Arch Orthop Trauma Surg (2017) 137:507–515
DOI 10.1007/s00402-017-2646-6

ORTHOPAEDIC SURGERY

Complications during hospitalization and risk factors in elderly patients with hip fracture following integrated orthogeriatric treatment

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Received: 19 October 2016 / Published online: 23 February 2017
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Abstract
Introduction This study aimed to evaluate the incidence of complications in elderly patients with a hip fracture following integrated orthogeriatric treatment. To discover factors that might be adjusted, in order to improve outcome in those patients, we examined the association between baseline patient characteristics and a complicated course.
Methods We included patients aged 70 years and older with a hip fracture, who were treated at the Centre for Geriatric Traumatology (CvGT) at Ziekenhuisgroep Twente (ZGT) Almelo, the Netherlands between April 2011 and October 2013. Data registration was carried out using the clinical pathways of the CvGT database. Based on the American Society of Anesthesiologists (ASA) score, patients were divided into high-risk (HR, ASA 3 ≥, $n=341$) and low-risk (LR, ASA 1–2, $n=111$) groups and compared on their recovery. Multivariate logistic regression was used to identify risk factors for a complicated course.
Results The analysis demonstrated that 49.6% ($n=224$) of the patients experienced a complicated course with an in-hospital mortality rate of 3.8% ($n=17$). In 57.5% ($n=196$) of the HR patients, a complicated course was seen compared to 25.2% ($n=28$) of the LR patients. The most common complications in both groups were the occurrence of delirium (HR 25.8% vs. LR 8.1%, $p \leq 0.001$), anemia (HR 19.4% vs. LR 6.3%, $p=0.001$), catheter-associated urinary tract infections (CAUTIs) (HR 10.6% vs. LR 7.2%, $p=0.301$) and pneumonia (HR 10.9% vs. LR 5.4%, $p=0.089$). Independent risk factors for a complicated course were increasing age (OR 1.04, 95% CI 1.01–1.07, $p=0.023$), delirium risk VMS Frailty score (OR 1.57, 95% CI 1.04–2.37, $p=0.031$) and ASA score ≥3 (OR 3.62, 95% CI 2.22–5.91, $p \leq 0.001$).
Conclusions After integrated orthogeriatric treatment, a complicated course was seen in 49.6% of the patients with a hip fracture. The in-hospital mortality rate was 3.8%. Important risk factors for a complicated course were increasing age, poor medical condition and delirium risk VMS Frailty score. Awareness of risk factors that affect the course during admission can be useful in optimizing care and outcomes. In the search for possible areas for improvement in care, targeted preventive measures to mitigate delirium, and healthcare-associated infections (HAIs), such as CAUTIs and pneumonia are important.

Keywords Learning healthcare system · Orthogeriatric care · Hip fracture · Adverse outcomes · ASA · Quality improvement

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Introduction

Due to the aging population, the number of hip fractures will increase because of the elevated risk of falling and osteoporosis [1, 2]. The consequences of a hip fracture are serious; an average of one in three patients dies within the first year of sustaining this fracture, and in more than half of patients, mobility is still limited after 1 year [3]. Age-related aspects such as comorbidity, polypharmacy, and frailty mean that management is complex. The risk that patients will develop adverse health outcomes is considerable and often associated with high treatment costs [4]. Striving for improvement in patient care and outcomes for the frail elderly, in 2008 the Centre for Geriatric Traumatology (CvGT) was founded, and was the first center in the Netherlands to implement the integrated orthogeriatric treatment model for elderly with a hip fracture [5]. Based on the principles of learning healthcare systems, from 2008 onward, the CvGT has been using data feedback for quality improvement in healthcare [6, 7]. One of the highlights of this treatment model is the proactive attitude on preventing patients from adverse events and premature death [8].

