

Delirium After Surgery for Proximal Femoral Fractures in the Frail Elderly Patient: Risk Factors and Clinical Outcomes

Eveline de Haan ^{1,2}, Veronique AJIM van Rijckevorsel ¹, Pepijn Bod¹, Gert R Roukema ¹, Louis de Jong ¹

On behalf of Dutch Hip Fracture Registry Collaboration (DHFR)

¹Surgery Department, Maasstad Hospital, Rotterdam, the Netherlands; ²Surgery Department, Franciscus Hospital, Rotterdam, the Netherlands

Correspondence: Eveline de Haan, Tel +31654922535, Email e.eveline.de.haan@gmail.com

Purpose: The primary aim of this study was to identify risk factors for delirium after hip fracture surgery. The secondary purpose of this study was to verify peri-operative clinical outcomes, adverse events and mortality rates in delirium patients after hip fracture surgery.

Patients and Methods: A prospective hip fracture database was used to obtain data. In total, 2051 patients older than 70 years undergoing a hip fracture surgery between 01–01-2018 and 01–01-2021 were included. A delirium was diagnosed by a geriatrician based on the DSM-V criteria.

Results: The results showed that 16% developed a delirium during hospital admission. Multivariable analysis showed that male gender (OR: 1.99, $p<0.001$), age (OR: 1.06, $p<0.001$), dementia (OR: 1.66, $p=0.001$), Parkinson's disease (OR: 2.32, $p=0.001$), Δ haemoglobin loss (OR: 1.19, $p=0.022$), pneumonia (OR: 3.86, $p<0.001$), urinary tract infection (UTI) (OR: 1.97, $p=0.001$) and wound infection (OR: 3.02, $p=0.007$) were significant independent prognostic risk factors for the development of a delirium after hip surgery. The median length in-hospital stay was longer in patients with a delirium (9 days) vs patients without a delirium (6 days) ($p<0.001$). The 30-day mortality was 7% (with delirium 16% vs with no delirium 6% ($p<0.001$)).

Conclusion: Significant independent prognostic factors associated with delirium after hip surgery were male gender, age, dementia, Parkinson's disease, Δ haemoglobin loss, pneumonia, UTI and wound infection.

Keywords: geriatric patients, hip fractures, delirium, risk factors, clinical outcomes

Introduction

In 2050, the population aged over 70 is expected to be doubled due to an increasing life expectancy.¹ In geriatric patients, falling incidents are frequently causing hip fractures.² During admission for a hip fracture, delirium is the most frequent complication with incidence rates between 19% and 39%.^{3–13} Delirium during admission is associated with an increased level of impaired cognitive and less functional recovery, with an extended admission duration, higher treatment costs and increased mortality rates.^{4,5,12,14–16} To enable preventive measures against delirium, determination of risk factors for delirium during hip fracture treatment is needed. Previous literature report risk factors such as age, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, cognitive impairment, Parkinson's disease, poly-pharmacy, living in an institution and acute admission.^{3,6,7,9,11,17–20} Previous research has been based on relatively small populations. Furthermore, a limited number of baseline and perioperative factors were analyzed in preceding articles.

The primary aim of this study was to identify new risk factors and validate earlier reported risk factors for delirium after hip fracture surgery. Furthermore, this study aimed to verify peri-operative clinical outcomes, adverse events and mortality rates in delirium patients after hip fracture surgery.

Patients and Methods

The STROBE guidelines were used to ensure the reporting of this study.

Study Design and Patient Selection

Baseline characteristics and clinical outcomes were retrospectively acquired from a prospective registry database from two level II trauma teaching hospitals in the Netherlands. The database is a hospital initiative in which all hip fractures from the two hospitals were added to collect data to improve hip fracture care. Patients who underwent surgical treatment for proximal femoral fractures (ie, femoral neck fracture, trochanteric fracture or sub-trochanteric fracture) between 01–01–2018 and 01–01–2021 were screened for eligibility. Patients older than 70 years receiving hip hemiarthroplasty, total hip arthroplasty, cannulated screw fixation, dynamic hip screw, femoral neck system and gamma-nail were included in the study (n=2051) (Figure 1). Follow-up duration was at least 3 months, in which patients were approached by phone or were seen at the outpatient clinic. All operations were performed in a laminar flow theater. Usual antibiotic prophylaxis, 1–3g cefazolin (Kefzol), was given prior to surgery.

