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Determinants of outcome in hip fracture patient care

Vochteloo, A.J.H.

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Determinants of Outcome in Hip Fracture Patient Care



Anne J.H. Vochteloo

Determinants of Outcome in Hip Fracture Patient Care

Anne Vochteloo

Colofon

Determinants of Outcome in Hip Fracture Patient Care

PhD thesis, Leiden University, the Netherlands

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dr. R.M. Bloem

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PART I

GENERAL INTRODUCTION



1

Introduction

The World Health Organization (WHO) estimated that the world population aged 65 years and older will increase by 88% over the next 25 years. (1) In this aging population, the incidence of osteoporosis has increased over the last decades as well. (2–4) As advanced age and osteoporosis lead to enhanced bone fragility and increased fracture risk, the amount of osteoporosis-related fractures has also increased in the past decennia. Lifetime risk for developing an osteoporotic fracture is 30 % with an estimated amount of nine million fractures worldwide in the year 2000. (5,6)

Fractures of the proximal femur, distal radius, proximal humerus and vertebrae are the most frequently seen types of osteoporosis-related fractures. For the individual patient the impact is huge; loss of independency, mobility and quality of life is very often observed after a hip fracture. (7–11) These fractures are also related with increased morbidity and mortality. For that matter, hip fractures can have a 1-year mortality rate between 18 to 32 %, compared to a mortality rate of 15 % after a vertebral fracture. (4,12–14) Half of all hip fracture patients will never recover their pre-fracture functional capacity and 25 % of these patients reside in a long-term care institution one year after sustaining a hip fracture. (15–17) It has been estimated that by 2050 the worldwide number of hip fracture patients aged 50 years and older will grow to around 6.3 million. (18,19) In contrast to this, a recent evaluation in The Netherlands shows a slight decrease in hip-fracture related hospital admissions. (20)

Reports from Sweden, Belgium and the UK have demonstrated the level and impact on society of costs associated with hip fracture care, both for acute care and subsequent dependency. (7,21–23) For example, these costs are almost two billion pounds (2.5 billion euro) per year in the UK, as presented in the National Report from the National Hip Fracture Database in 2011. (7)

Current issues

The focus of hip fracture research was initially on the technical aspects (type and technique of implants) of hip fracture treatment. However, since the surgical technique of fracture treatment has been more or less established, researchers have started addressing clinical and functional outcome of these fractures in these often-frail elderly. The latter has been seldom addressed in the past, despite the fact that overall patient outcome should be the goal for any treatment. Outcome with special focus on the “phenotype” of the patient

with a hip fracture will probably be the major determinant for this overall outcome. Are elderly patients with a hip fracture different than their peers without a hip fracture, i.e. the background population? Which patients will survive and which will not? Who will regain their pre-fracture level of mobility and independency and who will not?

In order to change outcome for these elderly patients, identifying risk factors for poor outcome and therewith patients at risk for poor outcome, preferably at an early (preoperative) stage, is essential and “hot” goals for research. Knowing these risk factors, valuable prediction models can be developed to predict, for example, the risk for delirium or discharge to an alternative location at an early stage.

Aims of the thesis

The first goal of this thesis is to evaluate clinical and functional outcome of a large cohort of hip fracture patients. The second goal is to identify risk factors for poor outcome, both in a clinical and a functional perspective. Finally, specific risk scores for delirium and discharge to an alternative location have been developed and validated.

Outline of the thesis

This thesis has three parts; discussing the clinical outcome of hip fracture patients (part I), the functional and social outcome after fracture treatment (part II) and finally establishing reliable prediction models for delirium and discharge location of these patients (part III).

I. CLINICAL OUTCOME

Although observational cohort studies can be biased by selection of included patients (e.g. non-consecutive series, lost of follow-up, non-blinded evaluation et cetera), this type of research remains the basis for novel research questions. An advantage of large cohort studies is the possibility of subpopulation analyses. To this end, a large, mostly retrospectively collected, cohort was created. To counter the limitations of retrospective research, the missing items during the first period (2005-2008) of the studied cohort were made obligatory in routine clinical care from 2008 as part of better quality assessment in patients with hip fractures. Thus a database containing 1262 consecutive

admissions between 2005 and 2009 of hip fracture patients aged ≥ 50 years was created. All patients from Reinier de Graaf Hospital, Delft and the Bronovo Hospital, The Hague during that period were included. Three analyses were performed using this database; the impact of anemia and blood transfusions on outcome, a comparison of the oldest old (nonagenarians) with their younger peers and an analysis on concomitant fractures in hip fracture patients. The results are presented in chapters two to four.

Anemia at admission and blood transfusion

Hip fracture patients are often old and suffer from several comorbidities, often referred to as the “frailty syndrome”. (24) One of the typical comorbidity features of this syndrome is the anemic status of the patient at admission. (24)

Increasing evidence suggests that low hemoglobin concentration is common in elderly patients and adversely affects morbidity and mortality risk, especially if they are in need of surgery. (24–27) Several studies on anemia in hip fracture patients reported increased morbidity, prolonged admission, higher readmission rate and increased mortality rate. (28–30) Studies on allogeneic blood transfusion (ABT) in hip fracture patients show ambivalent findings regarding outcome and mortality. (31–37)

The purpose of the study presented in chapter two was to evaluate the effect of preoperative hemoglobin level and perioperative ABT on mortality, delirium incidence, length of hospital stay, discharge to a nursing home and the 90-day readmission rate.

Nonagenarians versus younger patients

The number of nonagenarians is rapidly increasing and therewith the numbers of hip fracture patients aged 90 years and older. (2,4) Nonagenarian patients frequently suffer from comorbidities and functional impairment; both have a huge impact on outcome after hip fracture treatment. (37–39) In chapter three the results of a large consecutive series of nonagenarian hip fracture patients in comparison to hip fracture patients aged 65–89 years are presented.

Contralateral hip fractures and other concomitant fractures

An increased risk exists to sustain subsequent fractures of both the ipsilateral and contralateral extremities and vertebrae, particularly during the first two years after the

initial fracture. (40,41) In chapter four, the one-year and absolute risk of sustaining a contralateral hip fracture and other osteoporosis-related fractures was assessed as well as possible risk factors for sustaining a contralateral hip fracture.

II. FUNCTIONAL AND SOCIAL OUTCOME

As mentioned in the introduction, in the last two decades “social morbidity” due to lower level of activities of daily living, loss of independence and change of place of residence has increasingly become the subject of research, since these factors have a major impact on the outcome of the individual patient. (9,11)

A prospective hip fracture patient cohort of 498 consecutive admissions in Reinier de Graaf Hospital, Delft between 2008 and 2009 of hip fracture patients aged ≥ 50 years was created. They were evaluated with respect to return to the pre-fracture place of residence and the pre-fracture level of mobility (chapters five and six).

Return to pre-fracture place of residence

Discharge to an alternative location (i.e another place than pre-fracture place of residence) or the necessity to provide additional postoperative care at home after discharge could both contribute to a longer stay in the hospital and will thus create additional costs. (21,22)

In chapter five preoperative risk factors for failure to return to the pre-fracture place of residence are evaluated at three and 12 months postoperatively.

Regaining pre-fracture level of mobility

As a result of the loss of mobility after the initial treatment of a hip fracture, patients are often restricted in their daily activities, resulting in loss of confidence and loss of independence. (8,10) Healthcare costs are severely affected by loss of mobility, medical costs for hip fracture patients are about threefold larger compared to the background population (age and residence-matched controls without a fracture). (21)

Risk factors for failing to return to the pre-fracture level of mobility in the first year after a hip fracture are evaluated in chapter six.

III. PREDICTION MODELS

Delirium Risk Screening and Haloperidol Prophylaxis Program

Delirium is a common and serious complication in hip fracture patients, which results in limited functional abilities, longer hospital stay, impaired cognitive function, more admissions to long term special care facilities and higher mortality rates. (42–45) In 2008 an integrated hip fracture care pathway that included a Risk Model for Delirium was introduced at Reinier de Graaf Hospital. (46) The results of using this model are evaluated in chapter seven.

Validation of the Risk Model for Delirium

The Risk Model for Delirium (RD) score was developed in Reinier de Graaf Hospital. (46) This is a simple and easy to use model for prediction of the risk for delirium in an acute admission setting. The results, validity and feasibility of this RRD-score in daily practice are described in chapter eight.

Development and external validation of the Discharge of Hip fracture Patients score (DHP)

Early prediction of hospital discharge location of hip fracture patients who lived independently in their own home prior to sustaining a hip fracture, is an important quality indicator for both patients and their family. The Discharge of Hip fracture Patients score (DHP) was developed to predict the risk of discharge to an alternative location (chapter nine).

External validation of the DHP score was performed in a cohort of 125 hip fracture patients admitted to the University Medical Centre Groningen as presented in chapter ten.



PART II

CLINICAL OUTCOME



2

Outcome in hip fracture patients related to anemia at admission and allogeneic blood transfusion: an analysis of 1262 surgically treated patients

Anne JH Vochteloo, Boudewijn LS Borger van der Burg, Bart JA Mertens, Arthur HP Niggebrugge,
Mark R de Vries, Wim E Tuinebreijer, Rolf M Bloem, Rob GHH Nelissen and Peter Pilot

BMC Musculoskeletal Disorders 2011, 12:262

Abstract

Background: Anemia is more often seen in older patients. As the mean age of hip fracture patients is rising, anemia is common in this population. Allogeneic blood transfusion (ABT) and anemia have been pointed out as possible risk factors for poorer outcome in hip fracture patients.

Methods: In the timeframe 2005-2010, 1262 admissions for surgical treatment of a hip fracture in patients aged 65 years and older were recorded. Registration was prospective from 2008 on. Anemic and non-anemic patients (based on hemoglobin level at admission) were compared regarding clinical characteristics, mortality, delirium incidence, LOS, discharge to a nursing home and the 90-day readmission rate. Receiving an ABT, age, gender, ASA classification, type of fracture and anesthesia were used as possible confounders in multivariable regression analysis.

Results: The prevalence of anemia and the rate of ABT both were 42.5%. Anemic patients were more likely to be older and men and had more often a trochanteric fracture, a higher ASA score and received more often an ABT. In univariate analysis, the 3- and 12-month mortality rate, delirium incidence and discharge to a nursing home rate were significantly worse in preoperatively anemic patients.

In multivariable regression analysis, anemia at admission was a significant risk factor for discharge to a nursing home and readmission < 90 days, but not for mortality. Indication for ABT, age and ASA classification were independent risk factors for mortality at all moments, only the mortality rate for the 3-12 month interval was not influenced by ABT. An indication for an ABT was the largest negative contributor to a longer LOS (OR 2.26, 95% CI 1.73-2.94) and the second largest for delirium (OR 1.67, 95% CI 1.28-2.20).

Conclusions: This study has demonstrated that anemia at admission and postoperative anemia needing an ABT (PANT) were independent risk factors for worse outcome in hip fracture patients. In multivariable regression analysis, anemia as such had no effect on mortality, due to a rescue effect of PANT. In-hospital, 3- and 12-month mortality was negatively affected by PANT, with the main effect in the first 3 months postoperatively.

Background

Due to the ageing of the Western population, the number of elderly people will increase. Although age-adjusted incidence of hip fractures in many countries, like the US and Sweden, declined in the population of 50 years and older, there is a right-shift in hip fracture distribution towards the highest age groups [1]. These old patients have several co-morbidities, often described as the “frailty syndrome” [2]. One of the typical features of this syndrome is an anemic status [2]. Increasing evidence suggests that low hemoglobin concentration is common in elderly patients and adversely affects morbidity and mortality, especially if they are in need of surgery [2-5].

Several studies on anemia in hip fracture patients reported on increased morbidity, prolonged admission, higher readmission rate and increased mortality rate [6-8]. Studies on allogeneic blood transfusion (ABT) in hip fracture patients show ambivalent findings regarding outcome and mortality [9-14].

In this study, the effect of preoperative hemoglobin level and perioperative ABT was evaluated in a large cohort follow-up study of 1262 admissions for surgical treatment for hip fracture in patients of 65 years and older. The focus of our analysis was on mortality, incidence of delirium, length of hospital stay, discharge to a nursing home and the 90-day readmission rate.

Methods

An observational cohort study was conducted on hip fracture patients admitted to a 350- and a 450-bed teaching hospital in The Hague and Delft.

Aim of the study

To determine whether anemia at admission and perioperative allogeneic blood transfusion (ABT) have an independent negative effect with mortality, occurrence of a delirium, length of hospital stay (LOS), discharge to a nursing home and 90-day readmission rate in surgically treated hip fracture patients, aged 65 years and older. Delirium has been chosen, as it is one of the most serious and most common major in-hospital complications.

Patients and methods

All patients were extracted from our digital database that contains all consecutive hip fracture patients, admitted from January 2005 to January 2010. Data were collected retrospectively for patients in the timeframe 2005-2007 and prospectively for those in the period 2008-2009.

The exclusion criteria for this study were: age < 65 years, a pathologic hip fracture, a high-energy injury and conservative treatment. Duration of follow-up in all patients was 12 months. This resulted in a cohort of 1262 admissions for a hip fracture, in 1222 patients.

From the hospital's records (both digital and paper files), age, gender, ASA classification, type of fracture, type of treatment, type of anesthesia, pre- and post-operative hemoglobin level, perioperative need for an ABT, occurrence of a delirium, LOS and discharge location were collected onto a case record form (CRF) [15].

Diagnosis of delirium was based on criteria of the DSM IV [16]. Signs of a delirium are recorded in the medical and nursing records as a standard part of documentation of the daily characteristics of a patient. Delirium incidence in this series was scored based on these medical and nursing staff records. To calculate the 90- day readmission rate, all readmissions within 90 days after discharge were extracted from the digital hospital admission registration system. Postoperative mortality has been documented meticulously by repeated consultation of the population registers of the counties in the region of both hospitals as well as the hospital's patient registration systems. If present, readmissions and date of death were recorded at the CRF. As of 2008, all data were recorded prospectively in the CRF. All fore mentioned data were complete, both in the retrospective and prospective series and was performed by authors AV, BB, PP and AN.

Approval from the local ethical committee was not obtained, as this is an observational study without an intervention. Therefore, it is an evaluation of usual care as a part of good clinical practice. Since data could not be traced back to the individual patient there were no privacy issues.

Anemia and ABT policy

In all patients the hemoglobin level was measured at admission. Anemia at admission was defined based on the criteria of the World Health Organization (WHO) [17]. These

criteria classify anemia as a hemoglobin level below 7.5 mmol/L (12 g/dL) in women and below 8.1 mmol/L (13 g/dL) in men. They were tested and found sufficient for elderly by Izaks et al in their study on mortality in elderly patients [18].

In the Netherlands, the national CBO guideline advises ABT for subjects aged > 60 years when hemoglobin level drops below 5.0 mmol/L (8.0 g/dL) in the general population or 6.0 mmol/L (9.7 g/dL) if the patient has a serious cardiac condition or when anemia becomes symptomatic [19]. This guideline is general practice in both hospitals. Hemoglobin level was measured on the first postoperative day as a routine and if necessary repeated thereafter based on clinical judgment.

Statistical analysis

Demographic continuous data are presented as means, with standard deviations (SD). Categorical data are presented as the number of subjects in the category, along with the percentages. Chi-square test and Fisher's exact test were used for comparing groups of categorical data. The cohort was compared regarding differences in clinical characteristics and outcome between the anemic and non-anemic patients, based upon hemoglobin level at admission.

Univariate analysis performed to test the association between anemia and mortality (in-hospital, 3- and 12- month), delirium, LOS categories ($\leq$ versus > 11 days), discharge to a nursing home and 90-day readmission rate. Separate logistic regression analyses were executed for each outcome, for the mortality Cox proportional hazards regression analysis was used to calculate the hazard ratio and 95% confidence interval. In these analyses, correction was performed for the possible confounders; age, gender, perioperative risk (ASA classification I/II or III/IV), receiving an ABT, type of fracture (neck of femur, (inter-) trochanteric or subtrochanteric), and type of anesthesia (general or spinal). Because of the clinical relation between the anemia and receiving an ABT collinearity diagnostics of the logistic regression models were examined.

To robustify the analysis for LOS, this parameter was changed into a binary summary outcome, i.e. $\leq$ or > 11 days (the median), as the distribution of the value LOS was very wide.

Patients classified ASA I or II and III or IV were combined to two groups, as the separate groups of ASA I ($n = 82$) and ASA IV ($n = 50$) classified patients were too small to be analyzed separately.

P-values lower than 0.05 were considered statistically significant. Odds ratios are displayed with a 95% confidence interval if the p-value < 0.05. All data were analyzed in SPSS 17.0 (SPSS Inc. Chicago, USA).

Results

Clinical characteristics

1262 admissions for a surgical treatment of a hip fracture (1222 patients) were extracted from the database; 932 (73.9%) were female. Mean (SD) age was 83.6 (7.1) years and mean (SD) follow-up was 3.5 (1.4) years. Mean (SD) hemoglobin level at admission was 7.7 (1.0) mmol/l. According to the WHO criteria, 536 patients (42.5%) were anemic [17]. Transfusion of one or more unit(s) of allogeneic erythrocytes was given to 536 patients (42.5%), in the large majority (97.9%) postoperatively. Surgery within 24 hours after admission was performed in 84.4% of all patients. Overall mortality was 40.4% (510 of 1262 patients).

Anemic versus non-anemic patients

The patients were divided in an anemic and non-anemic group, based on the hemoglobin level at admission; clinical characteristics of the two populations are shown in Table 1.

The anemic group was significantly different from the non-anemic regarding age, gender, ASA, fracture distribution and ABT rate. There was no significant difference in mean follow-up. The relative risks for the different outcome parameters according to univariate analysis are presented in table 2. In this analysis, LOS and the in-hospital and 3-12 month interval mortality rate were not significantly different between both groups.

The 90-day readmission rate was significantly higher in anemic patients. Readmission for an orthopaedic reason (surgical site infection, revision operation or a contralateral hip fracture) was necessary in 43.5% (30 of 69) of the anemic patients and in 36.9% (24 of 65) of the non-anemics.

Table 1 Relative risks for different demographic characteristics in anemic and non-anemic patients

Outcome	Anemic n = 536	Non-anemic n = 726	RR (CI)	P-value
mean age in years (SD)	84.9 (6.9)	82.6 (7.0)	n/a	< 0.001
mean follow-up in months (SD)	42.7 (16.9)	42.2 (15.9)	n/a	0.578
Male gender	170 (31.7)	160 (22.0)	1.31 (1.15-1.50)	< 0.001
ASA III/IV	200 (37.3)	201 (27.7)	1.28 (1.12-1.45)	< 0.001
Fracture type				
-neck of femur	252 (47.0)	450 (62.0)		< 0.001*
-(inter) trochanteric	266 (49.6)	256 (35.3)	0.70 (0.62-0.80)	< 0.001**
-subtrochanteric	18 (3.4)	20 (2.8)		
Spinal anesthesia	494 (92.2)	684 (94.2)	0.84 (0.67-1.05)	0.149
ABT	309 (57.6)	153 (21.1)	2.36 (2.08-2.68)	< 0.001

Values are given as number (percentage), unless mentioned otherwise.

* P-value comparing 3 treatment groups, **RR and p-value comparing neck of femur with (inter-) trochanteric fractures.

RR = relative risk; CI = confidence interval; ASA = American Society of Anesthesiologists Physical Status classification, ABT = allogeneic blood transfusion.

Table 2 Relative risks for different outcome measures in anemic and non-anemic patients

	Anemic n = 536	Non- anemic n = 726	RR (CI)	P-value
Mortality				
In-hospital	30 (5.6)	31 (4.3)	1.17 (0.90-1.52)	0.277
3-month	113 (21.1)	87 (12.0)	1.42 (1.23-1.64)	< 0.001
3-12 month	60 (11.2)	71 (9.8)	1.09 (0.89-1.33)	0.415
12-month	173 (32.3)	158 (21.8)	1.34 (1.18-1.53)	< 0.001
Delirium	162 (30.3)	155 (21.3)	1.29 (1.13-1.48)	< 0.001
LOS > 11 days	272 (50.7)	368 (50.7)	1.00 (0.88-1.14)	0.984
Discharge to a NH	277 (51.7)	285 (39.3)	1.33 (1.17-1.51)	< 0.001
90-day readmission rate	69 (12.9)	65 (9.0)	1.24 (1.04-1.49)	0.025

Values are given as number (percentage), RR = relative risk, CI = confidence interval, LOS = length of stay, NH = nursing home

Multivariable logistic and Cox regression analysis

The Spearman's correlation coefficient between anemia and an ABT was low (0.38, $p < 0.001$) and the tolerance and VIF values indicated no multicollinearity.

Anemia at admission was not a significant independent risk factor for mortality at any moment in multivariable Cox regression analysis (table 3). Receiving an ABT was a

significant independent risk factor for in-hospital, 3- and 12-month mortality, as were higher age and ASA classification in all patients (both anemic and non-anemic). However, receiving an ABT was not a risk factor for the mortality in the 3 to 12 month interval. Anemia was a significant independent risk factor for discharge to a nursing home and readmission within 90 days. The odds ratio for anemia in the analysis for LOS was 0.63 when adjusted for ABT and age. The latter two both had an independent negative impact on LOS (OR 2.12 and 1.06). This meant that anemic patients had a shorter stay in hospital than non-anemic patients, when they were younger and did not receive an ABT. For the outcome parameters besides mortality, i.e. discharge to a nursing home, delirium, 90-day readmission rate and a LOS > 11 days, age played a more important role than ASA classification. Gender and type of anesthesia were of little importance. Type of hip fracture was not a significant independent contributor to any of our outcome parameters in multivariable analysis.

Anemia effecting ABT and vice versa

Mortality in patients with anemia at admission (21.1%) was higher than in non-anemics (12%, $p < 0.001$) and mortality in all patients that received an ABT (22.7%) was higher compared to those that did not (11.9%, $p < 0.001$).

The in-hospital mortality rate of anemic patients that received an ABT (6.5%) compared to those who did not (4.4%), was comparable ($p = 0.30$). However, the mortality rates in preoperative non-anemic patients who received an ABT compared to those who did not were respectively 9.8% and 2.8% ($p < 0.001$).

The 3-month mortality in anemic patients was 24.3% in transfused and 16.7% in non-transfused patients ($p = 0.035$) and in non-anemic patients rates 19.6% and 9.9% ($p = 0.001$) in transfused and non-transfused patients respectively.

The relative risk (RR) for 3-month mortality in patients with anemia at admission is significantly increased in patients that did not receive an ABT (RR 1.49, CI 1.13-1.96, $p = 0.07$) this was not the case in those that did receive an ABT (RR 1.09, CI 0.95-1.26, $p = 0.26$).

Table 3 Risk factors with a significant HR for mortality and a significant OR for the other outcome parameters

Outcome variable	Risk factor	HR/ OR	95% CI	P-value
Mortality* in-hospital	Age in years	1.07	1.02 to 1.11	0.002
	ASA	2.76	1.66 to 4.59	< 0.001
	ABT	1.88	1.12 to 3.14	0.017
3-month	Age in years	1.06	1.04 to 1.09	< 0.001
	ASA	1.94	1.47 to 2.57	< 0.001
	ABT	1.48	1.10 to 2.01	0.011
	Anemia	1.30	0.96 to 1.76	0.088
3-12 month	Age in years	1.05	1.02 to 1.08	< 0.001
	ASA	1.78	1.26 to 2.52	0.001
12-month	Age in years	1.06	1.04 to 1.08	< 0.001
	ASA	1.89	1.52 to 2.34	< 0.001
	ABT	1.42	1.13 to 1.77	0.002
Delirium	Age in years	1.06	1.04 to 1.08	< 0.001
	ASA	1.47	1.11 to 1.93	0.006
	ABT	1.67	1.28 to 2.20	< 0.001
LOS > 11 days	Male gender	1.99	1.49 to 2.66	< 0.001
	Anemia	0.63	0.48 to 0.81	< 0.001
	Age in years	1.07	1.05 to 1.08	< 0.001
	ABT	2.26	1.73 to 2.94	< 0.001
	ASA	1.24	0.97 to 1.59	0.089
Discharge to a NH	Anemia	1.41	1.10 to 1.81	0.007
	Age in years	1.05	1.04 to 1.07	< 0.001
	General anesthesia	1.67	1.05 to 2.64	0.029
	Male gender	0.75	0.58 to 0.99	0.038
	ABT	1.24	0.96 to 1.61	0.097
	Anemia	1.61	1.11 to 2.33	0.011
	90-day readmission rate			
	Age in years	0.97	0.94 to 0.99	0.006
	ASA	1.43	0.99 to 2.09	0.060
	General anesthesia	0.35	0.13 to 0.99	0.047

Female gender, ASA classification I-II, having no anemia, receiving no allogeneic blood transfusion and spinal anesthesia are reference categories.

* Expressed in HR (Hazard Ratio), all other risk factors in OR (Odds Ratio)

CI = confidence interval, LOS = length of stay, NH = nursing home, ASA = American Society of Anesthesiologists Physical Status classification, ABT = allogeneic blood transfusion.

As demonstrated in Figure 1 and 2, this effect of transfusion on mortality between anemic and non-anemic patients disappeared after about 3 months; the curves of anemic and non-anemic patients that receive an ABT (Figure 2) are parallel the first 90 days whereas the curves of those that do not receive an ABT diverge (Figure 1).

Mortality in patients that received an ABT was comparable in patients that were anemic at admission (24.3%) compared to the non-anemic (19.6%, $p = 0.26$).

In patients that did not receive an ABT mortality was higher in anemic (16.7%) than in non-anemics (9.9%, $p = 0.07$).

The RR for 3-month mortality in patients receiving an ABT was comparable between anemic patients (RR = 1.45, CI 1.02-2.06, $p = 0.035$) and non-anemic patients (1.97, CI 1.32-2.95, $p = 0.001$).

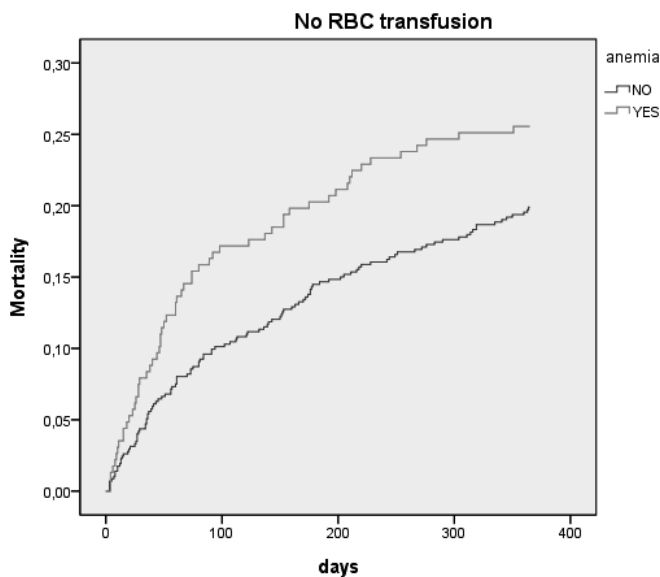


Figure 1 mortality in patients that did not receive an allogeneic blood transfusion (ABT).

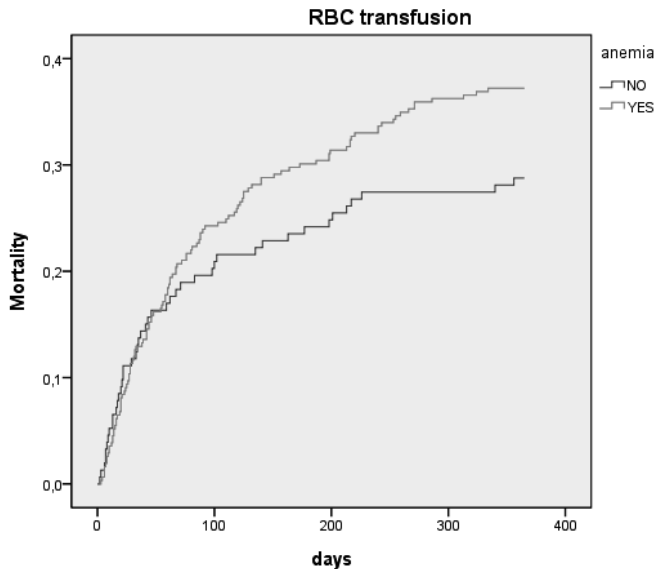


Figure 2 mortality in patients that received an allogeneic blood transfusion (ABT).

Discussion

In the current study we demonstrate that receiving an ABT, an ASA classification III/IV and higher age were risk factors for postoperative mortality. In the same analysis, anemia at admission was a significant risk factor for discharge to a nursing home and readmission within 90 days, but not for a higher mortality. LOS in anemic patients, corrected for age and ABT, was shorter. Finally, receiving an ABT was correlated with a longer LOS and a higher delirium incidence.

Anemic versus non-anemic patients

The incidence of anemia and the rate of ABTs in this cohort were consistent with previous studies in hip fracture patients [6-9,11-14].

Anemic patients were more likely to be older and to be men, to have a trochanteric fracture and a higher ASA score and to receive an ABT; the latter two results were demonstrated by others as well [7,8]. These studies [7,8] could not find a difference in gender distribution, one other could [6]. Others have shown that higher age, female

gender and worse health status are correlated to intertrochanteric fractures [20-22]. These findings show the complex correlation between anemia as a mirror of a poor general condition (expressed in higher ASA scores), age and fracture type and gender.

Multivariable logistic and Cox regression analysis

We found anemia not to be a significant risk factor for mortality in Cox regression analysis, in contrast to several other studies [6-9]. However, the largest of these studies contained only 791 patients and some methodological concerns could be identified [6]. We consider anemia therefore to be more a proxy for frailty than a direct cause related to mortality. Receiving an ABT was a risk factor for mortality at all follow-up moments, but not for the 3 to 12 months interval with its main effect in the first 3 months.

Mortality in transfused hip fracture patients was either higher or equal in previous series [10-14]. The two largest series were described by Johnston et al (n = 3571) and Carson et al (n = 8787) [12,14]. Johnston et al found a negative correlation at 120 and 365 days in univariate, but not in multivariable analysis [12]. Carson et al found no effect on 30- and 90-day mortality [14]. In contrast, fewer complications were seen in restrictive ABT regimen patients who had total hip and knee replacements [23].

Age and ASA classification as risk factors for mortality and poor outcome do not need further explanation; the negative effect of the latter in hip fracture patients has recently been published [24].

Younger patients with anemia who received no ABT had a shorter LOS in our series. LOS is more often reported upon in studies on anemia than in those on ABTs [7-14]. Gruson, and Halm found a longer LOS in anemic patients, whereas Hagino did not [7-9]. The only study on ABT in hip fracture patients that reported LOS found no difference [10]. Younger age is most probably the reason for the shorter LOS, not anemia or receiving no ABT.

Receiving an ABT did and anemia did not have a negative effect on delirium incidence in this series. None of the studies on anemia and ABTs in hip fracture patients we found, reported delirium incidence. We would have expected anemia to be of negative influence as well, because higher age and ASA classification and male gender were negative contributors; all part of the anemic patient profile. This is probably due to the fact that delirium occurs as a result of many more factors, like cognitive impairment and medication.

Finally, anemia at admission was of negative contribution to the 90-day readmission rate, ABT was not. Halm et al reported on readmissions, they found a lower 60- day readmission rate in patients with a higher hemoglobin level and in those receiving an ABT [9,13]. These different findings are probably due to the fact anemia and an ABT are only two minor of the many factors influencing the readmission rate.

Anemia effecting ABT and vice versa

As demonstrated, receiving an ABT had a rescue effect on mortality in anemic patients in the first 3 months. This was probably partly due to correction of the negative effect of anemia at admission. The RR for 3-month mortality in patients receiving an ABT was comparable between anemic and non-anemic patients; both groups are negatively affected by an ABT.

Limitations

Our study had a large sample size and the combined analysis of both anemia at admission and ABTs has never been done before. Limitations were that part of the data was collected retrospectively and documentation of occurrence of a delirium was based on clinical observations as described in the DSM-IV [16]. Although these criteria are sufficient, it is better to use a specific delirium score like the Confusion Assessment Score [25].

The time interval from fracture to admission is of no influence on the measured hemoglobin level at admission since in the Netherlands the mean interval between an accident and admission is no longer than a few hours.

Several limitations of the analysis for the impact of receiving an ABT can be identified. The number of ABTs was not reliably registered in the large majority of the patients, which made an interesting extra analysis using the number of transfusions not valid. For male and female patients different cut-off points for anemia (defined by the WHO) were used, but the transfusion threshold was not different [17,19]. Furthermore, the decision in daily clinical practice to give an ABT is not only based on the transfusion thresholds, but on clinical aspects as well as defined in the CBO guideline [19].

However, this represents daily practice for most hospitals. Because of these limiting factors we will not presume a causal link between mortality and the other outcome

parameters and receiving an ABT but we rather call it “postoperative anemia necessitating a transfusion, PANT” as a reflection of the whole of the condition of the patient that needs an ABT postoperatively.

The outcome of this study can be used for better inform consent, to perform early interventions for prevention of a delirium, to anticipate for a longer LOS and to provide an alternative discharge location early in patients at risk.

Finally, awaiting the results of large trials on ABTs like the FOCUS trial [26], it might be of benefit to use a lower cut-off transfusion threshold in hip fracture patients that are in a worse condition, like anemia.

Conclusions

This study has demonstrated that anemia at admission and PANT were independent risk factors for worse outcome in hip fracture patients. In multivariable regression analysis, anemia at admission as such had no effect on mortality, due to a rescue effect of PANT. PANT affected in-hospital, 3- and 12-month mortality negatively, with the main effect in the first 3 months postoperatively.

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Authors' contributions

AV, BB, BM, WT and PP participated in the design of the study. AV, BB, AN, PP and MV were responsible for data collection. BM and WT performed the statistical analysis. PP, RB and RN reviewed the article and supervised the surveillance and analysis. All authors have read and corrected draft versions of the manuscript and have approved the final manuscript.

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3

Do clinical characteristics and outcome in nonagenarians with a hip fracture differ from younger patients?

Anne JH Vochteloo, Boudewijn LS Borger van der Burg, Wim E Tuinebreijer, Mark R de Vries, Arthur
HP Niggebrugge, Rolf M Bloem, Andrea B Maier, Rob GHH Nelissen and Peter Pilot

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Abstract

Aim: To compare clinical characteristics and outcome of nonagenarian hip fracture patients with younger patients aged 65–89 years.

Methods: This was a cohort follow-up study of admissions for a hip fracture between 2005–2010 (mean follow up of 3.5 years) in two teaching hospitals in the Netherlands; 230 nonagenarians and 1014 patients aged 65–89 years were included. Clinical characteristics, adverse events, mobility and mortality were compared.

Results: Nonagenarians were more likely to be female and anemic (both $P < 0.001$), and had more trochanteric fractures ($P = 0.005$). The number of American Society of Anesthesiologists III/VI classified patients did not differ between the two groups. During the hospital stay, adverse events were more frequently observed in nonagenarians compared with younger patients ($P < 0.001$). The length of stay was significantly longer in nonagenarians ($P < 0.001$), and the 90-day readmission rate was similar. Absolute mortality was higher in nonagenarians ($P < 0.001$), excess mortality, however, was comparable. Before admission, 40.0% of the nonagenarians lived in their own home, and 40.9% had returned 3 months postfracture. The rate of returning to their own home was lower compared with younger patients ($P < 0.001$). Prefracture mobility was worse in nonagenarians compared with the younger group, but 3 months after discharge, the number of patients that regained prefracture mobility was comparable in both age groups.

Conclusions: Nonagenarian hip fracture patients differ significantly from younger patients aged 65–89 years with respect to clinical characteristics and long-term outcome. However, almost half of the nonagenarians returned to their own home and more than half regained their prefracture level of mobility. Given these findings, prevention strategies for hip fracture and adverse events during hospital stay that focus particularly on frail nonagenarians are highly recommended.

Introduction

The number of nonagenarians is rapidly increasing and therewith the number of hip fracture patients aged 90 years and older.^{1,2} Nonagenarian patients frequently suffer from comorbidities and functional impairment,^{3–5} which have a huge impact on outcome after hip fracture treatment. Previous studies have shown that advanced age is associated with increased mortality rates and worse functional recovery after a hip fracture.^{6–12}

Just two previous reports have compared clinical characteristics of nonagenarians with younger hip fracture patients;^{13,14} other reports are based on case series of nonagenarians or include relatively small numbers of patients.^{15–23} These studies show differences in clinical characteristics, number of adverse events, functional outcome and mortality rates.^{13–23} The differences in outcome might be as a result of a large variation in cohort characteristics and incomparability of the outcome variables.

Detailed clinical characteristics of nonagenarian hip fracture patients and their outcome after fracture treatment become increasingly important as life expectancy has been growing extensively over the last decades.²⁴ The aim of the present study was to assess clinical characteristics and outcome in a large Dutch cohort of 230 nonagenarian patients with a hip fracture compared with a younger cohort of hip fracture patients aged 65–89 years.

Patients and methods

Patients

This was an observational cohort study including all consecutive patients with a hip fracture admitted to two middle-sized teaching hospitals in Delft (Reinier de Graaf Hospital) and The Hague (Bronovo Hospital), in the Netherlands from January 2005 to January 2010. In total, 230 patients aged 90 years and older, and 1014 patients aged 65–89 years were included. The study was prospective from January 2008 onwards. Exclusion criteria were a pathological hip fracture and high-energy trauma. Minimum follow up was 1 year, or to death. The mean (SD) length of follow up was comparable between

the groups (65–89 years: 3.6 years [1.4], 90 years and older: 3.5 years [1.3]). Approval from the local ethical committee was not necessary, as no intervention was carried out and the study was an evaluation of standard usual care as part of good clinical practice. Furthermore, as data could not be traced back to the individual patient, no privacy nor ethical issues were at stake.

Outcome parameters

Available characteristics for all patients were age, sex, American Society of Anesthesiologists (ASA) Physical State classification,²⁵ type of fracture, surgical treatment and anesthesia, time to surgery (since admittance in hospital), presence of anemia at admission (based on the criteria of the World Health Organization as hemoglobin level below 7.5 mmol/L [12 g/dL] in women and below 8.1 mmol/L [13 g/dL] in men),²⁶ need for blood transfusion, in-hospital adverse events (delirium, cardiac adverse events, urinary tract infection, surgical site infection, bleeding problems, pressure sores, minor/ major strokes), length of hospital stay (LOS), discharge location, and 90-day readmission rate.

The national guideline from the Dutch Institute for healthcare Improvement (CBO) for red blood cell (RBC) transfusion was applied; a transfusion is indicated for patients aged 60 years or older if the hemoglobin level is lower than 5.0 mmol/L (8.0 g/dL) or 6.0 mmol/L (9.7 g/dL), if the patient has a serious cardiac condition or if anemia becomes symptomatic.²⁷

Mortality of all patients was scored meticulously by repeated consultation of the population registers of the counties in the region of both hospitals, as well as the hospital's patient registration systems. In-hospital, 3-month and 1-year follow-up data for mortality were available for all patients; data on 2-year follow up were available for 198 (85.3%) nonagenarians and 827 (81.6%) patients aged 65–89 years due to inclusion in 2009.

Patients with prospective follow up

In January 2008, a new hip fracture protocol was implemented as part of the regular care in both hospitals. Since then, place of residence, the level of activities of daily living expressed with the Groningen Activity Restriction Scale (GARS),²⁸ and the level of mobility were reported at admission and 3 months thereafter during the routine follow-up visit at the outpatient clinic or by a questionnaire sent to the patient or care-takers in case of cognitive impairment.

The GARS assesses competence in abilities in 11 personal basic activities of daily living (ADL) and seven instrumental activities of daily living (IADL). A summed score was calculated for basic IADL ranging from 18, indicating the ability to carry out all activities without assistance or undue effort, to 72, indicating disability.²⁸

Mobility was divided into four categories: mobile without use of an aid in- and outdoors, mobile in- and outdoors with the use of an aid, only mobile indoors (regardless the use of an aid) and immobile. A cane, crutch(es) or walker were considered an aid. Patients in a wheelchair were considered to be immobile.

Statistical analysis

Continuous data are presented as means, with standard deviations (SD). The independent Student's *t*-test was used to compare groups of continuous data. Categorical data are presented as the number of participants in the category, along with the percentages. The χ^2 -test and Fisher's exact test were used for comparing groups of categorical data.