The ASA classification has been reported in the literature as a predictor for morbidity and mortality after hip fracture [9]. Despite orthogeriatric care, elderly patients with higher ASA scores suffer from complications. This study was conducted to evaluate the incidence of complications during admission in high-risk patients compared to low-risk patients (based on the difference in ASA score). To discover factors that might be adjusted to improve outcome in those patients, we examined the association between baseline patient characteristics and a complicated course.

Methods

Study design and patients

Between April 2011 and October 2013, patients aged 70 years or older with a hip fracture and treated with the integrated orthogeriatric treatment model were identified for inclusion in this naturalistic cohort study. Patients with a pathological or peri-prosthetic fracture ($n=9$), or those requiring a total hip replacement ($n=37$) with referral to the orthopedic services, were excluded. Informed consent was obtained from all individual participants (or a proxy when patients were cognitively impaired).

Setting

The integrated orthogeriatric treatment model is characterized by early geriatric co-management from admission to the Emergency Department (ED), by following clinical pathways and implementing a multidisciplinary approach. The treatment pathway is shown in Fig. 1.

The aim is to have patients admitted to the CvGT ward within 1 h of arrival at the hospital. One of the standardized procedures in the ED is blood testing. The results are used both by the geriatrician and the trauma surgeon for further treatment, e.g., causes of falls, deficiencies, malnutrition and osteoporosis.

In the ED, the geriatrician is called by the ED physician. Depending on the medical condition, he/she is visiting the patient in the ED or the nursing ward. For identifying geriatric conditions, a comprehensive geriatric assessment is performed to develop a coordinated treatment plan. The geriatrician visits the patients daily on the ward and gives recommendations to the nurse practitioner (NP) or physician assistant (PA) specialized in trauma surgery. The role of the NP or PA is to ensure that the process is adhered to and to act as the case manager for individual patients.

For purposes of fall prevention, medication is evaluated by the geriatrician. When the patient is recovered, orthostatic blood pressure is measured. If there were environmental safety hazards at home, the occupational therapist is consulted. Osteoporosis status is investigated, and treatment is started if necessary. A multidisciplinary meeting was held twice a week to discuss treatment goals, patient progress, and discharge plan. The aim was to have the patients ready for discharge within 5–7 days. Surgery follow-up appointments involved patients attending a multidisciplinary outpatient clinic, where they visited a trauma surgeon, physical therapist, and nurse, specialized in osteoporosis (osteo-physio-trauma outpatient clinic).

Data collection

Uniform data collection and recording of all patient data were achieved by standard evaluation, according to the clinical pathway for hip fracture patients. In accordance with international guidelines, recommendations and national quality indicators for the auditing of care [7, 10, 11], patient characteristics such as, age, gender and the ASA score were registered at the baseline examination [12]. This scoring system is a widely used grading system for the preoperative health of surgical patients, which is also used in our hospital. Patients were divided into two groups based on ASA score: those with ASA score 1–2 were defined as low risk (LR) and patients with ASA 3≥as high risk (HR). The Hospital Safety Management (VMS) Frailty score and its separate items (i.e., delirium, prior falls, physical limitations in activities of daily living and malnutrition) [13], and previously diagnosed dementia, by a geriatrician or neurologist, based on the DSM-IV

