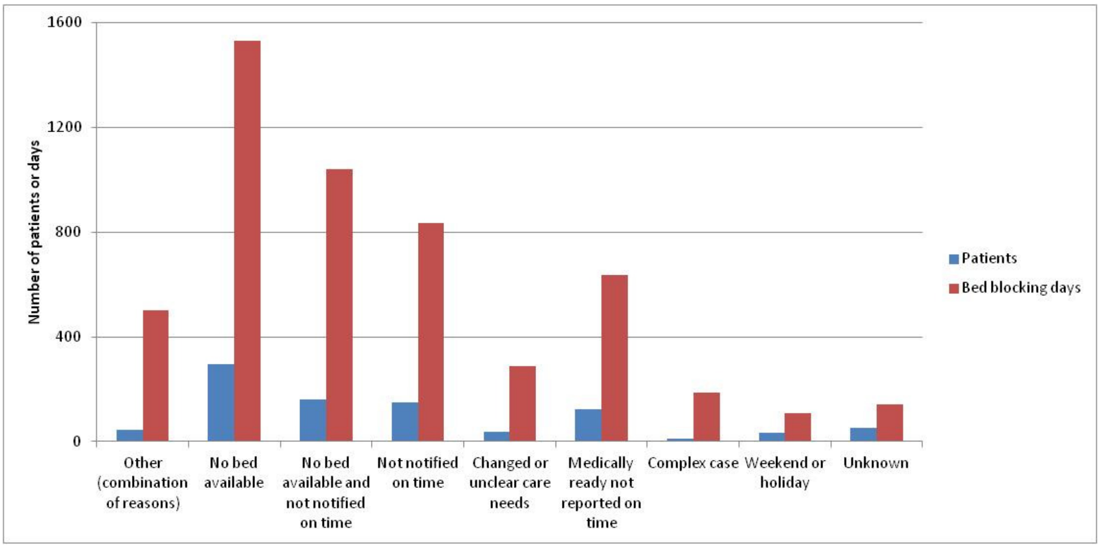

Figure 3: The number of patients (BR, CC, SOM, PG) and the number of bed blocking days per reason of bed blocking at MST in 2011

(Source: Database Transfer point MST, Jan-Dec 2011, N=1040)

To determine the variation of bed blocking during the year, the total number of bed blocking days caused by BR, CC, SOM and PG patients is calculated per week in 2011, as shown in Figure 4. The higher number of bed blocking days from week 28 till 32 is due to a temporary closure of one of the two BR/SOM ICDs caused by an MRSA outbreak. Figure 5 shows the total number of new medically ready patients at the MST per week in 2011. To determine whether the pattern in the number of bed blockings days per week and the number of new medically ready patients per week during the year in 2011 is random or nonrandom, a run-based pattern test with above/below and up/down methods is used [21]. As shown in Appendix 1, for the number of bed blocking days per week both the above/below and up/down methods show a nonrandom pattern with a confidence interval of 99%. Even if week 28 till 32 are not taken into account, the pattern is still nonrandom. However, the number of new medically ready patients per week does show a random pattern for both above/below and up/down methods.

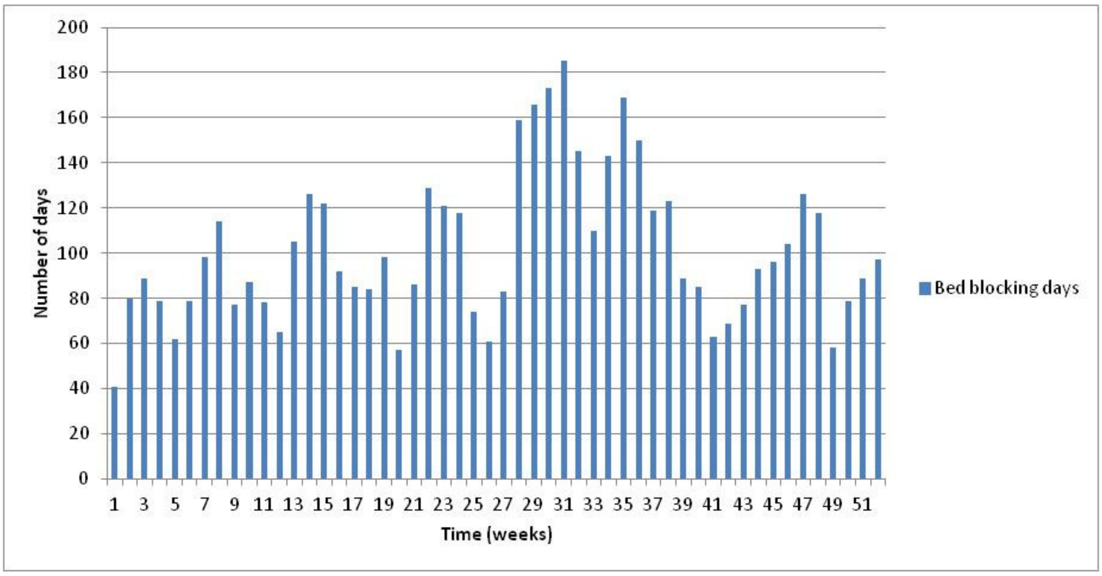

Figure 4: The total number of bed blocking days per week by BR, CC, SOM and PG at MST in 2011

(Source: Database Transfer point MST, Jan-Dec 2011, N=1040)

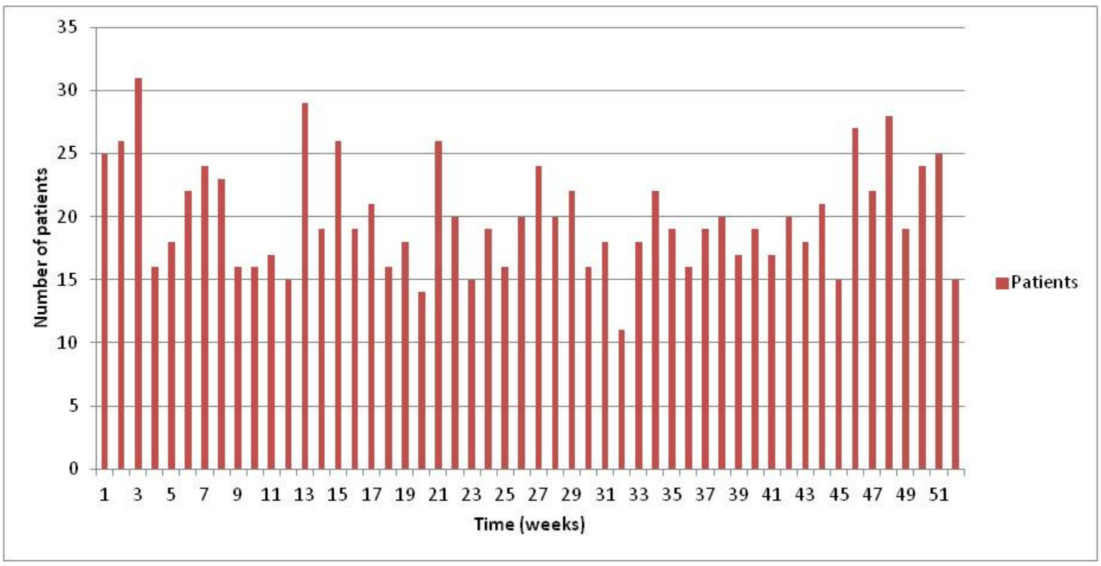

Figure 5: The total number of new medically ready patients (BR, CC, SOM and PG) per week at MST in 2011

(Source: Database Transfer point MST, Jan-Dec 2011, N=1040)

Simulation Model

In order to achieve the aim of this study, a simulation model is developed to test the influence of five possible interventions on five indicators of the transmural care chain. First, the assumptions which have been made in the simulation model are listed. Secondly, the possible interventions are explained. Finally, the five indicators of the transmural care chain are listed.

Figure 6 shows the part of the transmural care chain which is approximated with the simulation model. The SOM and PG aftercare is not included in the simulation model, because the catchment area is not exactly known and because a lot of patients from other hospitals or from home are also admitted to the SOM and PG aftercare.

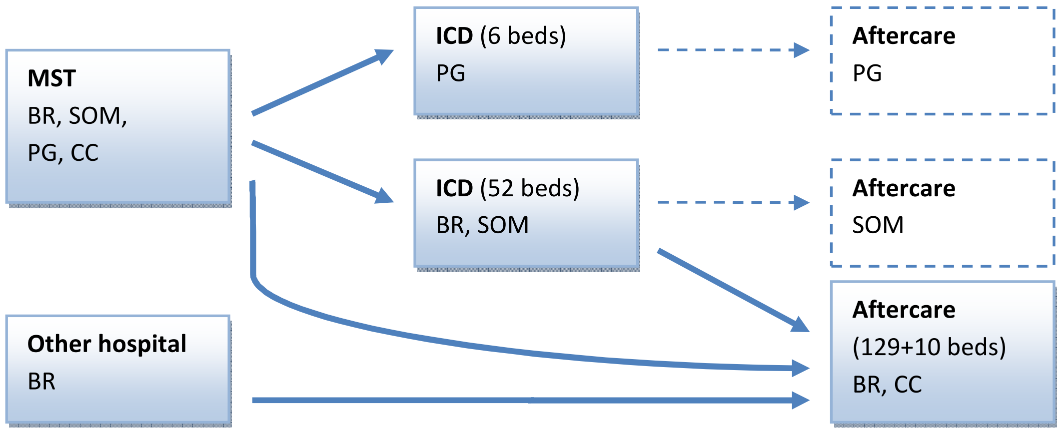

Figure 6: Part of the transmural care chain

The simulation model is based on data from 2011 gathered from the Transfer point MST database. The simulation runs for n=101 years, after a warm-up period of two years, because after less than two years the process is stable for all patient types. Only on weekdays patients can be admitted to an ICD or aftercare ward. Each year consists of 260 weekdays. The values of the indicators are determined on all days, including weekends. Patients enter the simulation according to a Poisson arrival rate. Arrival at the simulation model means that the patient is medically ready to leave the hospital for aftercare at a nursing home. Poisson arrival is a good discrete approximation for the number of new medically ready patients, with a deviation of 21% with the actual situation in 2011 in the MST. For each run of the simulation model of 103 years, the same Poisson arrival values are used in order to compare all runs fairly. Contrary to the actual situation, in the simulation model the only two reasons for bed blocking can be a shortage at the aftercare of either beds or physicians to perform the admission interview. Other possible causes of bed blocking as shown in Figure 3 are not taken into account.

All patients who are eligible for aftercare at a nursing home after their treatment at the MST, except readmission, have been included in the simulation. For BR patients there also is a group of patients from other hospitals who need aftercare at a BR ward. Based on data from 2011 of the Zorggroep Sint Maarten, 16.3% of all BR patients at the aftercare are not discharged from the MST or the ICD. Assumed is that this percentage is the same for all aftercare institutions. This patient group also arrives according to a Poisson arrival rate. Patients from other hospitals cannot account for bed blocking days at the MST.

All patients are divided into four different groups: brief reactivation (BR), complex cases (CC), somatic (SOM) and psycho geriatric (PG). BR patients need a temporary admission to a nursing home BR ward. The BR/SOM ICD ward is used as a buffer for the BR ward, but only for patients from the MST. The treatment of the patient already starts at the ICD. Patients at an ICD are given priority compared to patient at the hospital to be admitted to the BR ward, according to the first-come, first-served principle. When a BR patient cannot be admitted to the BR ward or the BR/SOM ICD, one BR patient per day can be admitted to the CC ward. Assumed is that this patient stays at the CC bed until the end of the treatment, while in the actual transmural care chain it is possible that these patients move to a BR ward at the same aftercare institution during their treatment. This causes an increased bed occupation rate at the CC ward and a slightly decreased bed occupation rate at the BR ward in the simulation model compared to the actual situation. Assumed is that this makes little difference for the total number of bed blocking days at the MST and the total occupation rate at the aftercare wards. After the length of stay BR patients exit the simulation model and go home. CC patients are a subgroup of the BR patients and can only be admitted to a CC ward. After the length of stay CC patients exit the simulation model and go home. SOM patients as well as PG patients need a prolonged admission to a nursing home. Respectively at the BR/SOM ICD and the PG ICD these patients wait until there is a prolonged bed available. After the length of stay at the ICD ward, patients exit the simulation model and are prolonged admitted to a nursing home. Assumed is that all SOM and PG patients need a temporary admission to an ICD to wait for a prolonged admission to a nursing home. Table 1 shows the total number of new medically ready patients per year per patient type.

