HIP FRACTURE SURGERY:
REASONS FOR SURGICAL DELAY

Master Thesis
Kim Thijssen
s0189529
February - August, 2012

Master Health Sciences
Health Technology and Services Research
School of Management and Governance
University of Twente

Bureau Acute Zorg Euregio, Enschede

UNIVERSITEIT TWENTE.

Supervision
C.J.M. (Carine) Doggen PhD, associate professor (first supervisor)
Department Health Technology & Services Research (HTSR)
University of Twente, School of Management & Governance
c.j.m.doggen@utwente.nl

S. (Sabine) Siesling PhD,assistant professor (second supervisor)
Department Health Technology & Services Research (HTSR)
University of Twente, School of Management & Governance

With cooperation of
B.P. Bertelink, MD, Trauma surgeon
Department of General and Trauma Surgery, Medisch Spectrum Twente

A.J.S. Renard, PhD MD, Orthopedic Surgeon
Department of Orthopaedic Surgery, Medisch Spectrum Twente

Abstract

Background

Hip fractures are a common trauma. In 2008 18,500 patients were hospitalized in the Netherlands because of hip fractures. It is expected that, due to the aging population, the incidence of hip fracture patients will rise to approximately 24,000 patients per year in 2025. Because surgical repair is the preferred treatment, this trend will lead to an increase in the number of surgical interventions. To ensure good quality of care for these patients and to reduce the risk of complications, the Dutch Health Care Inspectorate developed in cooperation with health care organizations and professionals the performance indicator 'percentage of hip fracture surgery within one calendar day'. Research has shown that reducing delays may result in a reduction of mortality and complications. However, for a number of patients it is neither desired nor feasible to undergo surgery within one calendar day, which results in surgical delay. It is not known how frequent and by what cause surgical delay within the hospital Medisch Spectrum Twente (MST) occurs. Therefore, it is important to identify and where possible to influence these causes.

Purpose

The purpose of this study is 1) to assess how often surgical delay longer than one calendar day after the day of admission occurs, 2) to investigate the most common factors influencing the decision to delay surgery and 3) to determine which of these factors may be influenced in order to reduce the delay.

Methods

This study is a combination of a prospective and a retrospective cohort study. The prospective cohort study includes 57 hip fracture patients that underwent a surgical intervention in MST during the period March 27, 2012 till July 9, 2012. To enlarge the dataset and give a better indication of the number of times delay occurs, 53 patients who underwent hip fracture surgery in MST during the period January 1, 2012 till March 27, 2012, have been included in the retrospective cohort study. Data collection in both cohorts regarding baseline characteristics was done by chart review using existing hospital databases. Time of admission at the Emergency Department was derived from the trauma registration database of Acute Zorg Euregio and the planning system for the operating department was used to obtain the time of surgery. For additional data collection in the prospective cohort study an item list was constructed based on the results of a literature study. The primary outcome parameters in the study are "presence of surgical delay" and "length of time between admission at hospital and surgery". Fisher's exact test was used to assess differences. Additionally,

relative risks (RRs) and their 95% confidence intervals (CIs) were calculated. Additional analyses on time till surgery have been done using independent-sample t-tests and multiple linear regression in order to identify factors influencing delay.

Results

Several causes for surgical delay were found in literature. These causes could be divided into three categories: logistical, organizational and medical causes. From January 1, 2012 till July 9, 2012, a total of 7 out of 110 (6%) patients had surgery after one calendar day after admission to the hospital. In case of delay mostly medical causes were present. Medical causes were 'presence of comorbidity' and 'use of anticoagulants'. Six out of the seven delayed patients had comorbidity and five out of these 7 patients used anticoagulants. The medical causes were followed by the organizational causes 'waiting for medical clearance or consultation' (2 out of 3 patients), 'waiting for laboratory or other diagnostic results' (1 out of 3 patients) and 'influence of preference' (1 out of 3). Information about these organizational causes was only available for the prospective cohort in which three patients were delayed. However, all these causes were also present when no delay occurred. Thus, no associations were found between causes and delay of surgery. When broadening the scope of the research and also investigate the number of patients that have surgery after 24 hours similar results were found. A total of 26 of 110 patients (24%) had surgery more than 24 hours after admission. A significant difference in mean time till surgery was found for 'use of anticoagulants' (difference in mean with respect to no use of four hours and 19 minutes; 00:06 – 08:33 95% CI) and for the logistical factor 'availability of operating rooms' (difference in mean of six hours and five minutes; 01:50 – 10:21 95% CI). Multiple regression showed that only 'use of anticoagulants' and 'influence of preference', were associated with time till surgery, accounting for 13.6% of its variance ($R^2 = 0.136$; $p<0.05$).

Conclusions

Surgical delay longer than one calendar day after admission does not often occur in hip fracture patients in MST. However, because of the lack of a standard it is not possible to say whether or not the percentage of delay is acceptable. In the cases delay occurs, factors of mostly medical origin are present. These factors cannot be easily changed or cannot be changed at all. Looking at factors that cause a difference in mean time till surgery several factors seem to be of influence. However, multiple regression analysis shows that only the factors 'use of anticoagulants' and 'influence of preference' are associated with the time till surgery.

Samenvatting

Achtergrond

Heupfracturen zijn een veel voorkomend trauma. In 2008 werden er in Nederland 18.500 patiënten met een heupfractuur in het ziekenhuis opgenomen. De verwachting is dat door de toenemende vergrijzing de incidentie van patiënten met een heupfractuur in 2025 zal toenemen tot ongeveer 24.000 patiënten per jaar. Omdat chirurgisch herstel de voorkeursbehandeling is bij heupfracturen, zal deze trend leiden tot een toename van het aantal chirurgische interventies. Om zorg van goede kwaliteit voor deze patiënten te verzekeren en het risico op complicaties te verminderen heeft de Inspectie voor de Gezondheidszorg in samenwerking met gezondheidszorgorganisaties en professionals een prestatie-indicator opgesteld, namelijk 'percentage heupfracturen geopereerd binnen een kalenderdag'. Onderzoek heeft laten zien dat het terugdringen van vertraging kan resulteren in een afname van mortaliteit en complicaties. Voor een aantal patiënten is het echter niet gewenst of haalbaar om binnen een kalenderdag een operatie te ondergaan. Dit kan dus leiden tot chirurgische vertraging. Het is niet bekend hoe vaak en door welke oorzaak chirurgische vertraging optreedt binnen het ziekenhuis Medisch Spectrum Twente (MST). Daarom is het van belang om deze oorzaken te identificeren en waar mogelijk te beïnvloeden.