Risk Factors for Delirium

Baseline characteristics of all included patients were collected to evaluate the risk factors for delirium after hip fracture surgery. Information about the living situation prior to hospital admission was obtained. The nutritional status was expressed in BMI and Short Nutritional Assessment Questionnaire for Residential Care (SNAQ) score. The Katz Index of Independence in activities of daily living (KATZ-ALD) was used as measurement to define the functional status of a patient. The Nottingham hip fracture score (NHFS) and the Charlson Comorbidity Index (CCI) were used as frailty prediction scores, in which patient's comorbidities and general status are combined.^{21–23}

Perioperative Risk Factors

We selected perioperative variables described in previous literature as risk factors for the development of delirium after hip fracture surgery.^{3,6,7,9,11,17–20} Risk factors were time to surgery, moment of the week (week or weekend), moment of the day (day or nighttime), duration of the surgery, estimated blood loss, complications and reoperations. The type of anesthesia (general or local) and the ASA score were also collected.

Delirium

Patients were admitted to the geriatric trauma unit (GTU) or the orthopedic trauma ward. Prior to surgery, the geriatrician was consulted as usual care for all patients with a hip fracture. Patients with dementia and patients with a high suspicion of development of a delirium by the geriatrician were admitted at the GTU. In general, frail elderly patients will be

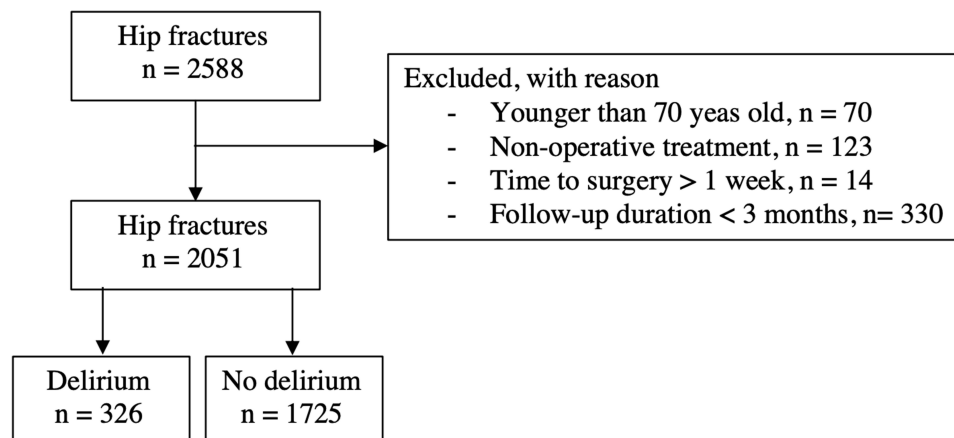


Figure 1 Flow chart of included patients.

admitted to the GTU because of a higher a priori chance on delirium, compared to cognitive and functional “healthy” patients who were admitted to the orthopedic trauma ward.

The Delirium Observation Screening Scale (DOSS) was used to screen patients for delirium, which was scored by trained nurses. Three or more points on the DOSS were considered as highly indicative of delirium. The geriatrician confirmed the diagnosis delirium based on the *DSM-V*.

Clinical Outcomes, Adverse Events and Mortality

The secondary aim of this study was to verify the effect of delirium on several peri-operative clinical outcomes, complications, the length of in-hospital stay, and mortality rates (30 days, 1 year).

Statistical Analysis

Categorical variables are presented as frequencies and percentages. Continuous variables are presented as mean (\pm SD) in case of a normal distribution or as median (IQR) in case of non-normal distribution. Associations between potential risk factors and the primary outcome delirium were analyzed by univariable logistic regression. To analyze the association with delirium, significant associations observed in univariable analysis and significant variables reported in previous literature were included in the multivariable model. Fixed variables in the multivariable model were CCI and type of admission ward (GTU or orthopedic trauma ward). Subsequently, backward elimination was performed until all remaining variables reached a P-value <0.10 . Stata version 14.0 was used to perform statistical analyses (StataCorp, College Station, TX, USA). All statistical tests were two-sided with a significance level of $P<0.05$. Mortality rates were estimated and displayed using the Kaplan–Meier estimator.

Ethics

The local ethics committee approved the study protocol (L2017044, Toetsingscommissie Wetenschappelijk Onderzoek Rotterdam (TWOR), Rotterdam). The local ethics committee established that patients consent to review their medical records was not required because of no change in standard practice of care and the high percentage of cognitive dysfunction. Patient data were stored anonymously. All the protocols were performed in compliance with the Declaration of Helsinki. For this study, no external funding was used.