Only from the BR patient group from the Zorggroep Sint Maarten over 2011, the distribution of the length of stay at the aftercare ward is known. Analysis shows that a log-logistic approximation deviates 10% from the actual distribution. Comparing the values of the indicators of the simulation using a log-logistic approximation with a deterministic approximation shows little difference, because the average length of stay is the same in both cases. Therefore, the length of stay of all patient groups at the ICD and aftercare wards is assumed deterministic, as shown in Table 1. On the day after a patient has left the nursing home, the bed is available for a new patient.

	Number of patients per year	Length of stay (days)
BR	845	48
CC	12	90
SOM	122	90
PG	61	31
BR extern	165	48

Table 1: Number of patients per year and length of stay per patient type

Only the three aftercare institutions in the in the catchment area of the MST have been taken into account in the simulation model, see Table 2. In this simulation model it is not possible for the patients to have a preference for a specific aftercare institution.

AriensZorgpalet	Klaaskateplein	32 BR beds
	Eschpoort	6 ICD PG beds
	Ariensplein G2 and G4	51 ICD BR/SOM beds
Livio	Wiedenbroek	40 BR beds and 5 CC beds
	Cromhoff	29 BR beds and 1 CC bed
Zorggroep Sint Maarten	Gereia	28 BR beds and 4 CC beds

Table 2: The number of beds included in the simulation model

Interventions

The first two interventions ‘number of beds’ and ‘length of stay’ are approximately continuous interventions. The influence of these interventions on the indicators is shown in graphs in the results. These interventions are used to determine the optimal number of beds or length of stay. The other three interventions ‘planning elective patients’, ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ are interventions where one aspect of the care chain changes. The influence of these interventions on the indicators is shown in a table together with the values of the indicators in the current situation in order to compare the different situations. Intervention ‘planning elective patients’ aims to decrease the number of bed blocking days by decreasing the variability of the number of new medically ready patients. Interventions ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ aim to decrease the number of bed blocking days by decreasing the chance of bed blocking caused by no physician available to perform the admission interview.

A major part of all bed blocking days is caused by a limited bed availability, as shown in Figure 3. According to interviews with transfer mediators of the aftercare institutions, this limited bed availability can have two causes: there is no bed available or there is no physician available to perform the admission interview. With intervention ‘number of beds’ the effect of a lower and higher number of beds at the ICDs and aftercare wards on the five indicators is determined.

Starting in 2013 nursing homes also will be financed according to a DOT-based system. This means that nursing homes get an incentive to decrease the length of stay in order to increase the throughput. Intervention ‘length of stay’ determines the effect of the length of stay of the different patient types on the indicators.

Of all 845 BR patients per year at the MST, approximately 140 are elective patients. Admission to the hospital of these patients can be postponed until there is a quiet period at the aftercare institutions, which means there are several empty beds, in order to decrease the number of bed blocking days. The treatment of elective patients at the hospital takes five days. However, it is not possible for aftercare institutions to know the number of beds that will be available in five days. Therefore, intervention ‘planning elective patients’ assumes that, when there is a quiet period at the aftercare, there is a high probability that in five days it will still be a quiet period at the aftercare. This assumption is proven in Appendix 1. Intervention ‘planning elective patients’ determines the effect of a feed-back loop from the aftercare to the elective admissions to the MST in order to regulate the flow of BR patients. This works as follows: each day for every three available beds at the aftercare BR ward, one elective patient is admitted to the MST if there is an elective patient on the waiting list. After the treatment of five days at the MST the BR patient is put on the BR waiting list, together with the medically ready emergency BR patients, and could cause bed blocking days. The expectation is that this intervention on one hand causes a decrease in the number of bed blocking days and also causes an increase in the occupation rate at the aftercare wards, caused by a decrease in variability of new arriving patients.

According to interviews with transfer mediators at the aftercare institutions the physicians are able to increase the maximum number of admission interviews per day, as shown in Table 3. Intervention ‘increased number of admissions per day’ determines the effect of an increased maximum number of admissions per day.

	Currently	Increased
ICD (BR, SOM)	3	5
ICD (PG)	1	1
Aftercare (BR)	5	10
Aftercare (CC)	1	1

Table 3: The maximum number of admissions per day

BR patients can go directly to an aftercare institution as shown in Figure 6. However, when there are no more admissions to the aftercare institution possible while there are still BR patients medically ready, these patients are temporary admitted to a BR/SOM ICD ward. A patient at the ICD does not cause bed blocking days and can already start with the aftercare treatment. When there is a bed available at the aftercare institution, currently, a patient from the ICD is admitted to this aftercare institution according to the first-come, first-serve principle. This causes indirect admissions to the BR ward. Intervention ‘priority to MST patients instead of ICD’ determines the effect of a priority of patients at the hospital instead of patients at an ICD to be admitted to a

BR ward, in order to increase the total number of direct admissions to the BR ward and therefore decrease the chance of bed blocking caused by a limited physician availability. The advantages of a direct admission to an aftercare institution are: fewer admissions are needed which is more pleasant for the patient and fewer admission interviews are needed which causes a decreased chance of bed blocking caused by a limited availability of physician to perform an admission interview.

Indicators

The indicators are used to determine the effect of the interventions. The first indicator 'number of bed blocking days' is the most important indicator for the MST. The aim of the MST is to reduce the number of bed blocking days in order to increase the throughput of patients [16]. The most important indicator for the aftercare institutions is 'occupation rate' of the ICDs and the aftercare wards. The aftercare institutions aim for a high occupation rate in order to maximize the bed utilization [1]. The other three indicators are used to determine the cause of a change in the number of bed blocking days and the occupation rate. Each indicator is reset after each year during the simulation. The average and the standard deviation with $\alpha=0.05$ is calculated for each of the $n=101$ years.

The number of patients on the waiting list at the end of the day is equal to the number of bed blocking days caused on that day. These bed blocking days have been summarized per patient type as the first indicator.

At the end of each day the occupation rate at each type of after care ward is estimated. The mean occupation rate per year is estimated as the second indicator.

The third indicator is the percentage of patients that causes bed blocking days per patient type. This indicator is used to determine the chance that a patient has to wait at the MST for admittance to an aftercare ward.

According to interviews with transfer mediators of the three aftercare institutions in the catchment area of the MST, there can be two reasons for a patient not to be admitted to a nursing home or an ICD. Therefore, the fourth indicator 'cause of bed blocking' is divided into two sub indicators. First there is a limited number of beds at a ward. If all beds of a specific type of patients are occupied and there are still patients on the waiting list at the end of a day, the bed blocking cause 'no bed available' for that type of patients is summed with one. Secondly there is a limited number of admissions each day, due to the limited availability of a physician to provide the admission interviews. When after the maximum number of admissions per day for a specific type of patients, there are still patients on the waiting list, the bed blocking cause 'no physician available' for that type of patients is summed with one. One year of the simulation model includes 260 weekdays. Therefore the maximum value of this indicator is 260.

BR patients can go directly to an aftercare institution or indirect via an ICD. Therefore, the total number of admissions of BR patients to an ICD or an aftercare institution can differ for the same total number of BR patients. The fifth indicator is the total number of transfers of BR patients.

Results

All interventions have been studied with $n = 101$ years and a confidence interval of 95% [22]. Only notable results have been summarized in this chapter, the other results are shown in Appendix 2.

With intervention 'number of beds', the influence of the number of beds at the ICD and aftercare institutions on the five indicators is studied for each patient group, by changing the number of beds separately per type of ward. The vertical line shown in the figures shows the current number of beds of that specific ward.

The current number of brief reactivation (BR) beds at the aftercare institutions is 129. Figure 7 shows a nearly exponential increase in the number of bed blocking days of BR patients when the number of BR beds decreases. Figure 11 shows a linear increase in the occupation rate at the BR ward when the number of beds decreases. A shortage of BR beds is scarcely buffered by the ICD as the ICD is meant to be, because there are not enough physicians available at the ICD to perform all admission interviews, as shown in Figure 10. And Figure 12 hardly shows an increase in the occupation rate at the BR/SOM ICD although the number of bed blocking day of BR patients increases. Figure 9 and Figure 10 show that even with a high number of beds there are still bed blocking patients due to a shortage of physicians. With a decreased number of beds, it occurs more often that there is a shortage of physicians. This is caused by in increased number of BR transfers, as shown in Figure 8.

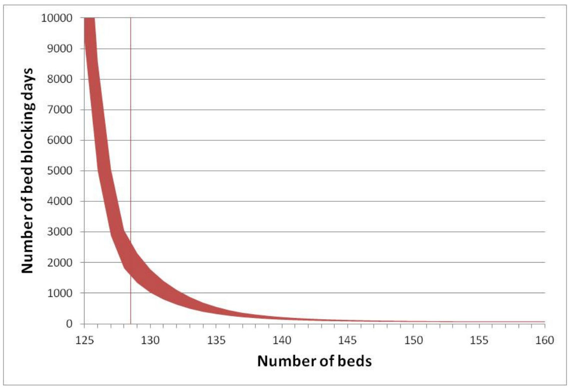

Figure 7: Influence of the number of BR beds on the number of bed blocking days of BR patients

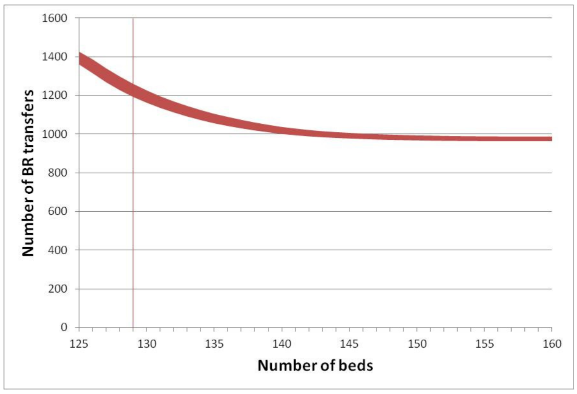

Figure 8: Influence of the number of BR beds on the number of BR transfers

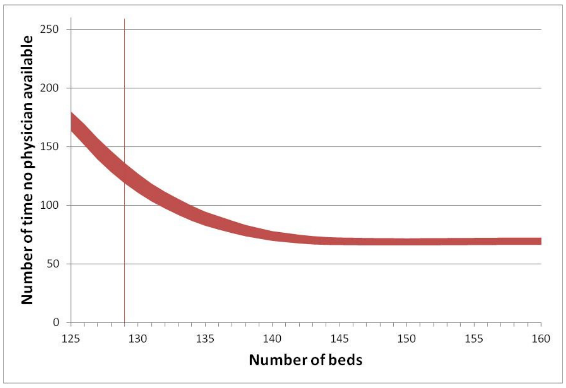

Figure 9: Influence of the number of BR beds on no physician available at the BR ward

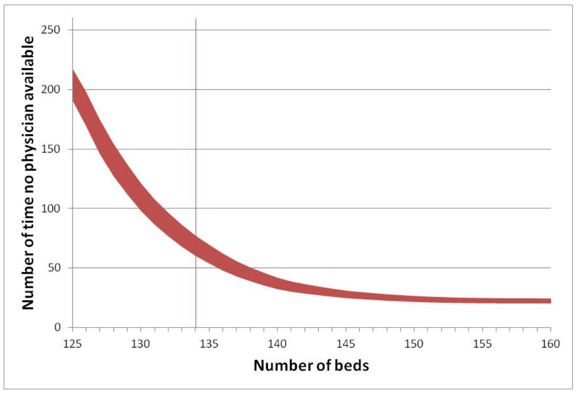

Figure 10: Influence of the number of BR beds on no physician available at the BR/SOM ICD