Doel

Het doel van dit onderzoek is 1) om vast te stellen hoe vaak chirurgische vertraging langer dan een kalenderdag na opname optreedt, 2) om te onderzoeken wat de meest voorkomende factoren zijn die de beslissing tot een vertraagde operatie beïnvloeden en 3) om te bepalen welke van deze factoren mogelijk beïnvloed kunnen worden om de vertraging te reduceren.

Methoden

Dit onderzoek is een combinatie van een prospectieve en een retrospectieve cohortstudie. Het prospectieve cohort includeert 57 patiënten met een heupfractuur die in de periode van 27 maart 2012 tot en met 9 juli in MST een chirurgische interventie hebben ondergaan. Om deze dataset uit te breiden en daarmee een betere indicatie te kunnen geven van het aantal keren dat vertraging voorkomt zijn er 53 patiënten, die gedurende de periode van 1 januari 2012 tot en met 26 maart in MST een chirurgische ingreep hebben ondergaan aan een heupfractuur, geïncludeerd in de retrospectieve cohortstudie. De data in beide cohorten met betrekking tot baseline karakteristieken werd verkregen uit de patiëntdossiers. De tijd van opname op de Spoedeisende hulp werd verkregen uit de database voor traumaregistratie van Acute Zorg Euregio en het planningssysteem van de operatieafdeling voorzag in het tijdstip van de operatie. Voor aanvullende dataverzameling in de

prospectieve cohort studie werd er een itemlijst samengesteld gebaseerd op de resultaten van een literatuurstudie. De primaire uitkomstmaten in de studie zijn 'aanwezigheid van chirurgische vertraging' en 'tijdsduur tussen opname in het ziekenhuis en operatie'. De Fisher exacte toets is gebruikt voor het vaststellen van verschillen en in aanvulling werden er relatieve risico's en bijbehorende betrouwbaarheidsintervallen berekend. Met behulp van de onafhankelijke t-toets en multipele lineaire regressie zijn aanvullende analyses van de tijd tot operatie gedaan om de factoren te identificeren die het ontstaan van vertraging beïnvloeden.

Resultaten

In de literatuur werden verschillende oorzaken voor chirurgische vertraging gevonden. Deze oorzaken konden worden onderverdeelt in drie categorieën: logistieke, organisationele en medische oorzaken. Van 1 januari 2012 tot en met 9 juli 2012 werden er in totaal zeven van de 110 (6%) van de patiënten later dan een kalenderdag na opname in het ziekenhuis geopereerd. In het geval van vertraging waren er voornamelijk medische factoren aanwezig. Medische factoren waren 'aanwezige comorbiditeit' en 'gebruik van antistolling'. Zes van de zeven patiënten die met vertraging geopereerd werden hadden comorbiditeit en vijf van de zeven patiënten gebruikten antistolling. De medische factoren werden gevolgd door de organisationele factoren 'wachten op medische vrijgave of consultatie' (2 van de 3 patiënten), 'wachten op laboratorium- of andere diagnostische resultaten' (1 van de 3 patiënten) en 'invloed van voorkeur' (1 van de 3 patiënten). Informatie over deze organisationele factoren was alleen beschikbaar voor het prospectieve cohort waarbinnen drie patiënten met vertraging waren geopereerd. Al deze factoren waren echter ook aanwezig wanneer er geen vertraging was opgetreden. Er werd dus geen associatie gevonden tussen de factoren en vertraging van de operatie. Wanneer men de scope van het onderzoek vergroot en ook kijkt naar het aantal patiënten die na 24 uur de operatie ondergaan, worden gelijke resultaten gevonden. In totaal werden 26 van de 110 patiënten (24%) later dan 24 uur na opname geopereerd. Er was een significant verschil in de gemiddelde tijd tot de operatie voor de variabelen 'gebruik van antistolling' (verschil in gemiddelde ten opzichte van geen gebruik van vier uur en 19 minuten; 00:06 – 08:33 95% BI) en de logistieke factor 'beschikbaarheid van de operatiekamers' (verschil in gemiddelde van zes uur en vijf minuten; 01:50 – 10:21 95% BI). Multipele regressie liet zien dat alleen 'gebruik van antistolling' en 'invloed van voorkeur' geassocieerd werd met de tijd tot operatie, waarbij 13,6% van de variantie verklaard werd (R^2=0,136; p<0,05).

Conclusie

Chirurgische vertraging langer dan een kalenderdag na opname komt niet vaak voor bij patiënten met een heupfractuur in MST. Het is echter door het gebrek aan een gestelde norm niet mogelijk om te zeggen in hoeverre het percentage vertraging wel of niet acceptabel is. In de gevallen dat vertraging optreedt zijn de aanwezige factoren meestal van medische aard. Deze factoren kunnen niet gemakkelijk of helemaal niet veranderd worden. Wanneer men kijkt naar factoren die een verschil in de gemiddelde tijd tot operatie veroorzaken lijken er verschillende factoren van invloed te zijn. Multipele regressie analyse laat echter zien dat alleen de factoren ‘gebruik van antistolling’ en ‘invloed van voorkeur’ geassocieerd zijn met de tijd tot operatie.

Introduction

Hip fractures led from 2000 till 2004 to 17,000 hospital admissions per year in the Netherlands. In this period each year there were about 1,000 deaths caused by hip fractures in the elderly [1]. Based on demographic developments, the aging of the society, it is expected that in the future there will be more patients with hip fractures. An increase in the incidence of hip fractures of approximately 40% is expected between 2005 and 2025, resulting in approximately 24,000 patients per year [1]. Because surgery is the preferred treatment this trend will lead to an increase in the amount of hip fracture surgery.

To make sure that the patients receive care of good quality the Dutch Health Care Inspectorate constructed, in collaboration with organizations and professionals with practical experience, the performance indicator “Percentage of hip fracture surgery within one calendar day” [2]. With the indicator, the Health Care Inspectorate advocates for early surgery. “Hip fracture surgery within one calendar day” means that a patient has to be operated within 24 hours after the day of admission. Therefore, the time span in which surgery has to take place can vary from 24 to almost 48 hours. The Health Care Inspectorate did not set a norm for this performance indicator. Practice shows, however, that during the assessment a comparison with the performance of hospitals in the region and across the relevant specialties (orthopedics and trauma surgery) in the hospital is made. Based on these comparisons a judgment is made whether or not the hospital meets the performance indicator.

There is some debate going on, whether early surgery really has an effect on the emergence of complications and mortality [3]. However, two meta-analyses of respectively sixteen observational studies including 257,367 patients [4] and sixteen observational studies including 13,478 patients [5] and one systematic review of 52 published studies including 291,413 patients [6], in which there is only a small overlap in studies reviewed, show that there is evidence that early surgery (within 48 hours after admission) may reduce complications up to 52% in case of pressure sores and even one-year mortality up to 45%.