Results

Risk and Prognostic Baseline Risk Factors

In total, 2051 patients were analysed of which 326 patients (16%) developed a delirium during hospital admission. In [Table 1](#), the results of the univariable analysis of the risk and prognostic baseline factors are presented. The risk at the development of a delirium is significantly increased by the gender male (OR: 1.66, 1.30–2.11, $p<0.001$), age (85 vs 79 years, OR: 1.07, 1.05–1.09, $p<0.001$), nursing home (27% vs 18%, OR: 1.68, 1.27–2.22, $p<0.001$), use of a walking aids (OR: 1.97, 1.55–2.51, $p<0.001$), SNAQ score ≥ 3 (20% vs 15%, OR: 1.48, 1.07–2.03, $p=0.016$), higher KATZ-ADL score (2 vs 0, OR: 1.21, 1.15–1.27, $p<0.001$), higher NHFS (5 vs 4, OR: 1.51, 1.39–1.65, $p<0.001$), higher CCI (5.4 vs 5.7, OR: 1.21, 1.13–1.28, $p<0.001$), ASA score 3 and 4 (OR: 2.21, 1.65–2.96, $p<0.001$), medical history of cardiovascular disease (69% vs 60%, OR: 1.47, 1.14–1.89, $p=0.003$), dementia (35% vs 18%, OR: 2.35, 1.81–3.04, $p<0.001$), myocardial infarction (12% vs 8%, OR: 1.52, 1.04–2.22, $p=0.032$), Parkinson’s disease (10% vs 4%, OR: 2.69, 1.74–4.18, $p<0.001$), transient ischemic attack (TIA) (12% vs 7%, OR: 1.84, 1.26–2.68, $p=0.002$), decreased glomerular filtration rate (GFR) (61 vs 71, OR: 0.99, 0.98–0.99, $p<0.001$), decreased haemoglobin (Hb) level (7.7 vs 7.9, OR: 0.87, 0.78–0.98, $p=0.019$) and polypharmacy (>4 medications) (65% vs 54%, OR: 1.56, 1.22–1.99, $p<0.001$).

Risk and Prognostic Perioperative Risk Factors

Results of the univariable analysis of the risk and prognostic perioperative factors are presented in [Table 2](#). The factors that significantly increase the risk of delirium are: time to surgery ≥ 48 hours (OR: 1.80, 1.12–2.90, $p=0.016$), receiving a prosthesis for a femoral neck fracture (OR: 1.38, 1.08–1.77, $p=0.011$), perioperative Hb loss (median 1.6mmol/L vs 1.2mmol/L, OR: 1.37,

Table 1 Univariable Analyses of Risk and Prognostic Baseline Factors

Variable	All Patients (2051) n	Delirium (326) n (%)	No Delirium (1725) n (%)	Odds Ratio (95% CI)	P-value
Male gender	656 (32)	136 (42)	520 (30)	1.66 (1.30–2.11)	<0.001
Age (mean \pm SD)	80 \pm 10	85 \pm 7	79 \pm 11	1.07 (1.05–1.09)	<0.001
Residential status					
Home (reference)	1479 (72)	209 (64)	1270 (74)	-	-
Semi-independent nursing home	166 (8)	29 (9)	137 (8)	1.29 (0.94–1.97)	0.247
Nursing home	406 (20)	88 (27)	318 (18)	1.68 (1.27–2.22)	<0.001
Walking aids					
None (reference)	1176 (57)	140 (43)	1036 (60)	-	-
Rollator	708 (35)	157 (48)	551 (32)	1.97 (1.55–2.51)	<0.001
Wheelchair/ mobility scooter	45 (2)	5 (1)	40 (2)	0.87 (0.34–2.22)	0.763
No functional mobility	7 (1)	1 (1)	6 (1)	1.15 (0.14–9.64)	0.895
Missing	115 (5)	23 (7)	92 (5)		
Fracture type					
FNF (reference)	1183 (58)	199 (61)	984 (57)	-	-
Trochanteric fracture	868 (42)	127 (39)	741 (43)	0.85 (0.67–1.08)	0.180
BMI (kg/m ²)					
\leq 18.5	105 (5)	14 (4)	91 (5)	0.80 (0.44–1.42)	0.440
18.5–30.0 (reference)	1246 (61)	202 (62)	1044 (61)	-	-
\geq 30.0	141 (7)	17 (5)	124 (7)	0.71 (0.42–1.20)	0.202
Missing	559 (27)	93 (29)	466 (27)		
SNAQ					
0 (reference)	1295 (63)	189 (58)	1106 (64)	-	-
1–2	274 (13)	53 (16)	221 (13)	1.42 (1.02–1.98)	0.038
\geq 3	301 (15)	60 (19)	241 (14)	1.48 (1.07–2.03)	0.016
Missing	181 (9)	24 (7)	157 (9)		
KATZ-ADL (median (IQR))	0 (0–4)	2 (0–5)	0 (0–3)	1.21 (1.15–1.27)	<0.001
NHFS (median (IQR))	5 (4–6)	5 (4–6)	4 (3–5)	1.51 (1.39–1.65)	<0.001
CCI (mean \pm SD)	4.8 \pm 1.8	5.4 \pm 1.7	4.7 \pm 1.9	1.21 (1.13–1.28)	<0.001
ASA score					
1 and 2 (reference)	660 (32)	63 (19)	597 (35)	-	-
3 and 4	1391 (68)	263 (81)	1128 (65)	2.21 (1.65–2.96)	<0.001
Medical history					
Cardiovascular disease	1265 (62)	225 (69)	1040 (60)	1.47 (1.14–1.89)	0.003
Cerebrovascular accident	257 (13)	34 (10)	223 (13)	0.78 (0.54–1.15)	0.212
COPD	258 (13)	45 (14)	213 (12)	1.14 (0.80–1.61)	0.468
Dementia	431 (21)	113 (35)	318 (18)	2.35 (1.81–3.04)	<0.001
Diabetes mellitus	378 (18)	57 (17)	321 (19)	0.93 (0.68–1.26)	0.631
Myocardial infarction	176 (9)	38 (12)	138 (8)	1.52 (1.04–2.22)	0.032
Parkinson	99 (5)	32 (10)	67 (4)	2.69 (1.74–4.18)	<0.001
TIA	162 (8)	40 (12)	122 (7)	1.84 (1.26–2.68)	0.002
Previous hip fracture surgery	193 (9)	34 (10)	159 (9)	1.15 (0.78–1.70)	0.492
Malignancy in <20 years	321 (16)	59 (18)	262 (15)	1.23 (0.90–1.68)	0.185
Polypharmacy (>4 medications)	1151 (56)	212 (65)	939 (54)	1.56 (1.22–1.99)	<0.001
GFR on admission (median, IQR)	70 (51–83)	62 (48–78)	71 (52–84)	0.99 (0.98–0.99)	<0.001
Hb on admission (mmol/l) (median (IQR))	7.9 (7.2–8.6)	7.7 (7.0–8.4)	7.9 (7.2–8.6)	0.87 (0.78–0.98)	0.019