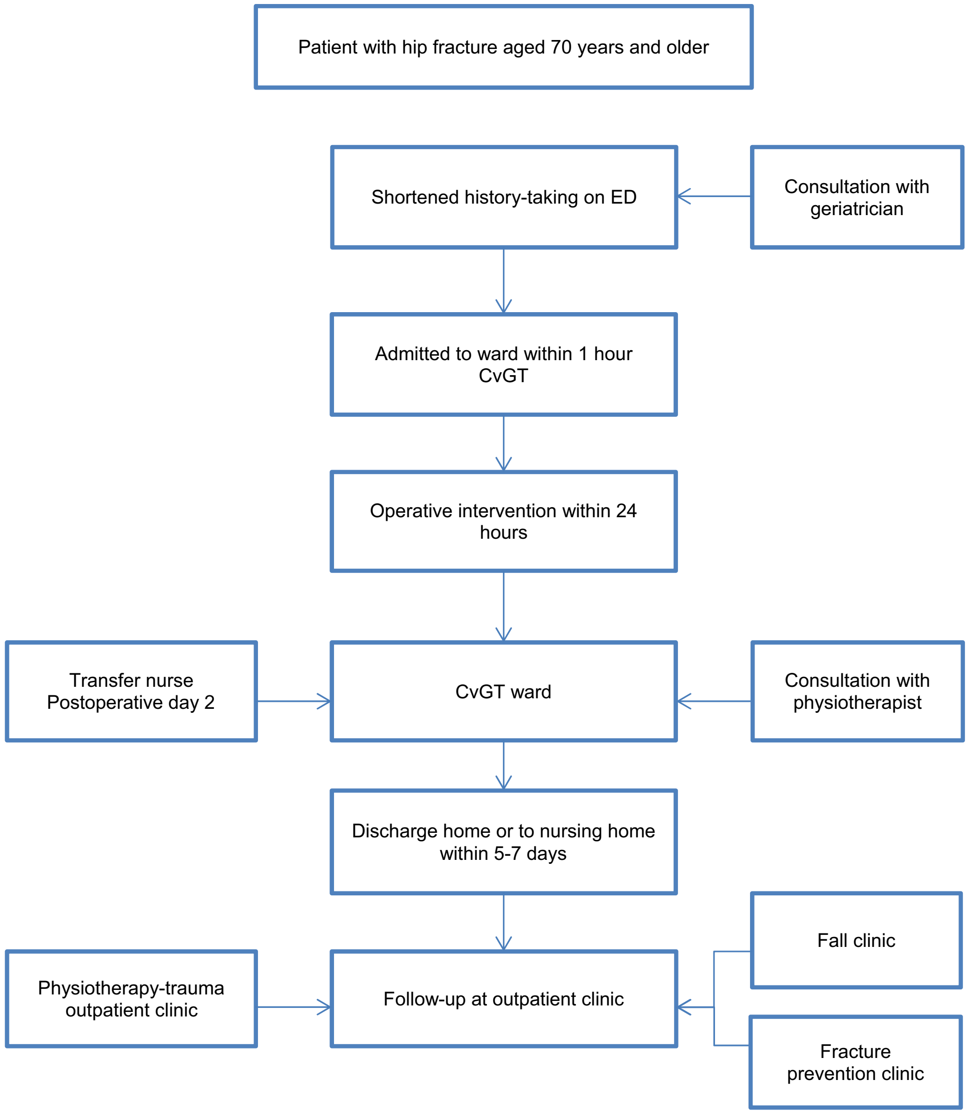

Fig. 1 Flowchart showing treatment process

criteria [14] were registered. Comorbidities were scored with the Charlson Comorbidity Index (CCI). The CCI categorizes and assigns weights and severities to 19 different comorbidities with a predicted 1-year mortality for CCI 0 of 12%, CCI 1–2 of 26%, CCI 3–4 of 52%, and CCI5 or more of 85% [15]. Furthermore, we registered type of fracture defined as, femoral neck or trochanteric fracture [16], history of osteoporosis, previous osteoporotic fracture (e.g., wrist, vertebral, or hip fracture), Barthel Index (BI) [17], Parker Mobility Score (PMS) [18] and place of residence. The length of stay in the ED in minutes, time from admission to hip surgery (i.e., within or after 24 h) and type of fracture treatment (conservative or surgical) were also registered. Patients with a very poor medical condition and a short life expectancy (less than 6 weeks) [16], bedridden patients or those who were confined to a wheelchair were treated conservatively. Length of hospital stay in days, BI and PMS scores on discharge, and readmissions 30 days after discharge, irrespective of specialty, were registered. Medical and surgical complications during admission were defined in advance [10, 19]. Delirium was based on the Delirium Observation Screening Scale with a score above 3. The geriatrician confirmed the diagnosis in the medical record. Anemia was defined as when a patient required a transfusion of red blood cells, based on transfusion guidelines (4-5-6 rules). Catheter-associated urinary tract infection (CAUTI) was diagnosed with testing the urine sediment and urine culture for the presence of positive WBC and nitrites and bacteria and cases were started with antibiotics. Pneumonia was defined as a clinical presentation; the diagnosis was confirmed with imaging and antibiotics were prescribed. Heart failure was defined as a clinical presentation and the diagnosis was confirmed on CXR, with the start of diuretics. Renal failure was detected with lab tests showing a significant decrease in glomerular filtration rate (GFR) compared to GFR at admission. In the hospital, mortality was confirmed by a physician, and time, date and cause of death were recorded in the electronic medical record. A new arrhythmia was diagnosed with an electrocardiogram and compared with the ECG at admission, with the need for treatment. Other, includes all complications that could not be categorized as any of the others: F.e.phlebitis, nervus femoralis paralysis, ileus, electrolyte abnormalities, falls, gastro intestinal bleeding, and pressure ulcers, which were classified as Grade 1–4 Braden scale. Acute urinary retention was defined as retention of 300 mL or more confirmed with a bladder scan. A cerebrovascular accident was defined, when acute