We compared the two age groups with respect to distribution of sex, ASA classification, presence of anemia, type of fracture, treatment and anesthesia, time to surgery, need for blood transfusion, in-hospital adverse events, LOS, 90-day readmission rate and mortality rates. Patients classified as ASA I or II and III or IV were combined into two groups, as the separate groups of patients with an ASA I or IV classification were too small to be analyzed separately. LOS was changed into a binary outcome; that is, 211 days or >11 days, based on the median LOS of the whole cohort. Both absolute mortality and excess mortality were compared between the two age groups. Excess mortality was defined as the mortality added by the hip fracture; that is, mortality of these groups minus the baseline mortality of the background Dutch population in 2005–2009, provided by the Central Bureau of Statistics.²⁹

Within the group of nonagenarians, patients who died during hospital stay or those that had died in the first year postoperatively were compared with the survivors, with regards to the same parameters as aforementioned.

From January 2008 to January 2010, 77 nonagenarians and 347 patients aged 65–89 years were admitted. Both groups were compared with respect to place of residence at admission, hospital discharge location and at 3 months postfracture treatment, level of ADL (using the GARS) and pre- and postfracture level of mobility.

Analysis for likelihood of returning to place of residence was carried out only in patients living in their own home or in a residential home at admission. Nursing home patients were excluded, as they all returned to this location.

P-values lower than 0.05 were considered statistically significant. Relative risks (RR) are shown with a 95% confidence interval if the *P*-value <0.05. All data were analyzed in SPSS 17.0 (SPSS, Chicago, IL, USA).

Results

Clinical characteristics

Table 1 shows the characteristics of the study cohort. A total of 230 nonagenarians with a mean (SD) age of 93.5 years (2.6) were compared with 1014 patients aged 65–89 years (mean [SD] age 81.3 years [5.8]). Nonagenarian patients were more often female, suffered more frequently from anemia and trochanteric fractures, but had similar ASA classifications compared with the younger group. In the group of nonagenarians, surgery was less frequently carried out within 1 day after admittance to the hospital. LOS was more frequently longer than 11 days in nonagenarians compared with the younger group.

Clinical adverse events and readmissions

Table 2 shows adverse clinical outcomes during hospital stay. A total of 77.8% of the nonagenarians had one or more clinical adverse events during admission compared with 61% of the patients aged 65–89 years ($P < 0.001$). Blood transfusion need, delirium and cardiac adverse events were significantly more often observed in nonagenarians. None of the other adverse events were significantly different in both groups. The 90-day readmission rate was lower in the group of nonagenarians compared with the patients aged 65–89 years. A deep wound infection or a revision of a failed osteosynthesis was the reason for readmission in five out of the 13 (38.5%) nonagenarians, and in 38 of the 117 (32.5%) patients aged 65–89 years.

Table 1 Clinical characteristics of patients aged 65–89 years and older than 90 years

	65–89 years <i>n</i> = 1014	390 years <i>n</i> = 230	<i>P</i> -value
Mean age, years (SD; range)	81.3 (5.8; 65–89.9)	93.5 (2.6; 90–103.5)	<0.001
Female	729 (71.9)	191 (83.0)	<0.001
ASA III/IV	322 (31.8)	80 (34.8)	0.38
Anemia	393 (38.8)	130 (56.5)	<0.001
Fracture type			0.01*
Neck of femur fracture	589 (58.1)	109 (47.4)	
(Inter-) Trochanteric fracture	397 (39.2)	112 (48.7)	0.005**
Subtrochanteric fracture	28 (2.8)	9 (3.9)	
Non-operative treatment	11 (1.1)	7 (3.0)	0.03
Surgery 21 day	855 (84.3)	176 (76.5)	0.005
Days to surgery, mean (SD)	0.86 (1.12)	0.97 (1.10)	0.18
Spinal anesthesia	938 (92.5)	207 (90.0)	0.71
LOS > 11 days	482 (47.5)	143 (62.2)	<0.001

P*-value comparing three treatment groups, *P*-value comparing (inter) trochanteric with neck of femur fracture. Values are given as number (percentage) if not given otherwise. ASA, American Society of Anesthesiologists Physical State classification; LOS, length of stay.

Table 2 Adverse events for hip fracture patients aged 65–89 years and older than 90 years

	65–89 years <i>n</i> = 1014	390 years <i>n</i> = 230	RR (95% CI)	<i>P</i> -value
Readmission <90 days	117 (11.5)	13 (5.7)	0.88 (0.30–0.87)	0.008
RBC transfusion for anemia	328 (32.3)	120 (52.2)	1.94 (1.54–2.44)	<0.001
Delirium	228 (22.5)	77 (33.5)	1.55 (1.21–1.97)	<0.001
Cardiac complications	104 (10.3)	44 (19.1)	1.75 (1.32–2.32)	<0.001
Urinary tract infection	111 (10.9)	34 (14.8)	1.31 (0.95–1.81)	0.10
Bleeding	52 (5.1)	18 (7.8)	1.42 (0.94–2.16)	0.11
Pneumonia	75 (7.4)	22 (9.6)	1.25 (0.85–1.84)	0.27
Surgical site infection	41 (4.0)	10 (4.3)	1.06 (0.60–1.88)	0.83
Pressure sores	35 (3.5)	12 (5.2)	1.40 (0.85–2.32)	0.21
Minor/major stroke	16 (1.6)	4 (1.7)	1.08 (0.45–2.62)	0.78

Values are given as number (percentage). CI, confidence interval; RBC, red blood cell; RR, relative risk.

Mortality

Table 3 shows the all-cause mortality rate for both age groups. All cause mortality rates, except the 3–12-month interval, were significantly higher in the group of nonagenarians. The 1-year mortality rate of the Dutch background population from 2005–2009 was 3.8%

for the patients aged 65–90 years and 26.5% for the nonagenarians. The excess 1-year mortality of both groups was comparable; 19.4% in the patients aged 65–90 years and 16.1% for the nonagenarians ($P = 0.29$).

Table 3 Relative risks for mortality of patients aged 65–89 years and older than 90 years

Mortality	65–89 years <i>n</i> = 1014	390 years <i>n</i> = 230	RR (95% CI)	<i>P</i> -value
In-hospital	41 (4.0)	22 (9.6)	1.98 (1.38–2.84)	<0.001
1 month	70 (6.9)	35 (15.2)	1.95 (1.44–2.63)	<0.001
3 months	136 (13.4)	69 (30.0)	2.17 (1.71–2.76)	<0.001
3–12 months	99 (9.8)	29 (12.6)	1.26 (0.89–1.77)	0.200
1 year	235 (23.2)	98 (42.6)	2.03 (1.61–2.55)	<0.001
2 years	303 (29.9)	124 (53.9)	2.24 (1.78–2.82)	<0.001

Values are given as number (percentage). The patients aged 65–89 years are the reference category. CI, confidence interval; RR, relative risk.

Comparison of surviving and deceased nonagenarians

The mean age of nonagenarians that died during hospital stay was higher compared with surviving patients (94.7 vs 93.4 years, $P = 0.02$). The percentage of patients treated conservatively (13.6 vs 1.9%, RR 1.60, CI 0.84–3.04, $P = 0.02$) was higher in the deceased nonagenarians. The percentage of patients with a LOS >10 days was lower in those who died during admission compared with those that did not. (64.9 vs 36.4%, RR 0.89 CI 0.80 to 0.98, $P = 0.009$)

The frequency of cardiac complications (63.6 vs 14.4%, RR 1.40, CI 1.14–1.72, $P < 0.001$) and presence of pneumonia (40.9 vs 6.3%, RR 1.59, CI 1.12–2.25, $P < 0.001$) was significantly higher in the nonagenarians who died in hospital, contrary to other complications, which were similar between the age groups.

Compared with the surviving nonagenarians, nonagenarians who died in the first year after they sustained a hip fracture, the mean age was higher (94 vs 93.1 year, $P = 0.012$), the ASA classification was more often III/IV (48 vs 25%, RR 1.60, CI 1.20–2.13, $P < 0.001$) and patients were more often treated conservatively (6.1 vs 0.8%, RR 4.11, CI 0.67–25.33 $P = 0.04$). Cardiac complications (26.5 vs 18%, RR 1.50, CI 1.03–2.18, $P = 0.014$) and pneumonia (15.3 vs 5.3%, RR 1.89, CI 1.01–3.52, $P = 0.011$) were found significantly more often in nonagenarians who died in the first year compared with the survivors.

Patients with prospective follow up

Table 4 shows differences between nonagenarians and the patients aged 65–89 years that had a prospective follow up considering place of residence and level of ADL and mobility.

Table 4 Place of residence, mobility and nutritional status of the subgroup of patients aged 65–89 years and older than 90 years with a prospective follow up

	65–89 years <i>n</i> = 347	390 years <i>n</i> = 77	RR (95% CI)	<i>P</i> -value
Place of residence at admission				<0.001*
In their own home	244 (70.5)	30 (40.0)	1.36 (1.18–1.58)	
Residential home	66 (19.1)	35 (46.7)		<0.001**
Nursing home	36 (10.4)	10 (13.3)		
Discharge to an alternative location				
Home-based patients	156 (65.3)	26 (89.7)	1.13 (1.05–1.21)	0.008
Residential home-based patients	37 (59.7)	25 (83.3)	1.40 (1.08–1.81)	0.023
Alternative location at 3 months				<0.001
Home-based patients	52 (23.6)	13 (59.1)	1.19 (1.05–1.35)	
Residential home-based patients	15 (27.8)	8 (38.1)	1.15 (0.82–1.61)	0.38
GARS, mean (SD)	41.0 (18.0)	50.3 (15.4)	n/a	<0.001
Mobility at admission				
Mobile without an aid	134 (38.7)	12 (16.0)		<0.001
Mobile with aid	159 (46.0)	31 (41.3)	n/a	
Only mobile indoors	47 (13.6)	26 (34.7)		
Immobile	6 (1.7)	6 (8.0)		
Regained mobility at 3 months [†]	136 (45.0)	24 (52.2)	0.78 (0.46–1.34)	0.37
Mortality at 3 months	36 (10.4)	28 (36.4)	3.21 (2.20–4.70)	<0.001

**P*-value comparing three groups. **Relative risk (RR) and *P*-value comparing residential home patients with patients living in their own home. [†]Information was missing in five of the patients aged 390 years and in nine of the patients aged 65–89 years. Values are given as *n* (percentage) if not given otherwise. CI, confidence interval; GARS, Groningen Activity Restriction Score; RR, relative risk.

Place of residence

At admission, 40.0% of the nonagenarians lived in their own home and 46.7% lived in a residential home. Both at discharge and after 3 months, nonagenarians were less likely to return to their own home compared with the younger group of patients. At 3 months after admission, 40.9% of the nonagenarians that lived in their own home and 62.8% of

those living in a residential home at admission had returned to their original place of residence.

Level of ADL and mobility

The level of ADL at admission was significantly lower in the nonagenarians compared with the younger group. A total of 57.3% of the nonagenarians were still mobile both in- and outdoors. The prefracture level of mobility was significantly worse compared with the younger group. At 3 months postfracture, 52.2% of the nonagenarians had regained their prefracture level of mobility, which was not significantly different from the patients aged 65–89 years.

Discussion

In the present study, nonagenarian hip fracture patients were more often female and anemic, and suffered more often a trochanteric fracture than patients aged 65–89 years. Furthermore, more adverse events, higher mortality rates, a lower level of mobility and a higher percentage of patients not returning to their own home were found in the group of nonagenarians compared with the patients aged 65–89 years. Excess mortality (because of the hip fracture), however, was comparable between both age groups. Before admission, almost half of the nonagenarians lived in their own home and the majority was able to walk in- and outdoors. At 3 months, approximately half of the nonagenarians regained their prefracture mobility and had returned to their original place of residence.

Just two other studies compared nonagenarians with a younger age group with respect to clinical characteristics, such as age, fracture type, ASA classification and mortality after a hip fracture: a smaller USA-based study with comparable age of the patient groups to the present study and a very large Scottish study of patients aged 95 years and older compared with patients aged 75–89 years.^{13,14} In line with the present study, patients were more often female in the latter study.¹⁴

We found a similar distribution of the ASA classification between both age groups, contrary to both former studies that found significantly more ASA III and IV patients at older ages.^{13,14} Regional differences in health status and socioeconomic background might account for these differences.

In concordance with the literature, most nonagenarians suffered from a trochanteric fracture.^{13,14,17–20,22,23} Trochanteric fractures are associated with older age and female sex, probably because of differences in the type and rate of bone loss in the sexes, or the changing rate and pattern of falling with aging.^{30–32}

Timing of surgery in the oldest older patients with comorbidities might influence the outcome, as early surgery might prevent adverse events, such as pneumonia and pressure sores, but postponing surgery to optimize patients with comorbidities might improve their outcome. This is still at the center of debate.^{33,34} In the Netherlands, surgery within 24 h is a quality indicator, used to assess surgical care by the government. The latter might explain our relative short time to surgery (0.97 days) compared with non-Dutch studies (1.3– 5.7 days).^{15,19,23} It is, however, comparable with another Dutch cohort.¹⁷

The LOS in the present study was shorter than in previous reported studies.^{17,19,21,23} LOS is a frequently reported outcome variable in literature indicating quality of care. However, LOS might not be the best parameter to compare the outcome of different cohorts, as it is influenced by many factors, of which several are non-medical. The difference in LOS between studies is likely not to be explained by differences in patient characteristics, such as adverse event rates. They show differences in organization of after-care and rehabilitation, and differences in social home environment between the different countries.³⁵

The 90-day readmission rate of nonagenarians was lower compared with the younger group. Only one previous study on nonagenarians reported readmission rates being higher compared with the present study population, which might be a result of a higher number of ASA III/IV-classified patients in that study.²³

Delirium, cardiac adverse events and postoperative anemia requiring a blood transfusion were significantly more often reported adverse events in the nonagenarians. Receiving blood products can be a risk factor for developing delirium.³⁶ As the number of patients receiving a blood transfusion was higher in nonagenarians, this might partly explain the difference in delirium incidence. Other reasons might be multimorbidity and polypharmacy; however, these factors were not registered in the present study. The higher number of blood transfusions can be explained by the higher prevalence of anemia

at admission. The reported rate of adverse events in literature differ widely between 14.6 and 100%, most probably because of differences in the thoroughness of registration and definition of an adverse event.^{13,15,18,19,23} Type of adverse events were mentioned in just two reports.^{18,19}

In-hospital mortality of nonagenarian hip fracture patients was comparable with recent studies (6–11.6%),^{13,17,19–23} whereas older studies showed higher mortality rates (18–24%),^{15,18} most probably as a result of a longer LOS. In the Netherlands, 1-year mortality for women aged 90–94 years is reported to be 21%, which is half of the percentage of the nonagenarian hip fracture population (42.6%) in the present study.²⁹ In a large series from the Scottish Hip Fracture Audit (SHFA), mortality in patients aged 85 years and older returned to that of the background population within 2–5 years.³⁷ These findings differ strongly from Alarcon *et al.*, showing that excess mortality had disappeared after 2 months.²³ However, they compared an older cohort (1961–1970) of younger patients (mean age 73.9 years) as a reference.^{23,38} There was no difference in the excess mortality between both age groups in this cohort. The two age groups-comparing papers did not compare excess mortality.^{13,14} This is a very interesting finding; the negative impact of a hip fracture on mortality is apparently the same in younger patients as it is in nonagenarian patients. Previously reported higher mortality rates in nonagenarians might therewith simply be caused by the effect of chronological aging.^{13,14}

The frequency of cardiac complications and pneumonia was significantly higher in nonagenarians who died during hospital stay or in the first year after the hip fracture, compared with the surviving nonagenarians. A large series of younger patients from the UK (2448 patients, mean age 82 years) reported a higher 1-year mortality in patients with these same complications as well.³⁹

Almost half of the nonagenarians still lived in their own home before admission and more than half of them had returned to their own home 3 months postfracture. Half of the nonagenarians lived in a residential home. None of the other studies mentioned a residential home as a place of residence. Either their own home or a nursing home was reported as a possible place of residence. In the Netherlands, a residential home is

a very heterogeneous form of living, ranging from an apartment in a complex with the availability of support to a location with full support for ADL. Because of large differences between countries in types of housing and traditions for homes for elderly people, the place of residence is hard to compare between studies.⁴⁰ This is reflected in the wide range of numbers of patients living in a nursing home before admission in the other studies (4.7–28.1%).^{20,21,23}

The lower level of mobility of the nonagenarians in comparison with the patients aged 65–89 years is in line with another report.¹³ Approximately half of the nonagenarians regained their prefracture mobility after, which is also in concordance with previous studies.^{13,16,19–21,23} Compared with a cross-sectional cohort of Dutch people aged 85 years and older that lived in their own home, a slightly reduced level of ADL at admission in nonagenarians was found, showing the higher daily dependence of the studied population.⁴¹

The strengths of the current study are its sample size, without bias as a result of exclusion criteria, except for pathological fractures and high-energy trauma fractures, and the meticulous registration of all variables including mortality. Limitations were the retrospective collection of a part of the data, and the relative smaller number of patients used for evaluation of mobility and place of residence. Furthermore, we did not have detailed information for all patients on medication and number of comorbidities, and no data on cognitive assessment were available. Significant differences were found between both age groups, most of which were most probably as a result of the effect of aging and not specific to hip fracture patients as such.

Most of our outcomes confirm the percentages previously presented in the literature. However, as the number of nonagenarians is rapidly growing, it is of importance to have reliable and reproducible data on clinical characteristics of these elderly patients.

Our data are valuable for not only the research community, but also for daily clinical practice, even if one does not find large new issues. With independent data, the latter also underscores the importance of predictive factors for morbidity in this category of patients. Furthermore, former studies came from the USA and UK, with very different healthcare systems and differences in society compared with the Netherlands.^{13,14}

To conclude, nonagenarian hip fracture patients differ significantly from patients aged 65–89 years with respect to clinical characteristics and long-term outcome. However, almost half of the nonagenarians returned to live in their own home and more than half regained their prefracture level of mobility. Given these findings, hip fracture prevention strategies and prevention of adverse events during hospital stay that focus particularly on the group of frail nonagenarians are highly recommended.

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4

Contralateral hip fractures and other osteoporosis-related fractures in hip fracture patients: incidence and risk factors. An observational cohort study of 1,229 patients

Anne J. H. Vochteloo, Boudewijn L. S. Borger van der Burg, Maarten A. Röling,
Diederik H. van Leeuwen, Peter van den Berg, Arthur H. P. Niggebrugge, Mark R. de Vries,
Wim E. Tuinebreijer, Rolf M. Bloem, Rob G. H. H. Nelissen and Peter Pilot

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Abstract

Purpose To report risk factors, 1-year and overall risk for a contralateral hip and other osteoporosis-related fractures in a hip fracture population.

Methods An observational study on 1,229 consecutive patients of 50 years and older, who sustained a hip fracture between January 2005 and June 2009. Fractures were scored retrospectively for 2005–2008 and prospectively for 2008–2009. Rates of a contralateral hip and other osteoporosis-related fractures were compared between patients with and without a history of a fracture. Previous fractures, gender, age and ASA classification were analysed as possible risk factors.

Results The absolute risk for a contralateral hip fracture was 13.8 %, for one or more osteoporosis-related fracture(s) 28.6 %. First-, second- and third-year risk for a second hip fracture was 2, 1 and 0 %. Median (IQR) interval between both hip fractures was 18.5 (26.6) months. One-year incidence of other fractures was 6 %. Only age was a risk factor for a contralateral hip fracture, hazard ratio (HR) 1.02 (1.006–1.042, $p = 0.008$). Patients with a history of a fracture (33.1 %) did not have a higher incidence of fractures during follow-up (16.7 %) than patients without fractures in their history (14 %). HR for a contralateral hip fracture for the fracture versus the non-fracture group was 1.29 (0.75–2.23, $p = 0.360$).

Conclusion The absolute risk of a contralateral hip fracture after a hip fracture is 13.8 %, the 1-year risk was 2 %, with a short interval between the 2 hip fractures. Age was a risk factor for sustaining a contralateral hip fracture; a fracture in history was not.

Introduction

The incidence of osteoporosis has increased over the last decades in our aging population [1– 3]. As advanced age and osteoporosis lead to enhanced bone fragility and increased fracture risk, the amount of osteoporosis-related fractures has also increased. Lifetime risk for developing an osteoporotic fracture is 30 % with an estimated amount of 9.0 million fractures worldwide in the year 2000 [4, 5]. Fractures of the proximal femur, distal radius, proximal humerus and vertebrae are the most frequently seen types of osteoporosis-related fractures. These fractures are related with increased morbidity and mortality. Hip fractures have the most devastating impact on a patients' life with 1-year mortality rates of 18 up to 32 %, compared to 15 % after a vertebral fracture [2, 6– 8]. Half of all hip fracture patients will never recover to their pre-fracture functional capacity and 25 % of these patients reside in a long-term care institution 1 year after sustaining a hip fracture [9– 11].

Besides high mortality and high morbidity rates, an osteoporosis-related fracture has been identified as an important risk factor for sustaining subsequent fractures, particularly during the first 2 years after the initial fracture [12, 13]. The risk of sustaining a contralateral hip fracture within 2 years after the initial hip fracture is reported to be 4–10 % [14, 15]. As hip fractures are the most devastating fractures for patients, the main goal of this study was to assess the 1-year risk and absolute risk of sustaining a contralateral hip fracture in our cohort. Secondary, possible risk factors for sustaining a contralateral hip fracture were identified.

Materials and methods

An observational cohort study of 1,229 consecutive hip fracture patients of 50 years and older, admitted to two teaching hospitals from January 2005 to July 2009. The study was retrospective for patients admitted between 2005 and 2008, and prospective for patients admitted between 2008 through June 2009. The first hip fracture sustained within this time frame was marked as the index hip fracture. Patients with a fracture due to a high-energy trauma or with a pathologic fracture were excluded. Osteoporosis-related fractures (contralateral hip, distal radius, proximal humerus and vertebrae at any level) in

the history of all patients were retrospectively scored. All hospital databases (emergency department, clinical and radiological records and operating theatre database) were used to collect fracture data. All admissions of the patients were entered into our database. When a patient was not admitted to hospital, emergency room data were still entered into the database. By combining the digital files of emergency department admittance, hospital records and operating theatre data all potential hip and other fractures were scored as complete as possible.

From the hospital's records, patient demographics like age, gender, ASA physical status classification, type of fracture, type of treatment, type of anaesthesia, were collected onto a case record form (CRF) [16].

Postoperative mortality has been documented by repeated consultation of the population registers present in every county in The Netherlands. For the assessment of concomitant fractures both before and after the index hip fracture, the patients record in the picture and archives system (PACS) was evaluated from January 2003 (2 years before the index fracture) up to January 2010. This time frame was chosen since 2003 a PACS was used in both hospitals. All low-energy trauma fractures of the contralateral hip, distal radius, proximal humerus and vertebrae at any level were scored. The patient record files were evaluated for notes on previous history for fractures occurred before 2003. If present, they were recorded at the CRF. As of 2008 all data were recorded prospectively at the CRF.

The 1-year incidence and prevalence of fractures of the contralateral hip, distal radius, proximal humerus and vertebrae both prior to and after the index hip fracture were determined.

Patients with bilateral hip fractures were compared to those with a unilateral hip fracture, regarding general demographics (age, gender, ASA classification, type of fracture and treatment), prevalence and 1-year incidence of concomitant fractures. This was done for patients with and without fractures prior to the index hip fracture. Finally, the different groups were compared regarding mortality rates.

It was not necessary to obtain approval from the local ethical committee due to the observational character of this surveillance study. Therefore, it is an evaluation of usual care as a part of good clinical practice. Since data could not be traced back to the individual patient there were no privacy issues.

Statistical analysis

Categorical data are presented as the number of subjects in the category, along with the percentages. Chi-square tests and Fisher's exact test were used for comparing groups of categorical data. All continuous data are presented as means with standard deviations (SD). The independent Student's *t* test was used to compare groups of continuous data.

Fracture and mortality rates were expressed for different time periods calculated using the Kaplan–Meier method. Univariable and multivariable Cox regression analysis was used to calculate the hazard ratios and 95 % confidence interval (CI) to compare the difference in mortality and fracture risk in patients with or without previous fractures. In multivariable analysis the hazard ratios were adjusted for possible confounders: age, gender and general condition expressed as the ASA classification (I/II vs. III/IV).

Combining ASA I or II and III or IV classified patients in two groups was done as the separate groups of ASA I (*n* = 108) and ASA IV (*n* = 44) classified patients were too small to be analysed separately.

Age was categorized in three groups: 50–65, 65–85 years and older than 85 years.

Results

Characteristics

1,229 hip fracture patients above 50 years were included, 891 female and 338 male. The median follow-up after the index hip fracture was 17.8 months [interquartile range (IQR) 28.6]. Mean (SD) age at admission for the index hip fracture was 81.7 (9.5) years. Women (mean 82.6, SD 9.0) were older than men (mean 79.4, SD 10.3, *p* < 0.001).

The majority of patients were treated with osteosynthesis (60.5 %), followed by (hemi-) arthroplasty (38.1 %). A small group was treated conservatively (1.4 %).

The overall 1-year mortality rate of the 1,229 patients was 23 % (95 % CI 21–26 %). More characteristics are shown in Table 1.

Table 1 Characteristics of unilateral and bilateral hip fracture patients and results of the univariable Cox regression analysis

	Study population N (%)	Unilateral hip fracture N (%)	Bilateral hip fracture N (%)	HR (CI)	p value
Median (IQR) follow-up in days	1,229 (100)	1,060 (86.2)	169 (13.8)		
Gender	543 (873)	536 (886)	563 (810)		0.81*
Female	891 (72.5)	768 (72.5)	123 (72.8)	1.15 (0.82–1.62)	0.41
Male	338 (27.5)	292 (27.5)	46 (27.2)		
Age, mean (SD)	81.7 (9.5)	81.7 (9.4)	82.0 (9.9)		0.74 [#]
Age HR per year				1.02 (1.01–1.04)	0.011
Age HR per decade				1.25 (1.05–1.48)	0.011
ASA classification					
I–II	849 (69.1)	727 (68.6)	122 (72.2)	1.07 (0.76–1.49)	0.71
III–IV	380 (30.9)	333 (31.4)	47 (27.8)		
Fracture type					
Neck of femur	704 (57)	617 (58)	87 (51.5)		
(Inter) trochanteric	485 (39)	412 (39)	73 (43.2)		
Subtrochanteric	40 (3)	31 (3)	9 (5.3)		0.11
Anaesthesia					
Spinal	1,129 (92)	1,032 (92)	97 (91)		
General	83 (7)	75 (7)	8 (7)		0.94

Female gender and ASA I–II are reference categories

HR Hazard ratio, CI confidence interval, IQR interquartile range, ASA American society of anesthesiologists physical status classification

* Mann–Whitney test

[#] t test

Bilateral hip fractures

169 of the 1,229 patients had bilateral hip fractures, indicating an absolute risk of 13.8 %. The first-, second-, and third-year risk of a contralateral hip fracture was 2, 1, and 0 %, respectively (Table 2).

Of the 169 patients with bilateral hip fractures, 115 sustained a hip fracture before the index hip fracture, i.e., the index fracture was their second hip fracture. In 54 patients the second hip fracture occurred during follow-up after the index fracture, i.e., the index fracture was the first hip fracture. The median (IQR) interval between the two hip fractures in all 169 patients was 18.5 months (26.6), 36.1 % occurred with 1 year and 61.5 % was sustained in 2 years.

The median (IQR) interval between both hip fractures in the 54 patients that suffered a contralateral hip fracture during follow-up was 231 (434) days. As the follow-up of this group was too short to calculate reliable fracture incidence ratios, further analysis was performed in the entire population of 169 patients.

The mean (SD) age of patients at admission for their first hip fracture in the bilateral hip fractures group was 75.9 (11.5) years. This was lower than the mean (SD) age 81.7 (9.4) years, of the 1,060 unilateral hip fracture patients ($p < 0.001$). The mean (SD) age at time of the second hip fracture was 82.0 (9.9) years, not different from the unilateral fracture group. The male to female ratio, the mean age, type of fracture and type of anaesthesia in the unilateral group were equal to the bilateral hip fracture group (Table 1).

In univariable Cox regression analysis, the hazard ratio for men versus women to sustain a second hip fracture was 1.15 (0.82–1.62, $p = 0.41$), for ASA III–IV versus I–II 1.07 (0.76–1.49, $p = 0.71$), for age per year 1.02 (1.01–1.04, $p = 0.011$) and age per decade 1.25 (1.05–1.48, $p = 0.011$).

In multivariable Cox regression analysis, the hazard ratio for men versus women for sustaining a contralateral hip fracture was 1.24 (0.88–1.75, $p = 0.22$), for ASA III–IV versus I–II 0.98 (0.69–1.38, $p = 0.90$), for age per year 1.02 (1.01–1.04, $p = 0.008$) and age per decade 1.27 (1.06–1.51, $p = 0.008$).

Table 2 Absolute risk and risk per year after the index fracture (both in %) for a subsequent (hip) fracture and for mortality during follow-up

	Absolute risk	Year 1	Year 2	Year 3	Year 4
Subsequent fracture risk	28.6	6	3	1	1
Subsequent hip fracture risk	13.8	2	1	0	0
Mortality risk	36.0	23	11	10	11

Concomitant osteoporosis-related fractures and risk factors

In 407 patients (33.1 %) an osteoporosis-related fracture prior to the index hip fracture was found. This group of 407 was compared to the 821 patients who did not suffer fractures prior to the index event.

The absolute risk of a contralateral hip fracture during follow-up in the group with fractures was 5.1 % (n = 21) and in the group without fractures 4.0 % (n = 33). The 1-year risk for a contralateral hip fracture for the prior fracture versus the non-prior fracture group was 3.0 versus 2.0 %. In univariable Cox regression analysis the hazard ratio for sustaining a contralateral hip fracture for the fracture versus the non-fracture group was 1.29 (0.75–2.23, p = 0.36).

The absolute risk of sustaining an osteoporosis-related fracture in the population without fractures in their medical history was 14.0 % with a 1-year risk of 9 %. In the group that did sustain prior fractures, the absolute risk was 16.7 % and the 1-year risk 9 %. In univariable Cox regression analysis the hazard ratio for sustaining an osteoporosis-related fracture in the population with fractures in their medical history versus the population without fractures in their medical history was 1.19 (0.88–1.61, p = 0.25).

The risks of sustaining different osteoporosis-related fractures after previous sustained fractures are listed in Table 3. A previous fracture was only a significant risk factor for sustaining a distal radius fracture (HR 1.66, 1.07–2.59, p = 0.025).

The 1-year risk after the index fracture for osteoporosis-related fractures was 9 % in both women and men and 4 % in both men and women in the second year. In univariable Cox regression analysis, the hazard ratio for sustaining an osteoporosis-related fracture for male gender versus female was 0.95 (0.68–1.31, p = 0.74).

The absolute risk of sustaining osteoporosis-related fractures after the index hip fracture was 15.9 % for ASA I/II and 12.6 % for ASA III/IV classified patients. The 1-year risk of osteoporotic fractures was 9 % for ASA I/II versus 8 % in ASA III/IV. In univariable Cox regression analysis the hazard ratio for sustaining an osteoporosis-related fracture for ASA III–IV versus ASA I–II was 0.79 (0.57–1.09, p = 0.15).

No differences were seen in fracture risks in different age categories. More characteristics of the different age groups are shown in Table 4.

Table 3 One-year risks (in %) for different osteoporosis-related fractures for the population with and without previous fractures

	With previous fractures		Without previous fractures		p value
	N	%	N	%	
Hip	21	5.1	33	4.0	0.36
Distal radius	36	8.8	43	5.2	0.025
Humerus	20	4.9	32	3.9	0.41
Vertebrae	42	10.3	69	5.0	0.32

HR hazard ratio, CI confidence interval

Table 4 Fractures in history and one-year (hip) fracture risk for three age categories

Age (years)	N (% of total population)	Fractures in history N (%)	One-year contralateral hip fracture risk (%)	HR (CI)	p value
50–65	87 (7.1)	23 (5.6)	3		
65–85	633 (51.5)	206 (50.5)	2	0.57 (0.23–1.39)	0.21
>85	509 (41.4)	179 (43.9)	3	0.65 (0.27–1.60)	0.35
			11		
			9	0.97 (0.56–1.70)	0.92
			8	0.85 (0.48–1.51)	0.57

Age group 50–65 was used as reference category

HR hazard ratio, CI confidence interval

Mortality

The 1-year mortality risk and hazard ratios for mortality for the age categories, gender, ASA classification, the occurrence of a bilateral hip fracture, a fracture in the history, a fracture during follow-up and a hip fracture during follow-up are presented in Table 5. The hazard ratios for mortality were significantly higher for the age categories 65–85 years and older than 85 years, male gender and ASA III–IV, but not for the occurrence of a bilateral hip fracture, a fracture in the history and not for having a (hip) fracture during follow-up compared with the reference categories.

Table 5 Mortality for age categories, gender, ASA classification, for patients with or without bilateral hip fractures, a fracture in the history, a fracture during follow-up and a hip fracture during follow-up

	N (% of population)	One-year mortality	HR (CI) for mortality (%)	p value
Age categories (years)				
50–65	87 (7.1)	3		
65–85	633 (51.5)	20	5.24 (2.33–11.81)	<0.001
>85	509 (41.4)	33	9.10 (4.05–20.47)	<0.001
Gender				
Female	891 (72.5)	23		
Male	338 (27.5)	26	1.23 (1.00–1.51)	0.046
ASA				
I–II	849 (69.1)	20		
III–IV	380 (30.9)	33	1.94 (1.61–2.35)	<0.001
Bilateral hip fracture				
No	1,060 (86.2)	25		
Yes	169 (13.8)	19	0.76 (0.57–1.03)	0.073
Fracture in history				
No	821 (66.8)	24		
Yes	408 (33.2)	24	0.88 (0.72–1.08)	0.22
Fracture during FU				
No	1,046 (85.1)	25		
Yes	183 (14.9)	21	0.91 (0.70–1.18)	0.47
Hip fracture during FU				
No	1,175 (95.6)	24		
Yes	54 (4.4)	19	0.87 (0.55–1.38)	0.56

Age 50–65, female gender and ASA I–II are reference categories

HR hazard ratio, CI confidence interval, FU follow-up, ASA American Society of Anesthesiologists physical status classification

Discussion

Our main goal was to describe the 1-year risk and absolute risks of sustaining a subsequent second hip fracture and other osteoporosis-related fractures in a hip fracture cohort. The absolute risk of a contralateral hip fracture was 13.8 %, the 1 year risk 2 %, for the other osteoporosis-related fractures this was 28.6 and 6 %, respectively. The median interval between the first and the second hip fracture was rather short, 18.5 months. The risk of a new osteoporosis-related fracture was not higher in patients with a fracture in their medical history than in those that did not.

Our second goal was to describe independent risk factors for sustaining a subsequent second hip fracture. We compared the population with a bilateral hip fracture with the unilateral population. There was no difference between patient's gender distribution, ASA classification, and type of fracture or mortality rate between the uni- and bilateral hip fractures population. A higher age was the only risk factor that could be identified for sustaining a contralateral hip fracture.

Providing reliable concomitant fracture incidence rates and identifying risk factors in hip fracture patients can help in decision-making policies for fracture prevention, like osteoporosis prophylaxis. Furthermore, more accurate information about the future can be provided to both patient and family with respect to be expected fractures.

In our population, the 1-year risk of a second hip fracture was 2.0 %. Lawrence et al. [17] found in their recent study of a large cohort of 6,331 patients a comparable 1 year incidence of 2.7 %. Other prospective studies found the same incidence of around 2 % [18, 19]. However, Lönnroos et al. [14] found a higher contralateral hip fracture incidence of 5 %. The fact that they analysed a smaller population (501 patients) might account for the difference. Overall, 28.6 % of our patients had one or more osteoporosis-related fractures in our cohort. This resembles the lifetime risk for developing an osteoporotic fracture as reported by Klotzbuecher and Cummings [2, 4]. Our 1- and 2-year risk for other osteoporosis-related fractures were 6 and 3 %. This resembles the figures reported by van Helden et al. [13] who found a cumulative incidence of 10.8 % after 2 years follow-up. Although female gender is described as a risk factor in many studies, our cohort did not support this suggestion [3, 9, 20]. Rates of successive fractures after admission for a hip fracture were also not significantly higher in patients with prior fractures compared

to those without. We found that a previous fracture was only a risk factor for sustaining a distal radius fracture in the future, not for other types of fractures. This is contrary to other series that reported a previous fracture at any site to be a significant risk factor for a future fracture. This might be explained by our retrospective collecting of data of previous fractures, accounting for a possible loss of fractures. A limitation is the potential loss of fractures in the retrospective review of medical charts. This might have led to an underestimation of fracture rates, thus influencing the calculated risk factors.

A multivariable Cox regression analysis on risk factors for a contralateral hip fracture showed only a significant influence of age, not of gender and ASA classification. This is an expected outcome; the more years lived, the more risk to sustain a fracture.

Patient's characteristics of the entire population and the bilateral hip fracture population were comparable. However, patients admitted for a second hip fracture did sustain their first hip fracture on a significant lower age than patients admitted for their first hip fracture (75.9 vs. 81.7 years, $p < 0.001$). Therefore, it might be good practice to screen patients who sustain their first hip fracture at a younger age thoroughly for osteoporosis and other risk factors.

The median (IQR) interval between the two hip fractures in all 169 patients was 18.5 months (26.6), 36.1 % occurred with 1 year and 61.5 % was sustained in 2 years. Nymark [21] (9,990 patients) showed that 50 % of the contralateral hip fractures occurred within 12 months in men, and within 19 months in women. Other reported mean intervals between two hip fractures differ from 2.1 years (Chevally, 4,115 patients), 2.3 years (Kok, 1,604 patients), 3.3 years (Schroder, 3,898 patients) to 4.3 years (Fukushima 835 patients) [22– 25]. The latter reported more that 70 % of all contralateral hip fractures to occur within 5 years, resembling our findings [25]. Therefore, the interval between two hip fractures is relatively short. The effectiveness of osteoporosis medication is high, with relatively early results; commonly used osteoporosis agents like risedronate and alendronate significantly reduce the incidence of non-vertebral fractures (21–39 %) compared to placebo during 3 or more years of follow-up [26– 31]. In post hoc analyses of these trial data, the reduction of non-vertebral fractures was present at 6 months for 5 mg daily dosing of risedronate [32] and at 12 months for 10 mg daily dosing of alendronate [33] or 24 months for 5 mg daily dosing of alendronate [26, 34].

These findings emphasize the importance of early screening for osteoporosis after a fracture; starting osteoporosis medication can prevent subsequent fractures in the future.

We presented a large series on hip fracture patients with a median follow-up of 2 years. The main limitation of our study was the retrospective collection of a part of the fracture patient data. This might potentially have led to an underestimation of the incidence of fracture from the medical chart. Although in this retrospective part of the study we vigorously analysed all radiographs and patient charts for presence of fractures after the index hip fracture, thus minimizing this potential error of underestimating fracture incidence. Furthermore, the reported fracture rates are comparable to a recent Dutch study [13]; therefore, the level of underestimation of the incidence of fractures might be low. Another limitation is the lack of data on bone mineral density; the actual number of patients suffering from osteoporosis is unknown. Finally, no data on the start of osteoporosis medication after the index fracture were available. This could have influenced the fracture rates during follow-up.

In conclusion, this large series adds important information to existing literature on hip fracture incidence rates and identifies risk factors. It emphasizes the importance of osteoporosis screening and treatment to prevent subsequent fractures because of the good and early effectiveness of current osteoporosis medication. Our outcomes can be used as a baseline for evaluating the efficacy of present osteoporosis screening and treatment modalities for successive fracture rates.

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PART III

FUNCTIONAL AND SOCIAL OUTCOME



5

Risk factors for failure to return to the pre-fracture place of residence after hip fracture: a prospective longitudinal study of 444 patients

Anne J. H. Vochteloo, Sabine T. van Vliet-Koppert, Andrea B. Maier, Wim E. Tuinebreijer, Maarten L. Röling, Mark R. de Vries, Rolf M. Bloem, Rob G. H. H. Nelissen and Peter Pilot

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Abstract

Introduction Long-term place of residence after hip fracture is not often described in literature. The goal of this study was to identify risk factors, known at admission, for failure to return to the pre-fracture place of residence of hip fracture patients in the first year after a hip fracture.