Note: Values in bold are significant (P<0.05).

Abbreviations: FNF, femoral neck fracture; BMI, body mass index; SNAQ, Short Nutritional Assessment Questionnaire; KATZ-ADL, Katz Index of Independence in Activities of Daily Living; NHFS, Nottingham hip fracture score; CCI, Charlson Comorbidity Index; ASA, American Society of Anesthesiology; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack; GFR, glomerular filtration rate; Hb Hemoglobin.

1.20–1.56, $p < 0.001$), and infection during admission: pneumonia (OR: 5.58, 4.03–7.73, $p < 0.001$), urinary tract infection (UTI) (OR: 2.69, 1.89–3.85, $p < 0.001$) and wound infection (OR: 4.03, 2.00–8.12, $p < 0.001$). The results suggest a decreased risk of delirium is decreased when surgery time is ≤ 45 minutes (OR: 0.77, 0.60–0.98, $p = 0.034$) and osteosynthesis of femoral neck fractures is performed (OR: 0.34, 0.19–0.61, $p < 0.001$).

Clinical Outcomes

Clinical outcomes are presented in Table 3. The median length of delirium was 4 (3–5) days. The median length of primary in-hospital stay was significantly longer in patients with a delirium compared to those without a delirium: 9 days (6–14) vs 6 days (4–9) ($p < 0.001$). The 30-day all-cause mortality was 7% ($n = 152$) (with delirium 16% ($n = 53$) vs with no delirium 6% ($n = 99$)).