hemiparesis or hemiplegia was present and a CT cerebrum was performed. Myocardial infarction (MI) was defined as a rise in biomarker (either troponin or creatine kinase MB fraction), in association with suggestive symptoms or electrocardiographic changes. Pulmonary embolism was confirmed with a CT-angiography. Deep venous thrombosis diagnosis was confirmed with echo duplex. Surgical complications were defined as dislocation of the prosthesis and failure of the osteosynthesis, with diagnosis confirmed on XR with need for revision. A surgical site infection (SSI) was defined as infection related to an operative procedure that occurred at or near the surgical incision within 30 days of the procedure, or within 60 days if prosthetic material was implanted at surgery. Incisional SSIs were further divided into superficial (i.e., those involving only the skin or subcutaneous tissue) or deep (i.e., those involving deep soft tissues of an incision, with need for revision). Bleeding/hemorrhage was defined as in need of re-operation.

Outcomes and statistical analyses

The primary outcome measure was the incidence of complications during admission in high-risk patients compared to low-risk patients (based on the difference in ASA score) and identification of associated risk factors for a complicated course. Descriptive results of the high-risk and the low-risk groups are presented. Normally distributed continuous variables were presented as mean with standard deviation (SD), non-normally distributed continuous variables were presented as median with interquartile range (IQR), and categorical variables were presented as a number with corresponding percentage. When variables were categorical, differences between the groups were analyzed using the Chi-square test or Fisher's exact test. When variables were continuous, Student's *t* test was used for two random samples in normally distributed variables, and Mann–Whitney *U* test was used in non-normally distributed variables. To identify a subset of independent variables that were associated with a complicated course, a univariate logistic regression was performed with: age, VMS Frailty items (i.e., delirium, physical limitations, malnutrition), CCI, fracture type, ASA score, and history of previous osteoporotic fracture. To prevent multicollinearity dementia, BI, PMS and pre-fracture living situation were excluded from the logistic regression analysis. The variables with a p value <0.15 were entered into a multivariate logistic regression model. Subsequently, variables with the highest p value were removed using backward stepwise regression, until the fit of the model significantly decreased (based on the likelihood ratio test). Statistical analysis was carried out using the Statistical Package for the Social Sciences version 22 (SPSS Inc., Chicago, US).