Despite of the performance indicator set by the Health Care Inspectorate and the evidence in favor of early surgery, in some occasions hip fracture surgery is still delayed. Only a few studies investigated the main reasons for this surgical delay. Three prospective studies were conducted to find reasons for surgical delay [7-9] and seven studies on the effect of surgical delay on complications and mortality reported some reasons for delay as well [10-16]. In the majority of studies in which factors for delayed surgery are mentioned, determination of these factors is not the scope of these studies. They only focus on the influence of delay on mortality. Because they do not focus on the

cause of the delay, these factors are only briefly outlined. Also with respect to the three prospective studies that mainly focus on the reasons for surgical delay, some remarks can be made. In two of the three studies the list of reasons for delay is not complete and all the studies focus on the problems specific for the situation in the UK and the USA. It is not sure whether these apply to a hospital in The Netherland like Medisch Spectrum Twente (MST). Therefore, to gain a complete picture of all factors that play a role in surgical delay and their importance, a prospective study has to take place that looks at medical, logistical and organizational reasons.

The aim of this study is to examine how frequent delay occurs, to assess the most common factors influencing the decision to postpone surgery until after one calendar day after the day of admission, as set in the performance indicator on time for treatment of hip fractures and to assess which of the factors may be influenced in order to reduce the delay.

Methods

The study includes a retrospective cohort study and a prospective cohort study. The study populations of both studies are identical, except for the inclusion period and data collection, which was extended with an item list in the prospective cohort study (see below).

Study population

All patients admitted to MST with a hip fracture between January 1, 2012 and July 9, 2012 who had undergone surgery were included in the study. Hip fracture patients who were treated conservatively (non-surgical) were excluded.

In contrast to the performance indicator as set by the Health Care Inspectorate there was no age constraint. By not excluding patients under the age of 65, a larger sample size was obtained.

Study design

1) Retrospective cohort study

Data were retrospectively collected on patients that were admitted and underwent surgery in MST during the period January 1, 2012 till March 27, 2012 by conducting chart review.

This retrospective chart review was done in order to get a larger sample size for analysis of the occurrence of delay and the time till surgery.

2) Prospective cohort study

Data were prospectively collected on patients that were admitted and underwent surgery in MST during the period March 27, 2012 till July 9, 2012. The prospective design makes it possible to use an item list for collecting additional data, mainly on organizational and logistical factors of delay, which are not recorded in a medical record and thereby cannot be found during chart review.

Data collection

1) Chart review

For both study populations baseline characteristics were collected through chart review collected. Baseline characteristics are for instance age, gender, type of fracture and type of treatment. Also the presence of comorbidity and the use of anticoagulants were collected using chart review. If the use of anticoagulants was not explicitly noted in the patient chart it is assumed that anticoagulants were not used. All different types of comorbidity, as derived from the charts and item lists, are categorized into eleven groups. The co morbidities Alzheimer and Dementia were taken together under the heading ‘Dementia’. ‘Pulmonary diseases’ contains Chronic Obstructive Pulmonary Disease, Asthma

and Pulmonary vascular diseases like pulmonary embolism. ‘Cerebrovascular disease’ contains cerebrovascular accident (CVA) or stroke and transient ischemic attack (TIA). The category ‘Cardiovascular disease’ includes myocardial infarction, claudicatio intermittens, etcetera. ‘Musculoskeletal disorders’ is about rheumatic arthritis and osteoporosis. The category ‘other’ includes all other conditions that were only present in less than three patients and could not be matched with the other categories.

Chart review for collecting data was done using the patient identification number in the digital hospital information system X/Care. This registration system contains information such as personal data of the patient like the patient’s gender and date of birth, surgical reports and discharge letters, which were used in collecting data of all hip fracture patients admitted to MST from January 1, 2012 till July 9, 2012. The discharge letter contained information about pre-existing medical conditions, which medication the patient uses and whether another medical specialist was consulted. The surgical reports gave information about the type of fracture and treatment and in some cases about the American Society of Anesthesiologists score (ASA) which gives information about the patients health status [17].

2) Trauma registration

The time of admission to the emergency department of the hospital for both cohorts were derived from the database of the Dutch trauma registration at Acute Zorg Euregio. In case this time was not registered in this database, the time of the first x-ray at the emergency department was used. On average this times differed approximately half an hour.

3) ORSuite

Using ORSuite, the planning system for the operating department in MST, information about date and time of start of the surgery for all patients that underwent surgery between January 1, 2012 and July 9, 2012 was collected.

4) Item list

The data from the patient charts were extended for the prospective patients by having extra data filled out by the surgeon (trauma surgeon or orthopedic surgeon) at the operating room immediately after the time-out procedure. To do this an item list was used which was based on the results of a literature research. Literature study was performed in order to identify the different reasons for surgical delay in hip fracture patients. This literature study was done by searching the PubMed database using the search terms: ‘hip fracture’ (MeSH term as well as text), delay, ‘surgical delay’,

'performance indicator', indicator and combinations of these terms. Only articles in Dutch and English language were selected.
Subsequently the item list was added as a form to the patient record. The extra items were, for instance ASA-score, whether or not another physician was consulted, additional diagnostics were necessary, the patient uses anticoagulants and an operating room was available.

Outcome parameters
The primary endpoints of the study are 'presence of surgical delay' and 'length of time between admission at the hospital and surgery'. Delay is defined as 'exceeding a period of one calendar day after admittance, between presentation at the emergency department and surgery'. 'Presence of surgical delay' is a categorical variable (Yes when present/No when absent). The variable 'length of time until surgery' is a continuous variable and is expressed in hours and minutes.

Statistical analyses
Descriptive statistics (mean and standard deviation (SD), median and range, percentages) were used to describe the research population and to present the frequencies at which the different reasons for surgical delay occur.
The Fisher's exact test was used to assess the possible influence of various factors is on whether or not delay occurs in the group of patients that had surgery between March 27, 2012 and July 9, 2012. This test can be used when the expected number in one of the cells of the contingency table is below five ($E < 5$). It shows whether there is an association between the possible cause of delay and the presence of delay, [18].
Contingency tables were used to calculate relative risks (RRs). These RRs give information about the strength of the relationship between a determinant and an outcome. The RR is the ratio of the probability of the occurrence of surgical delay in patients in which a factor for the delay is present compared to the probability of surgical delay in patients in which the factor is absent. When the RR equals 1 it is unlikely there is an association between a possible factor of delay and the occurrence of surgical delay. When the $RR > 1$ there is an increased risk that surgical delay occurs in the presence of the factor and when the $RR < 1$ there is a decreased risk. A confidence interval (CI) was calculated for each RR. When the value 1 is within the CI there is no increased risk for surgical delay and there is no statistical significance [19].