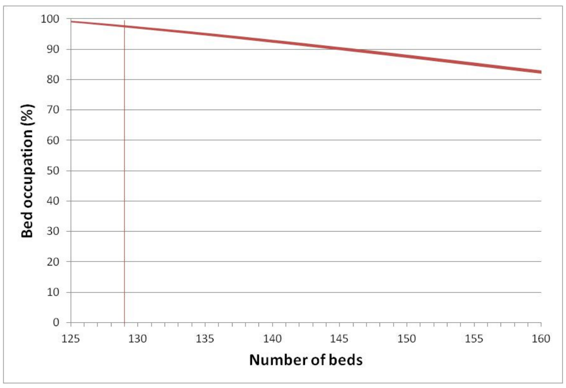

Figure 11: Influence of the number of BR beds on the occupation rate of the BR ward

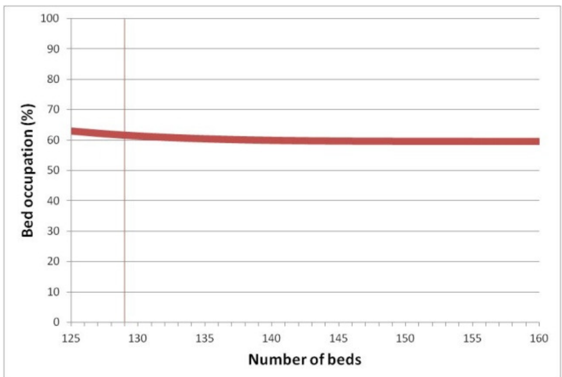

Figure 12: Influence of the number of BR beds on the occupation rate of the BR/SOM ICD

The current number of complex cases (CC) beds at the aftercare institutions is ten. In Figure 13 the number of bed blocking days of CC patients shows an exponential relation with the number of beds. The bed occupation rates of CC and BR wards, shown in Figure 17 and Figure 18, increase up to 100% if the number of beds decreases. The main barrier to reduce the number of bed blocking days for both patient groups is the number of beds available, because, as also shown in Figure 15 and Figure 16, the majority of the bed blocking days of CC patients is caused because there is no bed available. Figure 14 shows that the BR patient group is dependent on the CC beds. If the CC beds are not used as a buffer for BR patients, the number of bed blocking days is very high.

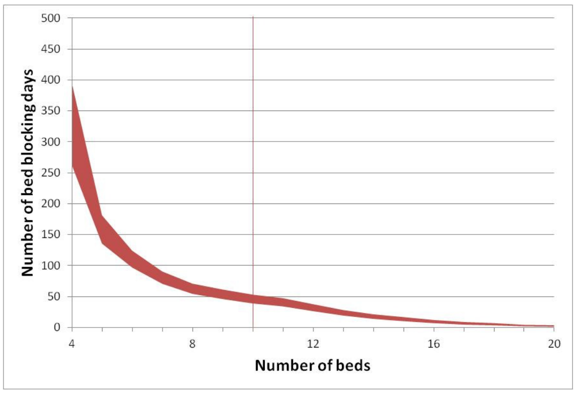

Figure 13: Influence of the number of CC beds on the number of bed blocking days of CC patients

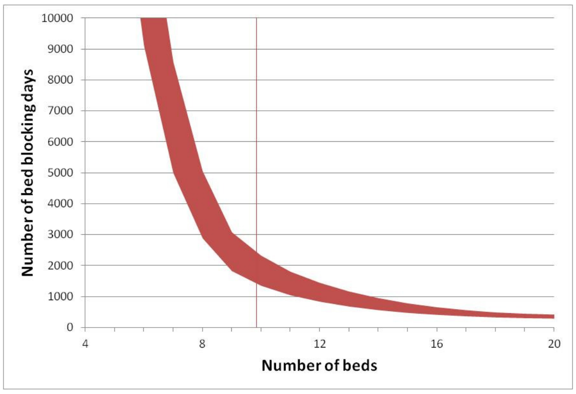

Figure 14: Influence of the number of CC beds on the number of bed blocking days of BR patients

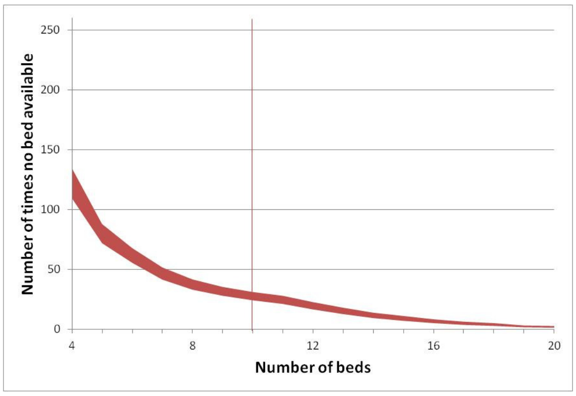

Figure 15: Influence of the number of CC beds on no bed available at the CC ward

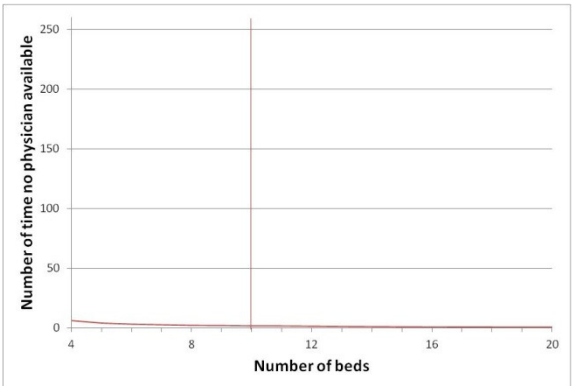

Figure 16: Influence of the number of CC beds on no physician available at the CC ward

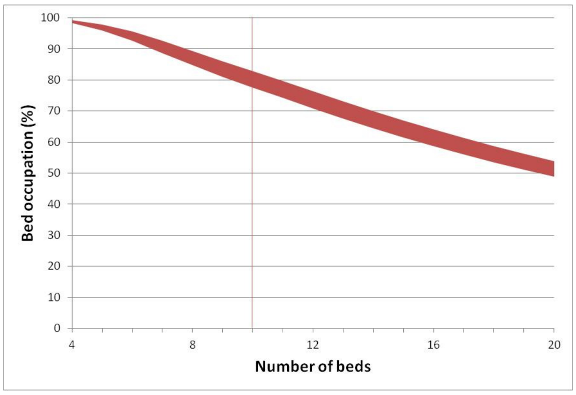

Figure 17: Influence of the number of CC beds on the occupation rate of the CC ward

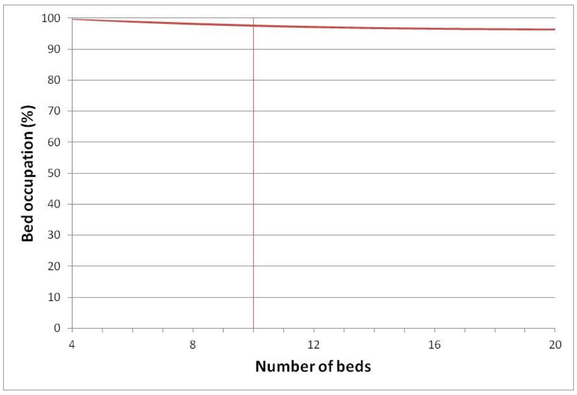

Figure 18: Influence of the number of CC beds on the occupation rate of the BR ward

The current number of BR/SOM beds at the ICD is 51. Figure 20 shows that with this current number of beds the occupation rate is merely 61%. However, as shown in Figure 22 approximately 120 days each year, there is no physician available at the ICD, while there are still somatic (SOM) or BR patients on the waiting list. Because there are 260 weekdays each year, this is equal to 45% of all days. As shown in Figure 19, SOM patients currently do not account for bed blocking days; therefore, the shortage of physicians is especially applicable for BR patients. This proves that the ICD is currently not used correct as a buffer for BR patients. Figure 21 and Figure 22 show a contrary shape: where Figure 21 decreases, Figure 22 increases. Therefore, with every number of beds either the number of beds or the number of physicians is a limiting factor to admit patients to the BR/SOM ICD. The decreased shortage of physicians when the number of BR/SOM ICD beds decreases is caused by a decreased number of transfers of BR patients, as shown in Figure 23.

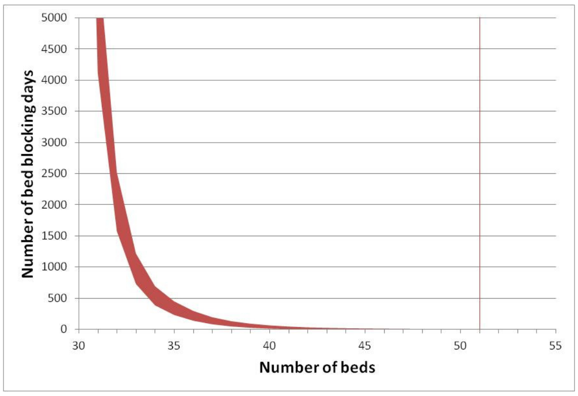

Figure 19: Influence of the number of BR/SOM beds on the number of bed blocking days of SOM patients

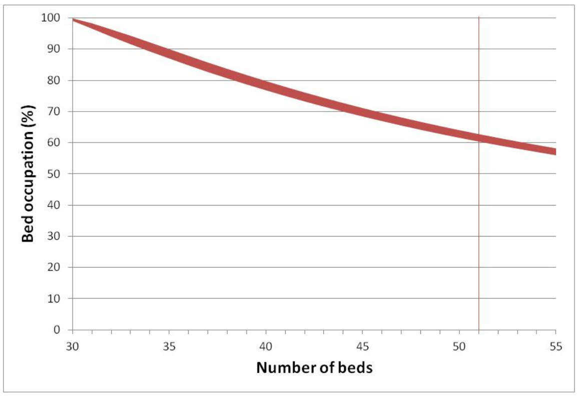

Figure 20: Influence of the number of BR/SOM beds on the occupation rate of the BR/SOM ICD

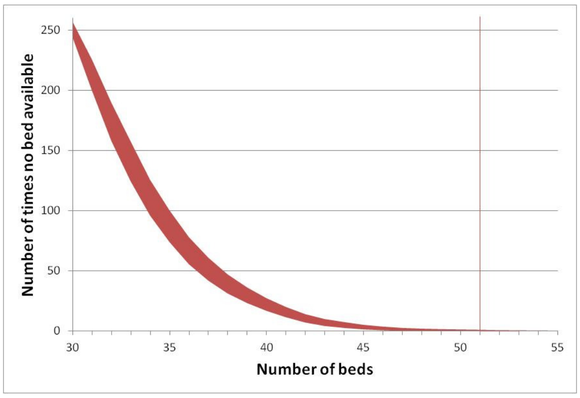

Figure 21: Influence of the number of BR/SOM beds on no bed available at the BR/SOM ICD

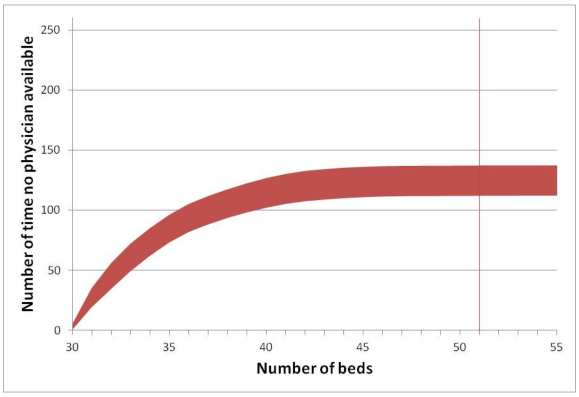

Figure 22: Influence of the number of BR/SOM beds on no physician available at the BR/SOM ICD

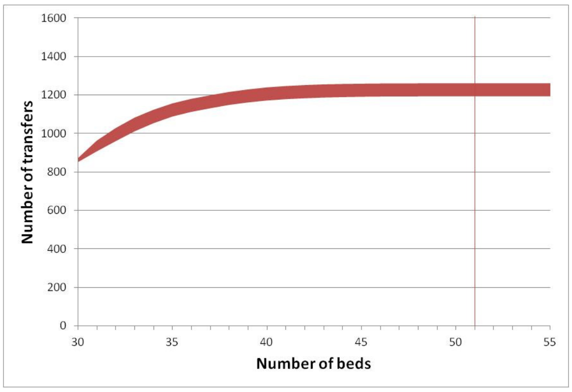

Figure 23: Influence of the number of BR/SOM beds on the number of BR transfers

Psycho geriatric (PG) is the only patient group that does not interact with other patient groups in the transmural care chain. The current number of PG beds at the ICD is six. As the analysis of the current situation at the MST shows, PG patients account for the highest average number of bed blocking days. Figure 24 shows that with the current number of beds the PG patients account for a total of 689 bed blocking days. Figure 26 and Figure 27 show that the availability of beds is the major problem of the number of bed blocking days. The occupation rate has an almost linear relation with the number of beds, see Figure 28. However, the line is much steeper compared to the occupation rate figures of the other patient groups, due to the low number of beds.