Results

Patient characteristics

Baseline characteristics of the study population are presented in Table 1. In comparison with low-risk (LR) patients, high-risk (HR) patients were older [mean (SD) age 83.7 ± 6.3 vs. 82.0 ± 6.7 years, $p = 0.016$], were more frail (median (IQR) VMS Frailty scores [2(2–3) vs. 2(1–2), $p \leq 0.001$], scored positive more often on the delirium risk VMS Frailty score (44.0% vs. 23.4%, $p \leq 0.001$), VMS Frailty score Physical limitations (72.6% vs. 41.4%, $p \leq 0.001$) and VMS Frailty score Malnutrition (20.9% vs. 12.0%, $p \leq 0.001$). Significant differences between the groups were observed in the proportion of HR patients suffering from dementia (25.2% vs. 4.5%, $p \leq 0.001$), the presence of more severe comorbidities (CCI 3 ≥ 36.9% vs. 7.2%, $p \leq 0.001$) and prior osteoporotic fractures (19.4% vs. 5.4%, $p \leq 0.001$). In the HR group, the pre-fracture median (IQR) BI was 14(10–19) and the PMS was 5(2–8) ($p \leq 0.001$) compared to 18(16–20) and 8(6–9), respectively, in the LR group. Before admission, compared with the low-risk group, significantly more HR patients lived in nursing homes (18.2% vs. 2.7%, $p \leq 0.001$).

Complications during admission

The analysis demonstrated that 49.6% ($n = 224$) of the patients experienced a complicated course with an in-hospital mortality rate of 3.8% ($n = 17$). Compared to 25.2% ($n = 28$) of the LR patients, a complicated course was found in 57.5% ($n = 196$) of the HR patients ($p \leq 0.001$) (Table 2). A detailed analysis of complications revealed that in HR patients, a total of 365 complications were diagnosed, and of those, 95.1% ($n = 347$) were medical complications and 4.9% ($n = 18$) were surgical complications, respectively. In the LR group, 35 complications were diagnosed, mainly medical (94.2%, $n = 33$). The most common complications in both groups were the occurrence of delirium (HR 25.8% vs. LR 8.1%, $p \leq 0.001$),

Table 1 Baseline patient characteristics and outcome measures

	Cohort $n = 452$	High risk[a] $n = 341$	Low risk[b] $n = 111$	*p* value
Age, years: mean (SD)	83.2 (6.4)	83.7 (6.3)	82.0 (6.7)	0.016
Female gender: *n* (%)	355 (75.7)	259 (76.0)	83 (74.8)	0.802
VMS-Frailty item: *n* (%)				
Delirium before admission	175 (38.9)	149 (44.0)	26 (23.4)	<0.001
Prior falls	451 (99.9)	340 (99.7)	111(100.0)	[c]
Physical limitations	292 (64.9)	246 (72.6)	46 (41.4)	<0.001
Malnutrition	76 (16.8)	71 (20.9)	22 (12.0)	<0.001
VMS-Frailty score: median (IQR)	2 (1–3)	2 (2–3)	2 (1–2)	<0.001
Dementia: *n* (%)	91 (20.1)	86 (25.2)	5 (4.5)	<0.001
Charlson Comorbidity Index: categories: *n* (%)				<0.001
0	109 (24.1)	37 (10.9)	72 (64.9)	
1–2	209 (46.3)	178 (52.2)	31 (27.9)	
3–4	105 (23.2)	97 (28.4)	8 (7.2)	
5 or more	29 (6.4)	29 (8.5)	0	
Fracture type: *n* (%)				0.071
Fracture of femoral neck	231 (51.1)	166 (48.7)	65 (58.6)	
Intertrochanteric fracture	221 (48.9)	175 (51.3)	46 (41.4)	
Osteoporosis: *n* (%)	54 (11.9)	45 (13.2)	9 (8.1)	0.151
Prior osteoporotic fracture: *n* (%)	72 (16.0)	66 (19.4)	6 (5.4)	<0.001
Barthel Index preoperatively: median (IQR)	16 (12–20)	14(10–19)	18(16–20)	<0.001
Parker Mobility Score preoperatively: median (IQR)	6 (3–9)	5(2–8)	8(6–9)	<0.001
Pre-fracture living: *n* (%)				<0.001
Independently evt. with home are service	328 (72.6)	224 (65.7)	104 (93.7)	
Care home/assisted living	59 (13.1)	55 (16.1)	4 (3.6)	
Institutionalized in nursing home	65 (14.3)	62 (18.2)	3 (2.7)	
Length of stay on ED in minutes: mean (SD)	102 (51)	102 (52)	105 (50)	0.501
Time to surgery >24 h: *n* (%)	101 (22.7)	83 (24.9)	18 (16.2)	0.058
Treatment: *n* (%)				0.209
Conservative	8 (1.8)	8 (2.3)	0	
Surgical	444 (98.2)	333 (97.7)	111 (100.0)	
Total length of hospital stay: mean (SD)	9.8 (8.4)	10.2 (8.8)	8.7 (6.9)	0.075
Barthel Index on discharge median (IQR)	10 (7–13)	9 (6–12)	13 (11–16)	<0.001
Parker Mobility Score on discharge: median (IQR)	2 (1–3)	1 (1–3)	3 (2–5)	<0.001
Discharge destination: *n* (%)				<0.001
Home evt with home care service	81 (17.9)	36 (10.5)	45 (40.5)	
Care home/assisted living	53 (11.7)	45 (13.2)	8 (7.2)	
Nursing home rehabilitation	233 (51.5)	177 (51.9)	56 (50.5)	
Long-term care nursing home	80 (17.7)	78 (22.9)	2 (1.8)	
Hospice	5 (1.1)	5 (1.5)	0	
Readmission within 30 days after discharge irrespective specialty; *n* (%)	7 (1.5)	5 (1.5)	2 (1.8)	0.682