Methods This is a prospective longitudinal study of 444 consecutive admissions of hip fracture patients aged 65 years. Place of residence prior to admission, at discharge, after 3 and 12 months was registered. Patients admitted from a nursing home ($n = 49$) were excluded from statistical analysis. Multivariable logistic regression analysis was performed, using age, gender, presence of a partner, ASA-score, dementia, anaemia at admission, type of fracture, pre-fracture level of mobility and level of activities of daily living (ADL) as possible risk factors.

Results Two hundred eighty-nine patients lived in their own home, 31.8% returned at discharge, 72.9% at 3 months and 72.8% at 12 months. Age, absence of a partner, dementia, and a lower pre-fracture level of ADL or mobility were independent contributors to failure to return to their own home at discharge, 3 or 12 months. 106 patients lived in a residential home; 33.3% returned at discharge, 68.4% at 3 months and 64.4% at 12 months. Age was an independent contributor to failure to return to a residential home.

Conclusions Age, dementia and a lower pre-fracture level of ADL were the main significant risk factors for failure to return to the pre-fracture residence. As the 3- and 12-month return-rates were similar, 3-month follow-up might be used as an endpoint in future research.

Introduction

The total number of hip fracture patients aged 50 years and older has been estimated to increase to over half a million in the US by 2040 and 6.3 million by 2050 worldwide [1, 2]. Elderly hip fracture patients suffer frequently from comorbidities and the 1-year mortality rate is high [3]. Social morbidity as measured by limited activities of daily life, loss of independency and the impact of a sudden change in place of residence due to a hip fracture has little focus in research, despite its importance for the quality of life for the patient [4]. Socio-economically, the impact of a hip fracture and its sequelae is large as well. Discharge to an alternative location or arranging additional postoperative care at home after discharge can attribute to a longer stay in hospital and creates additional costs [5, 6]. Only a limited number of prospective studies on pre- and post-fracture place of residence have been published. Most of them are focused on the discharge location, but not on the long-term place of residence [7– 12].

The aim of the current study was to identify risk factors, known at admission, for failure to return to the pre-fracture place of residence at discharge, 3- and 12-month post-fracture. These factors can be used to improve discharge protocols and could become important socio-economic parameters.

Methods

Patient cohort

A prospective longitudinal observational cohort study of 444 consecutive admissions for a hip fracture in 437 patients of 65 years and older was conducted. All patients were admitted to the orthopaedic or trauma surgery ward in a 450-bed teaching hospital in Delft, the Netherlands, from January 2008 to December 2009. In both wards professionals worked with a standardized care pathway for hip fracture patients that has been developed by a multidisciplinary team, including orthopaedic and trauma surgeons, geriatricians, psychiatrists and nurses from the emergency department, wards and liaison service. Patients with a fracture due to a high-energy trauma, with a pathologic fracture or those with a periprosthetic hip fracture were not included. Patients admitted from a

nursing home ($n = 49$, 12-month mortality 46.9%) were excluded from the analysis for failure to return to their pre-fracture nursing home as they all returned to the nursing home or died. Length of follow-up for all patients was 12 months or up to death.

It was not necessary to obtain approval from the local ethical committee due to the observational character of the study evaluating usual care as a part of good clinical practice. Since data could not be traced back to the individual patient, there were no privacy issues.

Data collection

Uniform collection and recording of data of all patients were achieved by standard evaluation at admission and after 3 and 12 months according to the standardized care pathway for hip fracture patients. Age, gender, presence of a partner, American Society of Anesthesiologists (ASA) physical status classification score, presence of dementia, presence of anaemia at admission, type of fracture, fracture treatment, anaesthesia, length of stay (LOS), discharge location and the in-hospital, 3- and 12-month mortality rate were registered [13]. One observer (AV) rated the ASA score of all patients. Mortality of the patients was scored meticulously by repeated consultation of the population registers of the counties in the region as well as the hospital's patient registration systems for the full length of follow-up.

Place of residence, level of mobility and level of activities of daily living (ADL) were obtained at admission and at 3- and 12-month post-fracture [14]. These parameters were registered during routine follow-up in the outdoor clinic or by a questionnaire sent to the patient or caretakers in case of dementia.

Anaemia

In all patients the haemoglobin level at admission was obtained. Anaemia at admission was defined based on the criteria of the World Health Organization (WHO) [15]. These criteria classify anaemia as a haemoglobin level below 7.5 mmol/L (12 g/dL) in women and below 8.1 mmol/L (13 g/dL) in men.

Place of residence

Patients were divided into three groups based on pre-fracture place of residence at admission, i.e. living in their own home, in a residential home or in a nursing home.

Living in their own home was defined as living independently, alone or with a partner.

A residential home is a heterogeneous form of living, ranging from the availability of support to almost full-time help in daily activities.

A nursing home is a residential facility caring for persons with predominant difficulties in activities of daily living.

Level of mobility and ADL

Mobility both in- and outdoors prior to hip fracture was classified as mobile without an aid, mobile with an aid or not able to ambulate ("immobile"). A cane, crutch(es) or walker were all considered an aid, patients in a wheelchair were considered to be immobile. The level of mobility was divided into four main categories; mobile without use of an aid in- and outdoors, mobile in- and outdoors with the use of an aid in- and/or outdoors, only mobile indoors (regardless the use of an aid) and immobile both in- and outdoors.

The Groningen Activity Restriction Score (GARS) is a functional ADL score [14]. It assesses competence in abilities in 11 personal basic ADL and 7 instrumental activities of daily living (IADL). A summed score was calculated ranging from 18 (indicating ability to perform all activities without assistance or undue effort) to 72 (indicating disability).

Statistical analysis

Continuous data are presented as mean with standard deviations (SD). The independent Student's *t* test or one-way anova was used to compare groups of continuous data. Categorical data are presented as the number of subjects in the category, along with the percentages. Chi-square test and Fisher's exact test were used for comparing groups of categorical data.

Bivariate and multivariable logistic regression analysis was performed to identify risk factors for patients living in their own home or in a residential home prior to admission for failure to return to the pre-fracture place of residence at discharge, 3- and 12-month post-fracture. For both analysis, only risk factors known at admission were used; age, gender, presence of a partner, perioperative risk (ASA score I/II vs. III/IV), dementia,

anaemia at admission, pre-fracture level of mobility (using the four categories of mobility), pre-fracture level of ADL (expressed with the GARS) and type of fracture [neck of femur, (inter) trochanteric or sub-trochanteric].

Patients classified as ASA I or II and III or IV were combined to two groups, as the separate groups of ASA I ($n = 22$) and ASA IV ($n = 26$) classified patients were too small to be analyzed separately. LOS was changed into a binary summary outcome based on the median, i.e. $\leq$ or >11 days.

The likelihood ratio backward test was used to find the best-fit model by selecting the variables one by one. The probability for entry was set at 0.05, and the probability for removal at 0.10. To calculate odds ratios (OR), logistic regression analysis was used. P values lesser than 0.05 were considered statistically significant. All data were analysed in SPSS 17.0 (SPSS Inc. Chicago, USA).

Results

Table 1 shows characteristics of all patients, based on the pre-fracture place of residence. Mean (SD) age of all patients was 83.4 years (7.3), 73.2% were female. Prior to hip fracture, the majority of patients ($n = 289$, 65.1%) lived in their own home and nearly one quarter ($n = 106$, 23.9%) lived in a residential home. A small group ($n = 49$, 11.0%) resided in a nursing home. Patients living in their own home were younger, more often male, had lower ASA scores, were less often known with anaemia and dementia and had more often a partner compared to patients living in a residential home or a nursing home.

A conservative treatment was chosen in 12 patients, who therefore did not receive any form of anaesthesia.

Mortality at 3 months was 15.1% ($n = 67$) and 26.4% ($n = 117$) at 12 months of the entire group, being higher in the group of patients that lived less independently. At 3-month follow-up, no data about place of residence were available in 13 patients (2.8%), and at 12-month follow-up this information was missing in 6 patients (1.4%).

Data on some variables were missing (most of them less than 4%, Table 1), since they were not entered in the prospective database at admission and could not be retrieved at a later period in time.

Table 1 Characteristics of patients with a hip fracture dependent on residency at admission

	Study population (n = 444)	Place of residence at admission			P value*
		Own home (n = 289)	Residential home (n = 106)	Nursing home (n = 49)	
Mean age in years (SD)	83.4 (7.3)	81.9 (6.9)	86.9 (7.4)	85.2 (6.2)	<0.001
Female gender	325 (73.2)	200 (69.2)	87 (82.1)	38 (77.6)	0.010
Partner at admission ^a	133 (32.4)	116 (40.4)	11 (10.8)	6 (27.3)	<0.001
ASA score					
I/II	289 (65.1)	205 (70.9)	59 (55.7)	25 (51.0)	<0.001
III/IV	155 (34.9)	84 (29.1)	47 (44.3)	24 (49.0)	
Dementia ^b	111 (25.9)	31 (11.2)	44 (42.3)	36 (76.6)	<0.001
Anaemia at admission	188 (42.5)	105 (36.5)	52 (49.5)	31 (63.3)	<0.001
Mobility at admission					<0.001
Without an aid in- and outdoors	152 (34.3)	133 (46.0)	14 (13.2)	5 (10.4)	
With an aid in- and outdoors	200 (45.1)	136 (47.1)	46 (43.4)	18 (37.5)	
Only mobile indoors	78 (17.6)	18 (6.2)	42 (39.6)	18 (37.5)	
Immobile	13 (2.9)	2 (0.7)	4 (3.8)	7 (14.6)	
Mean GARS (SD) ^c	42.9 (17.8)	34.8 (14.5)	55.3 (13.5)	63.7 (9.0)	<0.001
Fracture type					
Neck of femur	257 (57.9)	169 (58.5)	57 (53.8)	31 (63.3)	0.140
(Inter) trochanteric	169 (38.1)	106 (36.7)	45 (42.5)	18 (36.7)	
Subtrochanteric	18 (4.1)	14 (4.8)	4 (3.8)	0 (0)	
Treatment					
Osteosynthesis	248 (55.9)	162 (56.1)	64 (60.4)	22 (44.9)	0.093
(Hemi) arthroplasty	184 (41.4)	120 (41.5)	38 (35.8)	26 (53.1)	
Conservative	12 (2.7)	7 (2.4)	4 (3.8)	1 (2.0)	
Anaesthesia					
Spinal/epidural	406 (91.4)	268 (92.7)	94 (88.7)	44 (89.8)	0.302
General	26 (5.9)	14 (4.8)	8 (7.5)	4 (8.2)	
Not applicable	12 (2.7)	7 (2.4)	4 (3.8)	1 (2.0)	
LOS >10 days	209 (47.1)	133 (46.0)	62 (58.5)	14 (28.6)	<0.001
Mortality					
In-hospital	20 (4.5)	6 (2.1)	10 (9.4)	4 (8.2)	0.004
3 months	67 (15.1)	22 (7.6)	28 (26.4)	17 (34.7)	<0.001
3- to 12-month	50 (11.3)	26 (9.0)	18 (17.0)	6 (12.2)	0.017
12 months	117 (26.4)	48 (16.6)	46 (43.4)	23 (46.9)	<0.001

Values are given as number (percentage) unless mentioned otherwise

LOS length of stay, GARS Groningen Activity Restriction Score, ASA American Society of Anesthesiologists Physical Status classification Data not available in: ^a 33 patients, ^b 15 patients, ^c 7 patients

*Bivariate analysis

Patients living in their own home at admission

Discharge directly to their own home occurred in 90 patients (31.8%). At 3 months, 186 patients (72.9%) and at 12 months 171 patients (72.8%) returned to their own home. All values were corrected for mortality; in-hospital mortality was 2.1% ($n = 6$), mortality at 3 months was 7.6% ($n = 22$) and 16.6% ($n = 48$) at 12 months.

Risk factors for failure to return to their own home

Data of the bivariate regression analysis for risk factors for failure to return to home are shown in Table 2. Age, absence of a partner, dementia, a lower level of mobility and a lower level of ADL (i.e. a higher GARS) were significant contributors to failure to return to their own home at discharge, at 3 and at 12 months after discharge. Figure 1 shows the positive association of chronological age and failure of returning home at discharge and after 3 and 12 months. Multivariable logistic regression analysis showed that age, dementia and a lower level of ADL (i.e. a higher GARS) were the main significant independent contributors to failure to return to their own home at discharge, at 3 or at 12 months, as demonstrated in Table 3. Absence of a partner was a significant risk factor for failure to return to their own home only at discharge.

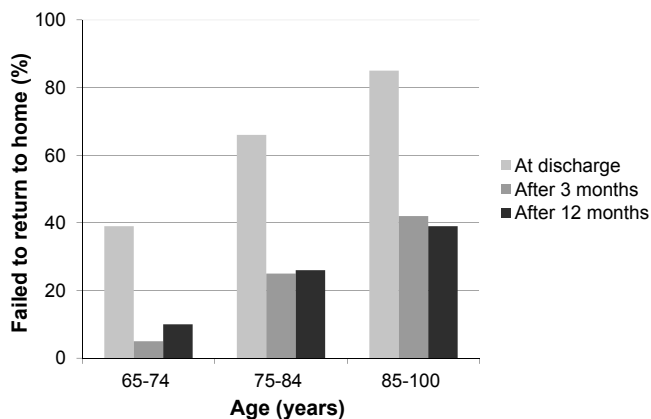


Fig. 1 Percentages of patients who failed to return to their own home at discharge, 3 and 12 months

Table 2 Characteristics of patients living in their own home at admission

	Discharge to own home		<i>P</i> [#]	At 3 months back at own home		<i>P</i> [#]	At 12 months back at own home		<i>P</i> [#]
	Yes (<i>n</i> = 90)	No (<i>n</i> = 193)		Yes (<i>n</i> = 186)	No (<i>n</i> = 69)		Yes (<i>n</i> = 171)	No (<i>n</i> = 64)	
Mean age in years (SD)	77.9 (6.8)	83.6 (6.2)	*	80.0 (6.5)	85.1 (6.0)	*	79.9 (6.5)	84.6 (5.8)	*
Female gender	47 (52.2)	148 (76.7)	*	127 (68.3)	47 (68.1)	*	115 (67.3)	47 (73.4)	*
Partner at admission	53 (59.6)	59 (30.7)	*	85 (45.7)	20 (29.0)	*	83 (48.5)	18 (28.1)	*
ASA score III/IV	21 (23.3)	58 (30.1)	*	44 (23.7)	22 (31.9)	*	32 (18.7)	23 (35.9)	*
Dementia	2 (2.3)	29 (15.6)	*	7 (3.9)	19 (29.2)	*	8 (4.8)	15 (25.4)	*
Anaemia at admission	27 (30.0)	73 (38.0)	*	60 (32.4)	24 (34.8)	*	48 (28.2)	23 (35.9)	*
Pre-fracture mobility									
Without an aid in- and outdoors	61 (67.8)	70 (36.3)		102 (54.8)	19 (27.5)		101 (59.1)	15 (23.4)	
With an aid in- and/or outdoors	28 (31.1)	105 (54.4)		77 (41.4)	42 (60.9)		65 (38.0)	42 (65.6)	
Cannot walk outside	1 (1.1)	16 (8.3)		6 (3.2)	7 (10.1)		3 (1.8)	7 (10.9)	
Immobile	0 (0)	2 (1.0)		1 (0.5)	1 (1.4)		2 (1.2)	0 (0.0)	
Mean GARS (SD)	27.2 (12.3)	38.0 (14.3)	*	38.1 (13.0)	60.7 (10.6)	*	35.3 (13.5)	58.8 (11.0)	*
Fracture type			*						
Neck of femur	62 (68.9)	105 (54.4)		116 (62.4)	38 (55.1)		107 (62.6)	36 (56.3)	
(Inter) trochanteric	23 (25.6)	79 (40.9)		62 (33.3)	26 (37.7)		56 (32.7)	24 (37.5)	
Subtrochanteric	5 (5.6)	9 (4.7)		8 (4.3)	5 (7.2)		8 (4.7)	4 (6.3)	

Values are given as number (percentage). * Significant at that moment in time, [#] *P* < 0.05, bivariate analysis

ASA American Society of Anesthesiologists Physical Status classification, GARS Groningen Activity Restriction Score

Table 3 Risk factors known at admission for failing to return to their own home

	Independent variables	Odds ratio	95% CI	P value
At discharge ^a	Age (per year)	1.10	1.05 to 1.16	<0.001
	Female gender	2.23	1.17 to 4.26	0.015
	Absence of a partner	2.00	1.06 to 3.78	0.032
	Dementia	4.84	1.02 to 23.0	0.047
	GARS (per 10 units)	1.48	1.16 to 1.89	0.002
At 3 months ^b	Age (per year)	1.10	1.03 to 1.16	0.003
	Dementia	9.21	3.14 to 27.0	<0.001
	GARS (per 10 units)	1.84	1.42 to 2.35	<0.001
At 12 months ^c	Age (per year)	1.09	1.03 to 1.16	0.003
	Dementia	5.96	2.23 to 15.9	<0.001
	Mobility category ^d			
	With an aid in- and/or outdoors	2.97	1.39 to 6.32	0.005
	Only mobile indoors	6.03	1.39 to 26.2	0.016

Multivariable logistic regression analysis

Analysis performed in ^a 268 patients, ^b 242 patients; ^c 225 patients

^d Reference category is mobile without an aid

GARS Groningen Activity Restriction Score

Patients living in a residential home at admission

Discharge directly to their residential home occurred in 32 patients (33.3%). At 3 months 54 (68.4%) and at 12 months 38 (64.4%) patients were residing in their pre-fracture residential home again. All values were corrected for mortality; in-hospital mortality was 9.4%, mortality was 26.4% at 3 months and 43.4% at 12 months.

Risk factors for failure to return to their residential home

Data of the bivariate analysis for risk factors for failure to return to a residential home are shown in Table 4. A lower level of ADL (higher GARS) was a risk factor for failure to return to the residential home at 3- and at 12-month post-fracture. Age and female gender were risk factors at discharge.

Multivariable logistic regression analysis (96 patients available) showed that age was the only independent contributor to failure to return to their residential home at discharge (OR 1.09, 95% CI 1.02–1.16, $P = 0.007$). None of the other potential risk factors reached significance at discharge, at 3- or at 12-month follow-up. The latter two analyses were performed in 79 and 59 patients, respectively.

Table 4 Characteristics of patients living in a residential home at admission

	Discharge to residential home		P [#]	At 3 months back at residential home		P [#]	At 12 months back at residential home		P [#]
	Yes (n = 32)	No (n = 64)		Yes (n = 54)	No (n = 25)		Yes (n = 38)	No (n = 21)	
Mean age in years (SD)	83.5 (9.0)	88.1 (6.2)	*	85.2 (8.3)	86.9 (5.6)		86.0 (7.7)	86.8 (6.7)	
Female gender	22 (68.8)	57 (89.1)	*	44 (81.5)	22 (88.0)		34 (89.5)	18 (85.7)	
Partner at admission	1 (3.2)	9 (14.5)		8 (15.1)	1 (4.2)		7 (18.9)	2 (10.0)	
ASA score III/IV	12 (37.5)	29 (45.3)		17 (31.5)	12 (48.0)		11 (28.9)	9 (42.9)	
Dementia	17 (53.1)	23 (37.1)		21 (40.4)	11 (44.0)		16 (44.4)	8 (38.1)	
Anaemia at admission	12 (38.7)	34 (53.1)		24 (45.3)	10 (40.0)		19 (50.0)	10 (47.6)	
Pre-fracture mobility									
Without an aid in- and outdoors	5 (15.6)	9 (14.1)		9 (16.7)	2 (8.0)		7 (18.4)	3 (14.3)	
With an aid in- and/or outdoors	14 (43.8)	29 (45.3)		25 (46.3)	10 (40.0)		19 (50.0)	7 (33.3)	
Only mobile indoors	12 (37.5)	26 (40.6)		20 (37.0)	12 (48.0)		12 (31.6)	10 (47.6)	
Immobile	1 (3.1)	0 (0.0)		0 (0.0)	1 (4.0)		0 (0.0)	1 (4.8)	
Mean GARS (SD)	55.2 (14.6)	54.0 (13.0)		59.7 (11.8)	66.3 (8.0)	*	58.1 (12.8)	66.8 (8.1)	*
Fracture type									
Neck of femur	17 (53.1)	34 (53.1)		27 (50.0)	15 (60.0)		21 (55.3)	10 (47.6)	
(Inter) trochanteric	14 (43.8)	29 (45.3)		26 (48.1)	10 (40.0)		17 (44.7)	10 (47.6)	
Subtrochanteric	1 (3.1)	1 (1.6)		1 (1.9)	0 (0.0)		0 (0.0)	1 (4.8)	

Values are given as number (percentage). * Significant at that moment in time, [#] P < 0.05, bivariate analysis

ASA American Society of Anesthesiologists Physical Status classification, GARS Groningen Activity Restriction Score

Discussion

The majority of the hip fracture patients in the studied population aged 65 years and older lived in their own home, whilst sustaining a hip fracture. During the first year after fracture treatment, three quarters of the surviving population had returned to their own home. Multivariable logistic regression analysis identified higher age, dementia and a lower level of mobility as the most important risk factors for failure to return to their own home at discharge, but also at 3- and at 12-month post-fracture.

The percentage of patients returning to their pre-fracture residence was stable between 3 and 12 months, the 3-month time mark can be used as an evaluation end point in future research. This is in line with a previous study which concluded that the 4-month time mark is adequate to evaluate ADL and residential status in hip fracture patients [16].

The medical and social morbidity of patients living in a residential home was worse compared to patients living in their own home, this is reflected in a higher 1-year mortality rate and a more limited level of mobility of the residential home patients. The overall 1-year mortality rate in our cohort (mean age 83 years) was 26%, comparable to the result of an US study (495 patients, mean age 85 years, 1-year mortality 26%) and a large Scottish cohort (27,475 patients, aged 50 and older, 1-year mortality 31%) [17, 18].

Early and reliable information on the potential discharge location after the hospital admission is of importance for both patients and caregivers to plan postoperative care. Furthermore, it is of socio-economical impact. When extrapolating the results of this study to different countries, one must be aware of bias at several levels. First, large differences between countries exist in type of housing and traditions for homes for elderly people [19]. In the Netherlands, a residential home is very heterogeneous form of living, as defined earlier in this paper. Secondly, large regional, national and international differences exist on discharge policies, like locations of discharge and availability of different kinds of temporary rehabilitation units [20, 21].

In a large Scottish series, the number of hip fracture patients living in their own home prior to sustaining a hip fracture and the percentage of these patients returning to this location after 4 months were comparable to our results [22]. In a series of hip fracture patients living in New York slightly more (85%) patients lived in their own residence

prior to the hip fracture, but only 20% could be immediately discharged home from the hospital. At 6 months, 83% had returned back to their own residence [10]. Finally, in a comparison of a Finnish and a British cohort of hip fracture patients, 62 and 69% lived in their own home prior to the hip fracture, of whom 44 and 54% respectively, had returned home four months after hospital discharge, which is less than that in our study [20].

Risk factors for not returning to their own home after hospital discharge were higher age, presence of dementia, absence of a partner, a lower level of mobility and a lower level of ADL prior to the hip fracture. Beside these risk factors, a longer LOS was also a risk factor for failure to return to their own home. A longer LOS is often associated with a higher rate of adverse outcomes during admission and might be related to worse outcome thereafter [23, 24]. LOS was not included in the statistical analysis, since the purpose of the current study was to identify risk factors known at admission of the patient. Subsequently, a prediction model for discharge location already at admission can be developed with these risk factors. If discharged to another location other than the patient's own home, length of hospital stay is usually longer, with subsequent additional costs [5, 6]. An instrument that predicts the discharge location already at admission would therefore be of great value, not only for liaison services but also for patients and their family.

Advanced age, dementia, a walking disability and con-comitant chronic systemic diseases were previously reported to be risk factors for failure to return to the patient's own home at discharge from hospital [7]. This is largely in concordance with our findings, although we used a more general categorisation for scoring the overall degree of comorbidities (ASA classification). But, others have shown that ASA score and the number and type of comorbidities are associated [13]. We found a higher ASA score to be a significant risk factor in the bivariate analysis, but not in the multivariable logistic regression analysis. Other papers identified presence of a partner, good general health, good cognition, a higher level of ADL and mobility (both pre-fracture and 2 weeks after surgery), a lower number of medication, and moderate use of nursing interventions (like bathing) as important variables predicting discharge to an own residence [7–10, 25, 26]. These findings are in line with our study. Other risk factors like anaemia at admission and fracture type were of small importance in the bivariate analysis and lost significance in the multivariable analysis. This is most probably because both anaemia and fracture type are strongly correlated to age, as shown in previous papers [27–32].

Deakin et al. [9] published the largest series (3,240 patients) on discharge location of hip fracture patients. Their analyses were not specified for pre-fracture place of residence. Pre-injury dependence, age, male gender and injury sustained whilst in hospital were identified as the main risk factors for discharge to an alternative location (DAL). In contrast to their findings, we identified female gender as an independent risk factor for DAL. This conflicting outcome is most probably due to difference in sample size between our and the former study. Furthermore, we only included patients admitted for a hip fracture at the emergency department; no patients with an in-hospital hip fracture were included.

Some limitations exist; first, the analyses of patients living in a residential home at admission were troubled by the limited numbers and a high mortality rate. At the 3-month follow-up, 86 patients could be analyzed; at 12 months only 66 patients. This is the main reason we could only identify age as a risk factor for failure to return to their residential home at discharge in the multivariate analysis. A lower level of ADL independency was the most important risk factor for not returning to their residential home in the bivariate analysis. A second limitation was the fact that the diagnosis of dementia was based on medical history. Cognitive performance was not assessed during hospital stay. The third limitation was that the type and number of comorbidities were not registered. Finally, many factors influence the location of residence after hospital discharge. Of these other factors, the role of the social network might be one of the largest. They can play an important role in the decision of an older person whether or not to stay living independently or to move to a residential home.

In conclusion, the large study population, the prospective character, adequate information on mortality rates and long follow-up make the study results valuable for analysis of socio-economic aspects after hip fracture treatment, especially for the patients living in their own home prior to hip fracture. This study identified higher age, dementia and a lower pre-fracture level of ADL as the most important independent risk factors for failure to return to the pre-fracture residence in patients living in their own home prior to hip fracture. In residential home patients, age was identified as the only risk factor, possibly due to the small patient numbers.

We will use these risk factors to develop a model that predicts discharge location at admission to provide better information for patients, family and physicians regarding the discharge and rehabilitation process.

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Conflict of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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6

More than half of hip fracture patients do not regain mobility in the first postoperative year

Anne JH Vochteloo, Sophie Moerman, Wim E Tuinebreijer, Andrea B Maier, Mark R de Vries,
Rolf M Bloem, Rob GHH Nelissen and Peter Pilot

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Abstract

Aim: To measure functional recovery and determine risk factors for failure to return to the prefracture level of mobility of hip fracture patients 1 year postoperatively.

Methods: A prospective cohort follow-up study of 390 hip fracture patients aged 65 years and older was carried out. Patients were stratified in categories based on prefracture mobility: mobile without aid, with aid in- and outdoors, or only mobile indoors. Immobile patients were excluded. Risk factors for not regaining prefracture mobility were identified.

Results: Nearly half of all patients regained their prefracture level of mobility after 1 year. Mobile patients without an aid were less likely to return to their prefracture mobility level compared with patients who were mobile with aid or mobile indoors. After 1 year, 18.7% of all patients had become immobile. Most important independent risk factors for failure to return to the prefracture level of mobility were a limited prefracture level of activities of daily living and a delirium during admission.

Conclusions: The risk not to regain prefracture mobility is highest in mobile patients without an aid. The risk of becoming immobile is higher in those having a lower prefracture mobility. Activities of daily living dependence and delirium were the main risk factors for not regaining mobility.

Introduction

Hip fractures are an important cause of loss of function in the aging Western population.^{1–4} Increasing life expectancy is accompanied by a higher number of fragility fractures.⁵ The total number of hip fracture patients aged 50 years and older has been estimated to increase to over 500 000 in the USA by 2040.⁵ The reported percentage of patients regaining their prefracture level of mobility varies largely between 11% and 82%, depending on the studied patient population.^{1,3,4,6–9} As a result of the loss of mobility after a hip fracture, patients are often restricted in their daily activities, causing loss of confidence and independence.^{1,4} Economically, the impact of deterioration of mobility is large as well; medical costs for hip fracture patients were about threefold greater than those of age- and residence-matched controls without a fracture.¹⁰ Older age, poor health status, a limited prefracture level of activities of daily living (ADL) and cognitive impairment have previously been identified as the main negative contributors to long-term functional outcome after a hip fracture.¹¹ Many other factors, such as sex, race, prefracture residence, hemoglobin level, type of fracture, delirium during admission and length of stay, show inconsistent results with respect to long-term outcome.^{4,12–17}

The majority of previous studies describe functional outcome (i.e. the level of daily activities and dependency)^{2–4,12,14,16–18} rather than walking ability solely.^{7–9,13,15} Furthermore, just a few had a follow up of 1 year or longer.^{3,6,8,12,16}

In this study, we present the mobility of hip fracture patients before admission, and at 3 and 12 months post-operatively. The main goals were to measure functional recovery and to identify risk factors for failing to return to the prefracture level of mobility in the first year after a hip fracture.

Methods

Patient cohort

A prospective observational cohort study of 444 consecutive admissions for a hip fracture in 429 patients was carried out. All patients were aged 65 years and older, and were admitted to a 450-bed teaching hospital (Delft, the Netherlands) between January 2008

and December 2009. Patients with a fracture as a result of a high-energy trauma or with a pathological fracture were not included in this cohort. Patients with a contralateral hip fracture within the time window of the study ($n = 15$), those who were treated conservatively ($n = 12$) and patients who were immobile before admission ($n = 12$) were excluded from the current study. Thus, 390 patients were included for final analysis. The length of follow up for all patients was 12 months.

Data collection

Uniform collection and recording of all patient' data was achieved by standard evaluation at admission, and after 3 and 12 months according to the standardized care pathway for hip fracture patients. Age, sex, presence of a partner and prefracture place of residence (living in their own home or in institutionalized care; i.e. a residential home or a nursing home) were registered at admission.

Clinical characteristics obtained during the hospital stay were American Society of Anesthesiologists (ASA) Physical Status classification, presence of dementia (based on the medical history and history-taking from patients, family and caretakers) or anemia at admission based on the criteria of the World Health Organization (hemoglobin level below 7.5 mmol/L [12 g/dL] in women and below 8.1 mmol/L [13 g/dL] in men), type of fracture and treatment, diagnosis of delirium based on Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV criteria, and length of stay (LOS).^{19,20}

The in-hospital, 3- and 12-month mortality rate of the patients was scored meticulously by repeated consultation of the population registers of the counties in the region of both hospitals, as well as the hospital's patient registration systems for the full length of follow up.

Level of mobility and activities of daily living

Mobility was registered at admission, and at 3 and 12 months after hip fracture during routine follow up in the outpatient clinic, or by a questionnaire sent to patients or caretakers in case of dementia. Mobility was divided into four categories: mobile in- and outdoors without the use of an aid, mobile in- and outdoors with the use of an aid in- and/or outdoors, only mobile indoors regardless of the use of an aid, and those who were immobile both in- and outdoors. A cane, crutch(es) or walker were all considered an aid.

Patients in a wheelchair or those who were bedridden were considered to be immobile. As aforementioned, immobile patients ($n = 12$) were excluded from the present study.

The Groningen Activity Restriction Score (GARS) was used to assess the functional ADL.²¹ It includes competence in abilities in 11 personal basic ADL and seven instrumental ADL. A summed score for the ADL was calculated ranging from 18 (indicating ability to carry out all activities without assistance or undue effort) to 72 (indicating disability). A higher GARS score therefore represents a lower level of ADL.

Statistical analysis

Categorical data are presented as the numbers, along with the percentages. The χ^2 -test and Fisher's exact test were used for comparing groups of categorical data.

Bivariate analysis was carried out for the whole cohort and for the three different prefracture mobility categories. Age, sex, presence of a partner, intraoperative risk (ASA classification I/II vs III/IV), dementia, anemia at admission, prefracture level of ADL (high vs low GARS), prefracture place of residence (own home vs institutionalized care), type of fracture (intra- vs extracapsular hip fracture) or treatment (osteosynthesis vs [hemi-] arthro-plasty), delirium during admission and LOS (2 or >10 days) were included in the analysis, being possible independent risk factors.

Age, ADL and LOS were used as a binary outcome, based on the median value. For the analysis of the three mobility categories, the median values of the age and GARS of the specific category were used, LOS was 2 or >10 days in all analysis. Multivariable logistic regression analysis was carried out in the same groups using the same possible risk factors to identify independent risk factors for failure to return to the prefracture mobility level at 3 and 12 months postoperatively. The likelihood ratio backward test was carried out to find the model by selecting the variables one by one. The probability for entry was set at 0.05, and the probability for removal at 0.10. All data were analyzed in SPSS 17.0 (SPSS, Chicago, IL, USA).

Results

Clinical characteristics

Table 1 shows the characteristics of the whole cohort and stratified by mobility category. The mean (SD) age of all patients was 83.4 years (7.1), 72.8% were female and the 12-month mortality was 24.9%. Patients that were mobile without an aid were significantly younger and in better general condition. The type of fracture or treatment was not related to a specific mobility category.

Mobility at follow up

At 3-month follow up, no data about the level of mobility and ADL was available in eight patients (2.3%). At 12-month follow up, this information was missing in four patients (1.3%). All percentages at 3- and 12-month follow up that are mentioned were corrected for mortality.

Figure 1 shows the percentage of patients who were able to regain their prefracture mobility for the whole cohort and stratified by mobility category. Overall, approximately half of the patients regained their prefracture mobility level. Mobile patients without an aid showed the lowest level of regaining mobility, and were the only subgroup with a significant improvement of mobility between 3 and 12 months.

Furthermore, Figure 1 shows the percentage of patients being immobile at 3- and 12-months follow up for the whole cohort and stratified by mobility category as well. In total, 18.7% of all patients became immobile.

The more limited the level of prefracture mobility, the higher the number of patients that became immobile. Solely patients who were only mobile indoors showed a significant increase in percentage in becoming immobile between 3 and 12 months postoperatively.

Table 1 Clinical characteristics of the whole cohort and stratified by mobility category

	Cohort <i>n</i> = 390	Mobility categories		<i>P</i> -value
		Without an aid <i>n</i> = 140	With an aid <i>n</i> = 181	
Median age, years (IQR)	83.7 (9.8)	79.4 (8.2)	86.0 (7.0)	88.1 (11.7)
Female sex	284 (72.8)	85 (60.7)	142 (78.5)	57 (82.6)
Absence of a partner at admission [†]	247 (67.3)	73 (54.5)	130 (73.9)	44 (77.2)
ASA classification III/IV	129 (33.1)	28 (20.0)	66 (36.5)	35 (50.7)
Dementia [‡]	91 (24.1)	19 (13.7)	41 (23.7)	31 (47.7)
Anemia at admission [§]	164 (42.2)	44 (31.4)	83 (46.1)	37 (53.6)
Median GARS (IQR) [¶]	43.0 (31.0)	21.5 (13.0)	45.0 (19.0)	64.0 (12.0)
Institutionalized prior to admission	129 (33.1)	18 (12.9)	58 (32.0)	53 (76.8)
Intracapsular hip fracture	220 (56.4)	85 (60.7)	99 (54.7)	36 (52.2)
Osteosynthesis	224 (57.4)	82 (58.6)	99 (54.7)	43 (62.3)
Delirium [§]	88 (22.6)	23 (16.4)	48 (26.7)	17 (24.6)
LOS >10 days	182 (46.7)	47 (33.6)	98 (54.1)	37 (53.6)
Regained prefracture mobility at 3 months	150 (45.5)	34 (27.4)	90 (58.1)	26 (51.0)
Regained prefracture mobility at 12 months	138 (47.8)	47 (39.5)	77 (57.9)	14 (37.8)
Immobile at 12 month follow up	54 (18.7)	6 (5.0)	26 (19.5)	22 (59.5)
Mortality				
In-hospital	13 (3.3)	2 (1.4)	6 (3.3)	5 (7.2)
3-month	52 (13.3)	12 (8.6)	21 (11.6)	19 (27.5)
12-month	97 (24.9)	18 (12.9)	47 (26.0)	32 (46.4)

Values are given as *n* (%) if not defined otherwise. Data not available in: [†]23, [‡]13, [§]1 and [¶]3 patient(s). ASA, American Society of Anesthesiologists Physical Status classification; IQR, interquartile range; LOS, length of stay; GARS, Groningen Activity Restriction Score.

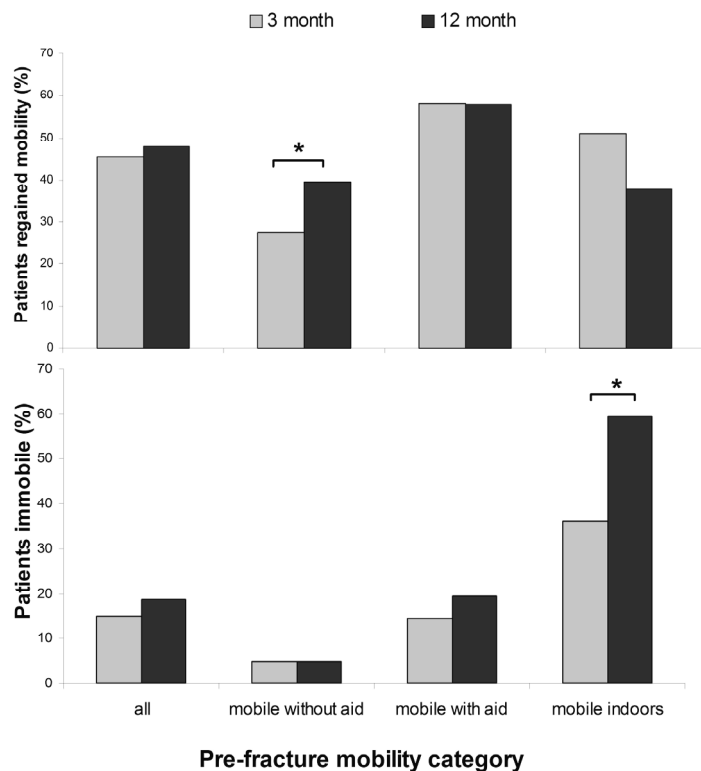


Figure 1 Percentages of patients who were able to regain their prefracture mobility and became immobile for the whole cohort and stratified by mobility category. * $P < 0.05$.

Risk factors for not regaining prefracture mobility

Table 2 shows the relative risks of the different variables for not regaining prefracture mobility at 3 months for the whole cohort and stratified by mobility category. For the whole cohort, dementia, living in institutionalized care before admission and a delirium during admission were significant risk factors for not regaining the pre-fracture level of mobility. In addition to these items, a longer LOS and a lower ADL level were significant in the two groups of patients that were mobile in- and outdoors (regardless the use of an aid). ASA and fracture type were significant factors only in the group that was mobile with an aid.