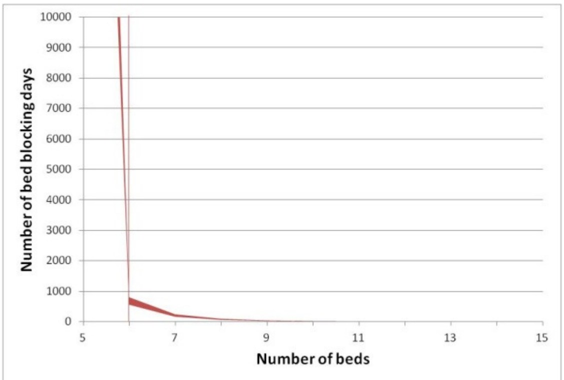

Figure 24: Influence of the number of PG beds on the number of bed blocking days of PG patients

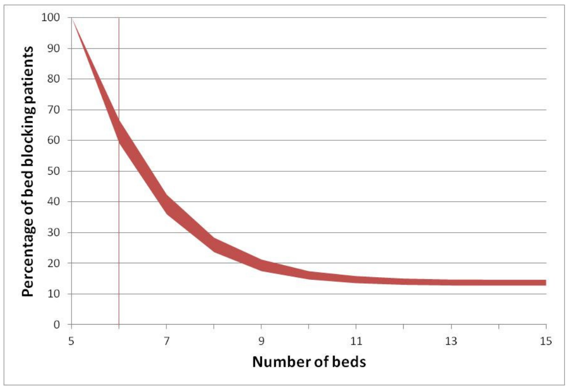

Figure 25: Influence of the number of PG beds on the percentage of bed blocking patients PG

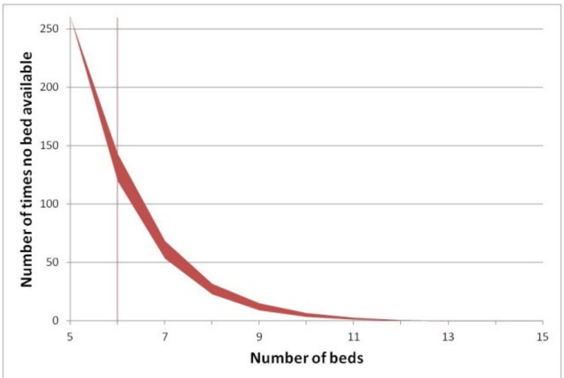

Figure 26: Influence of the number of PG beds on no bed available at the PG ICD

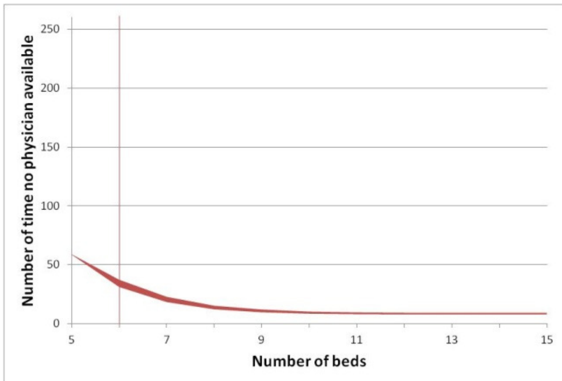

Figure 27: Influence of the number of PG beds on no physician available at the PG ICD

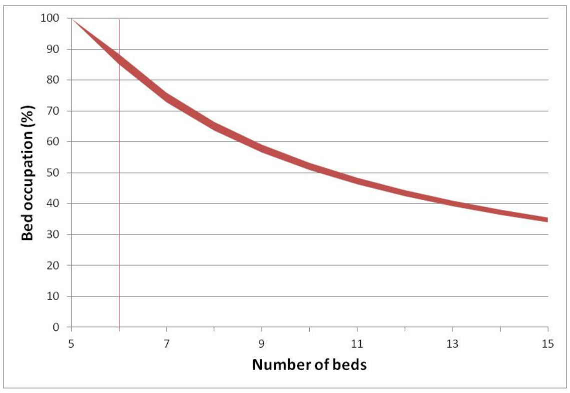

Figure 28: Influence of the number of PG beds on the occupation rate of the PG ICD

Intervention 'length of stay' determines the effect of the average length of stay per patient group on the five indicators.

According to the queuing theory, the 'number of beds' (s) and the 'length of stay' ($1/\omega$) are related, see Equation 1, where ρ=occupation rate and λ=arrival rate.

$$\rho = \frac{\lambda}{s\omega} \quad (1)$$

Due to this relation, both interventions show almost the same effect on the indicators, with a certain ratio. Therefore, the results of intervention ‘length of stay’ are shown in Appendix 2.

Table 4 shows the average value and the standard deviation with α=0.05 of the five indicators in the current situation and with possible intervention ‘planning elective patients’, ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’. The three interventions do not influence the indicators of PG, because this is a separate part of the simulation model where no changes can be made, except for the number of PG beds and length of stay of PG patients. Therefore only the values of the indicators for BR, CC and SOM patients are shown in Table 4.

Intervention ‘planning elective patients’ shows a decrease in the average number of bed blocking days of 11%. With a paired two-tailed student’s t-test, with α=0.05, is determined that this intervention is statistically not better than the current situation. Striking is the fact that the percentage of patients that causes bed blocking days does not decrease statistically nor does the number of times that there is no bed available at the BR wards.

Intervention ‘increased number of admissions per day’ shows a major decrease in the number of bed blocking days and bed blocking patients for patient group BR. This is partly caused by the increase in the maximum number of admissions per day at the BR wards. However, the number of times there is no physician available at the BR/SOM ICD has decreased even more. The occupation rate at the BR/SOM ICD and the aftercare institutions in the current situation is almost equal to the occupation rate when using intervention ‘increased number of admissions per day’.

Intervention ‘priority to MST patients instead of ICD’ accounts for a large decrease in the number of bed blocking days for BR patients, although the number of bed blocking days for SOM patients increases. The number of times no physician is available at the BR ward or BR/SOM ICD has decreased the most of all three interventions. The occupation rate at the BR wards decreases, while the occupation rate at the BR/SOM ICD increases. The number of transfers of BR patients has decreased significantly.

	Number of bed blocking days				Occupation rate (%)		
	BR	CC	SOM	Σ average	BR	CC	BR/SOM
Situation MST in 2011	1831 ± 486	47 ± 7	2 ± 3	1880	97.5 ± 0.4	80.3 ± 2.7	61.6 ± 1.2
Planning elective patients	1622 ± 398	56 ± 7	1 ± 0	1679	97.6 ± 0.3	81.0 ± 2.2	61.1 ± 1.1
Increased number of admissions per day	101 ± 18	53 ± 7	2 ± 3	156	97.2 ± 0.3	79.4 ± 2.4	62.7 ± 1.3
Priority to MST patients instead of ICD	83 ± 22	26 ± 5	13 ± 6	122	96.6 ± 0.3	70.2 ± 2.2	66.0 ± 1.4

	Bed blocking patients (%)			No bed available			No physician available			# Transfers
	BR	CC	SOM	BR	CC	BR/SOM	BR	CC	BR/SOM	BR
Situation MST in 2011	44 ± 5	43 ± 4	0 ± 0	119 ± 10	28 ± 3	0 ± 1	128 ± 9	1 ± 0	125 ± 13	1226 ± 34
Planning elective patients	41 ± 4	45 ± 4	0 ± 0	113 ± 9	31 ± 4	0 ± 0	125 ± 8	2 ± 0	118 ± 12	1219 ± 31
Increased number of admissions per day	7 ± 1	44 ± 4	0 ± 0	112 ± 10	31 ± 4	1 ± 1	84 ± 8	2 ± 0	27 ± 4	1199 ± 40
Priority to MST patients instead of ICD	5 ± 1	26 ± 3	3 ± 1	40 ± 3	16 ± 3	8 ± 3	46 ± 3	1 ± 0	14 ± 1	947 ± 10

Table 4: Current situation compared to intervention ‘planning elective patients’, ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’

Discussion

Based on the results an advice for the MST and the three aftercare institutions in the catchment area of the MST on modifications to the transmural care chain is given in order to decrease the number of bed blocking days and taking into account an occupation rate at the aftercare which is desired as high as possible.

According to the results, the major problem in the transmural care chain is a shortage of physicians to perform the admission interviews. This is especially a problem at the BR/SOM ICD, but also at the BR wards. Interventions ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ tackle this problem at these wards. Both interventions cause a major decreasing in the number of bed blocking days for

BR patients and are rather easy to implement according to interviews with transfer mediators at the aftercare institutions. Intervention ‘priority to MST patients instead of ICD’ ensures a statistically larger decrease in the number of bed blocking days of BR patients than intervention ‘increased number of admissions per day’. Another advantage of intervention ‘priority to MST patients instead of ICD’ is the larger decreased number of transfers of BR patients, because it is undesirable for patients to transfer more than necessary and less physicians are needed to perform admission interviews, which safes money for the aftercare institutions. Most patients choose an aftercare institution over an ICD ward. Therefore, the only disadvantage of intervention ‘priority to MST patients instead of ICD’ is that patients at the ICD stay there for a longer period of time, while patients from the MST have priority over them to go to a BR aftercare ward, which could be unfair.

It is clear that either intervention ‘increased number of admissions per day’ or ‘priority to MST patients instead of ICD’ should be implemented because they are easy to implement and ensure a large decrease in the number of bed blocking days, with almost no decrease in occupation rate at the aftercare wards. Furthermore it is disadvantageous for both the MST and the aftercare institutions if there is an empty bed at an aftercare ward and a bed blocking patient at the MST who cannot be admitted to the aftercare ward because of a shortage of physicians to perform the admission interviews, because this costs money for both organizations. The advice is to implement both interventions. This way the throughput of patients will be much better than it currently is, even if occasionally it is not possible to increase the number of physicians or if sometimes a patient from the ICD gets priority over a patient from the MST in order to keep the patients satisfied.

Currently there is a rather large fluctuation in the number of bed blocking days and the number of new medically ready patients during the year. The aim of intervention ‘planning elective patients’ is to slightly flatten out this fluctuation by only admitting elective patients to the MST during quiet periods at the aftercare institutions. Despite of the decreased fluctuation of new arriving patients, the simulation model shows that this intervention causes no statistical decrease in the number of bed blocking days. Implementing intervention ‘planning elective patients’ relatively takes a lot of effort compared to its benefit, therefore it is advised not to implement this intervention.