ASA American Society of Anesthesiologists Physical Status Classification System, *IQR* interquartile range, *SD* standard deviation, *VMS* Hospital Safety Management Frailty scoring system

[a]High risk: patients with ASA ≥3

[b]Low risk: patients with ASA 1–2

[c]No statistics are computed because Prior Falls is a constant

Table 2 Complications during admission

	Total group $n=452$	High risk[a] $n=341$	Low risk[b] $n=111$	p value
Patients with a complicated course: n (%)	224 (49.6)	196 (57.5)	28 (25.2)	< 0.001
Medical complications: n (%)				
Delirium	97 (21.5)	88 (25.8)	9 (8.1)	< 0.001
Anemia	73 (16.2)	66 (19.4)	7 (6.3)	0.001
Catheter-associated urinary tract infection	44 (9.7)	36 (10.6)	8 (7.2)	0.301
Pneumoniae	43 (9.5)	37 (10.9)	6 (5.4)	0.089
Others[c]	32 (7.1)	31 (9.1)	1 (0.9)	0.003
Arrhythmia	20 (4.4)	19 (5.6)	1 (5.0)	0.035
Heart failure	29 (6.4)	28 (8.2)	1 (0.9)	0.006
Renal failure	19 (4.2)	19 (5.6)	0	0.006
In-hospital mortality	17 (3.8)	17 (5.0)	0	0.017
Cerebrovascular accident	2 (0.4)	2 (0.6)	0	1.000
Myocardial infarction	3 (0.7)	3 (0.9)	0	1.000
Pulmonary embolism	1 (0.2)	1 (0.3)	0	1.000
Surgical complications: n (%)				
Wound infection				0.755
Superficial	15 (3.3)	14 (5.3)	1 (0.9)	
Deep	2 (0.4)	2 (1)	0	
Dislocation implant	3 (0.7)	2 (0.6)	1 (0.9)	0.572

[a]High risk: patients with ASA ≥3

[b]Low risk: patients with ASA 1–2

[c]F.e. gastrointestinal bleeding, Ogilvie ileus, fall with olecranon fracture, fall with contralateral femoral neck fracture, n.femoralis lesion, phlebitis, electrolyte disbalances, pressure ulcers, urinary retention. Not observered were deep venous trombosis, peri-prothetic fractures, bleeding/hemorrhage with need for re-operation

anemia (HR 19.4% vs. LR 6.3%, $p=0.001$), catheter-associated urinary tract infections (CAUTIs) (HR 10.6% vs. LR 7.2%, $p=0.301$) and pneumonia (HR 10.9% vs. LR 5.4%, $p=0.089$). Compared to no deceased patients in the LR group, the in-hospital mortality rate in the HR group was 5.0% ($n=17$).