Table 2 Univariable Analyses of Risk and Prognostic Perioperative Factors

Variable	All Patients (2051) n (%)	Delirium (326) n (%)	No Delirium (1725) n (%)	Odds Ratio (95% CI)	P-value
Time to surgery					
<24 hours (reference)	1457 (71)	217 (67)	1240 (72)	-	-
≥ 24 hours	594 (29)	109 (33)	485 (28)	1.28 (1.00–1.65)	0.053
<48 hours (reference)	1954 (95)	302 (93)	1652 (96)	-	-
≥ 48 hours	97 (5)	24 (7)	73 (4)	1.80 (1.12–2.90)	0.016
Moment of the week					
During the week (reference)	1474 (72)	238 (73)	1236 (72)	-	-
Weekend	577 (28)	88 (27)	489 (28)	0.93 (0.72–1.22)	0.618
Moment of the day					
Daytime (reference)	1785 (87)	290 (89)	1495 (67)	-	-
Night time (18:00–08:00)	266 (13)	36 (11)	230 (13)	0.81 (0.56–1.17)	0.260
Anaesthesia					
Spinal (reference)	1821 (89)	300 (92)	1521 (89)	-	-
General	223 (11)	26 (8)	197 (11)	0.67 (0.44–1.03)	0.065
Missing	7	0	7		
Surgery time					
≤ 45 minutes	875 (43)	123 (38)	752 (43)	0.77 (0.60–0.98)	0.034
45–90 minutes (reference)	1080 (53)	190 (58)	890 (52)	-	-
≥ 90 minutes	96 (4)	13 (4)	80 (5)	0.73 (0.40–1.34)	0.316
Fixation type					
Osteosynthesis femoral neck fracture	246 (12)	14 (4)	232 (13)	0.34 (0.19–0.61)	<0.001
Prosthesis femoral neck fracture	934 (46)	182 (56)	752 (44)	1.38 (1.08–1.77)	0.011
Osteosynthesis trochanteric fracture (reference)	871 (42)	130 (40)	741 (43)	-	-
Admission ward					
Trauma/orthopaedic surgery (reference)	933 (46)	68 (21)	865 (50)	-	-
Geriatric trauma unit	931 (45)	228 (70)	703 (41)	4.12 (3.01–5.50)	<0.001
Other	187 (9)	30 (9)	157 (9)	2.43 (1.53–3.86)	<0.001
Hb loss (mmol/l) (median (IQR))	1.3 (0.8–1.9)	1.6 (1.0–2.1)	1.2 (0.7–1.8)	1.37 (1.20–1.56)	<0.001
FICB	330 (16)	64 (20)	266 (15)	1.33 (0.99–1.81)	0.058
Reoperation	33 (2)	8 (2)	25 (1)	1.71 (0.76–3.83)	0.191
Infection					
Pneumonia	175 (9)	80 (25)	95 (6)	5.58 (4.03–7.73)	<0.001
Urinary tract infection	162 (8)	51 (16)	111 (6)	2.69 (1.89–3.85)	<0.001
Wound infection	33 (2)	14 (4)	19 (1)	4.03 (2.00–8.12)	<0.001

Note: Values in bold are significant ($P < 0.05$).

Abbreviations: Hb, hemoglobin; FICB, fascia iliaca compartment blockage.

Table 3 Clinical Outcomes After Delirium

Variable	Delirium (326) n / known n (%)	No Delirium (1725) n / known n (%)	P-value
Length of delirium (days) (Median (IQR))	4 (3–5)	-	-
DOS score (median (IQR))	8 (6–10)	-	-
Length of hospital stay (days) (median (IQR))	9 (6–14)	6 (4–9)	<0.001
Dementia	7 (4–13)	4 (3–7)	<0.001
Non-dementia	10 (7–15)	6 (4–9)	<0.001
Discharge destination			<0.001
Home	11 (3)	339 (20)	
Semi-independent nursing home	2 (1)	6 (1)	
Nursing home	66 (20)	282 (16)	
Rehabilitation center	214 (66)	1060 (61)	
In-hospital mortality	33 (10)	38 (2)	<0.001
Mortality			
30-days	53 (16)	99 (6)	<0.001
1-year	109 (42)	286 (22)	<0.001

Note: Values in bold are significant ($P < 0.05$).

Abbreviation: DOS, Delirium Observation Screening.

($p < 0.001$). After 1 year of follow-up, the overall mortality was 19% ($n = 395$). Thirty-three percent ($n = 109$) of the patients with a delirium during submission, died within 1 year after surgery compared with 17% ($n = 286$) in patients with no delirium ($p < 0.001$). The all-cause survival rate is available in [Figures 2 and 3](#) (Kaplan–Meier analysis).

Multivariable Analysis

A multivariable analysis of factors associated with delirium after hip surgery was performed fixed for CCI and type of admission ward ([Table 4](#)). Significant independent prognostic risk factors for the development of a delirium after