Table 2 Relative risks of different variables for not-regaining mobility at 3-month follow up (bivariate analysis)

	All patients [†]				Mobile without aid				Mobile with aid				Patients only mobile indoors			
	Mobility regained?		RR (CI)	n = 180	Mobility regained?		RR (CI)	n = 34	Mobility regained?		RR (CI)	n = 90	Mobility regained?		RR (CI)	n = 25
	Yes	No			Yes	No			Yes	No			Yes	No		
Older age [‡]	47.3	42.2	0.91 (0.74–1.11)		26.5	57.8	1.41 (1.13–1.77)*		50.0	40.0	0.79 (0.54–1.16)		61.5	44.0	0.70 (0.40–1.23)	
Female sex	74.7	70.0	0.90 (0.73–1.11)		50.0	63.3	1.17 (0.92–1.48)		81.1	76.9	0.87 (0.57–1.33)		84.6	76.0	0.77 (0.42–1.41)	
Absence of a partner	67.6	64.2	0.93 (0.76–1.15)		41.2	56.8	1.19 (0.95–1.50)		75.3	69.4	0.84 (0.56–1.26)		77.3	78.3	1.03 (0.51–2.07)	
ASA III/IV	28.7	31.1	1.05 (0.85–1.30)		8.8	17.8	1.19 (0.95–1.50)		28.9	44.6	1.46 (1.02–2.10)*		53.8	44.0	0.82 (0.46–1.44)	
Dementia	14.1	28.4	1.41 (1.16–1.70)*		0.0	16.3	1.44 (1.27–1.63)*		12.9	40.3	2.08 (1.48–2.93)*		37.5	41.7	1.09 (0.62–1.93)	
Anemia at admission	42.3	34.4	0.86 (0.69–1.06)		29.4	27.8	0.98 (0.77–1.25)		44.9	38.5	0.86 (0.58–1.26)		50.0	48.0	0.96 (0.55–1.68)	
lower level of ADL [†]	45.9	47.8	1.03 (0.85–1.26)		17.6	55.6	1.52 (1.22–1.89)*		31.8	70.8	2.58 (1.68–3.97)*		34.6	52.0	1.43 (0.82–2.49)	
Institutionalized	24.0	34.4	1.24 (1.02–1.51)*		0.0	14.4	1.44 (1.27–1.63)*		21.1	43.1	1.74 (1.22–2.47)*		65.4	84.0	1.80 (0.76–4.26)	
Intracapsular fracture	54.7	61.1	1.13 (0.92–1.39)		64.7	60.0	0.95 (0.76–1.18)		48.9	66.2	1.53 (1.02–2.29)*		61.5	52.0	0.82 (0.47–1.43)	
Osteosynthesis	56.7	56.1	0.99 (0.81–1.21)		61.8	60.0	0.98 (0.79–1.22)		56.7	47.7	0.81 (0.56–1.18)		50.0	64.0	1.35 (0.74–2.46)	
Delirium	10.1	26.7	1.54 (1.28–1.84)*		0.0	17.8	1.46 (1.28–1.66)*		13.5	38.5	1.98 (1.41–2.77)*		11.5	28.0	1.59 (0.94–2.72)	
LOS > 10 days	38.7	48.3	1.19 (0.98–1.45)		11.8	36.7	1.36 (1.13–1.64)*		44.4	60.0	1.44 (0.98–2.12)		53.8	60.0	1.14 (0.64–2.03)	

Values are given as percentage. *Significant at that moment in time; $P < 0.05$, bivariate analysis. [†]A total of 52 patients died and eight patients were lost to follow up of the baseline population. [‡]Based on the median of the different groups. ADL, activities of daily living; ASA, American Society of Anesthesiologists Physical Status classification; LOS, length of stay.

Table 3 Relative risks of different variables for not regaining mobility at 12-month follow up (bivariate analysis)

	All patients [†]				Mobile without aid				Mobile with aid				Patients only mobile indoors			
	Mobility regained?		RR (CI)		Mobility regained?		RR (CI)		Mobility regained?		RR (CI)		Mobility regained?		RR (CI)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	n = 138	n = 151	n = 47	n = 72	n = 47	n = 72	n = 77	n = 56	n = 14	n = 23	n = 14	n = 23	n = 14	n = 23	n = 14	n = 23
Older age [‡]	39.1	46.4	1.15 (0.92–1.43)	34.0	59.7	1.51 (1.11–2.04)*	51.9	39.3	0.74 (0.49–1.12)	64.3	43.5	0.73 (0.44–1.22)	64.3	43.5	0.73 (0.44–1.22)	43.5
Female sex	73.2	72.8	0.99 (0.77–1.27)	55.3	65.3	1.18 (0.86–1.62)	83.1	80.4	0.90 (0.55–1.47)	78.6	78.3	0.99 (0.54–1.82)	78.6	78.3	0.99 (0.54–1.82)	78.3
Absence of a partner	61.8	62.5	1.02 (0.80–1.29)	44.7	55.7	1.20 (0.88–1.62)	72.7	66.7	0.85 (0.55–1.30)	58.3	75.0	1.36 (0.69–2.70)	58.3	75.0	1.36 (0.69–2.70)	75.0
ASA III/IV	25.4	29.1	1.09 (0.86–1.39)	10.6	15.3	1.16 (0.80–1.68)	29.9	39.3	1.27 (0.85–1.88)	50.0	47.8	0.97 (0.58–1.60)	50.0	47.8	0.97 (0.58–1.60)	47.8
Dementia	12.3	27.2	1.48 (1.19–1.83)*	4.3	16.7	1.49 (1.13–1.95)*	12.7	35.2	1.88 (1.30–2.72)*	38.5	42.9	1.07 (0.63–1.82)	38.5	42.9	1.07 (0.63–1.82)	42.9
Anemia at admission	34.1	40.4	1.14 (0.91–1.42)	21.3	31.9	1.22 (0.91–1.64)	36.4	46.4	1.27 (0.85–1.88)	64.3	52.2	0.83 (0.51–1.37)	64.3	52.2	0.83 (0.51–1.37)	52.2
lower level of ADL [‡]	33.3	49.7	1.37 (1.10–1.70)*	17.0	59.7	1.98 (1.46–2.67)*	28.6	62.5	2.22 (1.46–3.38)*	35.7	47.8	1.20 (0.73–1.98)	35.7	47.8	1.20 (0.73–1.98)	47.8
Institutionalized	16.7	33.8	1.48 (1.20–1.83)*	0.0	16.7	1.78 (1.51–2.11)*	18.2	37.5	1.68 (1.15–2.45)*	64.3	78.3	1.33 (0.68–2.62)	64.3	78.3	1.33 (0.68–2.62)	78.3
Intracapsular fracture	58.7	57.0	0.97 (0.77–1.21)	68.1	56.9	0.83 (0.63–1.11)	51.9	55.4	1.08 (0.72–1.62)	64.3	60.9	0.95 (0.57–1.58)	64.3	60.9	0.95 (0.57–1.58)	60.9
Osteosynthesis	60.1	55.6	0.92 (0.73–1.14)	66.0	58.3	0.88 (0.66–1.18)	59.7	51.8	0.83 (0.56–1.23)	42.9	56.5	1.23 (0.74–2.06)	42.9	56.5	1.23 (0.74–2.06)	56.5
Delirium	10.2	26.5	1.56 (1.27–1.92)*	4.3	18.1	1.53 (1.18–1.98)*	14.5	37.5	1.88 (1.30–2.70)*	7.1	26.1	1.51 (0.98–2.34)	7.1	26.1	1.51 (0.98–2.34)	26.1
LOS > 10 days	30.4	53.6	1.56 (1.25–1.94)*	10.6	40.3	1.69 (1.31–2.17)*	40.3	64.3	1.77 (1.16–2.72)*	42.9	69.6	1.56 (0.86–2.84)	42.9	69.6	1.56 (0.86–2.84)	69.6

Values are given as percentage. *Significant at that moment in time; $P < 0.05$, bivariate analysis, †A total of 97 patients died and four patients were lost to follow up of the baseline population, ‡Based on the median of the different groups. ADL, activities of daily living; ASA, American Society of Anesthesiologists Physical Status classification; LOS, length of stay.

Table 3 shows the relative risks of the different variables for not regaining prefracture mobility at 12 months, which were the same as at 3-month follow up. The additional risk factors in the group that was mobile with an aid in the analysis at 3 months lost their significance at 12 months.

The outcome of the multivariable regression analysis of the risk factors for not regaining prefracture mobility for the whole cohort and stratified by mobility category is shown in Table 4. A lower level of ADL was, together with the occurrence of a delirium, the most important independent risk factor for not regaining the prefracture level of mobility in the whole cohort and the subgroups, without a difference between 3- and 12 month follow up. In the bi- and multivariable regression analysis of the group of patients who were only mobile indoors, none of the risk factors reached significance.

Table 4 Results of multivariable regression analysis of risk factors for not regaining prefracture level of mobility

	Risk factor	3-month follow up			12-month follow up		
		OR	95% CI	P-value	OR	95% CI	P-value
All patients [§]	Lower level of ADL [†]	3.01	1.40 to 6.45	0.005	3.79	1.69 to 8.50	0.001
	Delirium	3.94	1.92 to 8.07	<0.001	3.04	1.42 to 6.49	0.004
	LOS >10 days	1.71	1.00 to 2.92	0.050	2.81	1.58 to 4.98	<0.001
	Institutionalized before admission	2.72	1.40 to 5.28	<0.001	2.42	1.18 to 4.99	0.016
	Prefracture mobility [‡]						
	Mobile with an aid	0.08	0.04 to 0.17	<0.001	0.12	0.06 to 0.27	<0.001
Mobile without an aid [¶]	Only mobile indoors	0.05	0.025 to 0.24	<0.001	0.12	0.04 to 0.37	<0.001
	Lower level of ADL [†]	4.86	1.79 to 13.17	0.002	6.19	2.46 to 15.57	<0.001
	LOS >10 days	2.74	0.83 to 9.07	0.099	4.09	1.35 to 12.38	0.013
	Older age [†]	2.71	1.07 to 6.85	0.035	1.85	0.78 to 4.42	0.164
Mobile with an aid ^{**}	Lower level of ADL [†]	6.06	2.81 to 13.09	<0.001	4.04	1.89 to 8.63	<0.001
	Delirium	3.40	1.42 to 8.11	0.006	3.14	1.30 to 7.60	0.011

[†]Based on the median of the different groups. [‡]Mobile without an aid is the reference category. Analysis was carried out on: [§]330 patients at 3-month follow up and 289 patients at 12-month follow up; [¶]124 patients at 3-month follow up and 119 at 12-month follow up; and ^{**}155 patients at 3-month follow up and 133 at 12-month follow up. ADL, activities of daily living; LOS, length of stay.

Discussion

In the present study, approximately half of the patients had regained their prefracture mobility 3 months after a hip fracture. The majority of mobile patients without an aid did not regain their mobility, but improved their level of mobility between 3 and 12 months postoperatively. The level of mobility of patients in the other mobility categories did not significantly improve after 3-month follow up. Furthermore, the more limited the prefracture level of mobility, the higher the number that became immobile after 12 months. The most important independent risk factors for failure to return to the prefracture level of mobility were a lower prefracture level of ADL and a delirium during admission.

Previous series from Western societies reporting specifically on walking ability showed either a comparable^{3,6,9} or a much lower (11–16%)⁷ percentage of patients returning to their prefracture level. The pre-fracture level of mobility in these series was higher^{7,9} or defined differently.^{3,6}

A Japanese cohort was younger and less mobile before fracture than our cohort, but had a comparable level of mobility after 12 months.⁸ The number of patients that became immobile at follow up was within the previous reported range of 5–21%.^{6,7,9} The huge impact of a hip fracture can be shown by the percentage of patients becoming immobile. The present study showed that 60% of the patients who were mobile only indoors before the fracture occurred became immobile during the postoperative course of 1 year. Furthermore, the mobility of those patients deteriorated even more during the 1-year postoperative course, the latter has not been shown before.

Previous studies showed that functional recovery after hip fracture occurs within the first 4–6 months post-fracture.^{1,4,8,18} In the current study, functional recovery was stratified by prefracture mobility. We found an improvement of mobility in patients who were mobile without an aid between 3 and 12 months, and no significant difference in the other subgroups. These results were confounded by age and mortality, as the less mobile groups were older and had a higher mortality rate.

Comparison between studies is limited because of different definitions of walking ability and functional outcome. A recent review showed that higher age, worse health condition and cognitive status, and lower pre-fracture functional level were the strongest risk factors for worse functional outcome after a hip fracture.¹¹ In the present study, dementia, lower level of ADL, living in an institutionalized care environment, delirium and a LOS >10 days were the main risk factors in the bivariate analysis. Dementia lost significance in the multivariable logistic regression analysis. In patients who were mobile without an aid, age was an additional risk factor in both bivariate and multivariable analysis at 3 months.

As previously reported, a limited level of ADL is one of the most important contributors to poor outcome.^{6,7,11,12} Delirium as a risk factor was either confirmed or denied to be a risk factor in previous studies; in the present study, it was a risk factor in the whole cohort, as well as in the group that was mobile with an aid.^{12,16} Most probably, patients who suffer from a delirium are generally in worse general condition, contributing to the loss of mobility.²²

A longer LOS was reported by Magaziner *et al.* to be a risk factor for a poorer post-fracture functional level.⁴ This might be because of the fact that a longer LOS often means more complications and therefore worse functional outcome on the long term.

Finally, living in institutionalized care was a risk factor for not regaining mobility in the whole cohort, but not in the subgroups. Others found worse functional outcomes in institutionalized patients compared with patients living independently.^{15,17}

This is one of the few prospective studies reporting on the level of mobility from admission to 1 year after a hip fracture. The sample size, its prospective character, the accurate information on clinical characteristics, and the length and high rate of follow up make this study valuable. Its main limitation was the absence of more detailed data on cognitive function. Furthermore, we did not use an objective measuring instrument, such as the Confusion Assessment Method, to establish a delirium; the diagnosis was based on clinical examination, as stated in the DSM-IV.^{20,23} Another limitation is the fact that we did not have more objective data on the level of mobility (such as gait speed), besides the use of a walking aid or not. Finally, the number of patients that was categorized in the group only mobile indoors was rather small ($n = 69$).

In the present study, less than half of the patients regained their prefracture mobility 12 months after hip fracture. Just one-quarter of the mobile patients without an aid regained their level of mobility at 3-month follow up, this improved to approximately one-third at 12 months. The groups with a lower level of mobility regained their prefracture level of mobility in over half of the cases, but did not improve after 3 months. The most important independent risk factors for failure to return to the prefracture level of mobility were the prefracture level of ADL and a delirium during admission.

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PART IV

PREDICTION MODELS



7

Delirium risk screening and haloperidol prophylaxis program in hip fracture patients is a helpful tool in identifying high-risk patients, but does not reduce the incidence of delirium

Anne JH Vochteloo, Sophie Moerman, Boudewijn LS Borger van der Burg, Maarten de Boo, Mark R de Vries, Dieu-Donné Niesten, Wim E Tuinebreijer, Rob GHH Nelissen and Peter Pilot

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Abstract

Background: Delirium in patients with hip fractures lead to higher morbidity and mortality. Prevention in high-risk patients by prescribing low dose haloperidol is currently under investigation.

Methods: This prospective cohort surveillance assessed hip fracture patients for risk of developing a delirium with the Risk Model for Delirium (RD) score. High-risk patients (score ≥ 5 points) were treated with a prophylactic low-dose of haloperidol according to hospital protocol. Primary outcome was delirium incidence. Secondary outcomes were differences between high- and low-risk patients in delirium, length of stay (LOS), return to pre-fracture living situation and mortality. Logistic regression analysis was performed with age, ASA-classification, known dementia, having a partner, type of fracture, institutional residence and psychotropic drug use as possible confounders.

Results: 445 hip fracture patients aged 65 years and older were admitted from January 2008 to December 2009. The RD-score was completed in 378 patients, 173 (45.8%) high-risk patients were treated with prophylactic medication. Sensitivity was 71.6%, specificity 63.8% and the negative predictive value (NPV) of a score < 5 was 85.9%.

Delirium incidence (27.0%) was not significantly different compared to 2007 (27.8%) 2006 (23.9%) and 2005 (29.0%) prior to implementation of the RD- protocol.

Logistic regression analysis showed that high-risk patients did have a significant higher delirium incidence (42.2% vs. 14.1%, OR 4.1, CI 2.43-7.02). They were more likely to be residing at an alternative living situation after 3 months (62.3% vs. 17.0%, OR 6.57, CI 3.23-13.37) and less likely to be discharged from hospital before 10 days (34.9% vs. 55.9%, OR 1.63, CI 1.03-2.59). Significant independent risk factors for a delirium were a RD-score ≥ 5 (OR 4.13, CI 2.43-7.02), male gender (OR 1.93, CI 0.99-1.07) and age (OR 1.03, CI 0.99-1.07).

Conclusions: Introducing the delirium prevention protocol did not reduce delirium incidence.

The RD-score did identify patients with a high risk to develop a delirium. This high-risk group had a longer LOS and returned to pre-fracture living situation less often.

The NPV of a score < 5 was high, as it should be for a screening instrument. Concluding, the RD-score is a useful tool to identify patients with poorer outcome.

Background

Delirium is a common and serious complication in hip fracture patients. It leads to lower functional abilities, longer hospital stay, impaired cognitive function, more admissions to long term special care facilities and higher mortality rates [1- 5]. This advocates the importance of preoperative delirium risk assessment.

Reported post-operative incidence rates range widely from 16 to 62% [6]. This broad range can be explained by patient inclusion criteria and different scoring methods for delirium. Furthermore, delirium is frequently undetected or misdiagnosed [7].

Haloperidol is widely used for symptomatic treatment of delirium. However, prophylaxis with haloperidol did not lower delirium incidence, it did reduce duration of episodes and the severity in a recent randomized controlled trial [8].

In 2008 we introduced an integrated hip fracture care pathway that included a Risk Model for Delirium [9]. This model should identify high-risk patients that are subsequently prescribed prophylactic haloperidol. Primary purpose of this surveillance study was to determine whether using prophylaxis would diminish delirium incidence in hip fracture patients. The second aim was to investigate the value of the score and differences between low- and high-risk patients (as determined by the risk model) in delirium incidence, length of stay, return to pre-fracture living situation and mortality.

Methods

A surveillance was conducted on a series of consecutive admissions for a hip fracture to a 450-bed teaching hospital in Delft, the Netherlands.

Patients

From January 2008 to December 2009, all consecutive admissions for a hip fracture were registered and prospectively studied with respect to presence of delirium. Thus 529 admissions (522 patients) were recorded. These were all patients with a hip fracture due to a low-energy trauma and of non-pathologic origin. For this study, patients of 65 years and older (445 patients) were included for evaluation. Duration of follow-up was 1 year.

The control group for evaluating the effect of the use of the Risk Model for Delirium (RD-score) was a historical consecutive series of 611 hip fracture patients of 65 years and older admitted between 2005-2007, prior to implementation of our RD protocol.

As this study is an evaluation of our delirium protocol, it is considered to be a "Post Marketing Surveillance". Therefore, approval of a medical ethical committee was not necessary.

Assessment measures

Uniformed data collection of all patients was achieved by evaluating all patients on admission in a standard procedure and recording, according to our local hip fracture protocol [9]. The following data was collected of all patients; age, gender, having a partner, history of dementia, RD-score, pre-fracture living situation, ASA classification [10], psychotropic drug use, type of fracture, treatment and anaesthesia, in-hospital complications, discharge location, in hospital mortality and length of stay (LOS).

Diagnosis of delirium was based on criteria of the DSM IV [1]. Patients were observed for these criteria by both doctors and nursing staff during their daily rounds and assessments. When signs of delirium were notified, they were recorded in the medical and nursing records. Delirium incidence in this series was scored based on these medical and nursing staff records, directly after discharge. Living situation was assessed at 3 months post-admission by questionnaires sent to all patients. Mortality was assessed until 1 year after hospitalisation, using the digital registration system of the hospital.

Delirium incidence in the historical group (2005-2007) was drawn from our hip fracture database that was built retrospectively by evaluation of the patients' files and complication register.

Assessing the risk for a delirium at admission, using the RD-model (table 1), is a standard part of our local hip fracture protocol [9]. This model was developed in 2004 by the department of Psychiatry in our hospital and uses pre-disposing risk factors for delirium that were weighted, based on known literature at that moment [11- 17]. The model was designed with a cut-off point of 5; patients scoring 5 or more points were considered high-risk patients. For this group delirium prophylaxis is prescribed, being 2 times a day 1 mg of haloperidol. In the case of contra-indications for the use of haloperidol, like Parkinson's disease or Lewy-body dementia, alternative prophylaxis was started.

When patients developed a delirium, they were fully assessed to exclude a somatic cause and treated by the psychiatric department. The RD-score and the delirium protocol were implemented fully on the departments of Orthopaedics and Trauma surgery in 2008, as a part of the integrated hip fracture care pathway.

Table 1 The Risk Model for Delirium

Predisposing risk factors for delirium	Points
Delirium during previous hospitalization	5
Dementia	5
Clock drawing (displaying 10 past 11)	
- Small mistakes	1
- Big mistakes, unrecognizable or no attempt	2
Age	
- 70 to 85 years	1
- Older than 85 years	2
Impaired hearing (patient is not able to hear speech)	1
Impaired vision (vision less than 40%)	1
Problems in activities of daily live	
- Domestic help or help with meal preparation	0.5
- Help with physical care	0.5
Use of heroin, methadone or morphine	2
Daily consumption of 4 or more alcoholic beverages	2
Total score	

Outcome

The current cohort was analyzed for differences between low- (< 5) and high-risk (≥ 5) patients for delirium incidence, length of stay (LOS), alternative living situation (ALS) 3 months post-fracture (compared to the pre-fracture situation) and in-hospital, 3- and 12-month mortality.

Statistical analysis

Categorical data are presented as the number of subjects, along with the percentages. Continuous data are presented as means with standard deviations (SD). The value of the RD-score was evaluated using sensitivity, specificity, the negative predictive value of a low score and the positive predictive value of a high score.

Chi-square test, Fisher's exact test and independent Student's t-test were used as applicable for univariate analysis. A P-value lower than 0.05 was taken as the threshold of significance. LOS was divided in two groups at the level of the median (10 days).

The ability of the RD to discriminate was estimated by the receiver-operating characteristic (ROC) curve.

Univariate analysis was followed by multivariable logistic regression to test the association between the RD and delirium, mortality (in-hospital, 3 and 12-month), LOS, and ALS at 3 months. In these analyses age, gender, ASA score (I/II versus III/IV), psychotropic drug use, institutional residence and known dementia were seen as possible confounders. The analysis regarding return to the pre-fracture living situation was performed on patients that lived independent at home before they broke their hip. To this analysis "having a partner" was added as an extra possible confounder.

The likelihood ratio backward test was conducted to find the best-fit model by selecting the variables one by one. The probability for entry was set at 0.05, the probability for removal at 0.10.

All data were analyzed with SPSS 17.0 (SPSS Inc. Chicago, USA)

Results

Patients

In 378 of the 445 patients (85%) the RD-score was completed correctly. A delirium was diagnosed in 102 of them (27.0%). Due to the inability of patients to participate or a patient-to-nurse ratio that was too high at some moments, the RD-score was incomplete or not performed in 67 patients.

These 67 discarded patients, as of an incomplete RD-score, had a delirium incidence of 28.4%, not significantly different from study cohort ($P = 0.816$). Furthermore, there was no difference in age (82.4 vs. 83.8 years; $P = 0.168$), nor LOS (15.0 vs. 13.2 days, $P = 0.172$) and 1-year mortality (35.8% vs. 24.9%, $P = 0.061$) between the completed RD and non-completed RD-score groups.

Historical comparison

The mean age of the prospective cohort 2008-2009 (83.7 years) was not significantly different from the historical cohort 2005-2007 (82.9 years) ($P = 0.082$). The percentage of male patients was 26.2% in the prospective cohort and 24.3% in the historical cohort were the same as well ($P = 0.515$). No significant differences in delirium incidence were found between the prospective 2008/2009 (27%) and the historical cohorts; 2005 (29.0%, $P = 0.28$), 2006 (23.9%, $P = 0.81$) and 2007 (27.8%, $P = 0.44$). (Chi Square-test)

RD protocol

The protocol was violated in 49 out of 378 patients (13%); prophylaxis was not started in 26 patients with a score of ≥ 5 and was started in 23 patients scoring < 5 .

Delirium incidence in the 23 low-risk patients was 34.8%, significantly higher than in the 182 that were not prescribed prophylaxis, 11.5%. (Pearson Chi-Square, $P = 0.003$). Delirium incidence in the 26 high-risk patients not started on prophylaxis was 50.0%, not significantly higher than in the 147 that were prescribed prophylaxis, 40.8%. (Pearson Chi-Square, $P = 0.38$) When the protocol violations were excluded, high-risk patients still had a higher risk of delirium ($P < 0.001$), a longer LOS ($P < 0.001$) a higher likelihood of living at an alternative living situation after 3 months ($P = 0.001$) and higher mortality rates at 3 and 12 months ($P < 0.001$).

Value of the RD-score

A receiver-operating characteristic (ROC) curve (Figure 1), made of the continuous outcome of the RD-score showed an area under curve of 0.722 (CI 0.674-0.767, $P < 0.0001$). The best cut-off point for balancing sensitivity and specificity was 5, corresponding with the pre-study chosen cut-off point.

Sensitivity of the cut-off point was 71.6% (73/102), specificity was 63.8% (176/276). Excluding patients who were not treated according to the protocol, the sensitivity became 74.1% (60/81) and the specificity 64.9% (161/248).

The negative predictive value of a score < 5 (i.e. no delirium) was 85.9% (176/205), the positive predictive value for a score of ≥ 5 (i.e. delirium) was 42.2% (73/ 173).

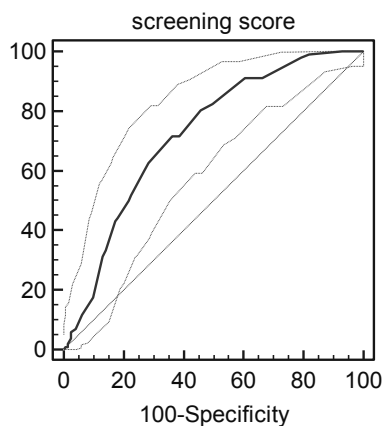


Figure 1 ROC curve of the RD-score with 95% confidence intervals. The diagonal indicate results no better than chance.

High- and low-risk patients

Specific details of 205 low-risk (score < 5) and 173 high-risk (score of ≥ 5) patients are shown in table 2. High-risk patients were significantly older, more often female, suffering from dementia, ASA classification III-IV, having no partner, residing in an institution, using psychotropic drugs and receiving spinal/epidural anesthesia during surgery.

At univariate analysis (table 2), patients with a RD-score of ≥ 5 had a higher risk for a delirium, ($P < 0.001$). Furthermore, they had a longer LOS, a higher chance of living at an alternative living situation after 3 months and a higher 3- and 12-month mortality rate (all $P < 0.001$).

Multivariable analysis per outcome variable is displayed in table 3. The RD-score was a significantly contributing variable for delirium, length of stay and alternative living situation at 3 months. Age and ASA classification were strong independently contributing variable as well.

Table 2 Relative risks for different demographic characteristics and outcome parameters with a RD-score ≥ 5 (univariate analysis)

	Score ≥ 5 (n = 173)	Score < 5 (n = 205)	Relative risk (CI)	P value
Age, mean $\pm$ SD	86.6 $\pm$ 6.5	81.4 $\pm$ 7.1	n/a	$< 0.001^{***}$
Female gender	79.2%	69.3%	1.35 (1.01-1.80)	0.029
Dementia	51.4%	0%	3.44 (2.87-4.12)	< 0.001
ASA -III-IV	45.7%	22.9%	1.68 (1.36-2.07)	< 0.001
Institutional residence	61.8%	10.2%	3.17 (2.54-3.95)	< 0.001
Having no partner	79.3%	60.9%	1.74 (1.26-2.41)	< 0.001
Psychotropic drug use	51.4%	24.4%	1.82 (1.47-2.25)	< 0.001
Fracture type				
neck of femur	56.1%	59.0%		0.85*
(inter) trochanteric	39.5%	37.0%	0.95 (0.78-1.15)	0.59**
subtrochanteric	4.4%	4.0%		
Treatment				
osteosynthesis	60.5%	50.3%		0.077*
(hemi-) arthroplasty	38.5%	46.8%	1.19 (0.98-1.44)	0.072**
conservative	1.0%	9%		
Spinal/epidural anesthesia	97.5%	91.1%	2.26 (1.05-4.85)	0.006
Delirium	42.4%	14.1%	1.98 (1.62-2.41)	< 0.001
Length of stay ≥ 10 days	65.1%	44.1%	1.61 (1.27-2.05)	< 0.001
Alternative living situation at 3 months*	62.3%	17.0%	4.25 (2.65-6.80)	< 0.001
In-hospital mortality	5.8%	2.0%	1.60 (1.12-2.26)	0.050
3-month mortality	23.1%	8.3%	1.69 (1.37-2.10)	< 0.001
12-month mortality	37.0%	14.6%	1.77 (1.45-2.17)	< 0.001

* Only calculated for the patients not yet living in institutions (n = 218, n = 32 missing), * Comparing 3 treatment groups; ** RR and p-value comparing femur neck with (inter) trochanteric fractures and osteosynthesis with arthroplasty; *** Independent T-test, CI = confidence interval

Table 3 Results of the multivariable logistic regression analysis per outcome variable

Outcome variable	Independent variables	Odds ratio	95% CI	P value
Delirium	Screening score ≥ 5	4.13	2.43-7.02	< 0.001
	Age in years	1.03	0.99-1.07	0.082
	Male gender	1.93	1.10-3.39	0.022
Length of hospital stay ≥ 10 days	Screening score ≥ 5	1.63	1.03-2.59	0.037
	Age in years	1.06	1.03-1.10	< 0.001
	ASA III-IV	1.55	0.97-2.47	0.069
Alternative living situation at 3 months	Screening score ≥ 5	6.57	3.23-13.37	< 0.001
	Age in years	1.09	1.04-1.06	0.001
In-hospital mortality	Age in years	1.14	1.03-1.26	0.014
	ASA III-IV	3.83	1.13-13.0	0.031
	Institutional residence	3.54	0.89-14.0	0.072
3-month mortality	Age in years	1.11	1.05-1.17	< 0.001
	ASA III-IV	2.48	1.33-4.61	0.004
	Institutional residence	2.97	1.55-5.68	0.001
12-month mortality	Age in years	1.08	1.03-1.12	0.002
	ASA III-IV	2.78	1.60-4.84	< 0.001
	Having no partner	2.22	1.07-4.61	0.033
	Institutional residence	2.06	1.16-3.68	0.014

Female, having a partner, ASA I-II, screening score < 5, not residing in an institution are reference categories

Discussion

Identification of hip fracture patients at risk for delirium is important in order to start early treatment with medication and psychogeriatric consultation. Therefore, it is of great value to have an accurate but simple to use, screening instrument.

We used the Risk Model for Delirium (RD-score) to identify patients at risk for delirium and started prophylactic haloperidol in the high-risk group. Large differences between high- and low-risk patients regarding delirium incidence, length of stay, discharge location and mortality were anticipated. However in this study, prophylactic treatment of high-risk patients as identified by our RD-score, did not reduce delirium incidence compared to our historical data. The score did identify patients with poorer outcome regarding delirium incidence, LOS and return to pre-fracture living situation.

The RD-score had a moderate sensitivity (71.6%) and specificity (63.8%), this is in accordance with other risk models [18]. The negative predictive value (NPV) of a score <

5 was quite high (85.9%), which is very important as a screening instrument should have a high NPV. The consequence of a false positive test (i.e. prophylactic treatment with low-dose haloperidol in a non-delirious patient) is generally modest as very few side effects of a low dose of haloperidol can be expected. Therefore, its moderate positive predictive value (42.2%) is of lesser importance.

The pre-study chosen cut-off value for the RD-score of 5 was confirmed to be right by the ROC curve analysis. This cut-off point provided a high-risk group with a significant higher relative risk of developing a delirium; OR (adjusted for age and gender) 4.13. Higher age and ASA classification, residing in an institution and absence of a partner suggested a higher vulnerability of the high-risk group. This is demonstrated in outcome; high-risk patients had a longer hospital stay, higher 3- and 12-month mortality, and a higher risk of staying at an alternative living situation at 3 months in univariate analysis. In multivariable analysis, the effect of the RD-score for mortality disappeared.

Several authors described a model that tried to identify high-risk patients for delirium. One study used a cohort of vascular surgery patients [18], another major elective (non-cardiac) surgery patients [15] and 4 others used cardiac surgery cohorts [19- 22]. All these models contained items that were not applicable to our patients, while they were patient group specific and designed for an elective surgery population. Kalisvaart et al [8] used a population that contained both elective hip surgery and hip fracture patients. They used visual impairment, disease severity (expressed by the Apache II score) [23], mental impairment (Mini Mental State Examination, MMSE) [24] and dehydration (expressed by blood urea nitrogen/creatinine ratio) as parameters. We chose to develop a simpler model that was easy to use in an acute admission, to achieve maximum use in daily practice. This has been accomplished; 85% of all patients had a complete RD-score. Despite the integration of the RD in a standard patient file, the prophylaxis protocol was violated in 13% of patients. High turnover of doctors in the emergency department may have contributed to these violations.

Older age, cognitive impairment, use of psychotropic drugs (for example benzodiazepines), functional impairment (both in daily activity and clock drawing) visual and hearing impairment were all included parameters that were found to be associated with delirium in a systematic review by Dasgupta et al [25]. Besides these, they found depression, psychopathologic symptoms, psychotropic drugs, institutional residence

and medical co-morbidity to be important delirium risk factors. We used institutional residence as a possible confounder in regression analysis, which was of non-significant contribution to risk for a delirium. However, it was a strong predictor of mortality at 3 and 12 months. Psychotropic drug use was associated with a RD-score ≥ 5 , but not a predictor of delirium or other outcome in multivariable analysis.

Based on our analysis, adding the factor “male gender” to the RD-score might improve its efficacy as this was a significant contributor to delirium (OR 1.93). This is in contrast to Dasgupta et al [25] who did not find a correlation between male gender and delirium.

Twenty-three low-risk patients were prescribed haloperidol prophylaxis, against the protocol. This group had a higher percentage of delirium than the rest of the low-risk group, which was not hypothesized. The doctor that prescribed haloperidol against protocol might be triggered by patient factors that are not taken into consideration by the score but that do predispose to a delirium as they have a higher delirium incidence.

The prospective character of the study, its large sample size and the use of a predefined risk-stratification model are important issues for interpretation of our results. The main limitations are the subjectivity of determining a delirium and mental impairment of a patient. In our study, delirium was diagnosed based on clinical examination, as stated in the DSM IV [1]. We did not use a measuring instrument like a Confusion Assessment Method [7] to establish delirium. A second limitation was, that in cognitively impaired patients it is difficult to distinguish between delirium and cognitive impairment. Furthermore, patients were scored for known dementia based on history taking and information from digital patient files, a cognitive impairment score like the MMSE was not used [24]. Another limitation is the comparison of the delirium incidence in the whole cohort with the historical cohort. Ideally, we would have compared only the high-risk groups of both cohorts. However, we could not identify high-risk patients in the historical group as the RD-score was implemented fully in 2008. We did demonstrate that both cohorts were comparable regarding mean age and number of male patients, being the main risk factors in the multivariable analysis of the prospective cohort, besides a high RD-score. Therewith one could have observed a decline in delirium incidence due to prophylaxis with haloperidol.

Haloperidol is widely used for symptomatic treatment of delirium, as prophylaxis it has a more disputable reputation. In one small study in gastrointestinal surgery patients, haloperidol prophylaxis was proved effective in reducing delirium incidence [26]. However, a large study in hip fracture patients [8] did not support this finding. Our protocol was developed with the intention to reduce delirium incidence by earlier identification of patients at risk with an objective scoring system, the RD-score. Compared to our historical data, however, we saw no decline in delirium incidence. This corresponded with a recent Cochrane review [27] on interventions preventing delirium. It stated that pro-active geriatric consultation could reduce delirium incidence, but that low-dose haloperidol prophylaxis did not diminish delirium rates [27]. Kalisvaart et al. [8] showed that low-dose haloperidol prophylaxis can reduce severity and duration of delirium and that this may shorten LOS. During the study period, we started using the Delirium Observation Scale [28] to monitor depth and duration of a delirium. However, this instrument was not yet used in a consistent way over the study period to take these data in account for this analysis. Further research should focus more on depth and duration of delirium instead of incidence, since this might give better insight in efficacy of prophylactic treatment. We believe that more emphasis should be given on non-pharmacological interventions to prevent a delirium. These interventions include providing orientation with calendars, clocks and photographs and maintain day-night rhythm. However, they take valuable manpower from the nursing staff. When these interventions can be targeted to the high-risk group (as identified with the RD-score) it would be preferable.

Conclusions

Prescribing prophylactic Haloperidol to high-risk patients as identified by the Risk Model for Delirium did not reduce delirium incidence in a cohort of hip fracture patients.

The RD-score did prove to be an accurate tool for identifying high-risk patients with poorer outcome regarding delirium incidence, length of stay and return to pre-fracture living situation.

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8

Validation of the Risk Model for Delirium in hip fracture patients

Sophie Moerman, Wim E. Tuinebreijer, Maarten de Boo, Peter Pilot,
Rob G.H.H. Nelissen, Anne J.H. Vochteloo

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Abstract

Objective: The Risk Model for Delirium (RD) score is a 10-item questionnaire that allocates hip fracture patients after admission to hospital to be either at high or at low risk for delirium. This allows targeted preventive actions. Clinical reliability, validity and feasibility of the RD score are discussed.

Methods: Demographic data, RD score and delirium incidence of all consecutive admissions for hip fractures in patients 65 years and older were collected. In 102 patients, the RD score was repeated. Interobserver reliability and validity were determined. The correlation between delirium and items both included and not included in the RD score was calculated.

Results: A total of 378 patients were included; 102 (27%) were diagnosed with a delirium. The intraclass correlation coefficient of the RD score was 0.77 [confidence interval (CI) 0.68–0.84]. Sensitivity was 80.4% (71.4–87.6), and specificity was 56.2% (50.1–62.1). Area under the receiver operating characteristic curve was 0.73 (CI 0.68–0.77). A multivariable logistic regression analysis showed that besides the RD score, a trochanteric fracture and male gender were independent risk factors for delirium.

Conclusions: The RD score is a reliable, feasible and valid instrument for predicting delirium in hip fracture patients.

Introduction

Delirium in hip fracture patients is a serious complication, leading to higher morbidity and mortality [1–4]. A recent Cochrane review states that proactive geriatric consultation can reduce delirium incidence [5]. To optimize patient care, it is important to perform a preoperative risk assessment in order to target preventive interventions. This risk assessment should be simple and brief to increase participation of both patients and medical professionals.

Several authors described a model that identifies patients at high-risk for delirium. These models were applied in cohorts of vascular surgery patients [6], elective (non-cardiac) surgery patients [7] and four cohorts of cardiac surgery patients [8–11]. All these models contained items that are not applicable to hip fracture patients. On the contrary, these models are not only patient group specific, but are also designed for elective surgery patients. Kalisvaart et al. published the outcome of a risk score for delirium in a population that contained both elective hip replacement surgery and hip fracture patients [12]. They scored visual impairment, disease severity [using the Acute Physiology and Chronic Health Evaluation (APACHE) II score] [13], mental impairment [scored with the Mini Mental State Examination (MMSE)] [14] and dehydration (expressed by blood urea nitrogen–creatinine ratio). We chose to develop a simpler model that is easy to use in an acute admission setting to achieve maximum use in daily practice: the Risk Model for Delirium (RD) score. Recently, we published the results of the use of the RD score in daily practice [15].

This study evaluates the clinical reliability, validity and feasibility of the RD score in hip fracture patients.

Methods

Patients

All consecutive admissions for a hip fracture to a 450-bed Dutch teaching hospital between January 2008 and December 2009 were registered prospectively. This was part of daily care and monitoring according to our local hip fracture protocol [16]. Patients of this cohort aged 65 years (n=445) and older were included in the current study.

Sixty-seven patients were excluded because the RD score was not completed sufficiently. Final analysis was therefore performed in 378 patients with a mean (S.D.; range) age of 83.8 (7.3; 65–101) years; 279 (73.8%) were female.

Failure to complete the RD score was mainly because of lack of time of medical personnel at the emergency department (ED) or refusal of patients to cooperate. The excluded patients had a delirium incidence of 28.4%, not significantly different from the included study cohort (27%, $P=.82$). Furthermore, there was no difference in mean (S.D.) age between these groups [82.4 (7.4) vs. 83.8 (7.3) years; $P=.17$].

The following baseline characteristics were collected at admission: age, gender, presence of a partner, presence of dementia, pre-fracture living situation, American Society of Anaesthesiologists (ASA) physical status classification, psychotropic drug use (antidepressant, antipsychotic or any form of tranquillizer), RD score, type of fracture, hip fracture treatment, type of anesthesia and occurrence of a delirium during admission [17]. Presence of dementia was determined upon history taking from patients, families and caretakers. Ward nurses observe patients three times a day for clinical signs of a delirium as described in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition

(DSM-IV) criteria [18]. Symptoms of a delirium were registered in both the medical and nursing staff records. Directly after discharge, both records were examined independently by two authors (S.M. and A.V.) to register prevalence of a delirium. In case of doubt (36 patients), a psychiatrist was consulted, who diagnosed a delirium in 27 patients.