To gain additional information on time till surgery and to find out the influence of the different logistical, organizational and medical factors on the occurrence of delay, the mean time till surgery

was compared for the patients where the factor was present and the patients where the factor was absent. For this analysis all patients that had surgery from January 1, till July 9, 2012 were combined. The comparison of mean time till surgery between the two groups of patients (factor present and factor absent) was performed by an independent-samples *t* test. This was done for every factor. Prior to this analysis, the dependent variable time till surgery was checked for normality by producing a histogram with normality curve. Based on the shape of the curve and the large sample size a normal distribution was assumed. A p-value of less than 0.05 is taken as significant.

Furthermore, stepwise linear multiple regression analysis was performed including the factors that were found to have a p-value < 0.1 in the independent-samples t test. This was done to determine their contribution to the time till surgery for hip fracture patients.

To be able to compare the outcomes of this study with results in literature a division was made for patients that had surgery within and after 24 hours.

Statistical calculations were done using the software package SPSS version 15.0.

Results

Literature study - Reasons for surgical delay

Literature research resulted in 10 studies mentioning reasons for surgical delay. The reasons resulting from these studies can be divided into logistical, organizational and medical causes and are summarized in table 1.

Table 1: Overview of causes for surgical delay

Logistical causes	Organizational causes	Medical causes
Availability of operating rooms [7, 9-15]	Waiting for medical consultation or clearance [7, 15]	Waiting for stabilization of a medical problem [7, 9-16]
Availability of surgeon and other surgical personnel [7, 11-14]	Waiting for family discussion on medical decision [7]	Patient's pre-existing medical condition (comorbidity) [9, 11, 14, 16]
Availability of anesthesiologist [8,10,11, 13]	Waiting for laboratory results and other diagnostic results [7-9, 11]	Suspicion of a pathological fracture [11]
Availability of equipment [9, 13]	The orthopedist's, surgeon's and anesthesiologist's preference in prioritizing patients on the surgical waiting list, time of admission [15]	Patient's health status [15]
Availability of prosthesis [8]	Delay in diagnosis [8, 11]	
Patient not on trauma board/list [8]	Poor ward management [9]	

The three prospective studies that mainly focus on the reasons for surgical delay were performed by Orosz *et al.*[7], Marsland and Chadwick [8] and Von Meibom *et al.* [9]. Orosz *et al.* did a multi-center prospective cohort study to find reasons for surgical delay. This study took place from August 1997 to August 1998 and contained 571 patients of 50 years and older in the New York City metropolitan area in the United States of America (USA). The main purpose of this prospective study was to quantify the surgical delay. Next to that they described reasons for delay which were selected from literature. However, the authors chose to look at only six reasons derived from literature, which they described as medical and system-related factors [7]. These system-related factors can be found under both organizational and logistical causes in table 1. The prospective cohort study on reasons for surgical delay, which included 101 patients from March 2004 to July 2004 and 105 patients from January 2006 to June 2006 in the United Kingdom (UK) performed by Marsland and Chadwick (2010), focused mainly on reasons for delay that could be influenced by increasing capacity through adding an extra trauma list per week and introducing an orthogeriatrician [8]. This makes that the resulting factors of delay of both studies are not complete. The prospective study of Von Meibom *et al.*, which was also done in the UK, included 235 patients and is more complete when pointing out the reasons for delay. It contains reasons which can be placed in all three categories (table 2) [9].

Table 2: Overview of studies identifying reasons for surgical delay

Author	Year of publication	Country	No. of patients	Logistical causes	Organizational causes	Medical causes
Prospective study						
Parker et al. [12]	1992	UK	468	X		X
Zuckerman et al. [15]	1995	USA	367	X	X	X
Orosz et al. [7]	2002	USA	571	X	X	
Moran et al. [11]	2005	UK	2,660	X	X	X
Siegmeth et al. [13]	2005	UK	3,628	X		X
Von Meibom et al. [9]	2007	UK	235	X	X	X
Marsland & Chadwick [8]	2010	UK	101 & 105	X	X	
Retrospective study						
Beringer et al. [10]	1996	Ireland	265	X	X	X
Sund & Liski [14]	2005	Finland	16,881	X		X
Blom et al. [16]	2007	The Netherlands	446			X

Surgery within one calendar day

During the period January 1, 2012 till March 27, 2012, 53 patients underwent hip fracture surgery in MST (retrospective cohort). Four out of these 53 (8%) patients underwent surgery with delay. The mean age of the patients in the 'no delay' group is around 75 years. In the 'delay' group the mean age is around 78 years. In both groups there were more women and most patients were treated by a trauma surgeon. The most frequent ASA score is II, followed by III. Most patients had a comorbidity. Often there was a combination of co-morbidities, sometimes one patient had up to six diseases. Almost half of the hip fracture patients used one type or a combination of anticoagulants. The medial collum fracture and the pertrochanteric fracture were the most common fractures. The Gamma Nail osteosynthesis was together with the head-neck prosthesis the most frequently used treatment (table 3).

During the period March 27, 2012 till July 9, 2012 a total of 91 patients were admitted in MST with a hip fracture (prospective cohort). Of these 91 patients 80 (88%) underwent a surgical treatment. Because not every surgeon filled out the item list only 57 patients out of these 80 (71%) patients were included (table 3). A total of three out of 57 (5%) patients had surgery after one calendar day after admission to the hospital. The time till surgery of these three delayed patients was 31 hours and 10 minutes, 40 hours and 35 minutes and 51 hours and 46 minutes. The mean age of the patients in the group without delay is 79 years (table 3). In the delay group the mean age is 83 years. In both groups there were more women and most of the patients were treated by a trauma surgeon. The most frequent ASA score in the group without delay is II, followed by III. The delay group contained two patients with ASA III and one with ASA I. Data regarding comorbidity, anticoagulant usage, fracture type and treatment were quite similar as in the retrospective population. The 23 patients for whom no item lists were completed were not included in the analyses. To exclude bias they were checked for surgical delay. None of these patients underwent surgery with delay.