The interventions ‘number of beds’ and ‘length of stay’ have a nearly L-shaped and in some cases exponential relation with the number of bed blocking days. This means that the number of bed blocking days is low until a certain number of beds or length of stay, where suddenly the number of bed blocking days increases dramatically. From now on this turning point is called the critical point. Before this critical point a change in the number of beds or the length of stay has little influence on the number of bed blocking days. However, past the critical point even a small change (e.g. one bed less or an increase in average length of stay of one day) causes an enormous increase in the number of bed blocking days. The interventions ‘number of beds’ and ‘length of stay’ have a linear relationship with the occupation rate at the ICDs and the aftercare wards.

An increase in the ‘length of stay’, compared to the ‘number of beds’, causes a contrary influence on the indicators according to Equation 1. Assumed is that it is not possible to change the current length of stay at the ICD and aftercare in combination with a change in the number of beds. Therefore, one advice is based on a modification in the number of beds, as shown above, and the other advice is based on a modification in the length of stay per patient group. Both advices ensure the same change in occupation rate at the aftercare wards.

In Figure 29 the number of bed blocking days for BR patients is plotted versus the occupation rate at the BR ward. Each dot illustrates a certain number of beds, where one dot to the right is one bed less. The current number of beds is 129. Because the author has not been informed of the exact costs of one bed blocking day nor of a decrease of the occupation rate at the aftercare of 1%, it is assumed that the optimal point for the MST and the aftercare institutions together occurs at circa 135 beds in this case. However, if interventions ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ are implemented, the curve changes, as shown in Figure 30. In this case there is no need to increase the number of BR beds or decrease the BR length of stay. Appendix 3 shows the advice for the MST and the three aftercare institutions in the catchment area of the MST in case that interventions ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ are not implemented. If they are implemented it only is necessary to increase the number of beds at the PG ICD to seven or to decrease the length of stay of PG patients at the PG ICD to 27 days, see Figure 31 and Figure 32. With an increase in the number of beds at the PG ICD from six to seven, the number of bed blocking days decreases from 689 to 212. The consequence of this increase in the number of beds is a decrease in bed occupation from 86.8% to 74.4%. This rather larger decrease in occupation rate is caused by the fact that the number of beds in this case is increased with 16.7%. Despite of the large decrease in bed occupation rate, the advice is to increase the number of beds at the PG ICD to seven.

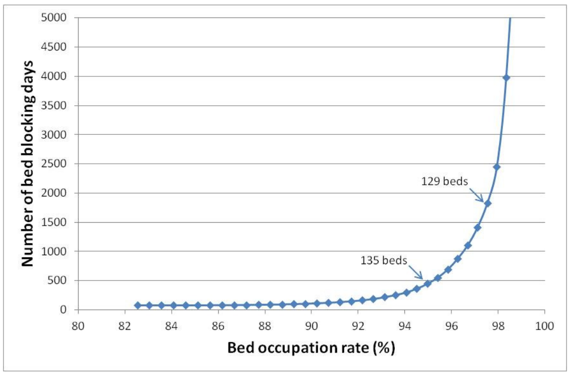

Figure 29: Influence of the number of BR beds on the number of BR bed blocking days and the occupation rate at the BR ward in current situation

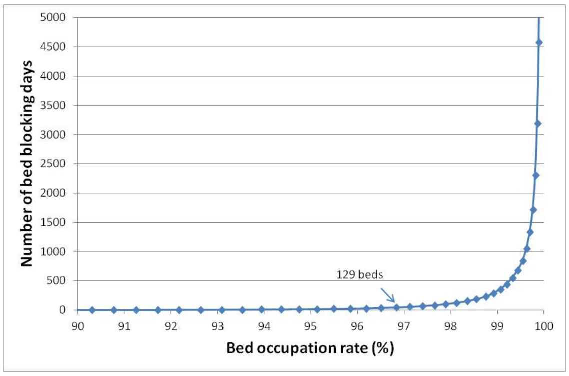

Figure 30: Influence of the number of BR beds on the number of BR bed blocking days and the occupation rate at the BR ward with interventions 'increased number of admissions per day' and 'priority to MST patients instead of ICD'

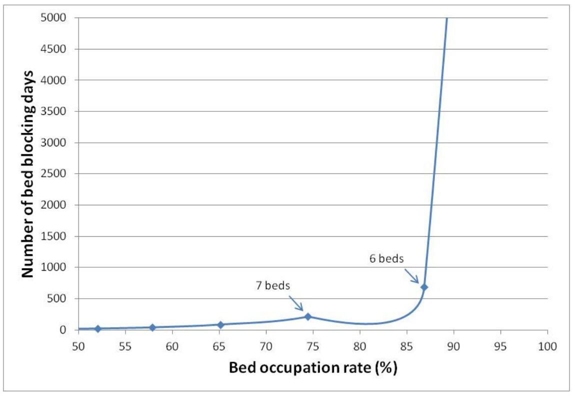

Figure 31: Influence of the number of PG beds on the number of PG bed blocking days and the occupation rate at the PG ward in current situation

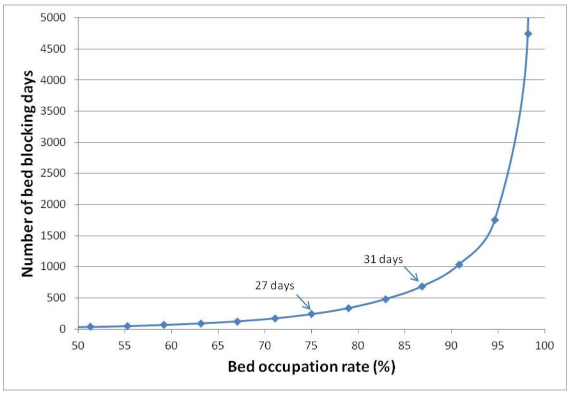

Figure 32: Influence of the length of stay of PG patients on the number of PG bed blocking days and the occupation rate at the PG ward in current situation

The overall advice is to implement interventions ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ together with either one extra PG bed or a decreased length of stay of PG patient at the ICD from 31 to 27 days.

Interventions ‘increased number of admissions per day’ and ‘priority to MST patients instead of ICD’ together show a decrease in the total number of bed blocking days caused by a shortage of either beds or physicians of 70%. The major problem in this case is the high number of bed blocking days caused by the PG patient group. A combination of these interventions with either one extra PG bed or a decreased length of stay of PG patient from 31 to 27 days causes a decrease in the number of bed blocking days of respectively 88% and 87%.

	Number of bed blocking days					Occupation rate (%)			
	BR	CC	SOM	PG	Σ average	BR	CC	BR/SOM	PG
Situation MST in 2011	1831 ± 486	47 ± 7	2 ± 3	689 ± 124	2569	97.5 ± 0.4	80.3 ± 2.7	61.6 ± 1.2	86.8 ± 1.7
Increased + priority	45 ± 18	34 ± 5	11 ± 5	689 ± 124	779	96.8 ± 0.3	74.2 ± 2.2	64.6 ± 1.4	86.8 ± 1.7
Increased + priority + # beds	45 ± 18	34 ± 5	11 ± 5	212 ± 40	302	96.8 ± 0.3	74.2 ± 2.2	64.6 ± 1.4	74.4 ± 1.6
Increased + priority + LOS	45 ± 18	34 ± 5	11 ± 5	242 ± 44	332	96.8 ± 0.3	74.2 ± 2.2	64.6 ± 1.4	74.0 ± 1.6

	Bed blocking patients (%)				No bed available				No physician available				# Transfers
	BR	CC	SOM	PG	BR	CC	BR/SOM	PG	BR	CC	BR/SOM	PG	BR
Situation MST in 2011	44 ± 5	43 ± 4	0 ± 0	63 ± 4	119 ± 10	28 ± 3	0 ± 1	131 ± 12	128 ± 9	1 ± 0	125 ± 13	34 ± 3	1226 ± 34
Increased + priority	2 ± 1	33 ± 4	2 ± 1	63 ± 4	46 ± 4	20 ± 3	7 ± 2	131 ± 12	28 ± 3	1 ± 0	2 ± 0	34 ± 3	936 ± 12
Increased + priority + # beds	2 ± 1	33 ± 4	2 ± 1	39 ± 3	46 ± 4	20 ± 3	7 ± 2	61 ± 8	28 ± 3	1 ± 0	2 ± 0	21 ± 2	936 ± 12
Increased + priority + LOS	2 ± 1	33 ± 4	2 ± 1	43 ± 3	46 ± 4	20 ± 3	7 ± 2	69 ± 8	28 ± 3	1 ± 0	2 ± 0	22 ± 2	936 ± 12

Table 5: Advice (# beds: 'Number of beds', LOS: 'Length of stay')

Concluding, the most important factor to decrease the number of bed blocking days is not only the number of beds at the aftercare institutions, but also the appropriate ratio of physicians to perform the admission interviews compared to the number of beds.

Recommendations

This study is based on data from 2011. Because of the aging society the number of patients that needs aftercare will increase in the coming years. A higher number of patients is expected to have the same influence on the number of bed blocking days as a lower number of beds or a higher length of stay. Therefore it is necessary to determine the appropriate number of beds and physicians to perform the admission interviews again in a few years with new data.

During this study, not the complete transmural care chain has been analyzed. It is recommended to perform a similar study on the whole care chain of SOM and PG patients in order to determine the optimal number of beds and physicians to perform the admission interviews at the SOM and PG ICD and aftercare wards.

Besides a shortage of beds or physicians to perform the admission interviews there can be several other causes of bed blocking, as shown in Figure 3. With further research these causes should also be tackled in order to optimize the whole transmural care chain.

In the actual transmural care chain the number of bed blocking days probably is higher and the occupation rate at the ICDs and aftercare institutions lower, because a forecast based on an average, such as the simulation model used in this study, shows less variability than the original data set does. The result of using averaging techniques is that minor variations are treated as random variations and essentially "smoothed" out of the data set [21]. The aim of all aftercare institutions is an occupation rate of 100%. However, as stated in the discussion this is very disadvantageous for the MST, because of the large number of bed blocking days. Therefore the aftercare institutions should be convinced that the occupation rates shown in the discussion are much better for the whole transmural care chain. The aim of the MST is 0 bed blocking days. However, as stated in the discussion this is very disadvantageous for the aftercare institutions, because of the low occupation rate. Therefore the MST should be convinced that the number of bed blocking days shown in the discussion is much better for the whole transmural care chain.

Appendix 1

To determine whether the pattern in the number of bed blockings days per week and the number of new medically ready patients per week during the year in 2011 is random or nonrandom a run-based pattern test with above/below and up/down method is used. Control chart patterns identified by runs require statistical testing of whether the runs are within expectations and hence the patterns are random, or beyond expectations and thereby nonrandomness is present [21]. The result is shown in Table 6.

$$99\%\ \text{Confidence Interval:}\ -2.58 \le z \le 2.58$$

$$z = \frac{Observed\ runs - Expected\ runs}{Standard\ deviation\ of\ runs} \quad (2)$$

N = number of weeks in 2011 = 52

$$E(run)_{A/B} = \frac{N}{2} + 1 \quad (3)$$

$$Expected\ runs = E(run)_{A/B} = \frac{52}{2} + 1 = 27$$

$$\sigma(run)_{A/B} = \sqrt{\frac{N-1}{4}} \quad (4)$$

$$Standard\ deviation\ of\ runs = \sigma(run)_{A/B} = \sqrt{\frac{52-1}{4}} = 3.57$$

$$E(run)_{U/D} = \frac{2N-1}{3} \quad (5)$$

$$Expected\ runs = E(run)_{U/D} = \frac{104-1}{3} = 34.33$$

$$\sigma(run)_{U/D} = \sqrt{\frac{16N-29}{90}} \quad (6)$$

$$Standard\ deviation\ of\ runs = \sigma(run)_{A/B} = \sqrt{\frac{832-29}{90}} = 2.99$$

	Above/below	Up/down	Conclusion
# bed blocking days	$z = \frac{11-27}{3.57} = -4.48$	$z = \frac{21-34{,}33}{2{,}99} = -4.45$	Both A/B and U/D exhibit nonrandomness
# new medically ready patients	$z = \frac{26-27}{3.57} = -0.28$	$z = \frac{40-34.33}{2.99} = -1.90$	Both A/B and U/D exhibit randomness

Table 6: Above/below and up/down pattern test with 99% Confidence Interval

Appendix 2

Results of intervention 'number of beds' and 'length of stay' that are not included in the article are listed in Appendix 2.