RD score

The RD score was developed in 2004 by the Department of Psychiatry of the Reinier de Graaf Hospital, Delft, the Netherlands [15]. At that moment, the most important known risk factors for a delirium were used in the RD score [7,19–24]. Fig. 1 shows the score, its items and the value assigned to the specific item. Predisposing, instead of precipitating, factors were selected while these are present at admission and more easy to use. Points assigned to each item were derived from the relative risk of that factor to develop a delirium [7,19–24]. Based on the clinical experience, patients with a score of 5 or more points were considered to be high-risk patients. At admission at the ED, nurses (or doctors) filled out the RD score with the patient and his or her family or caretakers. According

to the hospital's delirium protocol, high-risk patients (with a score of 5 or more points) received two times daily 1 mg of haloperidol as delirium prevention (in case of absence of contraindications). Independent of the RD score, all patients were monitored for delirium during hospitalization as described above. When patients developed a delirium, they were fully clinically assessed to exclude a somatic cause and treated in collaboration with the psychiatric department.

Predisposing risk factors for delirium	Points
Delirium during previous hospitalization	5
Dementia	5
Clock drawing (displaying 10 past 11)	
- Small mistakes	1
- Big mistakes, unrecognizable or no attempt	2
Age	
- 70 to 85 years	1
- Older than 85 years	2
Impaired hearing (patient is not able to hear speech)	1
Impaired vision (vision less than 40%)	1
Problems in activities of daily live	
- Domestic help or help with meal preparation	0.5
- Help with physical care	0.5
Use of heroin, methadone or morphine	2
Daily consumption of 4 or more alcoholic beverages	2
Total score	

Figure 1. The Risk Model for Delirium.

In 102 patients, the ward nurse at the orthopaedic department performed the RD score a second time when the patient and his or her family arrived on the ward. These 102 patients together with the raters [both ED and ward nurses (doctors)] were selected randomly. Ward and ED nurses (or doctors) completed the score independent of each other. We used these independently executed RD scores to calculate the interobserver variability.

All RD score sheets of all patients were checked for possible errors and, if applicable, were corrected.

Statistical analysis

All items of the questionnaires were imported into IBM SPSS Statistics 19. (IBM Corporation, Somers, NY, USA)

Clinical reliability

The clinical reliability of the RD score was analyzed using the intraclass correlation coefficient (ICC) and the kappa coefficient. The ICC and the kappa coefficient are measures of the interobserver reliability, which assesses the degree in which observers assign the same ratings. Values of 0–0.20 were regarded as slight agreement, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial and 0.81–1 as almost perfect agreement [25]. As a measure of test–retest agreement, the standard error of measurement was calculated by dividing the mean difference in score between the initial test and the retest by the square root of 2 [26]. The standard error of measurement must be interpreted in relation to the mean. To account for this relationship, the coefficient of variation was calculated. In order to test the validity of the results of this retrospective analysis of the RD score, a post hoc power analysis was performed. A sample size of 70 subjects with two observations per subject achieved an 84% power to detect an ICC of 0.70 under the alternative hypothesis when the ICC under the null hypothesis is 0.50 using an F-test with a significance level of .05 (calculated with PASS 2008, version 08.05).

Validity

A receiver operating characteristics curve (ROC) was created by plotting the sensitivity (true-positive rate) versus the 1–specificity (false-positive rate). The actual area under the ROC (AUROC) measures the ability of the instrument to classify correctly the patients with and without a high risk for delirium to identify the best cutoff point.

The percentages of scores below 5 and above 14 for the RD score were calculated to assess floor and ceiling effects.

Test items statistics

Reliability of the individual items of the RD score was expressed using the ICC of these items. Spearman correlation coefficient was calculated between items of the RD score and the occurrence of delirium to determine the convergent validity. Furthermore, the

odds ratio (OR) of each score item for the prevalence of a delirium was calculated using logistic regression analysis with the score items separately as independent variables. To test whether risk factors other than the RD score items would improve the risk model, a multivariable logistic regression was repeated with the RD score dichotomized in high- (score $\geq$ 4) and low-risk (score $<$ 4) patients. The items age, gender, ASA score, fracture type, psychotropic drug use, presence of a partner and institutional residence were used as possible predictors for delirium [27,28]. Based on the ROC curve analysis, the optimal cutoff point of the RD score was considered to be 4 instead of the clinical cutoff of 5 points. The likelihood ratio backward test was conducted to find the best-fit model by selecting the variables one by one. The probability for entry was set at .05, and the probability for removal at .10.

Feasibility

To assess the clinical feasibility, all the RD score sheets were evaluated for errors in interpreting or skipping items and summation of the individual item scores.

Results

Patients

Final analysis was performed in 378 patients; 110 (29.1%) had a partner at admission, 83 (22%) suffered from dementia, 250 (66.1%) lived noninstitutionalized, 252 (66.7%) had an ASA classification of I/II, and 124 (32.8%) used psychotropic drugs.

The mean (S.D.) RD score was 4.9 (3.7), 221 (58.5%) patients were classified as low risk ($<$ 5 points), and 157 (41.5%) patients were classified as high risk ($\geq$ 5 points) based on the clinical cutoff point. Delirium was diagnosed in 102 (27%) patients, 29 (14.1%) in the low-risk and 73 (42.4%) in the high-risk group.

Clinical reliability

In 102 patients (26.9%), an independent nurse performed the RD score for the second time. The ICC for a single measure was 0.77 (90% CI 0.68–0.84). ICC for an average measure of the two observers was 0.87 (90% CI 0.81–0.91). The standard error of measurement

of these 102 duplicate tests was 1.73. The coefficient of variation of the standard error of measurement was 29.4%. RD scores ranged from 0 to 17 points. The RD score was 5 points or less in 56.6% of all patients (i.e., clear floor effect); 2.4% of the cohort scored 15 points or more (i.e., no ceiling effect).

Validity

Fig. 2 shows the ROC; the AUROC was 0.73 (95% CI 0.68–0.77), and the best cutoff point for balancing sensitivity and specificity was 4 points. This was different from the cutoff point of 5 points that was used in daily practice to define high-risk patients.

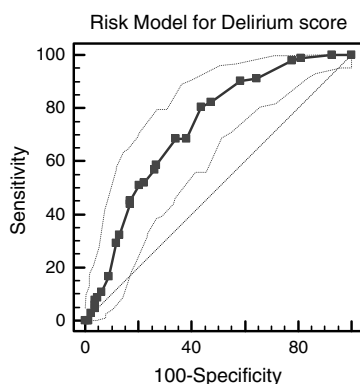


Figure 2. ROC curve of the RD score with 95% CIs. The diagonal indicate results no better than by chance.

The ability to predict a delirium for cutoff points of 4 and 5 is shown in Table 1. The likelihood ratio of an RD score ≥ 4 was 1.86, which means that the probability of a score ≥ 4 being associated with delirium is 1.86 times higher than the probability of this outcome to be associated with no delirium. The likelihood ratio of an RD score < 4 was 0.33, meaning that the probability of having < 4 points and a delirium is 0.33 less than the probability of having < 4 points and no delirium.

Table 1 Results of the validity analysis of the RD for two cutoff points of the RD score

	≥4 points		≥5 points	
Sensitivity % (CI)	81.4	(72.2–88.1)	68.6	(58.6–77.3)
Specificity % (CI)	56.2	(50.1–62.1)	66.3	(60.4–71.8)
Positive predictivity % (CI)	40.7	(33.9–47.8)	42.9	(35.3–50.9)
Negative predictivity % (CI)	89.1	(83.2–93.1)	85.1	(79.5–89.5)
Likelihood ratio positive (sens/1–spec)	1.86	(1.6–2.2)	2.04	(1.6–2.5)
Likelihood ratio negative (1–sens/spec)	0.33	(0.2–0.5)	0.47	(0.4–0.6)
Correlation with delirium	0.33		0.31	

CI=90% confidence interval.

Test items included in the RD

The RD score of all patients was analyzed per item as scored on the form. The prevalence of the following risk factors for a delirium was as follows: a delirium during a previous hospitalization was found in 50 patients (13.2%), 87 patients (23%) suffered from dementia, 89 patients (28.6%) made small mistakes, and 99 patients (33.7%) made big mistakes during clock-drawing. An impaired hearing was scored for in 100 (26.5%) patients, an impaired vision in 66 (17.5%), 214 patients (56.6%) needed help with the preparation of their meals or help for domestic work, and 158 patients (41.8%) received help with physical care. Nine patients (2.4%) had a daily consumption of more than four alcoholic beverages, and only five (1.3%) used heroin, methadone or morphine.

The reliability (ICC and kappa) of the items of the RD score is displayed in Table 2. The reliability of dementia was almost perfect: an ICC and kappa of 0.86. The use of heroin, methadone or morphine showed only a slight reliability (ICC and kappa of 0.01).

The correlations between delirium and items in the RD score expressed in OR are displayed in Table 2. Table 3 shows the correlation between the items and delirium expressed in ICCs. “Impaired hearing,” “impaired vision,” “use of heroin, methadone or morphine” and “daily consumption of four or more alcoholic beverages” had no significant correlation (both the ICC and OR) with delirium.

In the multivariable logistic regression analysis, an RD score of ≥4 (OR 7.1, CI 3.87–13.02, $P<.001$), a trochanteric fracture (OR 1.79, CI 1.07–3.01, $P=.03$) and male gender (OR 1.90, CI 1.06–3.43, $P=.03$) were significant independent predictors for a delirium.

Table 2 Reliability (ICC and kappa) and ORs of the items of the RD

Risk factor	ICC-single	CI	ICC-av.#	CI	Kappa	CI	OR	CI	P value
Delirium during previous hospitalization	0.59	0.45–0.70	0.74	0.62–0.83	0.59	0.39–0.79	2.96	1.61–5.45	<.001
Dementia	0.86	0.80–0.90	0.92	0.89–0.95	0.86	0.74–0.97	2.75	1.66–4.56	<.001
Clock drawing (displaying 10 past 11)	0.72	0.57–0.83	0.84	0.73–0.91	0.72	0.56–0.88			
Small mistakes in clock-drawing	–	–	–	–	–	–	2.27	1.10–4.71	.028
Big mistakes in clock-drawing	–	–	–	–	–	–	3.50	1.77–6.93	<.001
Age	0.72	0.61–0.80	0.84	0.76–0.89	0.72	0.54–0.89			
70–85 years	–	–	–	–	–	–	4.05	0.92–17.77	.064
Older than 85 years	–	–	–	–	–	–	6.62	1.52–28.87	<.001
Impaired hearing (patient is not able to hear speech)	0.59	0.45–0.71	0.74	0.62–0.83	0.59	0.42–0.76	1.31	0.79–2.16	.291
Impaired vision (vision less than 40%)	0.49	0.33–0.63	0.66	0.50–0.77	0.49	0.30–0.69	1.12	0.62–2.01	.716
Domestic help or help with meal preparation	0.52	0.36–0.65	0.68	0.53–0.78	0.52	0.34–0.70	2.74	1.66–4.51	<.001
Help with physical care	0.51	0.35–0.64	0.67	0.51–0.78	0.50	0.34–0.67	3.46	2.15–5.56	<.001
Use of heroin, methadone or morphine	0.01	0.00–0.18	0.03	0.0–0.31	–0.01	–0.03 to 0.005	4.15	0.68–25.21	.124
Daily consumption of 4 or more alcoholic beverages	0.66	0.53–0.76	0.79	0.70–0.86	0.66	0.21–1.0	1.36	0.34–5.56	.707

Av.#=average (after repeated measurement).

Table 3 Correlations between delirium and the items of the RD and between the items themselves

	Delirium	Delirium during previous hospitalization	Dementia	Clock-drawing	Age	Impaired hearing	Impaired vision	Domestic help or help with meal preparation	Help with physical care	Use of heroin, methadone or morphine
Delirium during previous hospitalization	.185									
Dementia	.207	.177								
Clock-drawing	.215	.158	.345							
Age	.157	.082	.470	.231	.242					
Impaired hearing	.054	-.075	.083	.040						
Impaired vision	.019	.006	.110	.107	.120	.309				
Domestic help or help with meal preparation	.207	.153	.224	.317	.230	.114	.150			
Help with physical care	.270	.223	.326	.343	.219	.112	.161	.666		
Use of heroin, methadone or morphine	.086	.023	-.008	.054	-.067	-.069	.069	.101	.090	
Daily consumption of 4 or more alcoholic beverages	.022	-.061	-.085	-.085	-.069	-.054	.020	.067	-.027	-.018

Correlation is significant at the .05 level (2-tailed).
Correlation is significant at the .01 level (2-tailed).

Feasibility

In 378 out of 445 patients (84.9%), the RD score was completed sufficiently. In some of these scores, mistakes were made in interpreting or skipping items and summation of the individual item scores. As a result of this, nine patients were categorized in the wrong group; four should have been qualified as low-risk instead of high-risk patients, and five vice versa.

Interpretation of the form and specific items

In nine patients who lived in a nursing home, no points were assigned for help with meal preparation or domestic help, or for help with physical care. None of these patients would have shifted to another risk group if corrected. In two patients that suffered from dementia according to the medical records, no points were assigned for this item, and in five patients who did receive points for dementia, this diagnosis was not mentioned in their medical records. Correcting for this error would lead to a shift of two patients from low to high risk and five from high to low risk. In 22 patients, the points for age were not correctly assigned; 17 patients were appointed too few points, the other five too many. Three of these patients would be treated as high-risk patients instead of low-risk patients if the age points had been assigned correctly. One patient would shift to the low- from the high-risk group.

Skipping items

In 84 (22.2%) patients, the clock-drawing part of the RD score was not completed, and no points were assigned to this item. In 47 of the 84 patients, an RD score of more than 5 points was already achieved based on the other items. In eight patients with no points on any other items on the RD score, clock-drawing was not performed; therefore, it was without consequences for shifting to the high-risk group. In the other patients that did not perform the clock-drawing, nine would have shifted to the high-risk group if they made big mistakes in this task.

Summation errors

In six patients, errors were made in summation of the points of the individual score items; two patients were treated as low-risk patients while they were actually high-risk patients. In the other four patients, the summation error had no consequence. Three other patients were assigned 1 point for, respectively, delirium or dementia (instead of 5 points). This had no consequence for the risk group that they were assigned to originally.

Discussion

In this paper, we analyze the validity of the RD score, a valuable new risk model for delirium in hip fracture patients. The RD score showed good reliability and validity. Furthermore, its clinical feasibility was reasonable, with an acceptable participation rate in daily use. The validity of the RD score was improved by adding the items “male gender” and “type of fracture” and removing the items “daily consumption of more than four alcoholic beverages” and “use of heroin, methadone or morphine.”

The RD score had a good interobserver agreement, which improved when a second observer was added. However, in daily practice, the distinction between two groups (i.e., low-or high-risk patients) with a single observer will suffice. In this population of hip fracture patients, the RD score had a clear floor effect; thus, it is not very sensitive to detect a delirium risk in patients with a low score (i.e., low risk). An explanation might be that the delirium incidence in our cohort (27%) was too low to differentiate between patients at risk or not at risk for delirium in this low-risk group. Another explanation might be that the current RD score items are not sensitive enough to differentiate for the risk of developing delirium in low-risk patients. The RD score could be improved by adding more relevant risk factors in order to diminish this floor effect, as is discussed below.

As for validity, the RD score had a high sensitivity and a moderate specificity using the optimum cutoff level of 4 points. The AUC was moderate, and the negative predictive value was high; thus, the RD score is suitable as a screening tool for evaluation of the risk for delirium in this patient group. The moderate specificity is of less clinical importance since this high-risk group is probably more closely monitored for delirium in daily practice.

All items of the RD score, as well as potential new items (like gender and type of fracture), were evaluated for their individual effect (i.e., multivariable regression analysis) on the presence of delirium, as was their correlation with each other. The item “dementia” of the RD score showed high correlations with the prevalence of delirium and with the other RD score items and thus severely influenced the RD score. Two items of the RD score could be removed (“use of heroin, methadone or morphine” and “daily consumption of four or more alcoholic beverages”). These two items were only scored positive in a very low number of hip fracture patients and had no significant correlation with the occurrence of a delirium. Two new items (“male gender” and “trochanteric fracture”) were added to improve the model. This is in contrast to two meta-analyses on delirium which report no or “a non-convincing” correlation between male gender and presence of delirium [27,28]. Two other studies did find a negative correlation between male gender and delirium [29,30]. However, the individual effect of these two items on occurrence of a delirium was smaller than the compound of a high RD score (i.e., 4 and more points). As for the effect of “fracture type,” none of the meta-analyses did include this risk factor [27,28].

The items of the RD score can easily be determined at the ED in an interview with both patients and family or caregivers. Adherence to the RD score protocol was good (85%). Of the 15% of all RD scores that were not completed, clock-drawing was the most frequently not-completed item. Since painful hip fracture patients are in a supine position on a stretcher and often have an additional injury to the dominant arm, drawing might be difficult. Furthermore, half of the non-completed clock-drawings were found in patients that already scored into the high-risk group (4 and more points) due to the other RD score risk items. Nevertheless, clock-drawing had a reasonable reliability and correlates with delirium. Therefore, better scoring of this item will be facilitated with the addition of a short manual explaining the necessity to have the clock-drawing performed by each patient.

Several risk models for delirium have previously been published [6–12,31]. However, they contained items that were not applicable to hip fracture patients since they were either specific for a certain patient group [medical ward, (cardio)vascular surgery] or designed for elective admissions. Furthermore, some items of these models take time and skills to obtain, like the APACHE II score or the MMSE used in the model of Kalisvaart

[12–14]. The RD score is a relatively simple model that works in daily practice and has now been validated for acute admissions of hip fracture patients.

The prospective study design, large sample size and the use of a predefined risk stratification model are important issues for interpretation of our results. A substantial amount of the RD scores was repeated; thus, reliability could be calculated. However, two limitations remain. The main limitation is the diagnosis of presence of a delirium and mental impairment, this despite the fact that in this study delirium was diagnosed based on the DSM-IV classification [18]. We did not use a specific instrument like the Confusion Assessment Method to establish delirium [32]. Furthermore, presence of dementia was based on history taking; a cognitive impairment score like the MMSE was not used [14].

High-risk patients were treated with prophylactic low-dose haloperidol. A recent Cochrane review, a randomized controlled trial of Kalisvaart et al. and our clinical series demonstrated that haloperidol did not have a diminishing effect on delirium incidence [5,15,33]. Therefore, prophylactic haloperidol most probably did not influence the results of the present study. However, labeling patients as “high-risk” might bias the nursing staff; they might be triggered to observe patients more closely for presence of a delirium. Discarding patients because of an incomplete RD score could potentially have influenced our outcome. However, this is highly unlikely since the incidence of delirium and the age of these patients were comparable to the evaluated cohort. Finally, we decided to correct errors in summation and errors as a consequence of not assigning the right amount of points to a specific item. This was only necessary in a limited number of cases, which emphasizes the clinical usefulness of the RD score.

Conclusions

The RD score is a recently introduced score that determines the risk for a delirium in hip fracture patients. It has a reasonable clinical feasibility and a good reliability and validity. It would be of additional value to adjust the model by adding “male gender” and ‘trochanteric fracture’ and removing “daily consumption of more than four alcoholic beverages” and “use of heroin, methadone or morphine” as score items.

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9

Predicting discharge location of hip fracture patients; the new discharge of hip fracture patients score

Anne JH Vochteloo, Wim E Tuinebreijer, Andrea B Maier, Rob GHH Nelissen, Rolf M Bloem and Peter Pilot

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Abstract

Purpose This paper reports on the development and validity of a new instrument, called the discharge of hip fracture patients score (DHP), that predicts at admission the discharge location in patients living in their own home prior to hip fracture surgery.

Methods A total of 310 patients aged 50 years and above were included. Risk factors for discharge to an alternative location (DAL) were analysed with a multivariable regression analysis taking the admission variables into account with different weights based on the estimates. The score ranged from 0–100 points. The cut-off point for DAL was calculated using a ROC analysis. Reliability of the DHP was evaluated. Results Risk factors for DAL were higher age, female gender, dementia, absence of a partner and a limited level of mobility. The cut-off point was set at 30 points, with a sensitivity of 83.8%, a specificity of 64.7% and positive predictive value of 79.2%.

Conclusion The DHP is a valid, simple and short instrument to be used at admission to predict discharge location of hip fracture patients.

Abbreviations

DHP	Discharge of hip fracture patients score
DAL	Discharge to an alternative location
ASA	American Society of Anesthesiologists
LOS	Length of stay
GARS	Groningen activity restriction score
ADL	Activities of daily living
SD	Standard deviation
OR	Odds ratio
CI	Confidence interval
ROC	Receiver operating characteristics curve

Introduction

The number of hip fracture patients is growing. It has been estimated that the total number of hip fracture patients aged 50 years and older will be around 6.3 million by 2050 worldwide [1, 2].

Traditionally, the focus of research on hip fracture patients has focussed on technical aspects, morbidity and mortality. However, in the last two decades social morbidity due to a more limited level of activities of daily living, loss of independence and a sudden change in place of residence has increasingly become the subject of research. Furthermore, costs of caring for this fragile population are rising [3, 4].

Discharge to an alternative location (DAL) or the necessity to arrange additional postoperative care at home for those that can go home directly after discharge can contribute to a longer stay in hospital and thus create additional costs [3, 4]. Early planning of the date of discharge and the type of discharge location can reduce these costs [4–6]. An instrument that predicts the discharge location at the time of admission would therefore be of great importance, not only for the liaison service but also for patients and their family. Although there are some publications about risk factors for DAL [7– 11], few discharge prediction scores for hip fracture patients have been published [12– 14]. These scores are of limited value in current daily practice as they are either relatively old, time consuming to fill out or not applicable at admission.

In this paper we offer a new instrument, the discharge of hip fracture patients score (DHP), that predicts on admission, the discharge location in patients living in their own home prior to admission for a hip fracture.

Methods

Patients

This is an analysis of a series of 498 consecutive hip fracture patients aged 50 years and older admitted to a 450-bed teaching hospital (Delft, The Netherlands) between January 2008 and December 2009. Patients with a fracture due to a high-energy trauma or with a pathological fracture were not included in this cohort. Only patients living in their own

home prior to admission (n=336) were included. Patients who were treated conservatively (n=8), those with incomplete data (n=11) and those who died during hospital stay (n=7) were excluded from this group. Thus, 310 patients with complete data were analysed.

Data collection

Uniform collection and recording of data of all patients was achieved by routine evaluation at admission, according to the standardised care pathway for hip fracture patients.

Demographic data collected were age, gender, presence of a partner and discharge location.

Characteristics obtained during hospital stay were American Society of Anesthesiologists (ASA) Physical Status classification, presence of dementia based upon history taking from patients, families and carers, presence of anaemia on admission based on the criteria of the World Health Organisation (haemoglobin level below 7.5 mmol/L [12 g/dL] in women and below 8.1 mmol/L [13 g/dL] in men), level of mobility and activities of daily living, type of fracture (intra- or extracapsular hip fracture), type of fracture treatment (osteosynthesis or arthroplasty), type of anaesthesia (general or spinal), diagnosis of dementia based on criteria of the DSM IV and length of stay (LOS) [15, 16].

Pre-fracture level of mobility and activities of daily living

The level of mobility was divided into four main categories: mobile without the use of an aid in- and outdoors, mobile in-and outdoors with the use of an aid in- and/or outdoors, only mobile indoors (regardless of the use of an aid) and the last group was immobile both in- and outdoors. A cane, crutch (es) or walker were all considered an aid, patients in a wheelchair were considered to be immobile.

The Groningen activity restriction score (GARS) is a functional activities of daily living (ADL) score [16]. A summed score for basic ADL was calculated ranging from 18 (indicating ability to perform all activities without assistance or undue effort) to 72 (indicating disability). A higher GARS score therefore represents a lower level of ADL.

Statistical analysis

Demographic continuous data are presented as means, with standard deviations (SD). Categorical data are presented as the number of subjects in the category, along with the percentages. A multivariable logistic regression analysis was used for analysis of patients that were discharged from hospital to an alternative location. As we wanted an instrument that predicted discharge to an alternative location (DAL) at admission, we used risk factors in the multivariable analysis that were known at admission: age, gender, presence of a partner, perioperative risk (ASA classification I/II or III/IV), presence of dementia, anaemia at admission, pre-fracture level of mobility (using the three categories of mobility and the GARS) and type of fracture (intra- or extracapsular hip fracture).

Patients classified ASA I or II and III or IV were combined into two groups, as the separate numbers of patients classified ASA I (n=41) and ASA IV (n=9) were too small to be analysed separately. Age was categorised into three groups: 50–64.9 years old, 65–79.9 years old and 80 years old and above.

For the multivariable logistic regression analysis, immobile patients (n=3) were excluded due to small numbers.

The likelihood ratio backward test was used to find the best-fit model by selecting the variables one by one. The probability for entry was set at 0.05, and the probability for removal at 0.10. P-values lower than 0.05 were considered statistically significant.

Discharge of hip fracture patients score (DHP)

All significant risk factors from the multivariable logistic regression analysis were used in the model as score items. Each item was assigned a weighing factor based on the beta-coefficient, in such a way that the score added up to a maximum of 100 points. As the subcategory “immobile” was excluded from this analysis, this item was assigned the same weighing factor as the “only mobile indoors” category.

Clinical reliability and validity

A receiver operating characteristics curve (ROC) was created by plotting the sensitivity (true positive rate) versus the 1-specificity (false positive rate). The actual area under the curve measures the ability of the instrument to classify correctly the patients with and without a high risk for not being discharged to their own home, therewith identifying the best cut-off point.

The percentages of scores below 10 and above 90 points were calculated to assess floor and ceiling effects.

Spearman's correlation coefficient was calculated between items of the DHP and DAL to determine the convergent validity. All data were analyzed in IBM SPSS Statistics 19.0 (SPSS Inc., Chicago, USA).

Results

Patients

Table 1 shows clinical characteristics of the cohort, stratified by discharge location. The mean (SD) age of all patients was 78.5 (10.5) years, and 67.1% were female. One hundred and nineteen (38.3%) patients were directly discharged from hospital to their own home. These patients were younger, less often female and in better general medical and social condition compared to those who were discharged to an alternative location. Furthermore, they had a shorter LOS.

Discharge of hip fracture patients score (DHP)

Based on outcome of the multivariable logistic regression analysis (Table 2), the model for the DHP (Table 3) was developed. Age (categorised in three groups), female gender, dementia, absence of a partner and a more limited level of mobility were used as score items. The weighing factor was calculated using the beta coefficient, demonstrated in Table 2.

Table 1 Clinical characteristics of the whole cohort and stratified by discharge location

Characteristics	Cohort n=310	Discharge location		P-value ^a
		Own home n=119	Alternative location n=191	
Age category				<0.001
50–64 years old	45 (14.5)	36 (30.3)	9 (4.7)	
65–79 years old	107 (34.5)	54 (45.4)	53 (27.7)	
≥80 years old	158 (51.0)	29 (24.4)	129 (67.5)	
Female gender	208 (67.1)	63 (52.9)	145 (75.9)	<0.001
Dementia	29 (9.4)	28 (14.7)	1 (0.8)	<0.001
Partner at admission	174 (56.1)	44 (37.0)	130 (68.1)	<0.001
ASA classification III/IV	78 (25.2)	20 (16.8)	58 (30.4)	0.007
Anaemia at admission	100 (32.3)	28 (23.5)	72 (37.7)	0.009
Pre-fracture mobility				<0.001
Without an aid	164 (52.9)	92 (77.3)	72 (37.7)	
With an aid	127 (41.0)	26 (21.8)	101 (52.9)	
Only mobile indoors	16 (5.2)	0 (0.0)	16 (8.4)	
Immobile	3 (1.0)	1 (0.8)	2 (1.0)	
Mean GARS (SD)	32.8 (14.7)	24.8 (11.2)	37.8 (14.4)	<0.001
Intracapsular hip fracture	192 (61.9)	87 (73.1)	105 (55.0)	0.001
Osteosynthesis	195 (62.9)	88 (73.9)	107 (56.0)	0.001
Spinal anaesthesia	297 (95.8)	116 (97.5)	181 (94.8)	0.383
Mean LOS, days (SD)	12.3 (9.2)	8.6 (6.5)	14.6 (9.8)	<0.001

LOS length of stay, GARS Groningen activity restriction score, ASA American Society of Anesthesiologists Physical Status classification

Values are given as number (percentage) if not stated otherwise

^a Bivariate analysis

Table 2 Risk factors identified for discharge to an alternative location, as identified with multivariable logistic regression analysis

Risk factors	Beta coefficient	OR	95 % CI	P-value
Age category ^a				
65–79.9 years	1.32	3.76	1.48–9.55	0.005
≥80 years	2.28	9.78	3.68–25.98	<0.001
Female gender	0.79	2.20	1.21–4.02	0.010
Dementia	2.30	9.98	1.23–80.85	0.031
Absence of a partner	0.87	2.39	1.33–4.29	0.004
Mobility category ^b				
Mobile with an aid	0.848	2.33	1.25–4.35	0.008
Only mobile indoors	3.58	35.9	3.68–350.1	0.002

OR odds ratio, CI confidence interval

^a 40–64.9 years (for age category)

^b mobile without an aid (for mobility category)

Table 3 Discharge of hip fracture patients score

Predisposing risk factors for discharge to an alternative location	Points
Age category	
50–64.9 years	0
65–79.9 years	10
≥80 years	20
Female gender	10
Dementia	20
Absence of a partner	10
Mobility at admission	
Mobile in- and outside without an aid	0
Mobile in- and outside with an aid for either one or both	10
Only mobile indoors	40
Immobile	40
Total score	

Clinical reliability and validity

The ROC curve of the DHP is demonstrated in Fig. 1, where the area under the curve was 0.84 (95% CI 0.79–0.88). The best cut-off point for balancing sensitivity and specificity was 30 points. Sensitivity and specificity of the DHP at this cut-off point were 83.8% and 64.7%; the positive predictive value was 79.2%. The predictive power for two cut-off points (≥30 and ≥40 points) is shown in Table 4. The likelihood ratio of a DHP ≥30 was 2.37, which means that the probability of a score of ≥30 points being associated with DAL is 2.4 times higher compared to the probability that the patient is discharged to his or her own home.

Table 4 Results of the validity analysis of the prediction model for failure to return to own home at discharge

Measurement	≥30 points		≥40 points	
	Value	95 % CI	Value	95 % CI
Sensitivity %, (CI)	83.8	77.8–88.7	67.0	59.9–73.6
Specificity %, (CI)	64.7	55.4–73.2	84.0	76.2–90.1
Positive predictivity %, (CI)	79.2	72.8–84.4	87.1	80.3–91.8
Negative predictivity %, (CI)	71.3	61.7–79.4	61.3	53.4–68.8
Likelihood ratio positive (sens/1-spec)	2.37	2.0–2.7	4.20	3.7–4.8
Likelihood ratio negative (1-sens/spec)	0.25	0.20–0.40	0.39	0.20–0.60
Correlation with discharge to alternative location	0.50	n/a	0.50	n/a

CI confidence interval

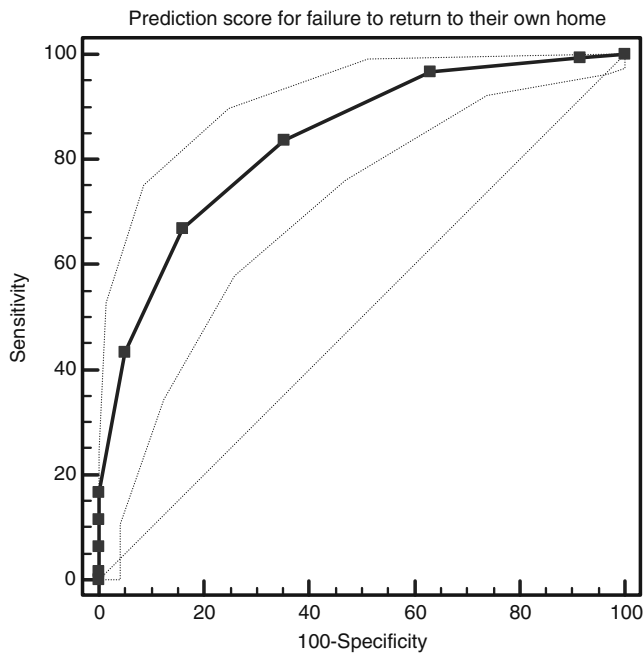


Figure 1. Receiver operating characteristic (ROC) curve of the prediction score with 95% confidence intervals. The diagonal indicates results no better than by chance

Table 5 shows correlations, expressed with Spearman correlation coefficient, between DAL and the items of the DHP and the correlation between the items themselves. All items had a significant correlation with DAL, indicating good convergent validity.

The DHP scores ranged from zero to 90 points. The score was 10 or less points in 39 (16.1%) patients, thereby the floor effect was small. A DHP score of 90 points or more was present in only three (1.0%) patients, thus no ceiling effect was present.

Table 5 Spearman's correlation coefficient between discharge to an alternative location and the items of the discharge in hip fracture patients score and between the items themselves

Measurement	DAL	Age categories	Female gender	Dementia	Absence of a partner
Age categories	0.459 ^b				
Female gender	0.238 ^b	0.139 ^a			
Dementia	0.231 ^b	0.206 ^b	0.083		
Absence of a partner	0.305 ^b	0.316 ^b	0.261 ^b	-0.005	
Mobility categories	0.392 ^b	0.385 ^b	0.157 ^b	0.171 ^b	0.155 ^b

DAL discharge to an alternative location

a Correlation is significant at the 0.05 level (2-tailed)

b Correlation is significant at the 0.01 level (2-tailed)

Discussion

A new prediction score for the discharge location of hip fracture patients living in their own home prior to admission was developed called the discharge of hip fracture patients score (DHP). This score was established using significant risk factors from multivariable regression analysis for failure to return to their own home: higher age, female gender, dementia, absence of a partner and a lower level of mobility. The score was easy to use due to readily obtainable data at admission and it had a good sensitivity and acceptable specificity.

The DHP can be used to facilitate the work of the liaison officers to make early arrangements for discharge, i.e. finding an appropriate alternative location or provide extra facilities (e.g. a walker or Zimmer frame, toilet seat risers, domestic help) needed in the first period after discharge. This can reduce LOS substantially [4– 6].

Patients

Mean age, the male to female ratio and fracture distribution of our series were comparable to a large cohort study of 3,683 hip fracture patients [17]. Another large series (3,240 patients) of Deakin et al. found a comparable mean age and percentage of patients living in their own home prior to admission [8]. The cohort we analysed was therefore representative for a general hip fracture population in Europe.

Risk factors

We identified higher age, female gender, dementia, absence of a partner and a lower level of mobility as risk factors for DAL. Deakin et al. published the largest series on risk factors for DAL of hip fracture patients [8]. In that study, pre-injury level of dependence, higher age, male gender and injury sustained in hospital were identified as main risk factors for DAL. Other smaller studies identified age, number or type of comorbidities or a poor general health status, dementia, absence of a partner, a trochanteric fracture, a more limited level of mobility and ADL or the expectations of the nursing staff as predictors for DAL [7, 9– 14]. In our study, poor general health (i.e. a higher ASA score) was identified as a predictor in the bivariate analysis, but lost its significance in the multivariate analysis.

Other models

Currently, few prediction scores for discharge location after admission following a hip fracture are available [12– 14]. However, these scores have their drawbacks. One model is more than 30 years old, thus data cannot be extrapolated to current day and practice [13]. Furthermore, all these models are based on small patient series (63–108 patients) [12– 14]. Finally, one score used items that were not yet known at admission, i.e. the level of ADL and mobility two weeks postoperatively [14]. Nevertheless, these three models did use similar risk factors as we used in our score [12– 14]. Only female gender was identified as an additional item compared to previous models, but with a modest impact indicated by the lowest weighing factor.

When extrapolating the results of our study to different countries, one must be aware of various possible influencing factors. First, there are large differences between countries in type of housing and traditions for homes for elderly people [18]. Second, as for the location and timing of discharge from the hospital, large local, national and international differences exist between discharge directly to home or to temporary revalidation units. This is reflected in the very wide range (3–81%) of reported rates of discharge to home directly from hospital [7, 12– 14, 19– 23].

Clinical reliability and validity

The sensitivity of the DHP was good, the specificity moderate, which is good as it is of more importance to have a high number of true-positives (i.e. those patients that were labelled DAL, really had a DAL) in a prediction model. Because of the small floor effect, it is not possible to further differentiate within patients with low scores. However, this is not a real issue as the model is developed for only two options: discharge to their own home or to an alternative location.

Limitations

Although this study describes a simple, valuable prediction model for discharge location in a well-sized cohort of hip fracture patients, some limitations remain. The first limitation was absence of more detailed data of cognitive function. Another limitation is the fact that the mobility category “immobile” and the category “only mobile indoors” were combined to one group due to the small number of patients who were immobile (n=3). Finally, this is a model for the Dutch social situation and might not be applicable to other countries. However, the score items we have used were very comparable to those in previous models from other countries (United Kingdom, Sweden, United States) [12– 14].

Conclusions

In this paper we presented a useful new score that predicts discharge location at admission in hip fracture patients living in their own home prior to admission. In the near future, we will validate this model and test its inter-observer reliability in another Dutch and a Swedish hospital to prove the reliability of the model in different hospitals and countries, therewith allowing better (international) comparison.

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10

External validation of the discharge of hip fracture patients score

Anne J. H. Vochteloo, Elvira R. Flikweert, Wim E. Tuinebreijer, Andrea B. Maier, Rolf M. Bloem,
Peter Pilot and Rob G. H. H. Nelissen

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Abstract

Purpose This paper reports the external validation of a recently developed instrument, the Discharge of Hip fracture Patients score (DHP) that predicts discharge location on admission in patients living in their own home prior to hip fracture surgery.

Methods The DHP (maximum score 100 points) was applied to 125 hip fracture patients aged 50 or more years admitted to an academic centre in the northern part of the Netherlands (Groningen cohort). The characteristics of this cohort, sensitivity, specificity and positive and negative predictive value (PPV, NPV) of the DHP for discharge to an alternative location (DAL) were calculated and compared with the original cohort of hip fracture patients from the western part of the Netherlands (Delft cohort). Scoring 30 points or higher indicated DAL.

Results The Groningen cohort was younger compared to the Delft cohort, (mean age 75.4 vs. 78.5 years, $P=0.005$) but was more often classified ASA III/IV (46.4 % vs. 25.2 %, $P<0.001$). Sensitivity of the DHP for DAL in the Groningen cohort was 75 % (vs. 83.8 %), specificity of 66.7 % (vs. 64.7 %) and a PPV of 86.3 % (vs. 79.2 %), compared to the Delft cohort.

Conclusion External validation of the DHP was successful; it predicted discharge location of hip fracture patients accurately in another Dutch cohort, the sensitivity for DAL was somewhat lower but the PPV higher. Therefore, the DHP score is a useful valid and easily applied instrument for general hip fracture populations.

Abbreviations

DHP	Discharge of Hip fracture Patients score
DAL	Discharge to an Alternative Location
ASA	American Society of Anesthesiologists
LOS	Length of Stay
ADL	Activities of Daily Living
SD	Standard Deviation
OR	Odds Ratio
CI	Confidence Interval
ROC	Receiver Operating characteristics Curve
AUC	Area Under the Curve
PPV	Positive Predictive Value
NPV	Negative Predictive Value
IQR	InterQuartile Range

Introduction

Worldwide, numbers of hip fracture patients are growing with associated rises in costs [1, 2]. Discharge to an alternative location (DAL, compared to the pre-fracture residence) or the necessity for arranging additional postoperative care at home for those that can go home directly after discharge can contribute to a longer stay in hospital and contributes to additional health care costs, which may be preventable [3, 4]. Early planning of the date and the type of discharge location may thus be a powerful tool in reducing costs [4– 6].