Table 3: Basic characteristics of hip fracture patients that underwent surgery from January till March, 2012 (retrospective) and from March till July, 2012 (prospective)

	Retrospective		Prospective		Total
	No delay (N=49)	Delay (N=4)	No delay (N=54)	Delay (N=3)	(N=110)
Mean age (SD)	74.9 (15.9)	77.8 (6.4)	78.9 (12.9)	83.0 (9.9)	
Gender					
Male	20 (41%)	1 (25%)	16 (31%)	1 (%)	38 (36%)
Female	29 (59%)	3 (75%)	36 (69%)	1 (%)	69 (64%)
Median time until surgery, hh:mm (range)	17:13 (02:05-30:12)	50:02 (37:07-58:53)	18:48 (02:05-30:49)	41:12 (31:10-52:07)	18:32 (02:03-58:31)
Specialization surgeon					
Trauma surgeon	30 (61%)	2 (50%)	33 (63.5%)	3 (100%)	67 (63%)
Orthopedic surgeon	19 (39%)	2 (50%)	19 (36.5%)	0	40 (37%)
ASA[1]					
I	5 (16%)	0	3 (6%)	1 (33%)	8 (7%)
II	16 (52%)	1 (50%)	27 (52%)	0	44 (41%)
III	9 (29%)	1 (50%)	18 (34%)	2 (67%)	30 (28%)
IV	1 (3%)	0	4(8%)	0	5 (4%)
Comorbidity present[2]	40 (82%)	4 (100%)	48 (92%)	3 (100%)	94 (88%)
Dementia	7	1	11	0	19
Parkinson	0	0	3	0	3
Pulmonary diseases	10	0	4	1	15
Diabetes Mellitus	6	1	7	0	14
Cerebrovascular disease	8	0	5	1	14
Hypertension	13	2	14	1	30
Atrial fibrillation	7	1	4	1	13
Cardiovascular disease	21	3	21	1	46
Malignancy	8	0	2	1	11
Musculoskeletal disorders	8	1	8	0	17
Other	19	2	10	0	31
Anticoagulants[2]					
Dipyridamol (Persantin)	4	0	2	0	6
Carbasalate calcium (Ascal)	13	1	11	0	25
Clopidogrel (Plavix and Vatoud)	1	0	0	0	1
Acenocoumarol (Sintrommitis)	8	0	9	1	18
Phenprocoumon (Marcoumar)	1	1	4	1	7
No use	26 (53%)	2 (50%)	23 (44%)	1 (33%)	51 (48%)
Type of fracture					
Medial collum fracture	26 (53%)	0	29 (56%)	1 (50%)	56
Pertrochanteric fracture	14 (29%)	4 (100%)	18 (34%)	1 (50%)	37
Subtrochanteric fracture	6 (12%)	0	3 (6%)	0 (0%)	9
Proximal femur fracture	0	0	1 (2%)	0 (0%)	1
Lateral collum fracture	3 (6%)	0	1 (2%)	0 (0%)	4
Type of surgery					
Gamma nail	18 (37%)	3 (%)	19 (36%)	1 (%)	41
Dynamic hip screw (DHS)	9 (18%)	0	6 (11%)	0 (%)	15
Head-neck prosthesis	12 (25%)	0	17 (33%)	1 (%)	31
Total hip prosthesis	6 (12%)	0	5 (10%)	0 (%)	11
Cannulated Screws	4 (8%)	0	2 (4%)	0 (%)	6
Omega plate fixation	0	0	3 (6%)	0 (0%)	3

[1] 20 missing from retrospective dataset (18 missing in no delay and 2 missing in delay)

[2] Multiple options possible per patient, therefore no percentages are calculated.

Causes of surgical delay

Information about the presence of the different causes of delay, including logistical, organizational and medical causes, was obtained from the item lists. Because the item list was only part of the prospective study design, the results on the factors only relate to the hip fracture patients that underwent surgery from March 27, 2012, till July 9, 2012. Only the 57 patients of whom the item list was filled out were used during this analysis.

Table 4: Frequency table of causes of surgical delay

	No delay (N=54)	Delay (N=3)	Total (N=57)
Logistical causes			
Availability of:			
Operating rooms	13 (24%)	0	13 (23%)
Surgeon	0	0	0
Surgical personnel	5 (9%)	0	5 (9%)
Anesthesiologist	2 (4%)	0	2 (4%)
Equipment	0	0	0
Prosthesis	0	0	0
Full trauma list	8 (15%)	2 (67%)	10 (18%)
Patient not on trauma board/list	0	0	0
Organizational causes			
Waiting for medical consultation or clearance (1 missing)	12 (22%)	2 (67%)	14 (25%)
Waiting for family discussion on medical decision	0	0	0
Waiting for laboratory results and other diagnostic results	8 (15%)	1 (33%)	9 (16%)
The orthopedist's, surgeon's and anesthesiologist's preference in prioritizing patients on the surgical waiting list	15 (28%)	1 (33%)	16 (28%)
Delay in diagnosis[1]	.	.	.
Poor ward management	0	0	0
Medical causes			
Waiting for stabilization of a medical problem	1 (2%)	0	1 (2%)
Patient's pre-existing medical condition (comorbidity)	50 (93%)	3 (100%)	53 (93%)
Suspicion of a pathological fracture	1 (2%)	1 (33%)	2 (4%)
Patient's health status			
ASA <= 2	33 (61%)	1 (33%)	34 (60%)
ASA >2	21 (39%)	2 (67%)	23 (40%)
Other	2 (4%)	0	2 (4%)

[1] Could not be answered based on item list. Was not asked concrete enough.

The most frequently reported logistical cause which may lead to a delay was the availability of operating rooms. Thirteen times out of 57 (23%) operating rooms were reported as not available. The next most common logistical cause was a full trauma list. This was reported 10 out of 57 patients (18%), of which it twice caused a delay longer than one calendar day. The unavailability of operating rooms did not cause any delay longer than one calendar day. The preference which may lead to a medical specialist in prioritizing patients on the surgical waiting list was the most common

organizational cause of delay. Nevertheless, it only caused a delay longer than one calendar day once. The need for medical consultation was reported in a total of 14 patients. It was present in two patients that had surgery with a delay. In nine out of 57 patients (16%) there had to be waited for laboratory results or other diagnostics. This factor was only seen in one delayed patient. The most frequently reported medical cause was the pre-existing medical condition of the patient, also referred to as comorbidity. Almost every patient had one or more pre-existing medical conditions and this was also the case in the three patients with surgical delay.
The causes of surgical delay often came in combinations. Especially medical consultation came in combination with comorbidity and comorbidity was sometimes reported together with the preference of the orthopedists, surgeons and anesthesiologists in prioritizing patients on the surgical waiting list, but other combinations were also observed.