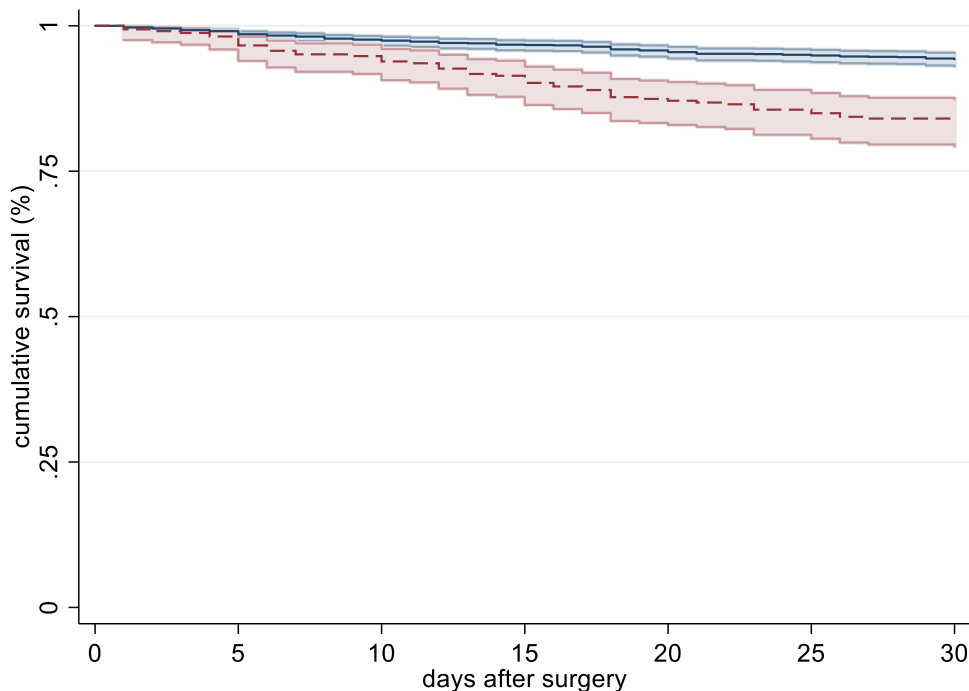


Figure 2 Kaplan–Meier curve of mortality rates in patients with and without delirium during 30-days follow-up.

Note: Patients with no delirium = blue, patients with delirium = red.

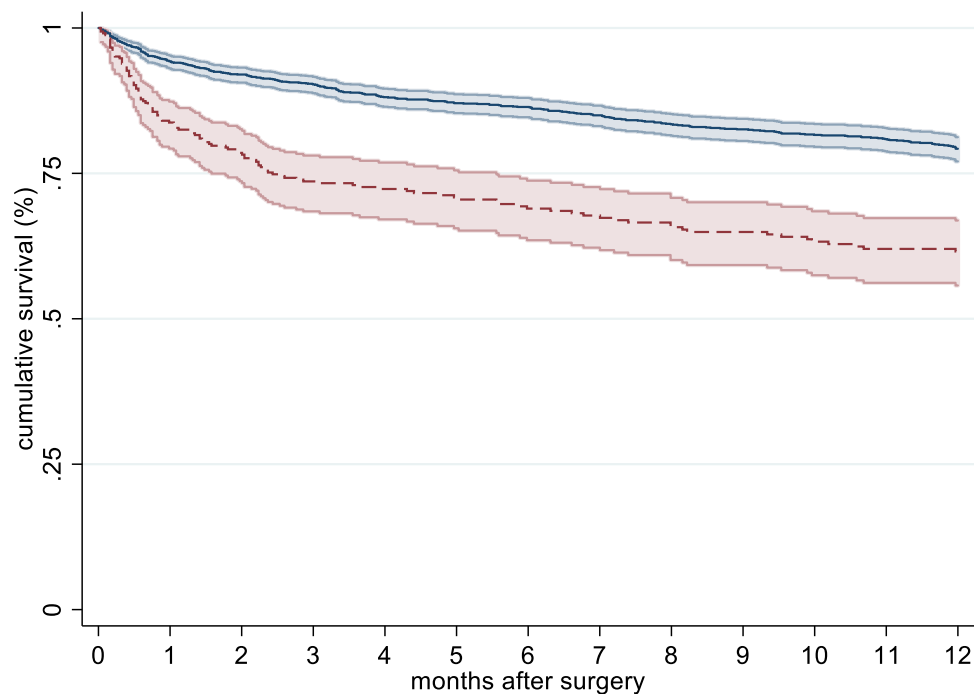


Figure 3 Kaplan–Meier curve of mortality rates in patients with and without delirium during 1-year follow-up.
Note: Patients with no delirium = blue, patients with delirium = red.

multivariable analysis, were that male gender (OR: 1.99, 1.51–2.63, $p < 0.001$), age (OR: 1.06, 1.04–1.08, $p < 0.001$), dementia (OR: 1.66, 1.24–2.23, $p = 0.001$), Parkinson’s disease (OR: 2.32, 1.42–3.80, $p = 0.001$), Δ Hb loss (OR: 1.19, 1.03–1.38, $p = 0.022$), pneumonia (OR: 3.86, 2.70–5.51, $p < 0.001$), UTI (OR: 1.97, 1.33–2.90, $p = 0.001$) and wound infection (OR: 3.02, 1.36–6.75, $p = 0.007$).