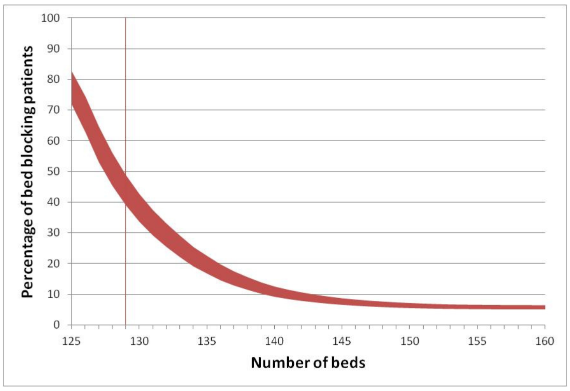

Figure 33: Influence of the number of BR beds on the percentage of bed blocking BR patients

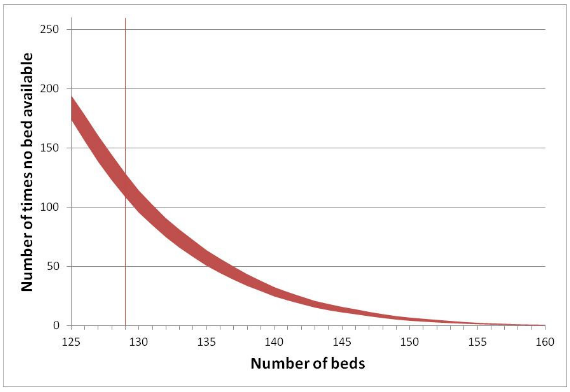

Figure 34: Influence of the number of BR beds on no bed available at the BR ward

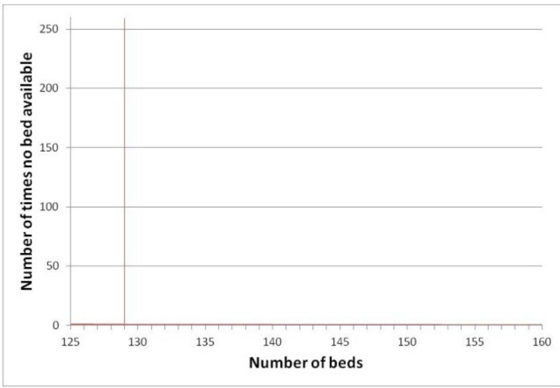

Figure 35: Influence of the number of BR beds on no bed available at the BR/SOM ICD

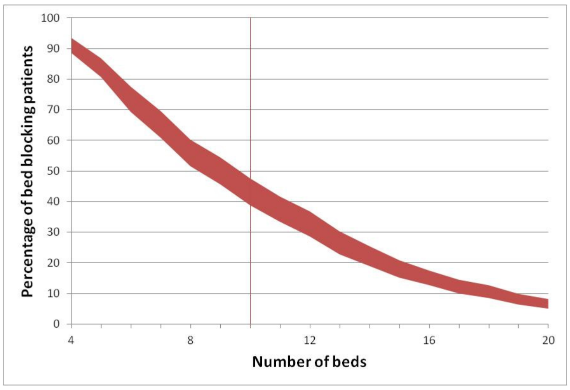

Figure 36: Influence of the number of CC beds on the percentage of bed blocking CC patients

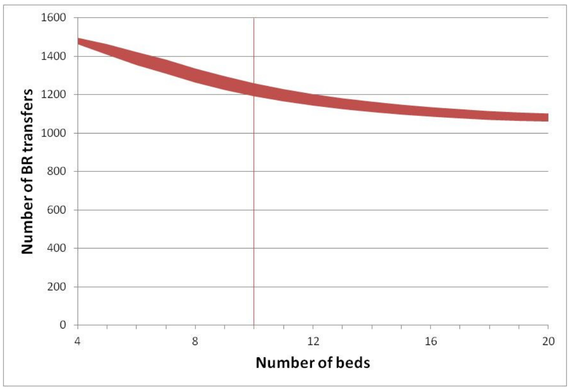

Figure 37: Influence of the number of CC beds on the number of BR transfers

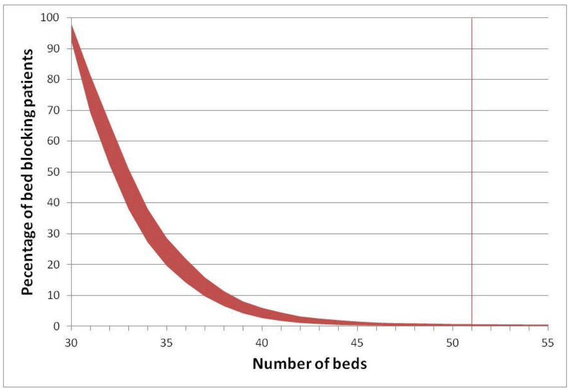

Figure 38: Influence of the number of BR/SOM beds on the percentage of bed blocking SOM patients

The vertical line shown in the figures shows the current length of stay. The current length of stay of brief reactivation (BR) patients is 48 days. Figure 39 shows that a slight increase in the current length of stay of BR patients causes a huge increase in the number of bed blocking days of BR patients due to a nearly L-shaped relation. The relation between the length of stay and the occupation rate of BR beds is linear, see Figure 41. The BR/SOM ICD should act as a buffer, according to interviews with transfer mediators at the aftercare institutions and should therefore compensate an increase in the length of stay. However, due to a shortage of physicians at the ICD, this is not possible, while the occupation rate at the ICD is merely 61%, see Figure 40 and Figure 42. The CC beds function as a buffer for the BR patients instead. Figure 43 shows that without BR patients using the CC beds, the occupation rate of the CC beds would be merely 28.4% instead of the current occupation rate of 80.3%.

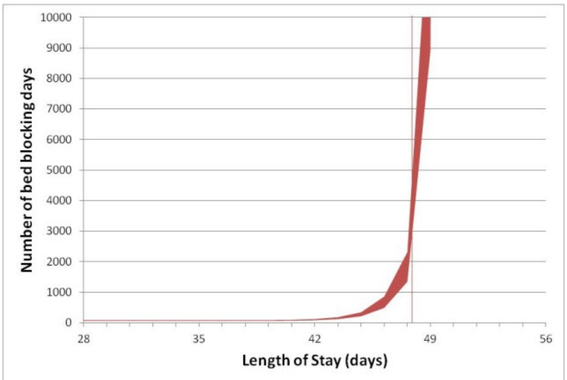

Figure 39: Influence of the length of stay of BR patients on the number of bed blocking days of BR patients

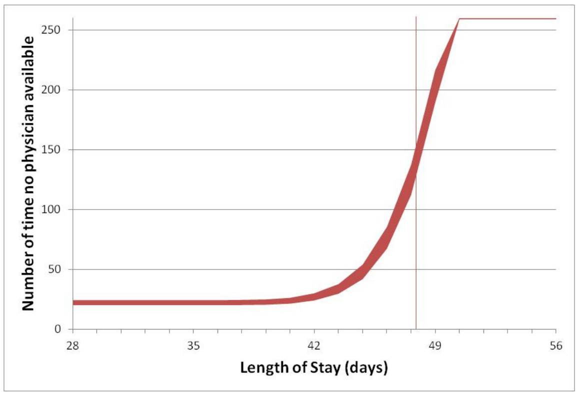

Figure 40: Influence of the length of stay of BR patients on no physician available at the BR/SOM ICD

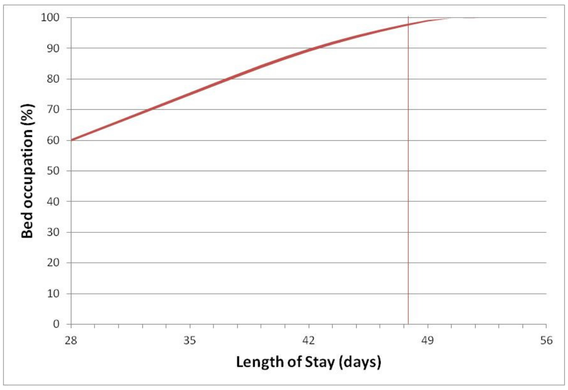

Figure 41: Influence of the length of stay of BR patients on the occupation rate at the BR ward

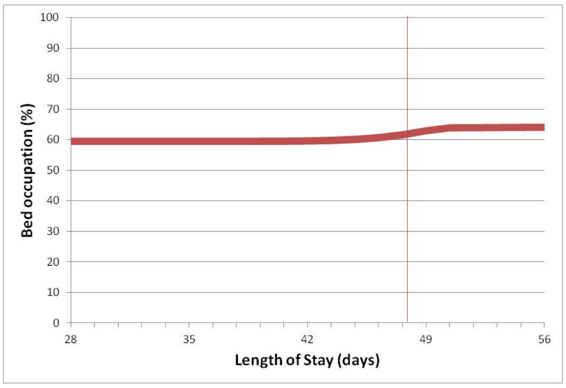

Figure 42: Influence of the length of stay of BR patients on the occupation rate at the BR/SOM ICD

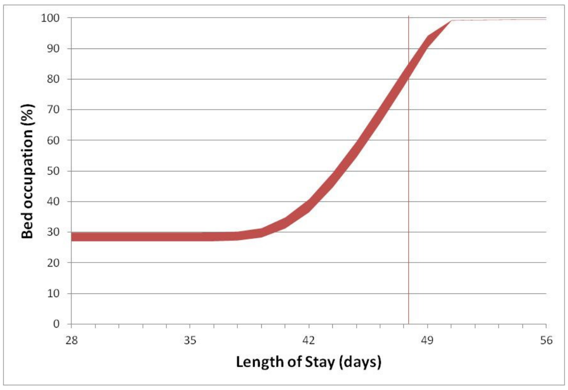

Figure 43: Influence of the length of stay of BR patients on the occupation rate of the CC ward

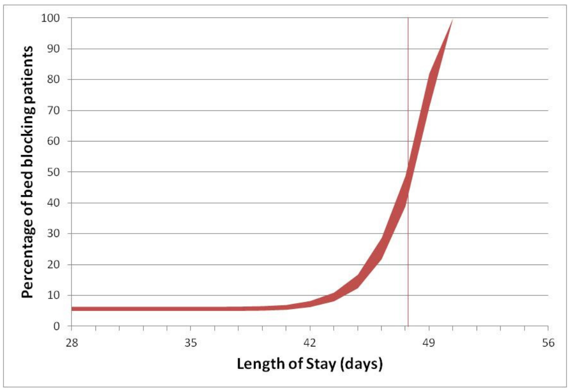

Figure 44: Influence of the length of stay of BR patients on the percentage of bed blocking BR patients

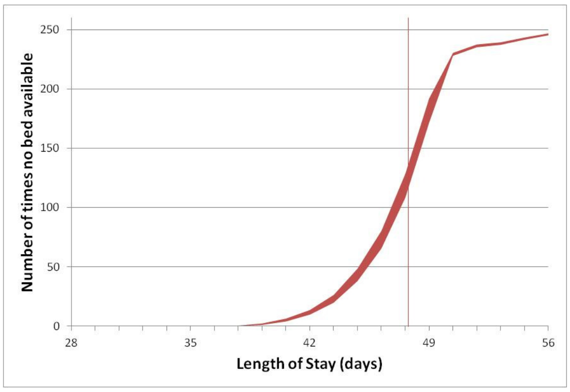

Figure 45: Influence of the length of stay of BR patients on no bed available at the BR ward

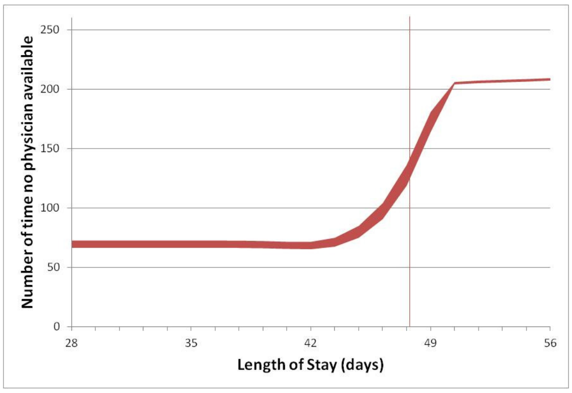

Figure 46: Influence of the length of stay of BR patients on no physician available at the BR ward

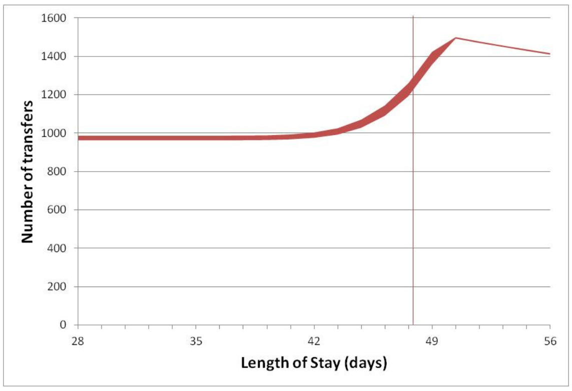

Figure 47: Influence of the length of stay of BR patients on the number of BR transfers

The current length of stay of complex case (CC) patients is 90 days. A decrease or increase in length of stay of CC patients has not much influence on the number of bed blocking days and the occupation of the CC beds (Figure 48 and Figure 49), because the majority of the CC beds are occupied by BR patients, as shown in Figure 43.