Risk factors of a complicated course

In the univariate logistic analysis, age, ASA score, the VMS Frailty items: Delirium, Physical limitations and malnutrition, CCI, history of previous osteoporotic fracture and fracture type were significantly related to a complicated course. Multivariate regression analyses revealed that increasing age (OR 1.04, 95% CI 1.01–1.07, $p=0.023$), delirium risk VMS Frailty score (OR 1.57, 95% CI 1.04–2.37, $p=0.031$) and ASA score ≥3 (OR 3.62, 95% CI 2.22–5.91, $p \leq 0.001$) were independent risk factors for a complicated course during admission, following hip fracture (Table 3). Nagelkerke R^2 was 13.8% for this model.

Treatment process

Treatment details for both patient groups are presented in Table 1. Compared to no patients in the LR group ($p=0.209$), in the HR group 2.3% ($n=8$) of the patients were treated conservatively. A borderline significant difference was found in time to surgery (surgery scheduled after 24 h from admission HR 24.9% vs. 16.2%, $p=0.058$). Compared to 8.7 (6.9) days in the LR group, patients from the HR group were discharged after a mean (SD) length of hospital stay of 10.2 (8.8) days ($p=0.075$). In both groups, almost half of the patients needed geriatric rehabilitation. Compared to 10.6% ($n=36$) in the HR group, in the LR group 40.5% ($n=45$) of the patients could be discharged to home ($p \leq 0.001$). Due to severe dementia, 16 HR patients were discharged to a long-term care nursing home.

Discussion

In the present study, a complicated course was found in 49.6% of the patients with a hip fracture and the in-hospital

Table 3 Risk factors for a complicated course during admission following hip fracture

	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p* value	OR	95% CI	*p* value
Age in years: mean (SD)	1.05	1.02–1.08	0.001	1.04	1.01–1.07	0.023
ASA score[a] ≥ 3	4.01	2.48–6.47	<0.001	3.62	2.22–5.91	<0.001
VMS Frailty delirium[b]	2.04	1.39–3.01	<0.001	1.57	1.04–2.37	0.031
VMS Frailty physical limitations[c]	2.09	1.41–3.11	<0.001			
VMS Frailty malnutrition[d]	1.69	1.02–2.79	0.041			
CCI 1–2[e]	1.78	1.10–2.85	0.018			
CCI 3–4[e]	2.05	1.19–3.54	0.010			
CCI ≥ 5[e]	4.53	1.84–11.17	0.001			
Previous osteoporotic fracture[f]	1.88	1.12–3.16	0.017			
Type of fracture[g]	1.45	1.00–2.10	0.049			

[a]reference cat. ASA 1–2

[b]not frail on VMS risk of delirium

[c]not frail on VMS physical limitations

[d]not frail on VMS malnutrition

[e]CCI 0

[f]no history of a previous osteoporotic fracture

[g]femoral neck fracture

mortality rate was 3.8%. Patients with ASA score ≥3 developed significantly more complications than those with an ASA score of 1–2. The most common complications in both groups were the occurrence of delirium, anemia, CAUTIs, and pneumonia. Important risk factors for a complicated course during admission were increasing age, poor medical condition and delirium risk VMS Frailty score.

Despite a proactive attitude in the orthogeriatric treatment model, patients with ASA score ≥3 suffered from more complications, and early identification of high-risk patients is of utmost importance. The ASA score is a common standard measure that is often used before every type of operation. This score rapidly identifies high-risk patients, by accounting for patient comorbidities and the medical stability of those comorbidities [12]. ASA score is also a well-recognized predictor of hip fracture mortality and adverse clinical outcomes [20]. The findings of this study support the assumption that not only ASA score but also increasing age and delirium risk VMS Frailty score are underlying factors that influence complication rates.