Recently, we described the Discharge of Hip fracture Patients score (DHP) [7]. This score predicts, on admission, the discharge location in patients living in their own home prior to admission for a hip fracture. The DHP was designed on prospective data of a Dutch cohort of 310 patients aged 50 or more years admitted to a general teaching hospital in the western part of the Netherlands [7]. Risk factors for DAL were identified using multivariable regression analysis [7]. Higher age, female gender, dementia, absence of a partner and a limited level of mobility were found to be predictive. These risk factors were used as score items, each with a weighing factor, based upon the beta coefficient.

In this paper we present the results of external validation of the DHP in another Dutch cohort of hip fracture patients.

Methods

Patients

The DHP was developed using data of 310 hip fracture patients aged 50 years and older admitted to a 450-bed teaching hospital (Delft, the Netherlands) between January 2008 and December 2009 [7]. Patients with a fracture due to a high-energy trauma or with a pathological fracture, patients not living in their own home prior to admission, those treated conservatively and those that died during hospital stay were not included in this cohort. This cohort will be referred to as the ‘Delft cohort’.

The DHP was externally validated in a cohort of 125 hip fracture patients admitted to a university hospital (Groningen, the Netherlands) between January 2010 and June 2011.

The same inclusion and exclusion criteria were applied to this cohort. This cohort will be referred to as the 'Groningen cohort'.

Data collection

Uniform collection and recording of data of all patients of both cohorts was achieved by standard evaluation on admission, according to the local standardized care for hip fracture patients.

Collected demographic data included age, gender, presence of a partner and discharge location.

Characteristics obtained on admission were American Society of Anesthesiologists (ASA) Physical Status classification, presence of dementia based upon history taking from patients, families and carers, presence of anaemia on admission based on the criteria of the World Health Organisation (haemoglobin level below 7.5 mmol/L (12 g/dL) in women and below 8.1 mmol/L (13 g/dL in men), level of mobility, type of fracture (intra- or extracapsular hip fracture) and length of stay (LOS) [8, 9].

Pre-fracture level of mobility

The level of mobility was divided into four main categories; mobile without the use of an aid in- and out-doors, mobile in- and outdoors with the use of an aid in- and/or outdoors, only mobile indoors (regardless the use of an aid) and the last group was immobile both in-and outdoors. A cane, crutch(es) or walker were all considered an aid, patients in a wheelchair were considered to be immobile.

Discharge of hip fracture patients score (DHP)

The DHP score ranged from zero to 100 points. Higher age, female gender, dementia, absence of a partner, and a more limited level of mobility are score items, each with a weighting factor based upon the beta coefficient in the multivariable regression analysis. The beta coefficients were rounded up and the regression coefficients associated with the questions were transformed into a simple score that could be summated up to obtain an aggregate score (Table 1) [7].

With ROC analysis, the cut-off point of 30 was calculated. Scoring 30 points or more predicted discharge to an alternative location in the Delft cohort with a sensitivity of 83.8 %, a specificity of 64.7% a negative predictive value of 71.3 % and a positive predictive value of 79.2 % [7].

Table 1 Discharge of Hip fracture Patients score (DHP)

Predisposing risk factors for discharge to an alternative location	Points
Age	
* 50–64.9 years	0
* 65–79.9 years	10
* ≥80 years	20
Female gender	10
Dementia	20
Absence of a partner	10
Mobility at admission	
Mobile in- and outside without an aid	0
Mobile in- and outside with an aid for either one or for both	10
Only mobile indoors	40
Immobile	40
Total score	

Statistical analysis

Demographic continuous data are presented as means, with standard deviations (SD or median with the interquartile range (IQR) in case of a non-normal distribution). Categorical data are presented as the number of subjects in the category, along with the percentages. Baseline characteristics of both cohorts were compared, using the Student's T-test. Sensitivity, specificity, positive and negative predictive value (PPV and NPV) for DAL and the positive and negative likelihood ratio were calculated for the Groningen cohort and compared to the Delft cohort.

A receiver operating characteristics curve (ROC) was created by plotting the sensitivity (true positive rate) versus the 1-specificity (false positive rate). The actual area under the curve (AUC) measures the ability of the instrument to classify correctly DAL.

P-values lower than 0.05 were considered statistically significant. All data were analysed in IBM SPSS Statistics 19.0 (SPSS Inc. Chicago, USA).

Results

Patients

Table 2 shows clinical characteristics of the Delft and Groningen cohorts, stratified by discharge location. The mean (SD) age of the Delft patients was 78.5 (10.5) years, 67.1 % were female. One hundred and ninety-one (61.7 %) patients were discharged from hospital to an alternative location. The mean (SD) age of the Groningen patients was 75.4 (9.2) years, 69.6 % was female. Ninety-two (73.6 %) patients were discharged to an alternative location from hospital in the Groningen cohort.

In both cohorts, patients discharged to an alternative location were older, more often classified ASA III/VI and had a longer LOS compared to those who were discharged directly to their own home. In the Delft cohort, they were also more often female and suffered more from dementia.

Some baseline parameters of both cohorts were significantly different: Patients of the Groningen cohort were younger ($P=0.002$), more often classified ASA III/IV ($P<0.001$) and had a better level of mobility (more patients walked without an aid, $P=0.01$). Furthermore, more patients were discharged to an alternative location in the Groningen cohort compared to the Delft cohort ($P=0.02$).

Validation of the DHP

The DHP was applied to the Groningen cohort; the results are displayed in Table 3.

Compared to the values in the Delft cohort, the PPV was higher (86.3 vs. 79.2 %), but the sensitivity (75 vs. 83.8 %) and the NPV for the score in the Groningen cohort were lower (48.9 vs. 71.3 %).

Figure 1a shows the ROC curve of the DHP in the Groningen cohort, the AUC was 0.75 (95 % CI 0.66–0.82), Fig. 1b demonstrates the Delft ROC curve with an AUC of 0.84 (95 % CI 0.79–0.88).

Table 2 Clinical characteristics of the Groningen and Delft cohort and stratified by discharge location

	Groningen All patients n=125	Discharge location Own home n=33	Discharge location Alternative location n=92	P-value ^a	Delft All patients n=310	Discharge location Own home n=119	Discharge location Alternative location n=191	P-value ^a
Age category				<0.001				<0.001
50–64.9 years old	19 (15.2)	10 (30.3)	9 (9.8)		45 (14.5)	36 (30.3)	9 (4.7)	
65–79.9 years old	64 (51.2)	20 (60.6)	44 (47.8)		107 (34.5)	54 (45.4)	53 (27.7)	
≥80 years old	42 (33.6)	3 (9.1)	39 (42.4)		158 (51.0)	29 (24.4)	129 (67.5)	
Female gender	87 (69.6)	21 (63.6)	66 (71.7)	0.385	208 (67.1)	63 (52.9)	145 (75.9)	<0.001
No partner at admission	60 (48.0)	12 (36.4)	48 (52.2)	0.119	174 (56.1)	44 (37.0)	130 (68.1)	<0.001
ASA classification III/IV	58 (46.4)	7 (21.2)	51 (55.4)	0.001	78 (25.2)	20 (16.8)	58 (30.4)	0.007
Dementia	9 (7.2)	0 (0.0)	9 (9.8)	0.111	29 (9.4)	28 (14.7)	1 (0.8)	<0.001
Anaemia at admission	39 (31.2)	6 (18.2)	33 (35.9)	0.060	100 (32.3)	28 (23.5)	72 (37.7)	0.009
Pre-fracture mobility				<0.001				<0.001
Without an aid	82 (65.6)	30 (90.9)	52 (56.5)		164 (52.9)	92 (77.3)	72 (37.7)	
With an aid	43 (34.4)	3 (9.1)	40 (43.5)		127 (41.0)	26 (21.8)	101 (52.9)	
Only mobile indoors	0 (0)	0 (0.0)	0 (0.0)		16 (5.2)	0 (0.0)	16 (8.4)	
Immobile	0 (0)	0 (0.0)	0 (0.0)		3 (1.0)	1 (0.8)	2 (1.0)	
Intracapsular hip fracture	71 (56.8)	23 (69.7)	48 (52.2)	0.081	192 (61.9)	87 (73.1)	105 (55.0)	0.001
Osteosynthesis	84 (67.2)	24 (72.7)	60 (65.2)	0.431	195 (62.9)	88 (73.9)	107 (56.0)	0.001
Median LOS, days (IQR)	7 (4)	6 (4)	8 (6)	<0.001 ^b	9 (7)	7 (5)	12 (9)	<0.001 ^b

Values are given as number (percentage) if not defined otherwise

LOS length of stay, ASA American Society of Anesthesiologists Physical Status classification, IQR interquartile range

^a Bivariate analysis^b Nonparametric analysis

Table 3 Results of the validity analysis of the DHP for discharge to an alternative location, for the cut-off point of 30 and higher (out of 100) in the Groningen and Delft cohort

	Groningen cohort		Delft cohort	
		95 % CI		95 % CI
Sensitivity	75.0	64.9–83.5	83.8	77.8–88.7
Specificity	66.7	48.2–82.0	64.7	55.4–73.2
Positive Predictive Value	86.3	76.7–92.9	79.2	72.8–84.4
Negative Predictive Value	48.9	33.7–64.2	71.3	61.7–79.4
Likelihood ratio Positive (Sens/1-Spec)	2.25	1.37–3.7	2.37	2.0–2.7
Likelihood ratio Negative (1-Sens/Spec)	0.38	0.24–0.58	0.25	0.20–0.40
Correlation with discharge to alternative location	0.38	n/a	0.50	n/a

CI: Confidence Interval, all values are percentage if not defined otherwise

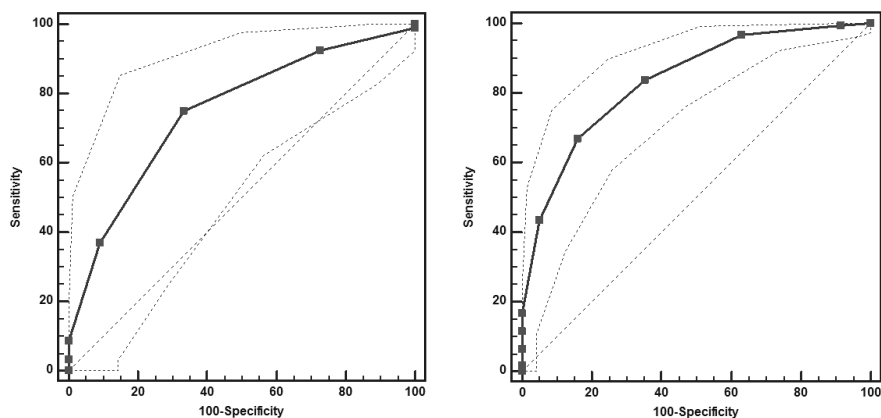


Figure 1 ROC curves of the DHP with 95 % confidence intervals in the Groningen (a) and Delft (b) cohorts. The diagonal indicate results no better than by chance.

Discussion

The goal of this study was the external validation of the DHP. This score has recently been developed in a cohort of Dutch hip fracture patients in Delft showing a good sensitivity and a reasonable PPV and was easy to use due to readily obtainable data on admission [7].

By providing early reliable prediction of discharge location, the DHP can be used to facilitate the work of the health care professionals, e.g., liaison officers to make early arrangements for discharge, thus potentially reducing LOS substantially [4– 7]. Since population density, hospital and rehabilitation potentials are different between the areas in The Netherlands, testing for external validity of a score is a necessity in order to judge its applicability in general. When performing an external validation, it is of importance to realise two issues. Firstly, appreciation of the important characteristics of the score (i.e., sensitivity vs. specificity and PPV vs. NPV), secondly, that external validation often results in lower scores in the second cohort compared to the first cohort, since the two cohorts are never exactly the same. The latter only underscores the necessity for validation before general application.

For example, external validation of a questionnaire for chronic obstructive pulmonary disease patients showed poorer discriminating ability (i.e., a smaller AUC) between normal and affected patients compared to the primary internal validation [10]. This was also the case in our study: a smaller AUC with a wider 95 % CI. The wider 95 % CI in the Groningen cohort could be attributed to the smaller sample size in this cohort (125 versus 310 patients) but also to confounders for discharge to an alternate location such as a different discharge policy, more potential for day care help at home and rehabilitation centres near the hospital.

We consider a good sensitivity and high PPV to be the most important features of the score. Sensitivity is the ability of a test to give positive results in true cases and the PPV the percentage of true positives of all positive scoring patients. In this study a positive result is a score of 30 or more points and true positive is a patient scoring 30 and higher on admission who is discharged to an alternative location. In contrast, specificity is the ability of a test to give negative results in negative cases, the NPV is the percentage of true negatives of all negative scoring patients: In this study a negative result is a score under 30 points and true negative is a patient scoring less than 30 who is discharged directly to their own home from hospital. In daily practice it is of greater importance and impact for both patient and health professionals, e.g., liaison officers to know whether a patient will be discharged to an alternative location. Therefore, a better sensitivity and a higher PPV are the most important features of the score. The PPV in the Groningen cohort was higher compared to the Delft cohort, the NPV was lower. The lower NPV is explained

by the fact that predictivity and prevalences are not comparable across groups because they depend on the prevalence of the outcome (in our case discharge to an alternative location, DAL). The prevalence of DAL in the Groningen cohort was higher (74 % versus 62 %), resulting in a lower chance of discharge directly to the own home, corresponding with the NPV. Finally, the differences in all characteristics of the score can also be explained by the fact that there are factors of influence that were not risk items in the DHP but that do influence the place of discharge.

We demonstrated in the previous paper on the DHP that the Delft cohort was representative for a general hip fracture population in Europe with regards to characteristics including age, distribution of type of fracture and gender and the number of patients living in their own home prior to sustaining a hip fracture [7]. The Groningen cohort was comparable to the Delft cohort, other than age, poorer general condition (ASA III/IV) and a higher level of mobility. The latter is directly related to the lower mean age, as we demonstrated previously [11]. The higher ASA scores despite younger age might be due to the fact that it was a cohort from a university hospital, often having more comorbidities. Furthermore, significantly more patients were discharged to an alternative location in the Groningen cohort compared to the Delft cohort, after a longer LOS. The LOS might have been longer due to the poorer general condition. The higher percentage of DAL can partially be explained by the longer LOS, often due to a more complicated postoperative course [4, 12– 14]. Another reason is the difference in local discharge policy. The Groningen cohort was more easily discharged to a nursing home compared to the Delft cohort. These differences are good for external validation; if a score is valid in a population that is somewhat different from the original population, the score might be even of higher value than if it would only work in exactly the same type of cohort.

Limitations

Although the DHP is externally validated and the score was easily applicable to the Groningen cohort as well, it has its limitations. First: absence of more detailed data of cognitive function, combining the mobility categories “immobile” and “only mobile indoors” to one group due to the small number of patients who were immobile and the fact that it might not be applicable to other countries than the Netherlands with its own typical private health care organisation [7]. However, the score items used were

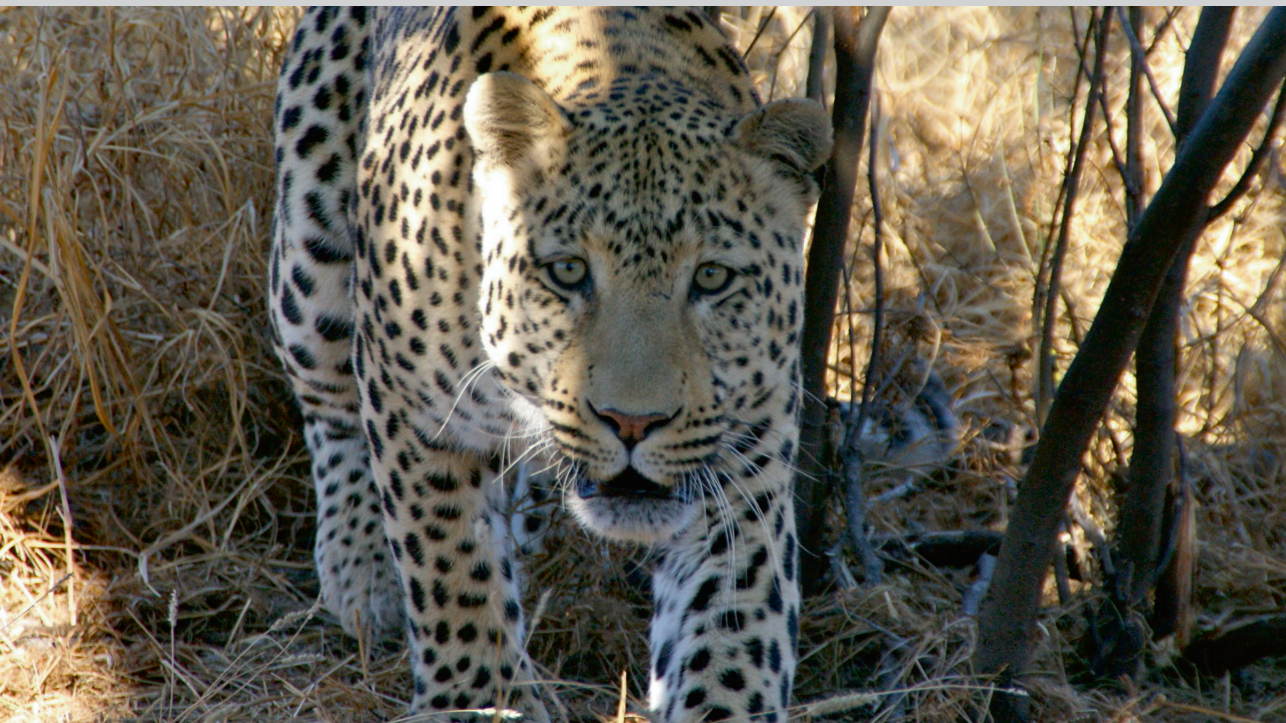
comparable to those in previous models from other countries, both with national health care as well as private health care systems (UK, Sweden, US) [15– 18]. The limitations of this validation study are the smaller AUC of the DHP in the Groningen cohort and the relatively small sample size, resulting in a wider 95 % CI of the AUC.

Conclusions

The external validity of the DHP for hip fracture patients is good in the Dutch health care setting, validated with an acceptable sensitivity and a good PPV. Therewith its use in other hip fracture cohorts is recommended. However, before extrapolating our Dutch results to another country, the score should preferably be validated in that specific country.

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PART V

GENERAL DISCUSSION



11

Summary and future perspectives

Samenvatting en toekomst perspectieven

Gearfetting en takomst

Summary and future perspectives

Overview

Some of the many clinical and functional outcome parameters and risk factors for poor outcome in hip fracture patients have been provided in this thesis. Furthermore, two risk models (for delirium and discharge to an alternative location) have been evaluated and validated. This chapter contains a summary of each chapter and some future perspectives. The table below demonstrates the numbers and origin of patients and time frame they were treated per chapter.

Chapter	Number of patients	Origin of patients	Time frame
2	1262	Delft and The Hague	2005-2009
3	230 vs. 1014	Delft and The Hague	2005-2009
4	1229	Delft and The Hague	2005-2009
5	444	Delft	2008-2009
6	390	Delft	2008-2009
7	445	Delft	2008-2009
8	378	Delft	2008-2009
9	310	Delft	2008-2009
10	125 vs. 310	Delft and Groningen	2008-2009

CLINICAL OUTCOME

Having large databases with reliable data on characteristics and clinical outcome of hip fracture patients is crucial to identify specific risk factors for poor outcome. Reliability of patient characteristics is often depending on the number of patients included in a study cohort. Therefore, a large database of 1269 admissions of hip fracture patients aged ≥ 50 years was made, using data that were collected in Reinier de Graaf Hospital, Delft and Bronovo Hospital, the Hague in the timeframe 2005-2009.

Anemia at admission and blood transfusion

Chapter two describes a retrospective analysis of 1262 admissions for surgical treatment of a hip fracture in patients aged 65 years and older. In multivariable regression analysis, anemia at admission was a significant risk factor for discharge to a nursing home and readmission < 90 days, but not for mortality. Indication for ABT, age and ASA classification were independent risk factors for mortality at all moments, only the mortality rate for the 3-12 month interval was not influenced by ABT. An indication for an ABT was the largest negative contributor to a longer LOS and the second largest for delirium.

It is demonstrated that anemia at admission and Postoperative Anemia Needing an blood Transfusion (PANT) were independent risk factors for worse outcome in hip fracture patients. However, anemia as such had no effect on mortality, due to a rescue effect of PANT. In-hospital, 3- and 12-month mortality was negatively affected by PANT, with the main effect in the first 3 months postoperatively. This paper demonstrates once again the complex interaction of anemia and ABT on outcome. Anemic patients should be monitored closely. Recently, the effect of more liberal transfusion regimes is discussed in the FOCUS trial. (47) This study showed no difference in morbidity in the first 60 days post-surgery between a restrictive and a more liberal transfusion strategy in high-risk patients. (47)

Nonagenarians versus younger hip fracture patients

In chapter three, a comparison between 230 nonagenarian hip fracture patients with 1014 patients aged 65–89 years regarding clinical characteristics, adverse events, mobility and mortality and outcome is presented.

Nonagenarians were more likely to be female and anemic, and more often had a trochanteric fracture. The number of patients classified ASA III/VI did not differ between the two groups. During the hospital stay, adverse events were more frequently observed in nonagenarians, compared with younger patients. The length of stay was significantly longer in nonagenarians, the 90-day readmission rate was similar. Absolute mortality was higher in nonagenarians however, excess mortality was comparable. Prior to admission, 40% of the nonagenarians lived in their own home, and 41% had returned there within three months. The rate of returning to their own home was lower compared to younger patients. Pre-fracture mobility was worse in nonagenarians compared with the younger

group, but at three months after discharge, the number of patients that regained pre-fracture mobility was comparable in both age groups.

Nonagenarian hip fracture patients differed significantly from younger patients aged 65–89 years with respect to clinical characteristics and long-term outcome. However, almost half of the nonagenarians returned to their own home and more than half regained their pre-fracture level of mobility. Being confronted with growing numbers of relatively fit nonagenarians in our society, reliable outcome data is of importance.

As the excess mortality (the mortality added due to the admission for a hip fracture) is comparable to their younger peers, nonagenarians should be treated in the same way as all hip fracture patients, with special geriatric attention to prevent avoidable complications and fallback in mobility and self-dependence.

Contralateral hip fractures and other concomitant fractures

In a cohort of 1229 consecutive patients of 50 years and older, who sustained a hip fracture between January 2005 and June 2009, the risk for concomitant fractures was evaluated. The absolute risk of a contralateral hip fracture after a hip fracture was 13.8%, the one-year risk 2%, with a short interval (median 18.5 months) between the two hip fractures. Age was a risk factor for sustaining a contralateral hip fracture; a prior fracture was not. Secondly, possible risk factors for sustaining a contralateral hip fracture were identified. Fractures were scored retrospectively for 2005–2008 and prospectively for 2008–2009. Rates of a contralateral hip and other osteoporosis-related fractures were compared between patients with and those without a history of a fracture.

The absolute risk for a contralateral hip fracture was 13.8%, for one or more osteoporosis-related fracture(s) 28.6%. First-, second- and third-year risk for a second hip fracture was 2, 1 and 0 %. One-year incidence of other fractures was 6%. Only age was a risk factor for a contralateral hip fracture. Patients with a history of a fracture (33.1%) did not have a higher incidence of fractures during follow-up (16.7%) than patients without fractures in their history (14%).

FUNCTIONAL AND SOCIAL OUTCOME

A prospective one-year follow-up of 498 hip fracture patients treated in Reinier de Graaf Hospital, Delft during 2008-2009 was studied in chapters five and six.

Return to pre-fracture place of residence

This chapter presents the results of a prospective cohort follow-up study of 444 hip fracture patients aged 65 years and older, stratified in categories based on pre-fracture place of residence. Of the hip fracture patients who lived at their own home prior to admission, 32 % returned to their home at discharge, at 3 and 12 months 73% had returned home. Age, absence of a partner, dementia, and a lower pre-fracture level of ADL or mobility were independent contributors to failure to return to their own home at discharge, three or 12 months.

Of the patients living in a residential home prior to admission, 33% returned at discharge, 68% at 3 months and 64% at 12 months. Age was the only independent contributor to failure to return to their residential home at discharge.

In this study, age, dementia and a lower pre-fracture level of ADL were the main significant risk factors for failure to return to the pre-fracture residence.

Many other factors might influence the location of residence after hospital discharge. Of these, the social network might have the largest effect on discharge location.

Regaining pre-fracture level of mobility

This chapter presents the results of a prospective cohort follow-up study of 390 hip fracture patients aged 65 years and older, stratified in categories based on pre-fracture mobility. The main conclusions of this study were that nearly half of all patients regained their pre-fracture level of mobility after one year. Mobile patients without an aid were less likely to return to their pre-fracture mobility level compared with patients who were mobile with aid or mobile indoors. After one year, 18.7% of all patients had become immobile.

The risk for the latter was higher in those having a lower pre-fracture level of mobility.

Pre-fracture level of activities of daily living, the level of dependence and sustaining a delirium during admission were the main significant risk factors for not regaining mobility.

As mentioned in the discussion of the paper, cognitive impairment might be one of the most important of the non-evaluated risk factors for not-regaining mobility.

PREDICTION MODELS

The Risk Model for Delirium was evaluated (chapter seven) and validated (chapter eight). A second prediction model, the Discharge of Hip fracture Patients score (DHP) was designed (chapter nine) and externally validated (chapter ten).

Delirium Risk Screening and Haloperidol Prophylaxis Program

In 2008 an integrated hip fracture care pathway that included a Risk Model for Delirium (RD-score) was introduced in Reinier de Graaf Hospital, Delft. The RD-score is a 10-item questionnaire that allocates hip fracture patients after admission to hospital to be either at high or at low risk for delirium. High-risk patients (score ≥ 5 points) are subsequently prescribed prophylactic haloperidol. This model was evaluated in 445 hip fracture patients aged 65 years and older, admitted in 2008 and 2009.

The RD-score was completed in 378 patients, 173 (45.8%) high-risk patients were treated with prophylactic medication. The sensitivity of a score < 5 was 71.6%, the specificity 63.8% and the negative predictive value (NPV) was 85.9%.

Delirium incidence (27.0%) was not significantly different compared to 2007 (27.8%) 2006 (23.9%) and 2005 (29.0%), years prior to implementation of the RD-protocol.

Logistic regression analysis showed that high-risk patients had a significant higher delirium incidence than low-risk patients (42.2% vs. 14.1%). They were more likely to be residing at an alternative place of residence after three months (62.3% vs. 17.0%) and less likely to be discharged from hospital within ten days (34.9% vs. 55.9%). Significant independent risk factors for a delirium were a RD-score ≥ 5 , male gender and age.

The main conclusion of chapter seven was that the RD-score is a useful tool to identify patients with a high risk to develop a delirium and with poorer outcome. However, introducing the delirium prevention protocol did not reduce delirium incidence.

The main limitations of this paper were the lack of detailed information on cognitive status and the length and depth of delirium.

Validation of the Risk Model for Delirium

Chapter eight contains the study that evaluated clinical reliability, validity and feasibility of the RD-score using demographic data, RD-score and delirium incidence of 378 hip fracture patients 65 years and older.

One hundred-and-two 102 (27%) were diagnosed with a delirium. The intra-class correlation coefficient of the RRD-score was 0.77 (CI 0.68–0.84), sensitivity 80.4% (CI 71.4–87.6), and specificity 56.2% (CI 50.1–62.1). The area under the receiver operating characteristic curve was 0.73 (CI 0.68–0.77). A multivariable logistic regression analysis showed that besides the RD-score, a trochanteric fracture and male gender were independent risk factors for delirium. The RD-score proofed to be a reliable, feasible and valid instrument for predicting delirium in hip fracture patients. It would be of additional value to adjust the model by adding “male gender” and ‘trochanteric fracture’ and removing “daily consumption of more than four alcoholic beverages” and “use of heroin, methadone or morphine” as score items.

Discharge of Hip fracture Patients score (DHP)

The goal of the study presented in chapter nine was to develop a reliable instrument that predicts the discharge location at admission in hip fracture patients living in their own home prior to admission; the discharge of hip fracture patients score (DHP). For this goal, 310 hip fracture patients aged 50 years and above were analyzed. The score ranged from 0–100 points. Risk factors for discharge to an alternative location (DAL) were higher age, female gender, dementia, absence of a partner and a limited level of mobility. The cut-off point was set at 30 points, with a sensitivity of 83.8%, a specificity of 64.7% and positive predictive value of 79.2%.

The DHP is a valid, simple and short instrument to be used at admission to predict discharge location of hip fracture patients. Other score systems are available but have serious limitations to use in the hip fracture population. Limitations of this study were the absence of detailed information on cognitive function and the fact that the mobility category “immobile” and the category “only mobile indoors” could not be evaluated separately. Finally, this is a model for the Dutch social situation and might not be applicable to other countries. However, the score items we have used were very comparable to those in previous models from other countries (United Kingdom, Sweden, United States). (48–50)

External validation of the Discharge of Hip fracture Patients (DHP) score

External validation of the DHP was performed with a cohort of 125 hip fracture patients aged 50 years and older admitted at the University Medical Centre Groningen.

The Groningen cohort was younger compared to the Delft cohort, (mean age 75.4 vs. 78.5 years) but was more often classified ASA III/IV (46.4% vs. 25.2 %). Sensitivity of the DHP for discharge to an alternative location (DAL) in the Groningen cohort was 75% (vs. 83.8%), specificity of 66.7% (vs. 64.7%) and a positive predictive value (PPV) of 86.3% (vs. 79.2%), compared to the Delft cohort.

External validation of the DHP was good; it predicted discharge location of hip fracture patients accurately in another Dutch cohort, the sensitivity for DAL was somewhat lower but the PPV higher. Therefore the DHP score is a useful valid and easy to apply instrument for general hip fracture populations in the Netherlands.

Future perspectives

Performing research almost always creates new questions and insights. General and specific improvements in hip fracture patient care have to be made to deliver better and more efficient care for this vulnerable population. The government and health care insurance companies are imposing quality indicators on hospitals and doctors with the goal to improve patient care. These indicators of quality should be just and (preferably) based on reliable parameters and outcome of hip fracture patients in the Netherlands. This can only be done when sufficient base line parameters and characteristics of hip fracture patients are registered. The success of the nationwide Dutch arthroplasty register LROI (mainly total hip and knee arthroplasties, www.lroi.nl) is an excellent example to follow. Some European countries already started a nationwide hip fracture database in the last decades. With these hip fracture databases appropriate indicators of good care for hip fracture patients can be identified, in order to improve patient care. For example, in the NHS system in Scotland outcome is analyzed every year, hospitals with a mortality rate that is higher than anticipated are reviewed and where possible care is improved. Regaining the pre-fracture level of mobility, place of residence and patient-reported quality of life could be important indicators of good hip fracture care. These values can be compared and hospitals that underachieve significantly compared to the national mean values should be reviewed.

Rising costs are a real problem for all countries with an aging population. As mentioned earlier, these costs are almost two and a half billion euros per year in the UK as presented in the Report from the National Hip Fracture Database in 2011. (7)

These costs can be reduced by making the current care for hip fracture patients more efficient by prevention of osteoporosis-related fractures and by implementing evidence based care pathways. These care pathways take important aspects of fragile hip fracture patients into account and standardize screening, prevention and treatment, both pre- and postoperatively.

Collaboration with geriatricians, preferably in so-called geriatric fracture units is essential to improve quality of care. These units are a combination of the skills and knowledge of orthopaedic and trauma surgeons on one hand and geriatricians, specialized nurses and physiotherapists on the other.

Admission of hip fracture patients to geriatric fracture units makes registration of base line parameters and measuring outcome easier as well.

Prevention of osteoporosis-related fractures can be realized in many ways and is a field of research itself. Early screening for osteoporosis and starting medication is only one part of the solution. But equally important is the identification of risk factors for falling. (51) Core stability training with physiotherapy or tai chi or virtual training programs might play an important role, as are screening on and improvement of impaired sight and hearing.

With regards to delirium prevention, multicomponent or multimodal intervention programs might contribute at least as much as chemical prophylaxis. (52)

Concluding, future research in hip fracture patients should address on all these different aspects of prevention of fractures. If a fracture does occur, the main goal should be minimizing the morbidity thus reducing the impact of this life event on the quality of life and activities of daily living of these often-frail elderly.

Samenvatting en toekomstperspectieven

Overzicht

In dit proefschrift worden enkele van de vele klinische en functionele uitkomsten en risicofactoren voor een slechte resultaten van patiënten met een heupfractuur gepresenteerd. Verder zijn er twee risicomodellen (voor delirium en ontslag naar een alternatieve locatie) geëvalueerd en gevalideerd. Dit hoofdstuk bevat een samenvatting van de verschillende hoofdstukken van dit proefschrift.

Afsluitend volgen enkele woorden over toekomstperspectieven.

In de onderstaande tabel staan per hoofdstuk de aantallen en de herkomst van de patiënten en de periode waarin ze zijn behandeld.

Hoofdstuk	Aantal patiënten	Herkomst	Periode
2	1262	Delft en Den Haag	2005-2009
3	230 vs. 1014	Delft en Den Haag	2005-2009
4	1229	Delft en Den Haag	2005-2009
5	444	Delft	2008-2009
6	390	Delft	2008-2009
7	445	Delft	2008-2009
8	378	Delft	2008-2009
9	310	Delft	2008-2009
10	125 vs. 310	Delft en Groningen	2008-2009

KLINISCHE RESULTATEN

Om specifieke risicofactoren voor een slechte uitkomst bij patiënten met een heupfractuur te identificeren is van groot belang om (grote) databases te hebben, met betrouwbare patiënten kenmerken en klinische uitkomsten. De betrouwbaarheid wordt onder andere bepaald door het aantal patiënten dat in de database is geïnccludeerd. Daarom werd er een grote database gemaakt van 1269 patiënten van 50 jaar en ouder met een heupfractuur, allen opgenomen in het Reinier de Graaf Gasthuis in Delft en het Bronovo Ziekenhuis in Den Haag in de periode 2005-2009.

Anemie bij opname en allogene bloedtransfusie (ABT)

Hoofdstuk twee beschrijft een retrospectieve analyse van 1262 patiënten van 65 jaar en ouder met een operatief behandelde heupfractuur. Uit de multivariabele regressieanalyse bleek dat anemie bij opname een belangrijke risicofactor was voor ontslag naar een verpleeghuis en een heropname binnen 90 dagen, maar niet voor sterfte. Indicatie voor een ABT, leeftijd en ASA classificatie waren onafhankelijke risicofactoren voor sterfte op alle momenten in de tijd, alleen het sterftecijfer gedurende drie tot 12 maanden na de operatie werd niet beïnvloed door ABT. Een indicatie voor een ABT was de grootste risicofactor voor een langer verblijfsduur in het ziekenhuis en de op één na grootste voor het ontwikkelen van een delirium.

Het is aangetoond dat anemie bij opname en postoperatieve anemie waarvoor een ABT nodig was (PANT) onafhankelijke risicofactoren waren voor slechtere uitkomst bij patiënten met een heupfractuur. Echter, anemie als zodanig had geen effect op de mortaliteit door een “rescue effect” van PANT. De mortaliteit tijdens opname in het ziekenhuis en na drie en 12 maanden werd negatief beïnvloed door PANT, met het grootste effect in de eerste drie maanden na de operatie.

Deze studie toont eens te meer de complexe interactie aan van anemie en ABT en hun effect op klinische resultaten. Anemische patiënten moeten derhalve zorgvuldig worden gecontroleerd. Het effect van verschillende transfusie regimes is recent onderzocht in de FOCUS studie. (47) Deze studie toonde geen verschil in morbiditeit in de eerste 60 dagen na de ingreep tussen een restrictief en een liberaal transfusie regime voor patiënten met een hoog cardiovasculair risico. (47)

Negentigplussers versus jongere patiënten met een heupfractuur

In hoofdstuk drie wordt de studie gepresenteerd waarin 230 negentigplussers met een heupfractuur worden vergeleken met 1014 patiënten in de leeftijd van 65-89 jaar. Hierbij is gekeken naar klinische kenmerken, complicaties, mobiliteit en mortaliteit. Negentigplussers waren vaker vrouw en hadden vaker bloedarmoede en een pertrochantere femurfractuur. Het aantal patiënten met een ASA classificatie III / VI verschilde niet tussen de twee groepen. Tijdens het verblijf in het ziekenhuis, werden meer complicaties gezien bij negentigplussers in vergelijking met de jongere patiënten. De negentigplussers hadden een significant langere opnameduur, het percentage heropnames binnen 90 dagen was

echter vergelijkbaar. De absolute sterfte van negentigplussers was hoger, de oversterfte (het sterftecijfer toegevoegd als gevolg van de ziekenhuisopname voor de heupfractuur) was vergelijkbaar. Veertig procent van de negentigplussers leefde in hun eigen huis voor de val en 41 procent van hen was binnen drie maanden na opname teruggekeerd naar de oude woonomgeving. Dit terugkeerpercentage was lager dan bij jongere patiënten. Het mobiliteitsniveau van de negentigplussers vóór de val was slechter dan dat van de jongere groep, maar het aantal patiënten dat de preoperatieve mobiliteit had herwonnen na drie maanden was vergelijkbaar.

Negentigplussers met een heupfractuur verschilden significant van jongere patiënten in de leeftijd 65-89 jaar qua klinische kenmerken en het uitkomsten op langere termijn. Echter, bijna de helft van de negentigplussers keert terug naar hun eigen huis en meer dan de helft van hen herwon hun preoperatieve mobiliteit.

Aangezien het aantal, vaak relatief gezonde, negentigplussers in onze samenleving groeit, zijn betrouwbare uitkomsten van belang.

Negentigplussers moeten op dezelfde manier worden behandeld als alle patiënten met een heupfractuur, mede gezien het feit dat de oversterfte vergelijkbaar is met hun jongere lotgenoten. Aan hen moet speciale aandacht worden besteed, om vermijdbare complicaties te voorkomen die een terugval in mobiliteit en verlies van onafhankelijkheid veroorzaken.

Contralaterale heupfracturen en andere fracturen

In een cohort van 1229 patiënten van 50 jaar en ouder, die een heupfractuur tussen januari 2005 en juni 2009 hadden opgelopen, werd het risico op bijkomende andere fracturen geëvalueerd. Het absolute risico op een contralaterale heupfractuur na de eerste heupfractuur was 13,8%, en 2% in het eerste jaar, met een kort interval (mediaan 18,5 maanden) tussen de twee heupfracturen. Leeftijd was een risicofactor voor een contralaterale heupfractuur, een eerder opgelopen fractuur niet.

Het tweede deel van deze studie was het aantonen van mogelijke risicofactoren voor een contralaterale heupfractuur. Alle fracturen werden retrospectief gescoord in de periode 2005-2008 en prospectief in 2008-2009. De percentages van een contralaterale heup en andere osteoporose-gerelateerde fracturen werden vergeleken tussen patiënten met en mensen zonder fractuur in de voorgeschiedenis.

Het absolute risico op een contralaterale heupfractuur was 13,8% en op één of meer andere osteoporose gerelateerde fracturen 28,6%. Het eerste-, tweede-en derdejaars risico voor een contralaterale heupfractuur was 2, 1 en 0%. De 1-jaars incidentie van andere fracturen was 6%. Alleen leeftijd was een risicofactor voor een contralaterale heupfractuur. Patiënten met een fractuur in de voorgeschiedenis (33,1%) hadden geen hogere fractuur incidentie tijdens follow-up (16,7%) dan patiënten zonder (14%).

FUNCTIONELE EN SOCIALE RESULTATEN

Hoofdstukken vijf en zes behandelen studies met resultaten van een prospectieve follow-up van 1 jaar van 498 patiënten met een heupfractuur, behandeld in het Reinier de Graaf Gasthuis, Delft in 2008-2009.

Terugkeer naar de woonomgeving van vóór de fractuur

In dit hoofdstuk worden de resultaten getoond van een prospectieve cohort follow-up studie van 444 patiënten van 65 jaar en ouder met een heupfractuur, gestratificeerd in categorieën op basis van de “pre-fractuur”-woonplaats. Tweeëndertig procent van de patiënten die zelfstandig in hun eigen huis woonden vóór de heupfractuur keerde terug naar huis bij ontslag, na drie en 12 maanden was 73% naar huis teruggekeerd. Leeftijd, het ontbreken van een partner, dementie, een lagere pre-fractuur ADL niveau (activiteiten van het dagelijks leven) en een beperkte mobiliteit waren onafhankelijke risicofactoren voor het niet-terugkeren naar huis bij ontslag en na drie en 12 maanden.