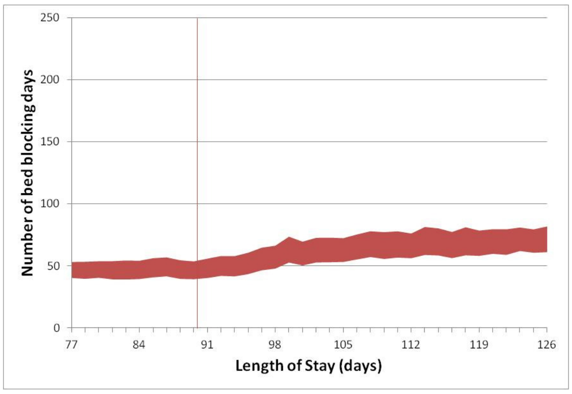

Figure 48: Influence of the length of stay of CC patients on the number of bed blocking days of CC patients

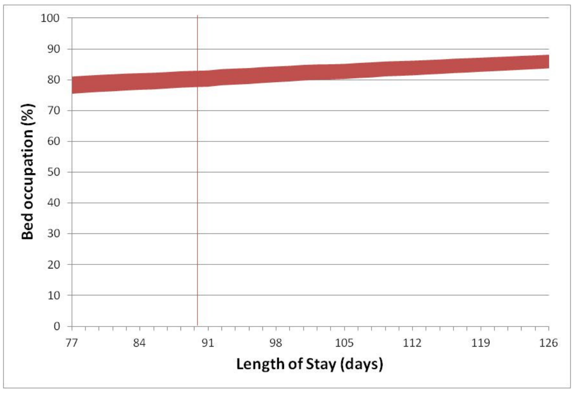

Figure 49: Influence of the length of stay of CC patients on the occupation rate of the CC ward

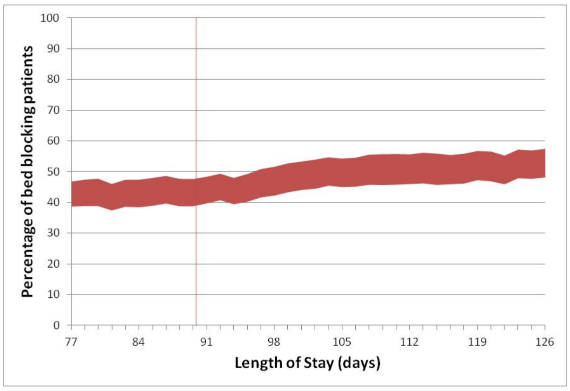

Figure 50: Influence of the length of stay of CC patients on the percentage of bed blocking CC patients

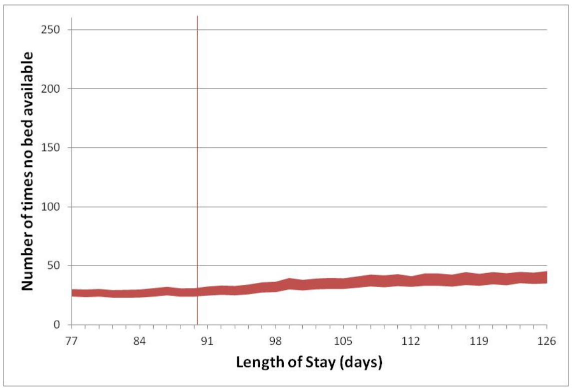

Figure 51: Influence of the length of stay of CC patients on no bed available at the CC ward

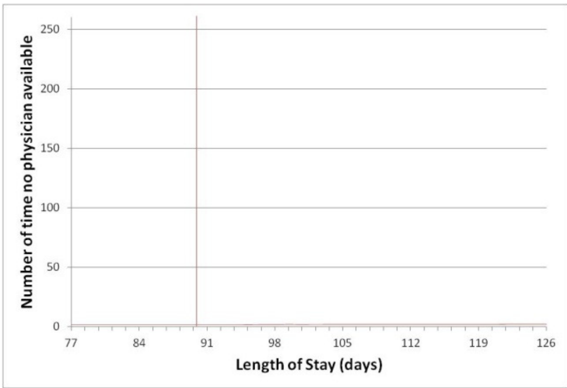

Figure 52: Influence of the length of stay of CC patients of no physician available at the CC ward

The current average length of stay of somatic (SOM) patients is approximately 90 days. However, this depends on the throughput of SOM patients at the aftercare institutions. The only reason for a bed to become available at the aftercare institutions is that a patient is deceased, just as with PG patients. With the current length of stay, SOM patients account for approximately zero bed blocking days, as can be seen in Figure 53. However, Figure 56 shows that in 45% of all days there are not enough physicians available for all BR and SOM patients on the waiting list. And because there are no SOM patients who cause bed blocking days, it must be the case that this shortage of physicians causes bed blocking days for BR patients. Figure 55 and Figure 56 show a contrary shape which is also shown in intervention one in Figure 20 and Figure 21.

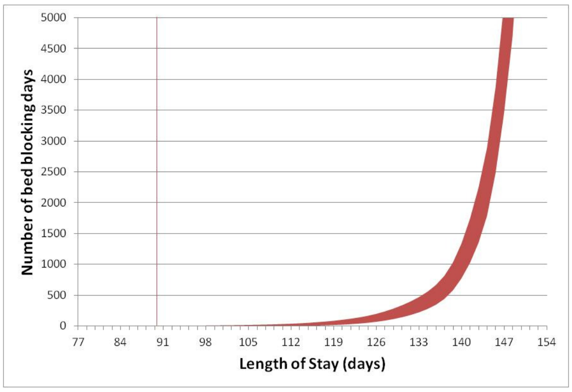

Figure 53: Influence of the length of stay of SOM patients on the number of bed blocking days of SOM patients

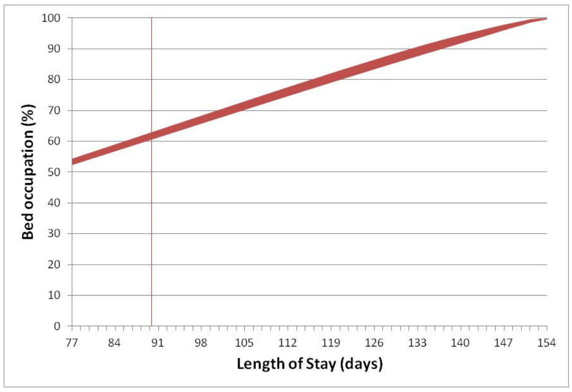

Figure 54: Influence of the length of stay of SOM patients on the occupation rate of the BR/SOM ICD

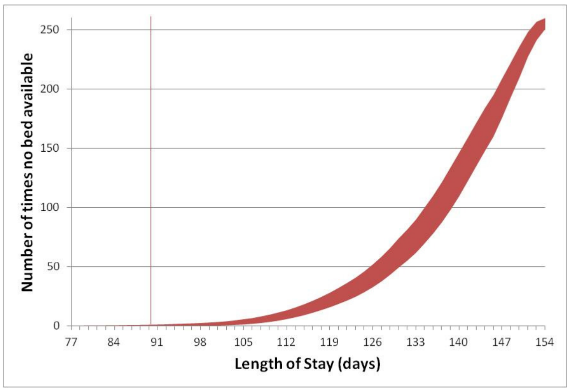

Figure 55: Influence of the length of stay of SOM patients on no bed available at the BR/SOM ICD

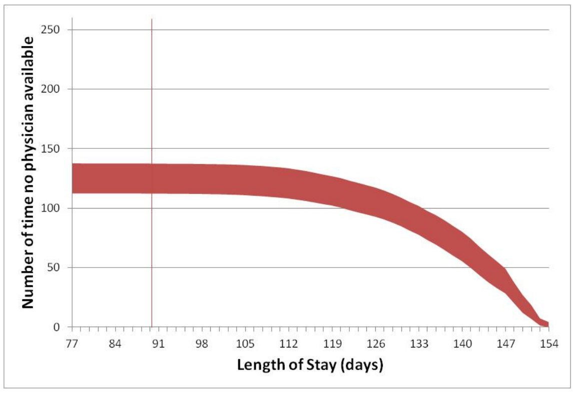

Figure 56: Influence of the length of stay of SOM patients on no physician available at the BR/SOM ICD

The average length of stay of psycho geriatric (PG) patients at the ICD is circa 31 days. Figure 57 shows an exponential relation between the length of stay of PG patients and the number of bed blocking days of PG patients. The bed blocking is mainly caused by a shortage of beds over a shortage of physicians, see Figure 59 and Figure 60. The occupation rate of the PG beds shows a linear relation with the length of stay of PG patients as shown in Figure 61. The ICD manager promises to the patients who are admitted to the ICD ward that within 13 weeks a bed at any aftercare institution is arranged. Fortunately this currently takes circa 4.5 weeks for PG patients. However, if this increases to the maximum of 13 weeks, the consequence is a dramatic number of bed blocking days.