The international literature deems early preoperative identification of frailty increasingly important for surgical procedures [20]. Throughout the world, a number of measuring instruments are used for the prognostic scoring of elderly patients at risk for adverse outcomes [21–23]. In Dutch hospitals, frailty is measured with the Safety Management scoring system for the Vulnerable Elderly (VMS) [13]. However, knowing risk factors is not the same as having an instrument that is sensitive and specific enough to be useful in clinical practice for stratifying patients. Current models, such as the VMS Frailty score, are able to predict some of the variance in outcome on a group level; however, these models are not good enough for clinical decisions on an individual level.

Evaluating healthcare performance strongly depends on the availability and quality of data feedback [6]. Previous studies have indicated that the integrated orthogeriatric approach leads to a decrease in complications and in-hospital mortality [24, 25]. As the number of studies with a standard set of outcome parameters is still very limited, it is currently not possible to draw firm conclusions based on our study results in an integrated orthogeriatric treatment model [25]. When we compare our outcomes to those from a historical control group treated with usual care in our hospital, the results indicate a significant decrease in the complication rate and in-hospital mortality [5].

In search for possible areas of improvement in care at the Centre, targeted preventive measures to mitigate delirium and healthcare-associated infections (HAIs) such as CAUTIs and pneumonia are important. Providing high-quality care is carefully based on evidence with regard to patient safety and experience [7, 26–30]. The European Centre for

Disease Prevention and Control (ECDC) has stated that at least 20% of HAIs are preventable [31]. When reducing CAUTIs, we also expect a decrease in delirium, because urinary catheters and infections are both precipitating factors for delirium [27]. There could be a prominent role for nurse leadership in these quality improvement trajectories [32].

Finally, it should be noted that integrated orthogeriatric treatment of elderly patients with hip fracture should be standard because of their multidimensional needs. Especially for patients with ASA ≥3, it is of vital importance to be aware of their risk of adverse events and poor outcomes. In clinical practice, this evidence indicates that surgeons should be highly aware of the risks of a complicated course and early mortality, while treating elderly patients with hip fracture, which also indicates tailored care. Integrated care is unlikely to be harmful for anyone; in future research, we have to determine the efficacy of a combined triage system with an integrated care pathway. Our data could give added dimensions to resource efficiencies and support process redesigning.

We are learning in small steps adapted to local performance. Despite differences in healthcare systems, we would like to use our experiences with, and results from, the integrated orthogeriatric treatment model, for benchmarking with other hospitals, and for national and international research on long-term effectiveness.

Strengths and weaknesses

There are some limitations to the present study. The study was set up to evaluate technical aspects of care, and as such, quality of life and the patients' perspective were not investigated. These characteristics should be part of future studies. Due to the inclusion criteria there is selection bias, because the fittest patients were treated with a total hip prosthesis and were excluded in this series. Overestimating the results would seem unlikely. One strength of this study is that it is the first study in the Netherlands to describe the course of elderly patients with a hip fracture, who were also treated with integrated orthogeriatric care. Additionally, use has been made of a specifically defined measurement instruments, and outcome measures for the treatment of a representative frail population. Thus, both can be used for benchmarking and national and international research.

Conclusion

After integrated orthogeriatric treatment, a complicated course was seen in 49.6% of the patients with a hip fracture, and the in-hospital mortality rate was 3.8%. Important risk factors for a complicated course were increasing age, poor medical condition and delirium risk VMS Frailty score. Awareness of risk factors that affect the course during hospital admission can be useful in optimizing care and outcomes. In search of possible areas for improvement in care, targeted preventive measures to mitigate delirium, and healthcare-associated infections (HAIs), such as CAUTIs and pneumonia are important.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Funding There is no funding source.

Ethical approval The Medical Ethical Committee of Medisch Spectrum Twente (MST) at Enschede, the Netherlands declared that this study does not meet the criteria necessary for an assessment by a medical ethical committee according to Dutch law. This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants (or patient proxy) included in the study.

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