Van de patiënten die in een verzorgingshuis woonden voor de opname, keerde bij ontslag 33% terug, 68% na drie maanden en 64% na 12 maanden. Leeftijd was de enige onafhankelijke risicofactor voor het niet-terugkeren naar het verzorgingshuis bij ontslag. Leeftijd, dementie en een lager pre-fractuur ADL niveau waren de belangrijkste risicofactoren voor het niet-terug te keren naar de pre-fractuur woonomgeving in deze studie.

Vele andere factoren kunnen keuze van woonplaats na ontslag uit het ziekenhuis beïnvloeden. Hiervan zou het sociale netwerk wel eens één van de belangrijkste kunnen zijn.

Herwinnen van het pre-fractuur mobiliteitsniveau

In dit hoofdstuk worden de resultaten gepresenteerd van een prospectieve cohort follow-up studie van 390 patiënten van 65 jaar en ouder met een heupfractuur, gestratificeerd in categorieën op basis van de pre-fractuur mobiliteit. Eén van de belangrijkste conclusies van deze studie was dat bijna de helft van alle patiënten hun pre-fractuur niveau van mobiliteit na een jaar had herwonnen. Verder bleek dat patiënten die mobiel waren zonder een hulpmiddel vóór de heupfractuur een lagere kans hadden om hun mobiliteit te herwinnen, vergeleken met patiënten die mobiel waren met een hulpmiddel of alleen binnenshuis liepen. Bijna 19% van alle patiënten is na één jaar niet meer mobiel, d.w.z. ze zitten in een rolstoel of zijn bedlegerig. Het risico hierop was hoger in de groep met al een meer beperkte mobiliteit vóór de fractuur. Het pre-fractuur ADL niveau (activiteiten van het dagelijks leven), de mate van afhankelijkheid van anderen en het oplopen van een delier tijdens opname waren de belangrijkste risicofactoren voor het niet-herwinnen van de oude mobiliteit.

Een cognitieve stoornis is één van de belangrijkste niet-geëvalueerde risicofactoren voor het niet-herwinnen van mobiliteit in deze studie.

VOORSPELMODELLEN

Het Risico Model voor Delirium werd geëvalueerd (hoofdstuk zeven) en gevalideerd (hoofdstuk acht).

Een tweede voorspelmodel, dat de ontslaglocatie voorspelt voor patiënten met een heupfractuur die vóór de val thuis woonden, de "Discharge of Hip fracture Patients score" (DHP), werd ontwikkeld (hoofdstuk negen) en extern gevalideerd (hoofdstuk tien).

Screenen op het risico op een delirium en het haloperidol profylaxe programma

In 2008 werd in het Reinier de Graaf Ziekenhuis een zorgpad geïntroduceerd voor patiënten met een heupfractuur, waarvan het Risico Model voor Delirium (RD-score) onderdeel is.

De RD-score is een 10-punts vragenlijst die het risico op een delirium inschat. Patiënten met een hoog risico (score ≥ 5 punten) kregen haloperidol als profylaxe voorgeschreven.

Dit model werd geëvalueerd bij 445 patiënten van 65 jaar en ouder met een heupfractuur, opgenomen in 2008 en 2009.

De RD-score werd bij 378 patiënten ingevuld; 173 (45,8%) hoog-risico patiënten werden behandeld met profylactische medicatie. De sensitiviteit van de RD score voor een delirium was 71.6%, de specificiteit 63.8% en de negatief voorspellende waarde (NPV) van een score <5 was 85.9%.

De delirium incidentie (27 %) was niet significant verschillend ten opzichte van die in 2007 (28%) 2006 (24%) en 2005 (29%), de jaren voorafgaand aan de introductie van de RD-score. Logistische regressie-analyse toonde aan dat hoog-risico patiënten een significant hogere delirium incidentie hadden dan laag-risico patiënten (42,2% versus 14,1%). Verder waren ze significant vaker niet teruggekeerd naar hun oude woonlocatie na drie maanden (62,3% versus 17,0%) en hadden ze minder kans om binnen tien dagen te worden ontslagen uit het ziekenhuis (34,9% versus 55,9%). Belangrijke onafhankelijke risicofactoren voor een delirium waren een RD-score ≥ 5 , het mannelijk geslacht en leeftijd.

De belangrijkste conclusie van hoofdstuk zeven was dat de RD-score een nuttig hulpmiddel is om patiënten te identificeren met een hoog risico op een delirium en op andere slechtere uitkomsten. Echter, de invoering van het delirium preventie-protocol heeft de delirium incidentie niet verminderd. De belangrijkste beperkingen van deze studie waren het ontbreken van gedetailleerde informatie over de cognitieve status en duur en diepte van het delirium.

Validatie van het Risico Model voor Delirium

Hoofdstuk acht bevat de studie die de klinische betrouwbaarheid, validiteit en haalbaarheid van de RD Score heeft geëvalueerd met behulp van demografische gegevens, de RD scores en delirium incidentie van 378 patiënten van 65 jaar en ouder met een heupfractuur.

Honderd-en-twee patiënten (27%) werden gediagnosticeerd met een delirium. De intra-class correlatie coëfficiënt van het RD score was 0,77 (CI 0,68-0,84), de sensitiviteit 80,4% (CI 71,4-87,6), en de specificiteit 56,2% (CI 50,1-62,1). De oppervlakte onder de "receiver operating characteristic" curve was 0,73 (CI 0,68-0,77). Een multivariabele logistische regressie analyse toonde aan dat naast de RD score, een perthrochantere

femurfractuur en het mannelijk geslacht onafhankelijke risicofactoren waren voor een delirium. De RD score blijkt een betrouwbaar, praktisch en een valide instrument voor het voorspellen van delirium bij patiënten met een heupfractuur. Het zou van toegevoegde waarde zijn om het model aan te passen door het toevoegen van score items “mannelijk geslacht” en “pertrochantere femurfractuur” en het verwijderen van de score items “dagelijkse consumptie van meer dan vier alcoholische dranken” en “het gebruik van heroïne, methadon of morfine”.

De ontslagscore (DHP)

Het doel van de studie beschreven in hoofdstuk negen was om een betrouwbaar instrument te ontwikkelen dat al bij opname de ontslaglocatie voorspelt van patiënten met een heupfractuur die vóór de fractuur zelfstandig woonden; de “Discharge of Hip fracture Patients score” (DHP). Voor dit doel werden 310 patiënten van 50 jaar en ouder met een heupfractuur geanalyseerd, allen behandeld in Delft. De score loopt van 0-100. Risicofactoren voor ontslag naar een alternatieve locatie (OAL) waren een hogere leeftijd, het vrouwelijk geslacht, dementie, afwezigheid van een partner en een beperkte mate van mobiliteit. Het afkappunt werd gesteld op 30 punten, met een sensitiviteit van 83,8%, een specificiteit van 64,7% en een positief voorspellende waarde van 79,2%.

De DHP is een betrouwbare, korte en eenvoudige score die al bij opname kan worden gebruikt om de ontslaglocatie van patiënten met een heupfractuur te voorspellen. Er zijn eerder vergelijkbare scores ontwikkeld, maar deze hebben hun praktische beperkingen. Beperkingen van onze studie waren het gebrek aan gedetailleerde informatie over de cognitieve functie en het feit dat de mobiliteitsscategorie “immobiel” en de categorie “alleen mobiel binnenshuis” niet afzonderlijk konden worden beoordeeld. Tot slot, dit is een model voor de Nederlandse sociale situatie en mogelijk niet van toepassing op andere landen. Echter, de score items die wij hebben gebruikt waren vergelijkbaar met die van de eerdere modellen die zijn ontwikkeld in andere landen (Verenigd Koninkrijk, Zweden, Verenigde Staten). (48-50)

Externe validatie van de ontslagscore (DHP)

De externe validatie van de DHP werd uitgevoerd in een cohort van 125 patiënten van 50 jaar en ouder met een heupfractuur opgenomen in het Universitair Medisch Centrum Groningen.

Het Groningse cohort was jonger vergeleken met het Delftse cohort, (gemiddelde leeftijd 75,4 versus 78,5 jaar), maar had vaker ASA classificatie III / IV (46,4% versus 25,2%). De sensitiviteit van de DHP voor ontslag naar een alternatieve locatie (OAL) in het Groningse cohort was 75% (versus 83,8%), de specificiteit 66,7% (versus 64,7%) en de positief voorspellende waarde (PPV) was 86,3% (versus 79,2%) vergeleken met het Delftse cohort.

De externe validatie van de DHP toonde dat deze score goed en betrouwbaar is, de score was een betrouwbare voorspeller van de ontslaglocatie van patiënten uit een andere Nederlandse cohort. Wel was de sensitiviteit voor OAL iets lager, de PPV daarentegen was hoger. Derhalve is de DHP score een nuttig, betrouwbaar en eenvoudig toe te passen instrument voor de algemene heupfractuur populatie in Nederland.

TOEKOMST

Onderzoek doen creëert bijna altijd nieuwe vragen en inzichten. Algemene en specifieke verbeteringen van de zorg voor patiënten met een heupfractuur moeten worden nagestreefd om betere en efficiëntere zorg te leveren voor deze kwetsbare populatie. De overheid en zorgverzekeraars stellen kwaliteitsindicatoren op voor ziekenhuizen (en artsen) om de patiëntenzorg te verbeteren. Echter, deze indicatoren moeten wel terecht zijn gekozen, bij voorkeur op basis van betrouwbare parameters en uitkomsten van Nederlandse patiënten. Dit kan alleen worden gedaan als er voldoende “baseline” parameters en kenmerken van patiënten met een heupfractuur zijn geregistreerd. Het succes van het landelijke Nederlandse implantaten register LROI (nu nog met alleen data van totale heup en knieprotheses, www.lroi.nl) is een uitstekend voorbeeld om te volgen. Sommige Europese landen zijn in het afgelopen decennium al begonnen met een landelijke heupfractuur database. Met deze databases kunnen geschikte indicatoren van goede zorg voor patiënten met een heupfractuur worden geïdentificeerd. In het NHS-systeem in Schotland bijvoorbeeld worden diverse uitkomsten jaarlijks geanalyseerd en ziekenhuizen met een sterftecijfer dat hoger is dan verwacht worden nader onderzocht en waar mogelijk worden er verbetertrajecten ingesteld. Het herwinnen van het pre-fractuur niveau van mobiliteit, terugkeren naar de oude woonomgeving en

patiënt-gerapporteerde kwaliteit van leven zouden belangrijke indicatoren van goede heupfractuur zorg kunnen zijn. De resultaten van de Nederlandse ziekenhuizen kunnen worden vergeleken en ziekenhuizen die beduidend lager presteren vergeleken met het nationale gemiddelde moeten verbeteringen van zorg doorvoeren.

Stijgende kosten zijn een reëel probleem voor alle landen met een vergrijzende bevolking. Zoals in de inleiding van dit proefschrift vermeld, bedragen volgens het rapport van de Nationale Hip Fracture Database uit 2011 deze kosten in het Verenigd Koninkrijk bijna twee en een half miljard euro per jaar. (7)

Deze kosten kunnen worden verminderd door de huidige zorg voor patiënten met een heupfractuur efficiënter te maken, door preventie van osteoporose-gerelateerde fracturen en door invoeren van “evidence-based” zorgpaden. Deze zorgpaden houden rekening met de meest belangrijke aspecten van deze fragiele patiëntenpopulatie en standaardiseren screening en preventie van diverse risico factoren en behandeling, zowel pre-, peri als postoperatief.

Samenwerking met gerieters, bij voorkeur op een zogenaamde “geriatrische fractuur afdeling” is een essentieel onderdeel om de kwaliteit van zorg te verbeteren. Op een dergelijke afdeling worden de vaardigheden en kennis van orthopedisch en traumachirurgen aan de ene kant en gerieters, gespecialiseerde verpleegkundigen en fysiotherapeuten anderzijds gecombineerd.

Ten slotte is het door opname van patiënten met een heupfractuur op een dergelijke geriatrische fractuur afdeling, de registratie van basislijn parameters en het meten van resultaten veel eenvoudiger. Preventie van osteoporose-gerelateerde fracturen kan op vele manieren worden gerealiseerd en is een onderzoeksgebied op zichzelf. Vroegtijdige opsporing van osteoporose en het starten van medicatie is slechts een deel van de oplossing. Even belangrijk is de identificatie van risicofactoren voor vallen. (51) Core stabiliteit training met fysiotherapie, tai chi of virtuele training kan een belangrijke rol spelen, net als screening op en verbetering van een verminderd gezichtsvermogen en gehoor.

Multi-component of multimodale interventieprogramma's dragen minstens evenveel bij aan de preventie van een delirium als chemische profylaxe. (52)

Concluderend, toekomstig onderzoek bij patiënten met een heupfractuur zou gericht moeten zijn op al deze verschillende aspecten van preventie van fracturen. Bij patiënten

met een fractuur, moet het minimaliseren van de morbiditeit de belangrijkste doelstelling zijn; hiermee wordt de impact van deze ingrijpende gebeurtenis op de kwaliteit van leven en de activiteiten van het dagelijks leven van deze vaak kwetsbare ouderen zo klein mogelijk.

Gearfetting en takomstperspektiven

Oersjoch

Yn dit proefskrift wurde inkele fan de folle klinyske en funksjonele útkomsten en risiko faktoaren foar minne resultaten fan pasjinten mei in heupfraktuer presintearre. Fierder binne der twa risiko modellen (foar delirium en ûntslach nei in alternative lokaasje) evalúearre en fallidearre. Dit haadstik befettet in gearfetting fan de ferskillende haadstikken fan dit proefskrift.

Ôfslutend folgje inkele wurden oangeande takomst perspektiven.

Yn ûndersteande tabel stean per haadstik de oantallen en werkomst fan de pasjinten en de perioade wêryn sij behannele waarden.

Haadstik	Oantal pasjinten	Werkomst	Perioade
2	1262	Delft en Den Haag	2005-2009
3	230 vs. 1014	Delft en Den Haag	2005-2009
4	1229	Delft en Den Haag	2005-2009
5	444	Delft	2008-2009
6	390	Delft	2008-2009
7	445	Delft	2008-2009
8	378	Delft	2008-2009
9	310	Delft	2008-2009
10	125 vs. 310	Delft en Groningen	2008-2009

KLINYSKE RESULTATEN

Om spesifike risiko faktoaren foar in minne útkomst bij pasjinten mei in heupfraktuer te identifisearjen is fan grut belang om (grutte) databases te hawwen, mei betroubere pasjinten skaaimerken en klinyske útkomsten. De betrouberens wurdt ûnder oaren bepaald troch it tal pasjinten dat yn de database ynkludeard is.

Om dy reden waard der in grutte database makke fan 1269 pasjinten fan 50 jier en âlder mei in heup fraktuer, dy't opnommen west binnen yn it Reinier de Graaf Gasthuis yn Delft en it Bronovo Ziekenhuis yn Den Haag yn de perioade 2005-2009.

Anemy by opname en allogene bloedtransfúzje (ABT)

Haadstik twa beskriuwt in retrospektive analyze fan 1262 pasjinten fan 65 jier en âlder mei in operatyf behannele heupfraktuer. Út de multi fariabele regressy analyze die bliken dat anemy bij opname in wichtige risikofaktor wie foar ûntslach nei in ferpleechhûs en in weropname binnen 90 dagen, mar net om te stjerren. Yndikaasje foar in ABT, leeftyd en ASA klassifikaasje wienen ûnôfhinklike risiko faktoaren foar deagean op alle mominten yn de tiid, allinnich it tal stjergefallen tusken de 3 en 12 moannen nei de operaasje waarden net beynfloede troch ABT. In yndikaasje foar in ABT wie de grutste riskofaktor foar in langer ferbliuwen yn it sikehûs en de op ien nei grutste foar it ûntjouwen fan in delirium.

It hat bliken dien dat anemy by opname en postoperative anemy wêrfoar in ABT nedich wie (PANT) ûnôfhinklike risikofaktoaren wienen foar in mindere útkomst by pasjinten mei in heupfraktuer. Lykwols anemy as sadanich gjin effekt hat op de mortaliteit troch in “rescue effect” fan PANT. De mortaliteit tidens opname yn it sikehûs en nei trije en 12 moannen waard negatyf beynfloede troch PANT, mei it grutste effekt yn de earste trije moannen nei de operaasje.

Dizze stúdzje toant nochris de komplekse ynteraksje oan fan anemy en ABT en har effekt op klinyske útkomsten. Anemyske pasjinten moatte om dy reden wiidweidich kontrolearde wurde. It effekt fan ferskillende transfúzje rezjyms is okkerdeis ûndersocht yn de FOCUS stúdzje (47) Dizze stúdzje toande gjin ferskil yn morbiditeit yn de earste 60 dagen nei de yngreep tusken restriktif en in liberale transfúzje rezjym foar pasjinten mei in heech kardiofaskulair risiko (47)

Njoggentichplussers fersus jongere pasjinten mei in heupfraktuer

Yn haadstik trije wurdt de stúdzje presintearre wêr yn 230 njoggentichplussers mei in heup fraktuer fergelike wurde mei 1014 pasjinten yn de leeftyd fan 65 – 89 jier.

Hjirby is sjoen nei klinyske skaaimerken, komplikaasjes, mobiliteit en mortaliteit. Njoggentichplussers wienen faker frou en hienen faker bloedearmoede en in pertrosjanteare femurfraktuer. It tal pasjinten mei in ASA klassifikaasje III / VI ferskilde net tusken de twa groepen. By it ferbliuw yn it sikehûs, waarden mear komplikaasjes sjoen bij njoggentichplussers yn fergelyk mei jongere pasjinten. De njoggentichplussers hienen in signifikant langere opnamedoer, it persintaazje dat men opnij opnommen waard, wie

lykwols fergelykber. De absolute stjerte fan njoggentichplussers wie heger, de oerstjerte (it stjertesifer taheakke as gefolch fan de sikehûsopname foar de heupfraktuer) wie fergelykber. Fjirtich prosint fan de njoggentichplussers libben yn harren eigen hûs foar de fal en 41 prosint fan harren wienen binnen trije moannen nei de opname werom nei de âlde wenomjouwing. Dit persintaazje wie leger as bij jonge pasjinten. It mobiliteitsnifo fan de njoggentichplussers foar de fal wie minder dan fan de jongere groep, mar it tal pasjinten dat de preoperative mobiliteit herwûn nei trije moanne hie wie fergelykber.

Njoggentichplussers mei in heupfraktuer ferskille signifikant fan jongere pasjinten yn de leeftyd 65 -89 jier kwa klinyske merktekens en de útkomsten op langere termyn.

Lykwols, hast de helte fan de njoggentichplussers giet werom nei hûs en mear as de helte fan harren herwûn harren preoperative mobiliteit.

Omdat it tal, faak relatyf sûne, njoggentichplussers yn ús mienskip ta nimt binne betroubere útkomsten fan belang.

Njoggentichplussers moatte op deselde wize behannele wurde as alle pasjinten mei in heupfraktuer, mei omdat de oerstjerte fergelykber is mei harren jongere lotgenoaten. Oan harren moat spesjaal omtinken jûn wurde, om te mijen komplikaasjes yn it foar te wêzen dy't in werom fal yn mobiliteit en ferlies fan ûnôfhinklikens feroarsaakje.

Kontralaterale heupfraktueren en oare fraktueren

Yn in kohort fan 1229 pasjinten fan 50 jier en âlder, dy't in heupfraktuer tusken jannewaris 2005 en juny 2009 oprûn hienen, waard it risiko op bykommende oare fraktueren evaluearre. It absolute risiko op in kontralaterale heupfraktuer nei de earste heupfraktuer wie 13,8% en 2% yn it earste jier, mei in koarte ynterfal (mediaan 18,5 moannen) tusken de twa heupfraktueren. Leeftyd wie in risikofaktor foar in kontralaterale heupfraktuer, in fraktuer dy't earder oprûn wie net. It twadde part fan dizze stúdzje wie it oantoanen fan mooglike risikofaktoaren foar in kontralaterale heupfraktuer. Alle heupen waarden retrospektyf skoart yn it tiidrak 2005-2008 en prospektyf yn 2008-2009.

De persintaazjes fan in kontralaterale heup en oare osteoporose-relatearre fraktueren wurde fergelike tusken pasjinten mei en minsken sûnder fraktueren yn de foarskiednis.

It absolute risiko op in kontralaterale heupfraktuer wie 13,8% en op ien as mear oare osteoporose relayearre 28,6%. It earste-, twadde- en treddejiars risiko foar in kontralaterale heupfraktuer wie 2, 1 en 0%. De 1-jiars ynsidintsje fan oare fraktueren wie

6%. Allinnich leeftyd wie in risiko faktor foar in kontralaterale heupfraktuer. Pasjinten mei in fraktuer yn de foarskiednis (33,1%) hienen gjin hegere fraktuer ynsidintsje yn it ferfolch (16,7%) as pasjinten sûnder (14%).

FUNKSJONIELE EN SOSJALE UTKOMSTEN

De haadstikken fiif en seis behannelje stúdzjes mei útkomsten fan in prospektive follow-up fan 1 jier fan 498 pasjinten mei in heupfraktuer, behannele yn it Reinier de Graaf Gasthuis, Delft yn 2008-2009

Werom gean nei de wenomjouwing fan foar de fraktuer

Yn dit haadstik wurde de útkomsten toant fan in prospektive kohort ferfolch stúdzje fan 444 pasjinten fan 65 jier en âlder mei in heupfraktuer, stratifisearre yn kategoryen op grûn fan it “pre-fraktuer”- wenplak. Twaentritich prosint fan de pasjinten dy’t selsstannich yn harren eigen wenning wennen foar de heupfraktuer, gong nei it ûntslach werom nei hûs, nei trije en 12 moannen wie dat 73%.

Leeftyd, it ûntbrekken fan in partner, demintens, in legere pre-faktuer ADL nivo (warberens fan it deistich libben) en in beheinde mobiliteit wienen ûnôfhinklike risiko faktoaren foar it net werom gean nei hûs nei it ûntslach en nei trije en 12 moannen.

Fan de pasjinten dy’t yn in fersoargingshûs wennen foar de opname, gong bij ûntslach 33% werom, 68% nei 3 moannen en 64% nei 12 moannen. Leeftyd wie de ienichste ûnôfhinklike risikofaktor foar it net werom gean nei it fersoargingshûs by ûntslach. Leeftyd, demintens en in leger pre-fraktuer ADL nivo wienen de wichtichste risikofaktoaren foar it net werom gean de pre-fraktuer wenomjouwing yn dizze stúdzje.

In protte oare faktoaren kinne de kar fan wenplak nei it ûntslach út it sikehûs beynfloedzje. Hjirfan soe it sosjaal netwurk wol ris ien fan de wichtichste wêze kinne.

Herwinnen fan it pre-fraktuer mobiliteitsnivo

Yn dit haadstik wurde de útkomsten presintearre fan in prospektive kohort follow-up stúdzje fan 390 pasjinten fan 65 jier en âlder mei in heupfraktuer, stratifisearre yn kategoryen op grûn fan de pre-fraktuer mobiliteit. Ien fan de wichtichste konklúzjes fan

dizze stúdzje wie dat hast de helte fan alle pasjinten syn pre-fraktuer nivo fan mobiliteit nei in jier werom hie. Fierder die bliken dat pasjinten dy't sûnder helpmiddels mobyl wienen minder kâns hienen om harren mobiliteit te herwinnen, yn fergelyk mei pasjinten dy't mobyl wienen mei in helpmiddels of allinnich binnen hûs rûnen. Hast 19% fan alle pasjinten is nei ien jier net mear mobyl, dat wol sizze se sitte yn in rolstoel of binne bûn oan bêd. It risiko hjir op wie heger yn de groep mei al mear as in beheinde mobiliteit foar de fraktuer. It pre-fraktuer ADL nivo (warberens fan it deistich libben), de omfang fan ôfhinklikens fan oaren en it oprinnen fan in delier bij opname wienen de wichtichste risiko faktoaren foar it net herwinnen fan de âlde mobiliteit.

In kognitive fersteuring is ien fan de wichtigste net-evalueare risikofaktoaren foar it net werwinnen mobiliteit yn dizze stúdzje.

FOARSPULMODELLEN

It Risiko Model foar Delirium waard evaluearre (haadstik sân) en falidearre (haadstik acht) In twadde foarspulmodel, dat de ûntslachlokaasje foarseit foar pasjinten mei in heupfraktuer dy foar de fal thús wennen, de "Discharge of Hip fracture Patients score" (DHP), dy't ûntwikkele waard (haadstik njoggen) en ekstern falidearre (haadstik tsien).

Neisjen op it risiko op in delirium en it haloperidol profylakse programma

Yn 2008 waard yn it Reinier de Graaf Gasthuis in soarchpaad yntrodusearre foar pasjinten mei in heupfraktuer, wêrfan it Risiko Model foar Delirium (RD-skoare) ûnderdiel fan is.

De RD- skoare is in út 10 punten besteande fragelist dy't in beoardieling makket fan it risiko op delirium. Pasjinten mei in heech risiko (skoare ≥ 5 punten) krigen haloperidol as profylakse foarskreaun. Dit model waard evaluearre bij 445 pasjinten fan 65 jier en âlder mei in heupfraktuer, opnommen yn 2008 en 2009.

De RD skoare waard bij 378 pasjinten ynfuld; 173 (45,8%) heech-risiko pasjinten waarden behannele mei profylaktyске medikaasje. De sensitivens fan de RD skoare foar in delirium wie 71.6%, de spesifisiteit 63.8% en de negatyf foarseine wearde (NPV) fan in skoare <5 wie 85.9%.

De delirium ynsidintsje (27%) wie amper ferskillend fan dy yn 2007 (28%) 2006 (24%) en 2005 (29%), de jierren foarôfgeande oan de yntroduksje fan de RD-skoare.

Logistike regresje analyze toande oan dat heech risiko pasjinten in belangryk hegere delirium ynsidintsje hienen dan leech risiko pasjinten (42,2 tsjinoer 14,1%). Fierder wienen se behoarlik faker net werom gongen nei harren âlde wenlokaasje nei trije moannen (62,3% tsjinoer 17,0%) en hienen se minder kâns om binnen tsien dagen ûntslein te wurden út it sikehûs (34,9% tsjinoer 55,9%). Wichtige ûnôfhinklike risikofaktoaren foar in delirium wienen in RD-skoare ≥ 5 , fan it manlik geslacht en leeftyd.

De wichtichste konklúzje fan haadstik sân wie dat de RD-skoare in nuttich helpmiddels is om pasjinten te identifisearjen mei in heech risiko op in delirium en op oare mindere útkomsten. Lykwols, de ynfiering fan it delirium previnsje foarskriften hat de delirium ynsidintsje net minder makke. De wichtichste beheinings fan dizze stúdzje wienen it ûntbrekken fan ynformaasje op fine puntsjes oer de kognitive status en doer en djippte fan it delirium.

Falidaasje fan it Risiko Model foar Delirium

Yn haadstik acht fynt men de stúdzje dy't de klinyske betrouberens, faliditeit en helberens fan de RD skoare evaluearre hat mei help fan demografyske gegevens, de RD skoares en delirium ynsidintsje fan 378 pasjinten fan 65 jier en âlder mei in heupfraktuer.

Hûndert en twa pasjinten (27%) waarden diagnostisearre mei in delirium. De 'intra-class correlatie coëfficiënt' fan de RD skoare wie 0,77 (CI 0,68-0,84), de sensitivens 80,4% (CI 71,4-87,6), en de spesifisiteit 56,2% (CI 50,1-62,1). De oerflakte ûnder de "receiver operating characteristic" kurve wie 0,73 (CI 0,68-0,77). In multifariabele logistyske regressy analyze toande oan dat njonken de RD skoare, in pertrosjanteare femurfraktuer en it manlik slach ôfhinklike risikofaktoaren wienen foar in delirium. It die bliken dat de RD skoare betrouber, praktysk en in falide ynstrumint wie foar it foarsizzen fan delirium bij pasjinten mei in heupfraktuer. It soe fan tafoege wearde wêze om it model oan te passen troch it tafoegen fan skoare manlik geslacht en "perthrochantere femurfractuur" en it fuortheljen fan de skoares "deistige konsumpsjes fan mear as fjouwer alkoaloyske dranken" en "it gebrûk fan heroïne, metadon of morfine".

De ûntslachskoare (DHP)

It doel fan de stúdzje beskreaun yn haadstik njoggen wie om in betrouber ynstrumint te ûntwikkeljen dat al bij de opname de ûntslachlokaasje foarseit foar pasjinten mei in heupfraktuer dy foar de fraktuer selsstannich wennen: de “Discharge of Hip fracture Patients score”. Foar dit doel waarden 310 pasjinten fan 50 jier en âlder mei in heupfraktuer analysearre, allegear behannele yn Delft. De skoare rûn fan 0-100. Risikofaktoaren foar ûntslach nei in alternative lokaasje (OAL) wienen in hegere leeftyd, it froulik geslacht, demintens, ôfwêzigens fan in partner en in beheinde mobiliteit. It ôfknappunt waard steld op 30 punten, mei in sensitivens fan 83,8%, in spesifisiteit fan 64,7% en in posityf foarsizzende wearde fan 79,2%.

De DHP is in betroubere, koarte en ienfâldige skoare dy't al bij opname brûkt wurde kin om de ûntslachlokaasje fan pasjinten mei in heupfraktuer te foarsizzen. Der binne earder fergelykbere skoares ûntwikkele, mar dizze ha harren praktyske beheiningen.

Beheinings fan ús stúdzje wie de krapte oan ynformaasje op detail nivo oer de kognative funksje en it feit dat de mobiliteit kategory “ymmobyl” en de kategory “allinnich mobyl yn hûs” net apart beoardielt wurde koenen.

Ta beslút, dit is in model foar de Nederlânske sosjale situaasje en mooglik net fan tapassing op oare lannen. Lykwols, de skoare ûnderdielen dy't wy brûkt ha wienen te fergelykjen mei dy fan eardere modellen dy't ûntwikkele waarden yn oare lannen ((it Feriene Keninkryk, Sweden, Feriene Steaten). (48-50).

Eksterne falidaasje fan de ûntslachskoare (DHP)

De eksterne falidaasje fan de DHP waard útfierd yn in kohort fan 125 pasjinten fan 50 jier en âlder mei in heupfraktuer opnommen yn it Universitair Medisch Centrum in Grins.

It Grinzer kohort wie jonger as men fergeliket mei it Delfts kohort, (gemiddelde leeftyd 75,4 tsjinoer 78,5 jier) mar hie faker ASA klassifikaasje III / IV (46,4% fersis 25,2%). De sensitiviteit fan de DHP foar ûntslach nei in alternative lokaasje (OAL) yn it Grinzer kohort wie 75% (tsjin 83,8%), de spesifisiteit 66,7% (tsjin 64,7%) en de posityf foarsizzende wearde (PPV) wie 86,3% (tsjin 79,2%) as men dat fergeliket mei it Delfts kohort. De eksterne falidaasje fan de DHP toande oan dat dizze skoare goed en betrouber wie, de skoare wie in betroubere foarsizzer fan de ûntslachlokaasje fan pasjinten út in oare Nederlânske kohort. Wol wie de sensitifiteit foar OAL eat leger, de PPV lykwols wat heger.

Om dy reden is de DHP skoare in nuttich, betrouber en ienfâldich ta te passen ynstrumint foar de algemiene heupfraktuer populaasje yn Nederlân.

TAKOMST

As men ûndersyk docht sil dit altyd nije fragen en ynsjoggen opsmite. Algemiene en spesjale ferbetteringen fan de soarch foar pasjinten mei in heup fraktuer moatte neistribbe wurde om bettere en doelmjittiger soarch te leverjen foar dizze kwetsbere populaasje. De oerheid en soarchfersekerders stelle kwaliteit yndikatoaren op foar sikehuzen (en dokters) om de pasjintensoarch te ferbetterjen. Lykwols, dizze yndikatoaren moatte wol terjochte koazen wêze, bij foarkar op grûn fan betroubere parameters en útkomsten fan Nederlânske pasjinten. Dit kin allinnich dien wurde as der foldwaande “baseline” parameters en bysûnderheden fan pasjinten mei in heupfraktuer registrearre binne. It sukses fan it lanlik Nederlânske ymplantaten register LROI (no noch allinnich mei data fan totale heup en knibbel protezen, www.lroi.nl) is in prima foarbyld om te folgjen.

Guon Europeeske lannen binne yn it ôfrûne desennium al begongen mei in lanlike heupfraktuer database. Mei dizze databases kinne geskikte yndikatoaren fan goeie soarch foar pasjinten mei in heupfraktuer werkend wurde. Yn it NHS-systeem yn Skotlân bygelyks wurde de útkomsten jierliks analysearre en sikehuzen mei in stjertesifer dat heger is as ferwacht wurde neier ûndersocht en wêr mooglik wurde der ferbetter projekten yn gong set. It herwinnen fan it pre-fraktuer nivo fan mobiliteit, werom gean nei de âlde wenomjouwing en pasjint rapportearre kwaliteit fan libben soenen wichtige yndikatoaren fan goede heupfraktuer soarch wêze kinne. De útkomsten fan de Nederlânske sikehuzen kin men fergelykje en sikehuzen die behoarlik leger prestearje yn fergelyk mei it nasjonaal trochstrings, moatte ferbetteringen fan soarch trochfiere.

Stigende kosten binne in wier probleem foar alle lannen mei in hieltyd grizer wurdende befolking. Sa as yn de ynliding fan dit proefskrift al neamt is, binne neffens it rapport fan de Nationale Hip Fracture Database út 2011 dizze kosten yn it Feriene Keninkryk hast twa en in heal miljard euro per jier (7)

Dizze kosten kinne fermindere wurde troch de hjoeddeiske soarch foar pasjinten mei in heupfraktuer doelmjittiger te meitsjen, troch previnsje fan osteoporose-relatearre

fraktueren en troch ynfieren fan “evidence-based” soarchpaden. Dizze soarchpaden hâlde rekkening mei de meast belangrike aspekten fan dizze fragile pasjinten populaasje en standardisearje de wize fan neisjen en previnsje fan ferskate risiko faktoaren en behanneling, sawol pre-, peri as postoperatyf.

Gearwurking mei gerieters, by foarkar op in saneamde “geriatrische fractuur afdeling” is in wêzenlik ûnderdiel om de kwaliteit te ferbetterjen. Op sa’n ôfdieling wurde it kinnen en kunde fan ortopedysk en trauma sjirurchen oan de iene kant en gerieters, spesjalisearre ferpleechkundigen en fysioterapeuten oan de oare kant, kombinearre.

Ta beslút is it troch opname fan pasjinten mei in heupfraktuer op sa’n geriatrikske fraktuer ôfdieling, de registraasje fan basislijn parameters en it mjitten fan útkomsten folle ienfâldiger. Previnsje fan osteoporose-relatearre fraktueren kin op ferskate wizen realisearre wurde en is in ûndersykmêd op himsels. Betide opspoaring fan osteoporose en it begjinnen fan medikaasje is mar in part fan de oplossing. Like wichtich is de identifikaasje fan risikofaktoaren foar fallen (51). Core stabiliteit training mei fysioterapy, tai chi as firtuele training kin in wichtige rol spylje, krekt as neisjen op en ferbettering fan in minder wurdend sicht en gehoar. Multi-komponint of multimodale yntervinsje programma’s drage op syn minst likefolle bij oan de previsje fan in delirium as gemyske profylaxe. (52)

De konklúzje is dat takomstich ûndersyk by pasjinten mei in heupfraktuer rjochte wêze moat op al dizze ferskate aspekten fan previnsje fan fraktueren. By pasjinten mei in fraktuer, moat it minimalisearjen fan de morbiditeit de wichtichste doelstelling wêze; hjirmei wurdt de ympakt fan dit yngripend barren op de kwaliteit fan libben en de aktiviteiten fan it deistich libben fan dizze faak kwetsbere âlderen sa lyts mooglik.



PART VI

ADDENDUM



12

Care pathway for patients with a
proximal femur fracture;
“Voor elke heup een rode map”

Medisch Contact 2010;65(11):504-7

‘Collum Care’, een zorgpad voor patiënten met een gebroken heup

Voor elke heup een rode map

drs. A.J.H. Vochtelo,
aio orthopedie,

drs. D.D. Niesten,
orthopedisch chirurg,

drs. H.B. Cornelisse,
anesthesioloog,

dr. M.R. de Vries,
chirurg traumatoloog,

dr. R.M. Bloem,
orthopedisch chirurg,

dr. P. Pilot,
senior onderzoeker orthopedie

Allen werkzaam bij de Reinier de
Graaf Groep Delft.

Correspondentieadres:
pilot@rdgg.nl;
c.c.: redactie@medischcontact.nl

Geen belangenverstrengeling
gemeld.

In het Reinier De Graaf Ziekenhuis verloopt de behandeling van patiënten met een heupfractuur volgens een vast model. Voor elke patiënt is er een rode map met formulieren en protocollen waarin allerlei facetten van de zorg zijn vastgelegd.

Omdat naar verwachting het aantal heupfracturen de komende jaren fors zal toenemen en omdat de behandeling ervan ingewikkeld is, moet deze zorg met innovatieve concepten verder worden gestroomlijnd. Parker en Johansen karakteriseren de heupfractuur in dat verband ‘als een echte test en bruikbare marker voor de integratie en effectiviteit van de moderne zorg’.¹ Het succes van zorgpaden voor electieve orthopedische ingrepen zoals totale heup- of knieprothesen was de aanleiding om ook voor de heupfractuur een zorgpad te ontwikkelen: ‘Collum Care’.²



Osteoporosescreeening is onderdeel van het proces geworden. Links aio orthopedie Anne Vochtelo en rechts nurse practitioner osteoporose Peter van den Berg.

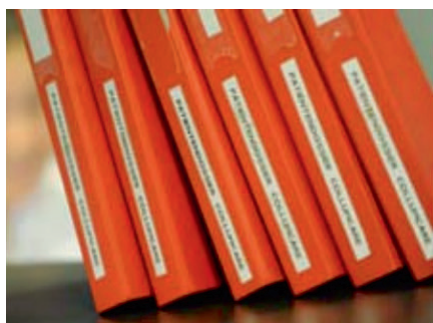
beeld: De Beeldredactie, Marco de Swart

De kwetsbaarheid van de patiënten met een heupfractuur blijkt wel uit de hoge mortaliteit.

De éénjaarsmortaliteit ligt rond 25 procent, terwijl dit bij leeftijdgenoten zonder fractuur ongeveer 10 procent is.^{1,3}

Zo'n 10 procent van de patiënten met een heupfractuur kan niet terugkeren naar de oude woonsituatie. Dit heeft ingrijpende gevolgen voor de patiënten en veroorzaakt daarnaast grote doorstroomproblemen in ziekenhuizen.¹

Naast het niet-electieve karakter van heup- fracturen zijn deze punten de meest in het oog springende verschillen met de patiëntenpopulaties van de zorgpaden voor electieve heup- en knieprothesiologie. Bij het vertalen van de basisprincipes zal daarom de nadruk op deze verschillen moeten liggen.



Met behulp van de 'rode mappen' kunnen anamnese, diagnostiek, communicatie en (peri) operatieve zorg op uni forme wijze worden uitgevoerd.

Standaardiseren en integreren

In het Reinier de Graaf Ziekenhuis (RdGG) wordt de traumatologie van het bewegingsapparaat – net als in veel (opleidings)ziekenhuizen – verzorgd door de afdelingen Orthopedie en Heelkunde. Het ontwikkelen van een zorgpad begon met het inventariseren van de bestaande opvattingen en protocollen voor de preoperatieve screening door internist en/of cardioloog, voor postoperatieve belastbaarheid van osteosynthesen, voor tromboseprofylaxe, voor perioperatieve pijnstilling en voor het screenen van osteoporose. Om dit nauwkeurig te doen, hebben we de patiëntenpopulatie van 2005-2007 retrospectief zo gedetailleerd mogelijk in kaart gebracht. Naast cijfers uit verschillende informatiesystemen en statussen zijn ook de gegevens van het verpleeghuis waar de meeste patiënten naartoe gaan, aan het geheel toegevoegd. Doordat in de status

expliciete vermeldingen van screening op onderwerpen als deliriumrisico, ondervoeding en osteoporose meestal ontbraken, was de kwaliteit van het beleid op deze gebieden niet te toetsen. In 2007 is de werkgroep 'heupfracturen' begonnen met het standaardiseren van de diverse protocollen en het integreren van deze protocollen tot een standaardpatiëntendossier dat leidend werd voor het (para) medische team. Onderdelen van dit dossier zijn het inschatten van het risico op een delirium en het inventariseren van de voedingstoestand, het mobilisatieniveau, de woonsituatie en de geestelijke en lichamelijke gezondheidsbeleving van de 'Collum Care'-patiënten. Dit dossier kreeg de werknaam de 'rode map'.