Discussion

In elderly patients, hip fracture surgery has a high impact on cognitive and functional outcomes. During admission for a hip fracture, early identification and treatment of (risk factors for) complications is useful to decrease the perioperative

Table 4 Multivariable Analysis of Factors Associated with Delirium (n = 2.012)

Factor	OR	95% CI	p-value
Male gender	1.99	(1.51–2.63)	<0.001
Age (years)	1.06	(1.04–1.08)	<0.001
Dementia	1.66	(1.24–2.23)	0.001
Parkinson’s disease	2.32	(1.42–3.80)	0.001
GTU ward	4.44	(1.77–11.17)	0.002
CCI	1.09	(0.95–1.24)	0.221
Interaction GTU and CCI	0.86	(0.73–1.02)	0.083
Δ Hb loss (mmol/l)	1.19	(1.03–1.38)	0.022
Pneumonia	3.86	(2.70–5.51)	<0.001
UTI	1.97	(1.33–2.90)	0.001
Wound infection	3.02	(1.36–6.75)	0.007

Notes: Values in bold are significant ($P < 0.05$). Fixed for: CCI, type of admission ward. For continuous variables, the odds ratio per one unit increase is shown.

Abbreviations: GTU, geriatric trauma unit; CCI, Charlson Comorbidity Index; Hb, hemoglobin; UTI, urinary tract infection.

complication and mortality rate. The most frequent reported complication after hip surgery is delirium.^{3–13} In this study, the incidence rate of delirium was 16% (n=326). Results of the multivariable analysis found male gender, age, dementia, Parkinson's disease, Δ Hb loss, pneumonia, UTI and wound infection as significant independent prognostic risk factors for the development of a delirium after hip surgery.

Risk and Prognostic Perioperative Risk Factors

Univariable analysis showed that time to surgery ≥ 48 hours was associated with a higher incidence rate of delirium after hip fracture surgery. This may be correlated with higher frailty of patients who must be optimized for surgery. The multivariable analysis supports this hypothesis because after correcting for frailty (CCI), no significant difference between time to surgery and the occurrence of a delirium was emerged. Furthermore, no significant difference was found between surgery performed during the week or weekend, as well as surgery performed during daytime or nighttime.

This study found type of anesthesia did not significantly influence the development of postoperative delirium. This is comparable with the results of two recent randomized controlled trials (2021 and 2022) and a systematic review (2018) showing no difference in the incidence of postoperative delirium after hip fracture surgery between spinal and general anesthesia surgery.^{24–26}

Ravi et al evinced prolonged surgical time was associated with a higher risk for delirium, with an OR of 1.06 per extra 30 minutes of surgery.²⁷ This study did not prove an association between a longer time of hip surgery and delirium, which is in accordance with other previous studies.^{3,8} Patients receiving a prosthesis for a femoral neck fracture were more likely to develop a delirium after surgery, while patients receiving osteosynthesis for a femoral neck fracture had a significant lower risk on delirium. This difference was eliminated after multivariable analysis correcting for frailty. This can be explained by the fact that patients who received a prosthesis were more vulnerable compared to patients who received an osteosynthesis for femoral head preserving surgery. Surgery time ≤ 45 minutes was associated with significantly lower percentages of delirium. However, osteosynthesis surgery takes in general less time compared to a prosthesis. As mentioned earlier, it seems plausible that the osteosynthesis group is less frailty, what can explain the significant difference.

Clinical Outcomes

The most frequent reported complication after hip surgery is delirium with incidence rates between 19% and 39%.^{3–13} In this study, the incidence rate of delirium was 16% (n=326). Hypothetically, the lower delirium incidence rate is due to the admission of frail patients to the GTU since 2018 in the participating hospitals. Domesticity and rhythm were preserved on the GTU. We expect that by maintaining routine and domesticity, delirium will be less likely to develop.

The median length of delirium in this study was 4 days, which is similar compared to the median delirium duration of 4 and 5 days in previous studies of Bellelli et al and de Jong et al.^{3,28} The length of hospital stay was 3 days longer for delirium patients compared to non-delirium patients (9 days vs 6 days). Patients with dementia and a delirium stayed 7 days in hospital, while patients with dementia and no delirium stayed 4 days in hospital. The difference in admission duration between dementia and non-dementia patients may be the result of more dementia patients already live in nursing homes before admission and can be discharged sooner.

This study found a 30-day overall mortality of 7% (with delirium 16% vs with no delirium 6%). After 1 year of follow-up, the overall mortality was 19% in all patients (with delirium 33% vs with no delirium 17%). These results are in line with a previous study of de Jong et al and Ruggiero et al who described respectively a 1-year mortality rate of 39% and 23.3% in the delirium-positive group and 19% and 8.1% in the non-delirium group, considering that Ruggiero et al included a younger population.^{3,29}

Multivariable Analysis

Previous literature reported higher age, male gender, BMI, higher ASA classification, living in a care institution pre-admission, dementia, Parkinson's disease, polypharmacy, acute admission, and infection during admission as risk factors for delirium after hip surgery.^{3,11,17–19} The multivariable analysis of this study identified male gender, age, dementia,

Parkinson's disease, Δ Hb loss, pneumonia, UTI and wound infection as significant independent prognostic risk factors for the development of a delirium after hip surgery.