There was no association between 'comorbidity', 'consultation', 'use of anticoagulants' and surgical delay (Fisher's exact $p>0.05$). The RR of delay for 'comorbidity' was RR 0.93 (95% CI 0.86-0.99), the RR for 'consultation' was 0.33 (95% CI 0.13-0.86) and the RR of 'use of anticoagulants' was 0.83 (95% CI 0.36-1.92). For the factor 'use of anticoagulants' there was no significance because 1, or indicating 'no association', is within the 95% CI.

Mean time till surgery

The mean time till surgery for hip fracture patients between January and March, 2012 (N=53) was 17 hours and 59 minutes. For the hip fracture patients between March and July, 2012 (N=57) the mean time till surgery was 17 hours and 19 minutes. These were quite comparable thus both groups were combined into one.

When combining all patients who had surgery between January and July, 2012 into one dataset, a difference in time till surgery was found for the medical causes 'ASA-score', 'use of anticoagulants', 'presence of comorbidity' and for the baseline characteristic 'type of surgeon' for a total of 110 patients (table 5). The mean time till surgery in ASA III and IV was three hours and 22 minutes longer than the mean time in ASA I and II. The use of anticoagulants caused a mean time till surgery that was four hours and 19 minutes longer than if no anticoagulants were used. In case of comorbidity the difference in mean time till surgery was 6 hours and 33 minutes longer. The difference in mean time till surgery for the type of surgeon that performed the surgery was one hour and 17 minutes.

This difference in time till surgery was not significant for 'ASA classification' ($p>0.1$, t-test), 'type of surgeon' ($p>0.1$, t-test) and 'presence of comorbidity' ($p<0.1$, t-test). Only in case of 'use of anticoagulants' ($p<0.05$, t-test) the difference in mean was statistically significant.

Table 5: Difference in mean time till surgery of basic characteristics and medical causes over the total dataset

Variable*(group 1, group 2)*	Mean time till surgery group 1 (hh:mm)	Mean time till surgery group 2 (hh:mm)	Difference in mean tts (hh:mm)	95% CI	P-value[1]
ASA *(<=2 N=56, >2 N=34)*[2]	16:12	19:35	03:22	-01:23 – 08:08	>0.1
Anticoagulants *(no N=53, yes N=55)*[3]	15:27	19:47	04:19	00:06 – 08:33	<0.05
Comorbidity *(no N=12, yes N=97)*[3]	11:45	18:18	06:33	-00:09 – 13:15	<0.1
Surgeon *(trauma N=70, orthopedic N=40)*	18:06	16:49	01:17	-03:06 – 05:41	>0.1

[1] P-value derived using independent-samples t test

[2] 20 missing from retrospective dataset

[3] 2 missing for anticoagulants, 1 missing for comorbidity

Looking at logistical and organizational causes that were identified using the item list between March and July, 2012, seven of the 15 different causes of delay were reported in 57 patients (table 4). Six out of these seven causes showed a difference in mean time till surgery from two hours and ten minutes till nine hours and ten minutes. Significant difference was only found for “availability of operating rooms” with a difference in mean of six hours and five minutes (p<0.01, t-test).

Table 6: Logistical and organizational causes of delay with a difference in mean time till surgery from March till July, 2012

Variable *(group 1, group 2)*	Mean time till surgery group 1 (hh:mm)	Mean time till surgery group 2 (hh:mm)	Difference in mean tts (hh:mm)	95% CI	P-value[1]
Operating rooms available *(yes N=45, no N=12)*	16:01	22:07	06:05	01:50– 10:21	<0.01
Consultation *(no N=43, yes N=13)*[2]	17:02	19:13	02:10	-04:16 – 08:37	>0.1
Influence of preference *(no N=41, yes N=16)*	15:42	21:26	05:43	-00:08 – 11:35	<0.1
Surgical personnel available *(yes N=52, no N=5)*	16:44	23:15	06:30	-02:58 – 15:59	>0.1
Anesthesiologist available *(yes N=56, no N=1)*	17:09	26:20	09:10	-11:27 – 29:48	>0.1
Full trauma list *(no N=47, yes N=10)*	16:14	22:22	06:08	-00:50 – 13:07	<0.1

[1] P-value derived using independent-samples t test

[2] 1 missing

For the multiple regression analysis only the factors that had a p-value <0.1 were used as independent variables. The stepwise multiple regression analysis showed that only two factors, “use of anticoagulants” and “preference”, were significantly associated with time till surgery, accounting for 13.6% of its variance (R2 = 0.136; p=0.019).

Table 7: results of multiple regression analysis

Predicting variable[1]	B	P-value
Anticoagulants	05:25	<0.05
Influence of preference	05:43	<0.05

[1]Constant = 12:40

Surgery within 24 hours

When the boundary is put at 24 hours instead of 1 calendar day, 19% (10 of the 53) of the hip fracture patients between January and March, 2012 had surgery after 24 hours. Of the patients that underwent surgery between March and July, 2012 25% (14 of the 57) had surgery after 24 hours. In total 24 of 110 patients (22%) had surgery after 24 hours between January and July 2012.

Table 8: Characteristics of patients displayed on the basis of the 24 hour boundary

	Surgery after 24 hours (N=24)	Surgery within 24 hours (N=86)
Mean age (SD)	79.8 (11.1)	75.5 (15.3)
Gender		
Male	10 (42%)	30 (35%)
Female	14 (58%)	56 (65%)
Specialization surgeon		
Trauma surgeon	11 (46%)	29 (34%)
Orthopedic surgeon	13 (54%)	57 (66%)
American Society of Anesthesiologists score[1]		
I and II	11 (58%)	45 (63%)
III and IV	8 (42%)	26 (37%)
Comorbidity present	23 (96%)	74 (86%)
Use of anticoagulants	15 (63%)	40 (46%)
No operating rooms available[2]	5 (21%)	7 (8%)
No anesthesiologist available[2]	1 (4%)	0
No surgical personnel available[2]	3 (13%)	2 (2%)
Full trauma list[2]	2 (8%)	8 (9%)
Waiting for medical consultation or clearance[2]	3 (13%)	10 (12%)
Waiting for laboratory and other diagnostic results[2]	2 (8%)	7 (8%)
Preference of physician[2]	5 (21%)	11 (13%)

[1] 20 missing ASA-scores for orthopedic patients that had surgery between January and March, 2012 (5 missing for surgery after 24 hours, 15 missing for surgery within 24 hours)

[2] 11 missing: data retrieved from item list that was only filled out for patients between March and July, 2012

The mean age of the 24 patients that had surgery after 24 hours was 79.8 years (table 8). Fourteen of these 24 patients (58%) were female. Trauma surgeons performed hip fracture surgery in 13 of the 24 (54%) patients. The percentage of patients that underwent surgery performed by a trauma surgeon after 24 hours is with 19% (13 out of 70) lower than the percentage that underwent surgery performed by an orthopedic surgeon (28%; 11 out of 40). One third of the patients of whom the ASA-score was known had a score above two and except for one patient, all patients had at least one pre-existing medical condition. Almost two third of the patients used some kind of anticoagulant. 'No operating rooms available' is together with 'preference of physician' the most common logistical cause of delay that is seen when surgery took place more than 24 hours after admission.