***Een totaalscore van
1 of 2 punten geeft recht op
extra tussengerechten***

In de nieuwbouwplannen van het RdGG staat een verpleeghuisafdeling van de Pieter van Foreest Stichting (PvF) gepland. Doordat er vanaf oktober 2007 een ruimte in het huidige ziekenhuis beschikbaar kwam, de 'Herstelunit', kon er ervaring worden opgedaan. Er werd een begin gemaakt met de doorstroom van stabiele patiënten die alleen nog in het ziekenhuis verbleven om te revalideren.

Delirium

Hoewel er een screeningsprotocol bestond, werd vóór de invoering van het zorgpad 'Collum Care' noch op de Spoedeisende Hulp (SEH) noch op de verpleegafdelingen standaard de voedingstoestand en het risico op een delirium bepaald.

Nu vult de verpleegkundige of de dienstdoende a(n)ios op de SEH het Risicomodel Delirium in.⁴ Als deze score boven de 5 is, wordt er preoperatief gestart met profylaxe, te weten haloperidol (Haldol) en lorazepam (Lorazepam, Temesta). Bij contra-indicaties voor haloperidolgebruik wordt in overleg met de psychiater een alternatief gezocht.

Voor de voedingstoestand wordt de SNAQ-score ingevuld.⁵ Deze score bestaat uit drie vragen die elk 1 punt kunnen opleveren. Een totaalscore van 1 of 2 punten geeft recht op extra tussengerechten; bij een score van 3 punten wordt de ziekenhuisdiëtiste geconsulteerd.⁵

De afdelingen Heelkunde en Orthopedie hanteerden een verschillend tromboseprofylaxe-protocol (vitamine-K-antagonisten versus laagmoleculaire heparine). Het nieuwe uniforme protocol bestond uit zes weken laagmoleculaire heparine of hervatten van

vitamine-K-antagonisten bij patiënten die deze al preoperatief gebruiken. De nierfunctie werd voorheen niet standaard berekend, terwijl van enkele patiënten die NSAID's kregen de nierfunctie onnodig achteruitging. Sinds 2008 wordt standaard met paracetamol als pijnstilling gestart en een NSAID bij een acceptabele nierfunctie (de creatinineklaring wordt nu standaard berekend), zo nodig aangevuld met een opiaat.

Preoperatief consult

In veel ziekenhuizen worden acuut opgenomen oudere patiënten met een operatie-indicatie preoperatief gezien door een internist en vaak nog apart door een cardioloog. Anesthesiologen willen echter vaak andere informatie over de medische conditie van een patiënt dan hetgeen de geconsulteerde internist aanbiedt. Bovendien waren de consulten in het RdGG erg wisselend van inhoud en sterk afhankelijk van het aandachtsgebied van de superviserende internist. Om de meerwaarde van het preoperatieve consult te vergroten en dubbelwerk te voorkomen is er, in samenspraak tussen Anesthesiologie en Interne Geneeskunde een consult opgesteld met standaardaandachtspunten die specifiek zijn gericht op de perioperatieve zorg. Zo is er een kant-en-klaardocument met perioperatieve adviezen over vochtbeleid en medicatie voor anesthesioloog en a(n)ios op de verpleegafdeling ontstaan.



In de 'Herstelunit' verblijven patiënten die alleen nog in het ziekenhuis zijn om te revalideren.

Rode map

Per 1 januari 2008 zijn we begonnen met een prospectieve registratie van de gegevens uit de 'rode map'. Hierin zitten vragenlijsten die de patiënt invult, eventueel met hulp van familie, begeleiders of een SEH-verpleegkundige.

Deze vragenlijsten zijn de SF-12 (een score voor emotionele en lichamelijke gezondheidsbeleving), de Groningen Activity Restriction Score (GARS, een score voor functionele algemene dagelijkse levensverrichtingen), de eerder genoemde SNAQ-score en het Risicomodel Delirium.⁴⁻⁶

***De osteoporosescreening
was op beide afdelingen
beneden de maat***

Verder worden de mobiliteit, de woonsituatie en de geleverde mantelzorg van de patiënt vastgelegd. Daarnaast bevat de rode map het gestandaardiseerde preoperatieve consult interne geneeskunde en een opnamestatus met een invulvel voor anamnese, lichamelijk onderzoek, ASA-classificatie en doktersorders. Ook zitten er formulieren in voor de postoperatieve statusvoering.

Daardoor kan op uniforme wijze de anamnese, diagnostiek, communicatie en (peri) operatieve zorg worden uitgevoerd. Bovendien worden er gegevens verzameld om de kwaliteit te toetsen.

Osteoporose

Vóór de invoering van het zorgpad besteedde de afdeling Heelkunde meer aandacht aan het screenen op osteoporose dan Orthopedie. Op beide afdelingen was de osteoporosescreening echter beneden de maat. Momenteel wordt op de tweede dag na de operatie het routinebloedonderzoek (onder andere hemoglobinebepaling) uitgebreid met aanvragen die specifiek bij osteoporosescreening horen.

Bij ontslag uit het ziekenhuis wordt de post-operatieve afspraak bij de behandelend (orthopedisch) chirurg gecombineerd met een bezoek aan een nurse practitioner op het osteoporose- spreekuur. Afhankelijk van een vragenlijst en de laboratoriumuitslagen van het klinisch bloedonderzoek wordt een botdensitometrie uitgevoerd. Osteoporosescreening is hiermee een onderdeel van het proces geworden. Behalve dat er enkele wetenschappelijke studies zijn gestart, is er ook een follow-up van alle patiënten bijgehouden over 2008. Deze bestaat uit de klinische registratie van alle patiënten, een beoordeling van de mortaliteit 3 en 12 maanden na de operatie en een beschrijving van

de woonsituatie, de mobiliteit en de gezondheidsbeleving, vaak ingevuld met hulp van mantelzorgers.

Herstelunit

Aan de hand van de vragenlijsten krijgt men een goed beeld van pre- en postoperatieve woonsituatie van patiënten. Van degenen die naar de Herstelunit werden ontslagen, ging na gemiddeld 30 dagen, 90 procent terug naar de oude woonsituatie. Uiteindelijk is na drie maanden twee derde van de mensen die uit een zelfstandige woonsituatie of uit een verzorgingshuis kwamen, weer terug in de oude situatie.

Bij het evalueren van de pre- en postoperatieve mobiliteit vielen twee zaken op. Preoperatief liep 36 procent van de patiënten zonder hulpmiddel, drie maanden na de operatie kon slechts 11 procent dit. Verder was 4 procent preoperatief bedlegerig, na drie maanden is dit toegenomen tot 13 procent. Bij 106 (86%) patiënten was er sprake van homogene dataverzameling.

Verbetering

Vooraf het feit dat de Spoedeisende Hulp veel door jonge, vaak onervaren artsen wordt bemand, maakt het gebruik van een zorgpad met een standaardpatiëntendossier (waarin alle benodigde stappen staan aangeven en de benodigde papieren zitten) een nuttig hulpmiddel. Inventariseren van het risico op een delier en van de voedingstoestand, goede perioperatieve adviezen over (pijn)medicatie, vochtmanagement en poliklinische screening op osteoporose zijn standaard geworden. Daarnaast zijn door het invoeren van het zorgpad alle protocollen doorgelicht en uniform gemaakt. Daarom kunnen wij zeggen dat een zorgpad als 'Collum Care' een kwaliteitsverbetering is voor ons ziekenhuis, hoewel deze nieuwe opzet nog minder dan een jaar operationeel is. De behaalde verbeteringen zijn weergegeven in het *overzicht*.

Het geïntegreerde programma is verder een goede basis om de zorg verder te optimaliseren door middel van de diverse opgezette wetenschappelijke projecten en analyse van de prospectief verzamelde gegevens.

Verbeteringen door 'Collum Care'		
onderwerp	uitgangssituatie	huidige situatie
osteoporose	willekeurige screening	standaardscreening
trombose profylaxe	twee verschillende protocollen	één uniform protocol
voedingstoestand	geen standaardinventarisatie op SEH, aandacht protocol verschilt per verpleegafdeling	altijd SNAQscore bij opname
delierrisico	geen standaardrisico inschatting op SEH, aan dacht protocol verschilt per verpleegafdeling	standaarddelierscore bij opname
preoperatief consult	willekeurige aandachtspunten en adviezen	gestandaardiseerde aandachtspunten en adviezen
pijnstilling	artsafhankelijk terug houdendheid met NSAID's	NSAID's afhankelijk van nierfunctie

Samenvatting

De verschillende protocollen van de afdelingen Orthopedie en Heelkunde voor patiënten met een gebroken heup zijn tot één uniform multidisciplinair zorgpad samengevoegd.

Het zorgpad levert complete zorg door middel van integratie van eenvoudige interventies.

Dataverzameling levert in de nabije toekomst zeer relevante informatie over onder andere het postoperatieve beloop van woonsituatie en mobilisatiegraad van patiënten met een gebroken heup.

De literatuurlijst en een eerder MCartikel over heupfracturen vindt u onder dit artikel op www.medischcontact.nl.

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13

Experiences with a fracture clinic.

“De Delftse Fractuur- en Osteoporosepolikliniek.

Via casefinding naar lifestyle interventie:

meer aandacht voor medicatietrouw.”

Medisch Contact, 18 maart 2010, 65 nr. 11



beeld: Getty Images

Screening en tijdige behandeling voorkomen fractures

Osteoporose vroeger signaleren

*Peter van den Berg,
nurse practitioner fractures en
osteoporose*

*dr. Dave Schweitzer,
internistendocrinoloog; drs. Anne
Vochteloo, aios orthopedie; dr.
Peter Pilot, senior onderzoeker
orthopedie; drs. Dieu Donné
Niesten, orthopedisch chirurg;
dr. Mark de Vries, chirurg-
traumatoloog; dr. Maarten van der
Elst, chirurg-traumatoloog, allen
werkzaam bij de Reinier de Graaf
Groep in Delft.*

*Correspondentieadres:
pberg@rdgg.nl;
c.c.: redactie@medischcontact.nl*

*Geen belangenverstrengeling
gemeld.*

Met de juiste behandeling zijn veel osteoporotische fractures te voorkomen. Maar dan moeten de risicofactoren voor osteoporose wél in een vroeg stadium worden gesignaleerd. En de patiënt moet trouw zijn medicijnen slikken.

Osteoporotische fractures komen de laatste decennia steeds vaker voor. Ze zijn echter voor een groot deel te voorkomen door risicofactoren vroegtijdig te onderkennen en een passende behandeling te starten.

Zo'n behandeling zou volgens de CBO-consensus geschikt zijn voor patiënten van 50 jaar en ouder met een laagenergetische fractuur.¹ In 2005 werd, in navolging van

***De casefinding vindt
plaats in de gipskamer
en de traumapoli***

McLellan en Hegeman, in het Delftse Reinier de Graaf Gasthuis een werkgroep opgericht die een fractuur- en osteoporosepolikliniek moest opzetten.^{2 3} De werkgroep bestond uit een chirurg/traumatoloog, een orthopedisch chirurg, een endocrinoloog/internist, een nucleair geneeskundige, een fysiotherapeut en een gipsverbandmeester/nurse practitioner. De oprichting van de polikliniek werd mogelijk gemaakt door een eenmalige financiële injectie van de lokale zorgverzekeraar DSW.

De Delftse Fractuur en Osteoporose Polikliniek screent fractuurpatiënten van 50 jaar en ouder op risicofactoren voor osteoporose, verstrekt leefstijladviezen, schrijft medicatie voor (indien geïndiceerd), communiceert met de huisarts en ondersteunt de patiënt bij de medicatietrouw. Dit laatste is een belangrijk aspect; uit de literatuur is namelijk bekend dat de medicatietrouw een jaar na het voorschrijven van de medicatie sterk is afgenomen.⁴ Sommige rapportages melden al in het eerste jaar een medicatieontrouw van 50 procent; de groep die met medicatie was gestopt had een significant hogere fractuurkans.⁵

Risicopatiënt

In de periode van 1 juli 2007 tot 1 juli 2008 is in het Reinier de Graaf Gasthuis een groep mannen en vrouwen van 50 jaar en ouder gescreend, die met een fractuur op de Spoedeisende Hulp (SEH) waren terechtgekomen. Na de initiële fractuurbehandeling zijn de patiënten doorverwezen naar de Fractuur en Osteoporose Polikliniek. Daar werd aan de hand van de botdichtheid (gemeten met de DEXA-scan) het fractuurrisico vastgesteld op basis van de standaardindeling van de Wereldgezondheidsorganisatie WHO (T-score <-2,5 SD bij osteoporose, -2,5 tot -1,0 SD bij osteopenie). Bij een T-score van <-2,0 werd laboratoriumonderzoek verricht en werden röntgenfoto's van de wervelkolom gemaakt. In de optiek van de werkgroep is de volgende werkwijze efficiënt: het identificeren van de risicopatiënt, een zorgvuldige diagnostiek, de start van een effectieve behandeling en ondersteuning door goede communicatie met de patiënt en huisarts.⁶ Met alle betrokken partijen is afgesproken om gedurende het eerste jaar van de behandeling vier maal

telefonisch contact op te nemen met de patiënt. Dit contact is vooral gericht op de vraag naar medicatie- trouw en op ondersteuning van de patiënt om met de medicatie door te gaan.

De casefinding vindt bewust niet plaats op de SEH vanwege de hectiek, maar in de gipskamer en de traumapoliklinieken. Daar wordt het belang van screeningsonderzoek naar osteoporose uitgelegd en een combinatieafpraak gemaakt voor een DEXA-onderzoek en een gesprek over de uitslag met de nurse practitioner. Deze controleert met behulp van de SEH-gegevens de volledigheid van de inclusie en benadert de patiënt zo nodig schriftelijk voor een onderzoek op osteoporose. Fractuurbehandeling én onderzoek op osteoporose worden op dezelfde dag gedaan (*one-stop visiting*). Voor patiënten met een heupfractuur is de screening op osteoporose al geïntegreerd in een vast zorgpad.⁷

Om het polikliniekbezoek te stroomlijnen en de patiënt in staat te stellen alle informatie te overdenken, krijgt elke patiënt schriftelijke informatie en een vragenlijst mee naar huis. Met behulp van dit anamneseformulier volgt een soepel en vlot verlopend anamnesegebesprek en krijgt de patiënt een leefstijladvies op maat.

1. Fractuurrisico naar botmineraaldichtheid (BMD)			
	vrouw (n=507)	man (n=129)	totaal (n=636)
normale BMD T-score $\geq -1,0$	121 (23%)	39 (30%)	160 (25%)
osteopenie T-score $-1,0 \geq -2,4$	206 (41%)	49 (38%)	255 (40%)
osteoporose T-score $\leq -2,5$	180 (36%)	41 (32%)	221 (35%)

Het fractuurrisico van 636 patiënten gemeten aan de hand van de botmineraal- dichtheid (BMD). De T-score vergelijkt de gemeten BMD met de gemiddelde waarde bij een groep jonge, gezonde personen van hetzelfde geslacht.

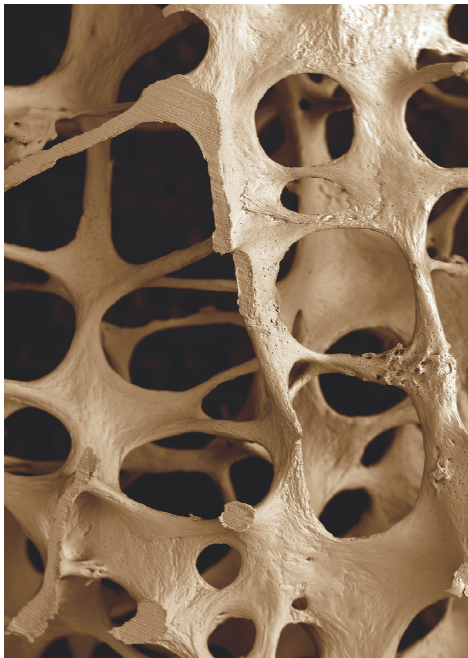
2. Verwijzingen na screening			
verwijzing	vrouw (n=180)	man (n=41)	totaal (n=221)
internist	52 (28%)	32 (78%)	84 (38%)
andere specialist	15 (10%)	3 (8%)	18 (8%)
huisarts	113 (62%)	6 (14%)	119 (54%)

Na screening in de osteoporosepolikliniek wordt ruim de helft van de patiënten doorverwezen naar de huisarts. De patiënten met een ernstigere vorm van osteoporose moeten door een internist worden onderzocht.

Leefstijladvies

In totaal werden 636 patiënten doorverwezen; zij kregen een eerste voorlichtingsgesprek met de nurse practitioner en werden geëvalueerd met behulp van een DEXA-analyse. Het betrof 129 mannen en 507 vrouwen met een gemiddelde leeftijd van 63 jaar (zie *tabel 1*). Patiënten met vormen van secundaire osteoporose werden doorverwezen naar de internist; sommige patiënten werden naar een andere specialist (terug)verwezen (zie *tabel 2*). Patiënten met een normale botdichtheid en patiënten met een verlaagde botmassa kregen een leefstijladvies met betrekking tot bewegen, het reduceren van het valrisico en de inname van calcium met de voeding. De overblijvende groep (221 patiënten) werd nader onderzocht.

Van deze patiënten werd de vitamine-D-spiegel onderzocht; van hen hadden 100 patiënten (45%) vitamine-D-insufficiëntie (<50 nmol/l) en 10 patiënten (0,5%) vitamine-D-deficiëntie (<20 nmol/l). Patiënten met een vitamine-D- spiegel lager dan 50 nmol/l adviseerden wij een vitamine-D-houdend preparaat. De huisartsen van deze patiënten ontvingen een schriftelijke rapportage van uitgevoerd onderzoek en de door ons ingestelde behandeling.



Een bot van een 89-jarige vrouw met osteoporose.

beeld: Corbis

Medicatierouw

Uiteindelijk ontdekten we met behulp van onze casefindingstrategie dat 119 patiënten (19%) met een fractuur een vorm van osteoporose hadden die door de huisarts verder kon worden behandeld. Deze patiënten kregen een bisfosfonaat als medicatie voorgeschreven en zo nodig calciumsuppletie. Voor deze groep werd de huisarts gevraagd de behandeling over te nemen. De medicatierouw werd echter gedurende het eerste jaar vanuit het ziekenhuis ondersteund door de nurse practitioner. Deze nam in het eerste jaar vier keer telefonisch contact op met alle patiënten die werden behandeld met bisfosfonaten. Alle gegevens werden systematisch toegevoegd aan een bewerkbaar databestand met eerder verkregen uitkomsten. De telefooncontacten, aan de hand van een vaste vragenlijst, vonden plaats na één, drie, zeven en twaalf maanden. De nurse practitioner vroeg in deze gesprekken naar eventueel opgetreden nieuwe fracturen, de valfrequentie, voeding en medicatierouw.

Bij het vierde telefonische contact, een jaar na de fractuur, bleek dat 93 patiënten (80%) medicatierouw waren gebleven. Er waren 3 patiënten overleden gedurende de follow-up, 9 patiënten hadden de bisfosfonaten gestaakt in overleg met de huisarts zonder terugkoppeling aan ons, 9 patiënten waren uit eigen beweging gestopt en 5 patiënten namen de bisfosfonaten niet meer volgens voorschrift in.

Bijwerkingen

Voornaamste beweegredenen die osteoporosepatiënten aanvoeren voor het stoppen met de onderhoudsmedicatie zijn enerzijds gebrek aan geloof in het effect, anderzijds de vrees voor bijwerkingen van de medicatie op korte en langere termijn.

De medicatie wordt ook gestopt in overleg met de huisarts en meestal vindt geen vervolgbehandeling plaats.^{8,9} Onderzoek onderstreept echter het belang van de mening van de behandelaar ten aanzien van onderhoudsmedicatie én de positieve communicatie hierover met de patiënt.¹⁰ Daar komt bij dat frequenter contact de therapietrouw bevordert.¹¹ Onze ervaring is dat de fractuur een centrale rol speelt in de beleving van patiënten. Velen vinden in deze traumatische ervaring een motivering om trouw de medicatie te blijven nemen. Om die reden propageren wij de medicatie zo spoedig mogelijk na een fractuur te starten. Een tweede argument voor een vlotte start van de behandeling is het gegeven dat de eerste recidiefractuur veelal zal optreden binnen één jaar na de eerste fractuur.¹²

Het eerste telefonische contact via de nurse practitioner concentreert zich op de eerste ervaringen van de patiënt met het gebruik van bisfosfonaten; in verband met de mogelijke bijwerkingen vindt dit contact al na vier weken plaats. Na de eerste doses ontstaan vaak griepachtige verschijnselen die vanzelf weer overgaan, maar die de medicatietrouw negatief kunnen beïnvloeden. Wij veronderstellen dat extra uitleg en aandacht dit effect zullen tegengaan.

De overige telefonische contacten zijn voornamelijk gericht op het bevorderen van medicatietrouw en het benadrukken van het belang van de leefstijl; ook wordt nagegaan of de huisarts herhalingsrecepten heeft voorgeschreven. Uit de gesprekken kwam naar voren dat algemene gezondheidsadviezen zonder uitgebreide toelichting tegenstrijdig kunnen overkomen.¹³

Motiverend

De telefonische contacten namen in ons onderzoek doorgaans 10 minuten per gesprek en verslaglegging in beslag. Dat resulteerde in $119 \times 10 \text{ minuten} \times 4 \text{ gesprekken} = 4760 \text{ minuten}$ (79,3 uur) op jaarbasis. Ons inziens een waardevolle tijdsinvestering indien men zich realiseert dat hieraan voorafgaand 636 patiënten werden gescreend. Per fractuur betekent dit 40 minuten, oftewel 8 minuten per gescreende patiënt.

Vier telefoontjes resulteerden in een medicatietrouw van 80 procent na een jaar

Financieel gezien is hiervoor echter vaak geen ruimte in de krappe intramurale budgettering van een ziekenhuis. Om kosten te besparen hebben wij daarom besloten de telefonische contacten voort te zetten met een lagere frequentie van drie keer in het eerste jaar. De ervaringen hiermee gaan we in de toekomst vergelijken met de hier gepresenteerde gegevens.

Casefinding door screening in de setting van een Fractuur en Osteoporose Polikliniek blijkt een goede strategie om patiënten met verhoogd osteoporoserisico op te sporen. Naast de 13 procent die naar de internist werd verwezen, kon bij 19 procent van de patiënten van 50 jaar en ouder (gemiddelde leeftijd 61 jaar) de diagnose osteoporose worden gesteld. De vier telefonische contacten in het eerste jaar werden door deze patiënten als motiverend ervaren en resulteerden in een medicatietrouw van 80 procent na één jaar. Deze doelmatigheidsslag vereist een goede organisatie maar betaalt zichzelf terug.

Samenvatting

De Delftse Fractuur en Osteoporose Polikliniek screent fractuurpatiënten van 50 jaar en ouder op risicofactoren, biedt leefstijladviezen, start medicatie en communiceert de interventies met de huisarts.

De patiënt krijgt telefonisch ondersteuning bij leefstijl(verandering) en medicatietrouw.

Deze contacten met een verpleegkundige ervaart de patiënt als motiverend, wat zich uit in een hoge medicatietrouw.

De literatuurlijst en MC- artikelen over osteoporose vindt u bij dit artikel op www.medischcontact.nl.



14

Cemented versus non-cemented hemiarthroplasty of the hip as a treatment for a displaced femoral neck fracture: design of a randomised controlled trial

Anne JH Vochteloo, DieuDonné Niesten, Roeland Riedijk, Willard J Rijnberg, Stefan BT Bolder,
Sander Koëter, Keetie Kremers-van de Hei, Taco Gosens and Peter Pilot

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Abstract

Background: A discussion is ongoing whether displaced femoral neck fractures in elderly patients should be treated with a non-cemented or a cemented hemiarthroplasty. A recent Cochrane analysis stresses the importance of further research into the relative merits of these techniques. We hypothesise that non-cemented hemiarthroplasty will result in at least the same technical-functional outcome and complication rate, with a shorter operation time.

Methods and design: A randomised controlled multicentre trial will be performed.

The study population consists of 200 patients of 70 years and older. Patients with a displaced femoral neck fracture will be allocated randomly to have a cemented or a non-cemented hemiarthroplasty. Data will be collected preoperatively, immediately postoperatively, and 6 weeks, 3 months and 1 year postoperatively.

The main outcome measures of this study are technical-functional results of the hemiarthroplasty, duration of surgery, complications, and mid-thigh pain. Secondary outcome measures are living conditions at final follow up, self-reported health-related quality of life, and radiological evaluation of the hemiarthroplasty.

Conclusion: A recent Cochrane analysis did not find arguments in favour of either non-cemented or cemented hemiarthroplasty. The forthcoming trial will compare treatment for a displaced femoral neck fracture by cemented versus non-cemented hemiarthroplasty. Our results will be published as soon as they become available.

Trial Registration: Trial Registration Number NTR1508

Background

Patients with a hip fracture form a heterogeneous group with a high mortality rate, frequently troubled with multiple and severe co-morbidities. They are usually frail and elderly, with more than 30% aged ≥ 85 years. In European series, hip fracture patients have a 30-day mortality of $>10\%$, and a 1-year mortality of 25–30%.[1] Despite the advances in surgical and anaesthetic techniques during the last 20 years there has been no decrease in mortality after surgical repair of hip fractures. [1]

The discussion about cemented or non-cemented hemiarthroplasty is similar to the discussion about cemented or cementless prostheses in primary hip arthroplasty. With respect to the latter, conflicting data are presented by the Swedish and Norwegian arthroplasty registers. [2,3] The general opinion is that cementless hip arthroplasties are more suitable for younger patients owing to the quality of their bone stock. In hemiarthroplasty for hip fracture surgery there are insufficient data from randomised trials to conclude on the superiority of either type of arthroplasty. Some authors found patients with cemented stems to have less pain and better mobility postoperatively than those with an non-cemented press fit.[4] Mid-thigh pain is frequently reported in primary cementless total hip arthroplasties. However, the reported incidence varies tremendously; D'Lima et al.[5] in a control-matched study reported 34% vs. 3%, while Gröbl et al.[6] in a non-controlled series reported only 3% for cementless primary total hip arthroplasties.

In cemented hemiarthroplasties polymethylmethacrylate bone cement is applied at the time of surgery, forming a solid bond between the prosthesis and the femoral bone; on the contrary, in cementless prosthesis the bonding between prosthesis and femur is dependent upon bony in-growth. Potential advantages of cementing are a less post-operative mid thigh pain, as the prosthesis is firmly fixed within the femur, and a reduced long-term revision rate from loosening of the prosthesis. Major side effects of cement are cardiac arrhythmias and cardiorespiratory collapse, which occasionally occur on application. These potentially fatal complications are caused either by embolism from marrow contents forced into the circulation or by a direct toxic effect of the cement. [7] Another major disadvantage of a cemented prosthesis is that revision arthroplasty will be more difficult.

The non-cemented hemiarthroplasty used in our study is the DB-10 (Biomet, Warsaw, USA), a straight collared stem designed to provide primary stability and to prevent migration. The primary stability of the stem, which has a narrow tip to guide the implant, is optimised by metaphyseal anchoring: intimate trabecular bone contact and optimised load transfer to the dynamic bone through to the posterolateral angle situated in the axis of the neck. Secondary stability (prevention of migration) is facilitated by optimizing bone in-growth surface through full hydroxyapatite coating on macro-structured titanium and grooves on A/P sides.

The cemented hemiarthroplasty used in our study is the Müller Straight Stem prosthesis (Zimmer, Warsaw, USA), developed with the advice of Professor M.E. Müller. It has now been in use reliably for many years; Ried et al. found a 15-year survival of 94%. [8] The fluted structure of the stem, with the two particularly marked longitudinal grooves AP in the stem axis, enables good cement adhesion. The small proximal collar serves to compress the cement, prevents the stem from sinking into the cement, and, together with the fine-blasted surface of the straight stem, achieves a stable anchorage of the implant.

Both prostheses have a unipolar head.

Methods and design

Study design

A single blinded randomised clinical multicentre trial will be conducted. Patients will be randomised to 2 groups of 100 in the operation theatre by a randomisation computer (IRIS®, SDS Medical, The Netherlands). The treatment will be either a cemented hemiarthroplasty or a non-cemented hemiarthroplasty. If complications occur during the procedure, the surgeon can change the procedure to ensure best medical practice.

We acknowledge the possibility that the patients might be able to tell which prosthesis they have received due to seeing their X ray during the outpatient clinic visits.

All patients with a displaced femoral neck fracture who are admitted to one of the participating hospitals and meet the inclusion criteria are asked to join the study. In case

of (mental) incompetence of the patient his/her legal representative is consulted to obtain informed consent.

The study design, procedures and informed consent are approved by the Medical Ethical Committee of South West Netherlands.

Trial number Netherlands Trial Registry NTR 1508, <http://www.trialregister.nl>

Study population

The study will be conducted at the Orthopaedic Departments of the Reinier de Graaf Gasthuis Delft, Ziekenhuis Rijnstate Alys Zorggroep Arnhem, Canisius Wilhelmina Ziekenhuis Nijmegen and Elisabeth Ziekenhuis Tilburg.

Authors PP and AV will be responsible for the data and safety monitoring.

Inclusion criteria: patients aged $\geq$ 70 years, with a displaced femoral neck fracture (Garden type III or IV) not older than 7 days are included.

Exclusion criteria: patients with a pathological fracture, a fracture older than 7 days or ASA-V classification are excluded.

Accrual is planned in the period from August 2008 to August 2009.

Intervention

Patients will be receive either a cemented hemiarthro-plasty, type Müller Straight Stem (Zimmer, Warsaw USA), or a non-cemented hemiarthroplasty, type DB-10 (Biomet, Warsaw USA). Every surgeon will use the same surgical approach for all implants – either straight lateral or posterolateral. The approach of choice is up to the surgeon's preference, as Parker's Cochrane analysis has shown that insufficient evidence is available for superiority of either approach. [9]

Anaesthesia, analgesia and postoperative physical therapy will be standardized in both groups.

Study variables

Preoperatively, social demographic data, the ASA classification, Groningen Activity Restriction Scale (GARS, from which the Parker mobility score can be derived) and the SF-12 are obtained from each patient. [10,12,13]

The main outcome measures of this study are the functional results, complication rate and duration of surgery of the hemiarthroplasty.

Primary outcome measures

- Duration of surgery is defined as skin-to-skin surgical time, measured in minutes.
- Complications, divided in major and minor complications, are recorded during the follow up period of 1 year. The complications are ranked in the modified Elixhauser mode, as described by Parvizi.[11]
- Functional outcome is measured by the Timed-Up-and-Go (TUG) score and the Groningen Activity Restriction Scale (GARS). [10,14]
- Postoperative mid-thigh pain is defined as pain explicit in the front and mid part of the femur, and scored on a 4-point ordinal scale (non/mild/moderate/severe).

Secondary outcome measures

Living conditions at final follow up are measured in percentage of pre-fracture situation.

- Self reported health-related quality of life is measured by the SF 12. [13]
- Standard radiological evaluation of hemiarthroplasty and cement positioning and adequate size of the hemiarthroplasty measured on plain AP and axial X-rays of the operated hip. Adequate AP positioning is defined as less than 10 degrees varus or valgus. Adequate axial positioning is defined as 0–15 degrees anteversion.

Follow up

The primary follow up for each patient will be 1 year. The first postoperative assessment will be in a clinical setting as the patient is still in the hospital. Assessments at 6, 12 and 52 weeks postoperatively will be made in the outpatient clinic, unless the patient is not able to visit the out-patient clinic; in that case questionnaires are mailed to the patient (possibly through contact with a relative) to obtain as much data as possible.

Determination of sample size

(a) Duration of surgery

It is expected that a cemented hemiarthroplasty on average will take 12 min longer than a non-cemented hemiarthroplasty. Taking into account an estimated standard deviation of 12 min, a 1-year mortality of 25% and 10% of patients being lost to follow up or providing insufficient data we need a minimum of 46 patients per group.

(b) Functional outcome

Only for patients who are admitted from their own homes or assisted living facilities, functional outcome is measured by the Timed-Up-and-Go (TUG) score and the Groningen Activity Restriction Scale, and mid-thigh pain a non-inferiority design is used. [10,14]

- TUG performed; Giving the fact that at discharge with a cut-off point of over 30 seconds is significantly associated with falls. Less than 24 seconds is considered good functioning and has hardly any chance to fall. 42 seconds is considered poor functioning with a considerable chance to fall. [14] About 30% of the patients have a poor score at discharge. About 70% of all patients are admitted from their own homes or assisted living facilities. If non-inferiority is considered for TUG, a worsening of score from 30 to 42 is considered clinically relevant, with a SD of 10 sec., giving 16 patients a group. Corrected for the percentage admitted from home or assisted living facility (70%) and the drop out of 35% gives 34 patients a group
- GARS: The GARS data for this group of patients are insufficient to make valid calculations of statistical power. While data for multiple sclerosis patients and healthy older patients are available, there are none for patients with a hip fracture. An estimate is made based on preliminary data from a prospective survey in progress. As soon as sufficient data from this survey are available a final power calculation for GARS will be done.

• Mid thigh pain

Rather varying figures about mid-tight pain are reported in literature. D'Lima [5] reported 40 vs. 3% whereas v/d Wal et al. [15] reported 20 vs. 12% in non-tight proximal fit prosthesis. Therefore the average values of these two studies are taken.

$$\pi_1 = 30\%, \pi_2 = 7.5\%, \pi = (30\% + 7.5\%) / 2 = 18.75\%$$

$$n_1 = n_2 \geq 21 * (0,1875 * (1 - 0,1875)) / (0,225)^2 = 63.2.$$

If the 25% 1-year mortality combined with expected 10% lost-to follow-up (or missing values) is taken into account this number is raised by 35%, then a total of 86 patients a group is needed. [16]

(c) Complications

The complication rate in this patient category is rather high, but heterogeneous. The rate of thromboembolic complications may depend on the type of intervention (cemented vs. non-cemented).

However, the incidence of deep vein thrombosis (DVT) and pulmonary embolism (PE) is such that an unachievable high number of patients is needed to acquire adequate power.

In conclusion, the total number of patients per group is set on 100, making a total of 200 patients is needed for this study.

Statistical analysis

Primary outcome measures

The differences in operation time, mid-thigh pain, complications and TUG test will be analyzed using a Student's t-test, setting the level of significance at $p < 0.05$.

Secondary outcome measures

We will use the chi-squared test or Fisher's exact test for the binary variables. In cases of paired binary data (out-come variables) we will use the McNemar test and a paired t-test for mean differences. In the case of a statistically significant association ($p < 0.05$), we will use a logistic regression to model the probability/odds of an outcome.

The variables obtained from the clinical evaluation will be tabulated and analysed as mean, standard deviation, minimum and maximum values. All analyses will be performed using SPSS software (SPSS Inc., Chicago, IL, USA).

Kaplan Meijer survival analysis will be done after final follow up, using failure (reoperation) and mortality as end-points.

Discussion

In the treatment of displaced femoral neck fractures with hemiarthroplasty in elderly patients the use of bone cement is a controversial topic. A cemented hemiarthroplasty has been used in the majority of cases in most countries, but the non-cemented prosthesis is gaining popularity. Parker et al. [1] concluded that there is only limited evidence from randomised studies that cementing prosthesis in place may reduce the amount of post-operative pain and may lead to improved mobility. Furthermore no study has adequately addressed long-term outcome measures concerning this topic.

Cementing has potential physiologically adverse side effects. The major side effects are cardiac arrhythmias and cardio-respiratory collapse, which occasionally occur upon application; these potentially fatal complications are caused either by embolism from marrow contents forced into the circulation or by a direct toxic effect of the cement. [7] Transesophageal echocardiography could be used to monitor emboli during surgery, but logistics prevent this in our centres, as most patients are operated outside regular working hours. Nevertheless, Pitto et al. [17] have already shown severe embolic events and intraoperative pulmonary impairment during fixation of the cemented femoral component in total hip arthroplasty, while fixation without cement clearly demonstrated a low risk of embolism. Clark et al. [18] found a transient but significant reduction in cardiac output and stroke volume for those receiving cement.

In non-cemented prostheses, bone quality is of importance; this is generally poor in elderly patients. LaPorte et al. [19] stated two relative contraindications for non-cemented total hip prosthesis: interference with bone in-growth and inability to achieve a congruent fit; both of these preclude establishment of rigid initial stability.

The purpose of this study is to compare treatment for displaced femoral neck fracture by cemented versus non-cemented hemiarthroplasty. We hypothesise that, relative to cemented hemiarthroplasty, non-cemented hemiarthroplasty will result in at least the same technical-functional outcome and complication rate, with a shorter operation time. The results of this study will be presented as soon as they become available.

Competing interests

Author PP has received fundings of both Biomet and Zimmer. However none of these were related to this project or used prosthesis’.

Authors’ contributions

PP and DN originated the idea for the study, led its design and will supervise the project. AV and PP participated in the design of the study and in developing the protocol. AV and PP will coordinate the trial and are responsible for data acquisition. WR, TG, SK, SB and RR provided extra protocol information in order to expand the original study design from single-centre to multi-centre. AV, TG, SK, RR and KK are responsible for data collection at their respective locations. All authors have read and corrected draft versions of the manuscript and have approved the final manuscript.

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The first interest in hip fracture patients was aroused during my two years of surgical training in Bronovo hospital, whilst collaborating with my colleagues Guus Haeseker and Boudewijn Borger van der Burg.

The Bronovo database was combined with the Delft one, which Peter Pilot and I built in 2007 to 2009. Peter was a very important motivator and supervisor in the first years of our project. The hip fracture project would never have started without his help and input.

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Curriculum Vitae

Anne Jochem Hendrik Vochteloo was born on November 5th 1977 in Ureterp (Opsterland), the Netherlands. In 1995, he graduated from the Gymnasium of the “Drachtster Lyceum” in Drachten. He studied Biofarmaceutical Sciences for one year and then switched to Medicine, both at Leiden University (1996).



During Medical School his love for orthopaedics was born, resulting in his first scientific publication with Rolf Bloem, his orthopaedic “godfather”.

In 2004, he started his training to become an orthopaedic surgeon at the Department of Surgery of Bronovo Hospital, The Hague (dr. A.B.B. van Rijn and dr. H.J. Smeets). From 2006 to 2010, his orthopaedic training was continued at Leiden University Medical Center (prof. dr. P.M. Rozing and prof. dr. R.G.H.H. Nelissen) and Reinier de Graaf Gasthuis, Delft. (dr. R.M.Bloem).

In Delft this thesis was born, inspired and supported by Peter Pilot. The databases were made and many hours of data collection followed.

In both Delft and Leiden Anne developed a special interest in disorders of the upper extremity and orthopaedic trauma.

A fellowship in Indonesia and a working visit in the St. Josef Hospital in Ghana during his training made him realize that the world was larger than Leiden and Fryslân.

Therefore, after finishing his training in 2010, he went to Cape Town, South Africa with the love of his life, Barbara. One of the best years in their lives so far followed. Two fellowships were conducted in the Cape: a shoulder and elbow fellowship (dr. Basil Vrettos and dr. Steve Roche, Life Orthopaedic Hospital Vincent Palotti and Groote Schuur Hospital) and one for orthopaedic trauma combined with hand and wrist surgery (Prof G.J. Vlok, Tygerberg Hospital). Many friends were made and the country was well explored. South Africa became a “home away from home”.

The year of 2012 was another special year: the author married Barbara and their wonderful son Ids was born. Furthermore, he became part of the team of consultant orthopaedic surgeons of “Orthopedisch Centrum Oost-Nederland” (OCON) in Hengelo as a specialist in upper extremity and orthopaedic trauma. Working in OCON and living in Twente are a great pleasure for the author and his family.