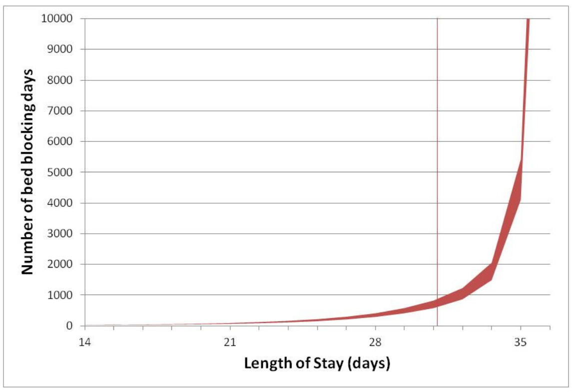

Figure 57: Influence of the length of stay of PG patients on the number of bed blocking days of PG patients

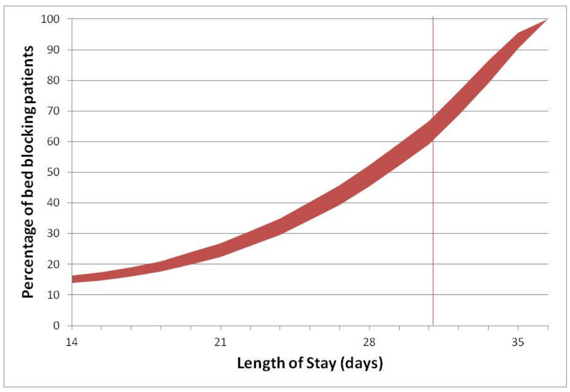

Figure 58: Influence of the length of stay of PG patients on the percentage of bed blocking patients PG

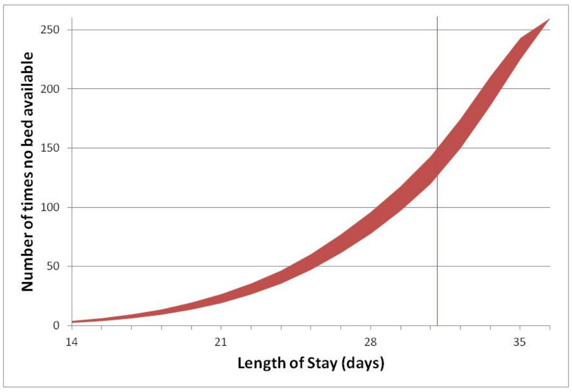

Figure 59: Influence of the length of stay of PG patients on no bed available at the PG ICD

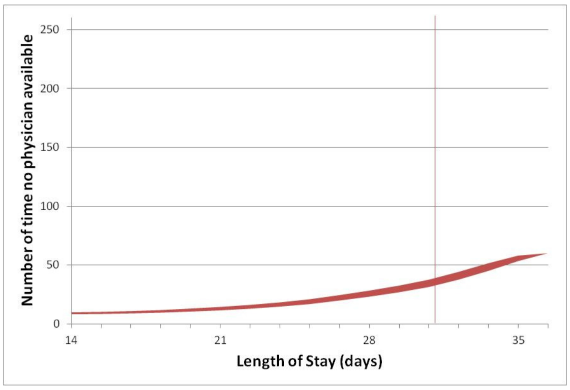

Figure 60: Influence of the length of stay of PG patients on no physician available at the PG ICD

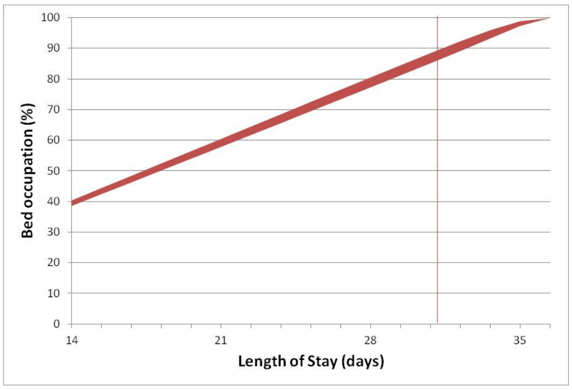

Figure 61: Influence of the length of stay of PG patients on the occupation rate at the PG ICD

Appendix 3

If interventions 'increased number of admissions per day' and 'priority to MST patients instead of ICD' are not implemented in the current transmural care chain, the advice is to change the number of beds or the length of stay as follows.

The total number of beds at all ICD and aftercare ward currently is 196. The advice in modification of the number of beds is based on the same total number of beds. An increase in the number of beds from 129 to 135 at the BR ward causes a decrease in the number of bed blocking days from 1831 to 447. This increase in the number of beds causes a decrease in occupation rate of merely 2.5% (97.5% to 95.0%). The CC patient group is far before the critical point as shown in Figure 64. Currently the BR patients use the CC ward as a buffer. The number of CC beds could decrease to six when the CC beds are not used as a buffer for BR patients this often. Using the CC ward instead of the BR/SOM ICD as a buffer for BR patients ensures a direct admission to the aftercare instead of an indirect admission. Another reason to keep the relatively high number of beds for the CC patient group is that this is the only patient group without an ICD. Therefore a higher buffer at the CC ward itself is needed to restrain the number of bed blocking days. Thus advised is to keep using the CC beds as a second buffer for BR patients and to not change the number of CC beds. The SOM patient group currently is far before the critical point, see Figure 65. Because of the low occupation rate it is possible to decrease the number of beds at the BR/SOM ICD to 44 in order to increase the occupation rate, without a large increase in the number of bed blocking days. The PG patient group currently is at the critical point, as shown in Figure 66. As stated before it is better to be just before the critical point. With an increase in the number of beds at the PG ICD from six to seven, the number of bed blocking days decreases from 689 to 212. The consequence of this increase in the number of beds is a decrease in bed occupation from 86.8% to 74.4%. This rather larger decrease in occupation rate is caused by the fact that the number of beds in this case is increased with 16.7%.

Despite of the large decrease in bed occupation rate, the advice is to increase the number of beds at the PG ICD to seven.

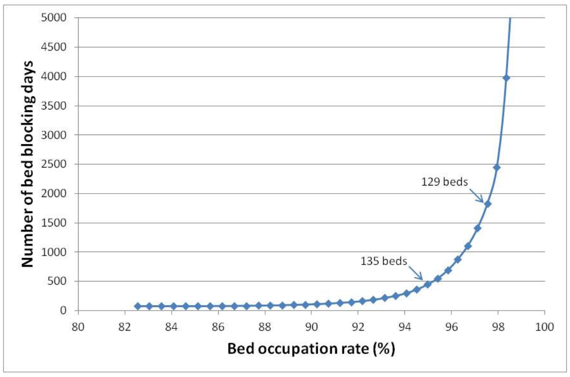

Figure 62: Influence of the number of BR beds on the number of BR bed blocking days and the occupation rate at the BR ward

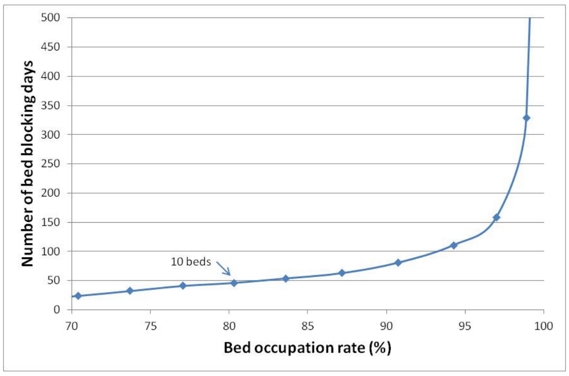

Figure 63: Influence of the number of CC beds on the number of CC bed blocking days and the occupation rate at the CC ward

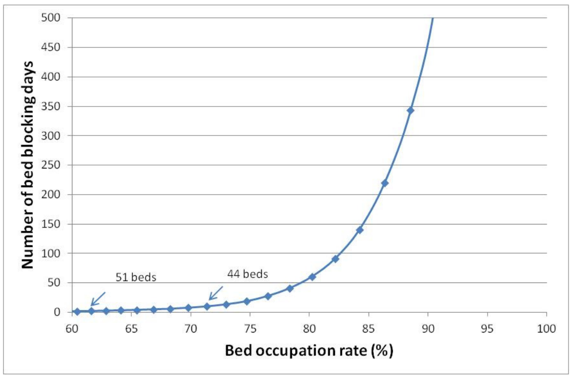

Figure 64: Influence of the number of SOM beds on the number of SOM bed blocking days and the occupation rate at the BR/SOM ward

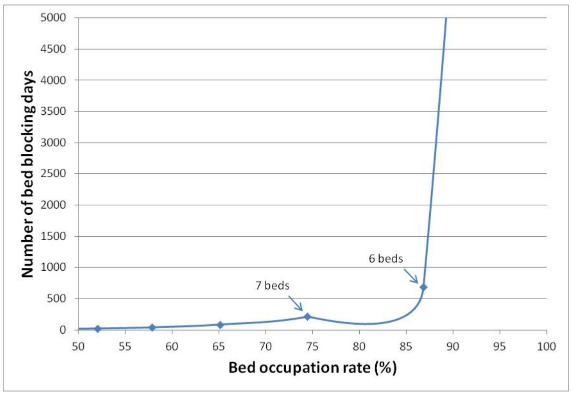

Figure 65: Influence of the number of PG beds on the number of PG bed blocking days and the occupation rate at the PG ward

An increase in the 'length of stay', compared to the 'number of beds', causes a contrary influence on the indicators according to Equation 1. Assumed is that it is not possible to change the current length of stay at the ICD and aftercare in combination with a change in the number of beds. Therefore, one advice is based on a modification in the number of beds, as shown above, and the other advice is based on a modification in the length of stay per patient group. Both advices ensure the same change in occupation rate at the aftercare wards.

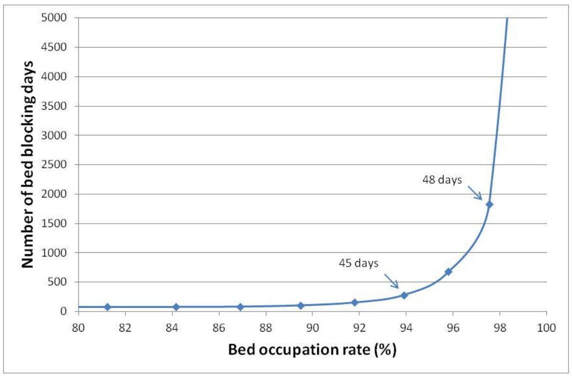

Figure 66: Influence of the length of stay of BR patients on the number of BR bed blocking days and the occupation rate at the BR ward

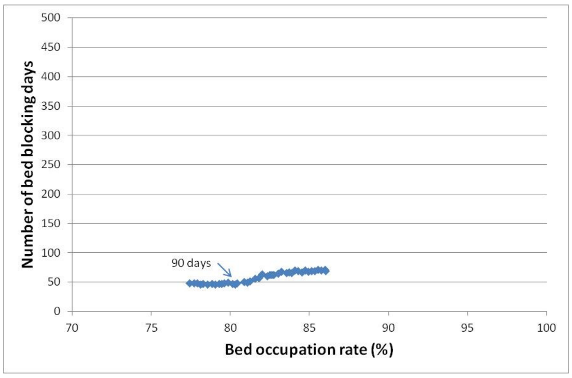

Figure 67: Influence of the length of stay of CC patients on the number of CC bed blocking days and the occupation rate at the CC ward

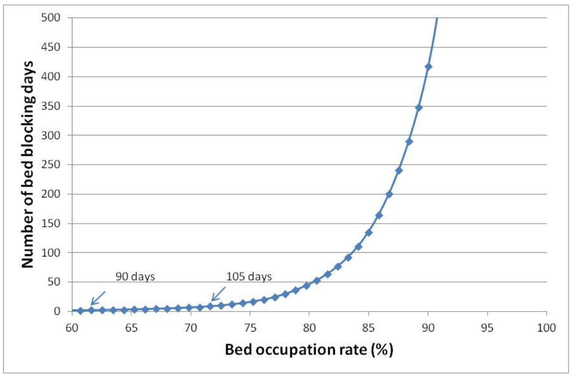

Figure 68: Influence of the length of stay of SOM patients on the number of SOM bed blocking days and the occupation rate at the BR/SOM ward

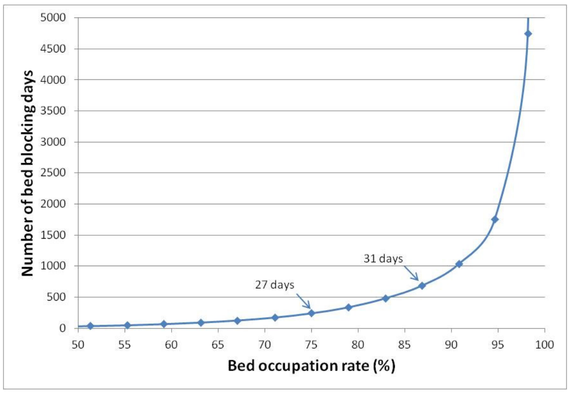

Figure 69: Influence of the length of stay of PG patients on the number of PG bed blocking days and the occupation rate at the PG ward

	Current number of beds	Advised number of beds
BR	129	135
CC	10	10
BR/SOM	51	44
PG	6	7

Table 7: Advised number of beds

	Current length of stay (days)	Advised length of stay (days)
BR	48	45
CC	90	90
SOM	90	105
PG	31	27

Table 8: Advised length of stay

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