The mean age of patients that had surgery within 24 hours was with 75.5 years a little lower than that of the patients that had surgery after 24 hours. Of this group 56 (65%) patients were female and the surgery was in 66% of the patients performed by a trauma surgeon. Like in the group that had surgery after 24 hours one third has an ASA-score higher above two. The number of patients that had a pre-existing medical condition was with 86% a little lower. This was also the case for the use of anticoagulants (46%). 'Preference of physician' was in 13% of the patients reason to postpone surgery to a later moment in time, followed by 'waiting for medical consultation or clearance (12%).

Discussion

This study examined how frequent surgical delay longer than one calendar day after admission occurs in hip fracture patients and which are the most common factors influencing the decision to postpone surgery, resulting in such delay. Based on the results it can be assumed that MST is doing well. It is not possible to give a hard judgment instead of making an assumption due to the lack of a standard and the absence of numbers obtained through the same method and/or about the same period in time. The percentage of patients that had hip fracture surgery after one calendar day is only 6% (7/110). Of these seven patients that had delayed surgery between January 1, 2012, and July 9, 2012, six patients had at least one kind of comorbidity at the time of admission in the hospital and five patients used anticoagulants. These factors of delay are of a medical origin and thereby cannot be easily changed or cannot be changed at all.

Filling out an item list by the orthopedic and trauma surgeons for all 57 hip fracture patients of the prospective cohort study, that underwent surgical repair between March 27, 2012, and July 9, 2012, provided in data that could not be retrieved using a retrospective design. Organizational factors like a full trauma list, and logistical factors like medical consultation waiting for laboratory and other diagnostic results and the physicians' preference in prioritizing patients on the surgical waiting list were reported for the three patients that underwent surgery with delay. However, these factors were also reported several times in patients that had surgery without delay. Previous factors were not the only factors mentioned. The organizational factor 'no operating rooms available' was reported 13 times, but this never led to a delay exceeding one calendar day after admission. 'Full trauma list' and 'availability of operating room' were often seen as a combination. This can be partly explained by a full trauma list causing an operating room being occupied and thereby being unavailable. However, during a normal working day with elective surgery the operating rooms can also be occupied. In this case there are no operating rooms available, but this is not due to a full trauma list. Looking at the time till surgery several factors seem to cause a difference in the mean time till surgery, but only 'use of anticoagulants', 'availability of operating rooms', 'influence of preference' and 'availability of surgical personnel' were statistically significant. After combining these factors in a multiple linear regression analysis, only 'use of anticoagulants' and 'influence of preference' were significantly associated with the time till surgery.

Comparing the outcome with other studies is difficult because of the different definitions of delay used in these studies. Most studies use the division between surgery within 24 hours and after 24 hours, where the latter one is the delayed category. Delay defined as one calendar day after

admission does not fit those categories. Surgery can take place within 24 and 48 hours and not be delayed. In order to tackle that problem the percentage of patients that had surgery after 24 hours was calculated in addition to the results concerning surgery after one calendar day. The percentage of patients that had surgery after 24 hours (19%) is relatively low in comparison to the percentages found in literature. One prospective cohort study in four hospitals in the New York City metropolitan area including 571 patients reported that 68% of the patients had surgery after 24 hours [7]. The most common reasons for surgical delay during the study were 'waiting completion of medical evaluation' (210 patients, 54%) which was also described as waiting for medical consultation and 'operating room/surgeon unavailable' (159 patients, 41%). A prospective two-centre study in England including 235 patients showed similar results with regard to the availability of operating rooms [9]. In the first centre 30 % of the patients had surgery after 24 hours. Of these patients 18 (78%) had delayed surgery because of operating rooms being unavailable. In the second centre, where 70% of the patients had surgery after 24 hours this was in 54 patients (76%) also due to lack of operation rooms. These results are in contrast to the results of our present study were the unavailability of the operating room was only present in 21% (five out of 24) of the patients that had surgery after 24 hours and even if no operating room was available in most cases patients could be operated within the prescribed time. 'Waiting for medical consultation' was reported in only 14% of the patients that had surgery after 24 hours. 'Preference of the physician' which was reported in 19% of the patients was not mentioned in both studies.

A previous retrospective follow-up study in MST on waiting time among patients with a hip fracture, including 472 patients, showed a higher percentage (42%) of patients that had surgery after 24 hours and were operated by an orthopedic surgeon in comparison to the percentage (36.5%) for operated by trauma surgeons [20]. This is in accordance with the results of this study, where 28% of the patients operated by orthopedic surgeons and 19% operated by trauma surgeons had surgery after 24 hours. However, the retrospective study did not give any insight on the factors causing the delay like was done in this study.

The Health Care Inspectorate has included an age restriction in the inclusion criteria of the performance indicator 'Percentage of hip fracture surgery within one calendar day'. Despite of the age restriction this study does include patients under the age of 65 years (22 patients). Including patients under the age of 65 can cause a distorted image of surgical delay. Because younger patients are expected to find themselves in a better state of health, the impact of health status on the occurrence of delay in the overall group may be underestimated. In addition, including younger patients may also influence the mean time till surgery in a positive way; the time till surgery may become shorter. This has to be taken in mind when interpreting the results.

Not every surgeon filled out the item list. They often forgot to fill them out, because it was not part of their daily routine. The group of patients for whom no item list was filled out included 23 patients. The group did not contain any patient that underwent surgery with delay. Including these patients into the dataset would have decreased the percentage of surgical delay and also the percentage of surgery after 24 hours. A large proportion of the item lists were filled out at a later moment in time. There was no reason to believe that filling out the item list was of influence on the appearance of delay or on the alertness of the surgeons with respect to the prevention of surgical delay.

Future research

Based on the results of this study one can question the need for further research on this topic. However, when one decides for future research there are some recommendations for improvement of the research. First, in future analysis the patients under the age of 65 can be filtered out. Secondly, some improvements can be made on the item list. Not all factors that were derived from literature study were represented in the item list as concrete as they should be. Thirdly, the item list should be integrated into the digital hospital information system or the digital patient record. Integration of the item list gives the possibility to fill out different parts of the item list at different moments. Some tasks are performed by different physicians and therefore the surgeon does not always have all the information that is necessary to fill out the entire item list. It also creates the possibility of a reminder when surgery is performed but no item list was filled out. This may result in a more complete and more accurate dataset. When expanding this way of registration to more hospitals benchmarking becomes a possibility.