This study shows the female gender is less likely to develop delirium after hip fracture surgery (OR: 0.60), comparable with results of a meta-analysis of Yang et al with an OR of 0.83.⁶ A higher age was found to be an independent prognostic baseline factor for the development of delirium. The median age of the delirium group was 85 years and 79 years in the non-delirium group. This is in accordance with previous literature showing higher age is an independent risk factor for delirium in elderly hip fracture patients.^{3,17,19}

Cognitive impairment is reported to be associated with the occurrence of delirium after hip fracture surgery.³⁰ This study demonstrated dementia as a strong independent predictor associated with the occurrence of delirium. Patients with Parkinson's disease showed in this study a significant higher delirium incidence rate compared to patients with no Parkinson's disease (10 vs 4%). Choi et al showed Parkinson's disease to be an independent predictor of delirium after hip fracture surgery (OR: 5.75). Patients living in a nursing home pre-operatively sustained a delirium significantly more often (27%) compared to those who did not (18%). These outcomes are comparable to previous studies.^{3,6}

Frail patients were admitted at the GTU ward to prevent a delirium. Nevertheless, admission on the GTU ward showed more delirium compared to admission at another ward. Our hypothesis is that admission at the GTU ward decreases the incidence of delirium in frail elderly patients but not to such an extent that it reaches the incidence level of delirium at a "normal" ward. We added the CCI GTU interaction at the multivariate analyses what confirmed our hypothesis. The GTU is not a significant factor associated with a delirium anymore after correction for CCI (frailty) after multivariable analyses ($P=0.083$, OR: 0.86).

After multivariable analysis, higher peri-operative hemoglobin loss was associated with higher rates of delirium after hip surgery (OR: 1.19). A meta-analysis (2021) evinced higher blood loss was associated with the occurrence of postoperative delirium after knee and hip replacement.²⁰ Reducing blood loss perioperatively may reduce the incidence of delirium after hip fracture surgery.

The present study approved that infection during admission was independently associated with delirium, with the largest association of pneumonia, followed by wound infection and UTI. Our findings are also in line with a meta-analysis of Smith et al, who evinced that hip fracture patients who experienced post-operative pneumonia or a urinary tract infection were at nearly three-times and four-times greater chance of postoperative delirium, respectively.¹⁹ A previous study by de Jong et al found infection during admission, as an independent prognostic factor highly associated with the development of delirium during admission after hip hemiarthroplasty.³

Strengths

This study examines what clinical factors are associated with delirium after hip fracture surgery and the clinical outcomes including the rate of mortality after a delirium. The strength of this study is that we were able to examine a large and detailed prospective hip fracture database which prevents selection bias. We controlled for various confounders, including patient characteristics and hospital properties in the multivariate analysis.

Limitations

The study is observational, which means that causal relationships cannot be established, only risk factors that are strongly associated with delirium could be examined. In addition, due to its observational nature, it is not a standardized study. Despite the multivariate analysis, there may still be confounding. Secondly, this study is an observational cohort study based on patients' medical charts, which can ensure that unreported data is not included in our analysis. Finally, there is always a similarity in symptoms between delirium and dementia, so that the distinction cannot always be made during hospitalization. In addition, the diagnosis of dementia cannot be made during a hospital stay if there is a suspicion. Both influence the reported incidence of delirium and dementia.

Conclusion

This study found male gender, higher age, dementia, Parkinson's disease, hemoglobin loss, pneumonia, UTI and wound infection during admission as factors highly associated with delirium after hip fracture surgery. Delirium was associated with a two times as high 30-day and 1-year all-cause mortality.

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¹Surgery Department, Maasstad Hospital, 3079 DZ Rotterdam, the Netherlands;

²Surgery Department, Franciscus Hospital, 3045 PM Rotterdam, the Netherlands;

³Science Board, Maasstad Hospital, 3079 DZ Rotterdam, the Netherlands.

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Ethics Approval

The local medical ethics committee approved the study and the study was registered in the Dutch Trial Register (nr NL 8313).

Consent to Participate

Due to the high percentage of cognitive dysfunction in the study population and since there were no changes in usual practice of care, the committee determined that patients' consent to review medical charts was not required.

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Disclosure

The authors report no conflicts of interest in this work.

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