In conclusion, surgical delay longer than one calendar day after admission does not occur often in hip fracture patients in MST. In the cases it does occur, factors of mostly medical origin are present. These factors cannot be easily changed or cannot be changed at all. Looking at factors that cause a difference in mean time till surgery several factors seem to be of influence, like ‘use of anticoagulants’, ‘comorbidity’, ‘operating rooms available’, ‘influence of preference’ and ‘full trauma list’. However, multiple regression analysis shows that only the factors ‘use of anticoagulants’ and ‘influence of preference’ are associated with the time till surgery. When broadening the scope of the research and also look at the number of patients that have surgery after 24 hours similar results are found. Factors of medical origin are dominating over the logistical factors present. Therefore, further improvement of the time till surgery is, based on the presence of logistical factors, not impossible, but the expectations should not be too high.

Acknowledgement

I would like to express my gratitude towards Germaine Vos - Deckers, Lia Simon - van Giersbergen, Rolf Egberink, Willy Brandwagt, Edwin Hofmans, and Joost Hofhuis (all employees of Acute Zorg Euregio) for support and assistance during my time at Acute Zorg Euregio. Furthermore, I would like to thank Auke Renard (orthopaedic surgeon at MST) and Paul Bertelink (trauma surgeon at MST) for the provision of the research topic and their guidance and support during the whole process of performing this research. Finally, I would like to extend my sincere thanks to Carine Doggen (Twente University) for her guidance and supervision and Sabine Siesling (Twente University) for her critical view on this report that helped me to make further improvements.

References

1. Lanting LC, Stam C, den Hertog PC, Brugmans MJP. Heupfracturen samengevat. In: Volksgezondheid Toekomst Verkenning, Nationaal Kompas Volksgezondheid. Bilthoven: RIVM; 2008 [cited 2012 February 17th]; Available from: http://www.nationaalkompas.nl/gezondheid-en-ziekte/ziekten-en-aandoeningen/bewegingsstelsel-en-bindweefsel/heupfractuur/heupfracturen-samengevat/.
2. Inspectie van de Gezondheidszorg. Basisset kwaliteitsindicatoren ziekenhuizen 2012. Utrecht 2011 [updated cited 2012 February 14th]; Available from: http://www.igz.nl/onderwerpen/handhavingsinstrumenten/gefaseerd-toezicht/kwaliteitsindicatoren/basissets/
3. Pillay J, Van der Wouden JC, Leenen LPH. De prestatie-indicator 'heupfractuur: opereren binnen 24 uur' retrospectief toegepast bij 217 patiënten in het Universitair Medisch Centrum Utrecht, 2000-2003: postoperatief minder vaak pneumonie, maar niet minder sterfte. Nederlands Tijdschrift voor Geneeskunde. 2007;151:967-70.
4. Shiga T, Wajima Z, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. Canadian Journal of Anesthesia. 2008;55(3):146-54.
5. Simunovic N, Devereaux PJ, Sprague S, Guyatt GH, Schemitsch E, De Beer J, et al. Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. Canadian Medical Association Journal. 2010;182(15):1609-16.
6. Khan SK, Kalra S, Khanna A, Thiruvengada MM, M.J. P. Timing of surgery for hip fractures: A systematic review of 52 published studies involving 291,413 patients. Injury, International Journal of the Care of the Injured. 2009;40(7):692-7.
7. Orosz GM, Hannan EL, Magaziner J, Koval K, Gilbert M, Aufses A, et al. Hip Fracture in the Older Patient: Reasons for Delay in Hospitalization and Timing of Surgical Repair. Journal of the American Geriatrics Society. 2002;50:1336-40.
8. Marsland D, Chadwick C. Prospective study of surgical delay for hip fractures: impact of an orthogeriatrician and increased trauma capacity. International Orthopaedics. 2010;34:1277-84.
9. Von Meibom N, Gilson N, Dhapre A, Davis B. Operative delay for fracture of the hip: a two-centre prospective study. The Journal of bone and joint surgery. 2007;89(1):77-9.
10. Beringer TRO, Crawford VLS, Brown JG. Audit of surgical delay in relationship to outcome after proximal femoral fracture. The Ulster Medical Journal. 1996;65(1):32-8.

11. Moran CG, Wenn RT, Sikand M, Taylor AM. Early Mortality After Hip Fracture: Is Delay Before Surgery Important. The Journal of Bone & Joint Surgery. 2005;87(3):483-9.
12. Parker MJ, Pryor GA. The timing of surgery for proximal femoral fractures. The Journal of Bone & Joint Surgery. 1992;74-B(2):203-5.
13. Siegmeth AW, Gurusamy K, Parker MJ. Delay to surgery prolongs hospital stay in patients with fractures of the proximal femur. The Journal of Bone & Joint Surgery. 2005;87-B(8):1123-6.
14. Sund R, Liski A. Quality effects of operative delay on mortality in hip fracture treatment. Quality & Safety in Health Care. 2005;14(5):371-7.
15. Zuckerman JD, Skovron ML, Koval KJ, Aharonoff G, Frankel VH. Postoperative Complications and Mortality Associated with Operative Delay in Older Patients Who Have a Fracture of the Hip. The Journal of Bone and Joint Surgery. 1995;77-A(10):1551-6.
16. Blom BJ, Van Dis H, Simons MP, Willems WJ. De samenhang tussen uitstel van operatie en het complicatierisico. Nederlands Tijdschrift voor Geneeskunde. 2007;151:2050-4
17. American Society of Anesthesiologists. ASA Physical Status Classification System. [updated cited 2012 February 20th]; Available from: http://www.asahq.org/For-Members/Clinical-Information/ASA-Physical-Status-Classification-System.aspx
18. Van Houwelingen JC, Stijnen Th, Van Strik R. Inleiding tot de medische statistiek. Maarssen: Elsevier gezondheidszorg; 2000.
19. Bouter LM, Van Dongen MCJM, Zielhuis GA. Epidemiologisch onderzoek. Opzet en interpretatie. Houten: Bohn Stafleu van Loghum; 2005.
20. Roelofsen Y. What is the effect of orthopaedic and trauma surgical treatment on waiting time, length of hospital stay and mortality among patients with a hip fracture, specifically pertrochanteric hip fracture? 2010