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ORIGINAL RESEARCH

Risk Factors for 30-Days Mortality After Proximal Femoral Fracture Surgery, a Cohort Study

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Purpose: The primary objective of this study was to identify new risk factors and to confirm previously reported risk factors associated with 30-day mortality after hip fracture surgery.

Patients and methods: A prospective hip fracture database was used to obtain data. In total, 3523 patients who underwent hip fracture surgery between 2011 and 2021 were included. Univariable and multivariable logistic regression was used to screen and identify candidate risk factors. Twenty-seven baseline factors and 16 peri-operative factors were included in the univariable analysis and 28 of those factors were included in multivariable analysis.

Results: 8.6% of the patients who underwent hip fracture surgery died within 30 days after surgery. Prognostic factors associated with 30-day mortality after hip fracture surgery were as follows: age 90–100 years (OR = 4.7, 95% CI: 1.07–19.98, p = 0.041) and above 100 years (OR = 11.3, 95% CI: 1.28–100.26, p = 0.029), male gender (OR = 2.6, 95% CI: 1.97–3.33, p < 0.001), American Society of Anesthesiologists (ASA) 3 and ASA 4 (OR = 2.1, 95% CI: 1.44–3.14, p < 0.001), medical history of dementia (OR = 1.7, 95% CI: 1.25–2.36, p = 0.001), decreased albumin level (OR = 0.94, 95% CI: 0.92–0.97, p < 0.001), decreased glomerular filtration rate (GFR) (OR = 0.98, 95% CI: 0.98–0.99, p < 0.001), residential status of nursing home (OR = 2.1, 95% CI: 1.44–2.87, p < 0.001), higher Katz Index of Independence in Activities of Daily Living (KATZ-ADL) score (OR = 1.1, 95% CI: 1.01–1.16, p=0.018) and postoperative pneumonia (OR = 2.4, 95% CI: 1.72–3.38, p < 0.001).

Conclusion: A high mortality rate in patients after acute hip fracture surgery is known. Factors that are associated with an increased mortality are age above 90 years, male gender, ASA 3 and ASA 4, medical history of dementia, decreased albumin, decreased GFR, residential status of nursing home, higher KATZ-ADL score and postoperative pneumonia.

Keywords: hip fracture, mortality, independent risk factors, clinical outcomes

Introduction

Hip fractures are a common injury among the elderly population.[1] Due to rising life expectancy, the incidence of hip fractures is expected to increase.[2] Hip fractures, having significant impact on morbidity and mortality, may be an early indication of approaching the end of life.[3–5]

A major concern in hip fracture patients is high risk of 30-day mortality. The incidence rate of 30-day mortality has been reported to be between 6.0% and 12.0%.[6–14] Several risk factors have been identified that contribute to 30-day mortality risk, including: advanced age, male gender, higher American Society of Anesthesiologists (ASA) classification, higher Charlton Comorbidity Index (CCI), higher Nottingham Hip Fracture Score (NHFS), history of chronic obstructive pulmonary disease (COPD), dementia, hypoalbuminemia, time to surgery, postoperative delirium and pneumonia.[2,6,8–16] The majority of mortality risk factors relate to baseline factors of medical history. Potential interventions for prevention based on those patients' characteristics are limited (for example: we can correct an anemia, but we can not influence whether a patient has dementia or not).

Non-operative management of patients with hip fractures seems to be a viable alternative for institutionalized frail older patients with limited life expectancy.[5] For patients with a very high risk of death, an operative treatment may be an act of overreaching, these patients may be better off with supportive care rather than admission and surgery (with complications)

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resulting in death. The decision-making process regarding the surgical intervention for frail hip fracture patients with a potentially limited life expectancy is complex and challenging, since it is difficult to precisely assess this patient population and the major consequences of the treatment decision. The potential population of patients who could benefit from a non-operative approach may be larger, especially among those who have a short life expectancy after hip fracture surgery (<30 days). In non-operative treatment it is crucial to accurately assess the risk profile for 30-day mortality.

The primary aim of this study was to identify risk factors in hip fracture patients and to confirm previously reported risk factors for 30-day mortality. The secondary aim of this study was to verify peri-operative clinical outcomes in patients who died within 30 days after hip fracture surgery.

Methods

Study Design and Patient Selection

Data were obtained from a prospective database of two level II trauma teaching hospitals in the Netherlands. We prospectively included patients (n=3523) who underwent a hip fracture surgery between 2011 and 2021 (Figure 1). A detailed overview of the data collection and the standards of hip fracture treatment is available in the FAMMI study protocol.[17] The 30-day time frame was chosen based on the commonly used follow-up period by studies evaluating the association between perioperative mortality and a hip fracture.[8–10]

Baseline and Perioperative Factors

Baseline characteristics and data on previously described risk factors for 30-day mortality after hip fracture surgery were collected.[2,6,8–16] To predict frailty, the ASA classification, CCI and NHFS prediction models were used in which patient's comorbidities and general status are combined.[18,19] The Katz Index of Independence in Activities of Daily Living (KATZ-ADL) was scored to determine the functional performance of a patient. Nutritional status were expressed using Body Mass Index (BMI) and the Short Nutritional Assessment Questionnaire for Residential Care (SNAQ) score. The mortality statistics were obtained by verifying the citizen service number with the corresponding municipality.

Statistical Analysis

Categorical variables are presented as frequencies and percentages. Continuous variables are presented as mean (standard deviation, ±SD) in case of a normal distribution or as median (interquartile range, IQR) in case of non-normal distribution. Associations between potential risk factors and 30-day mortality were tested by univariable logistic regression. Significant associations observed in univariable analysis and significant variables reported in the literature[2,6,8–16] were included in the multivariable model analyzing the association with 30-day mortality. Subsequently, backward elimination was applied until all remaining variables reached $p < 0.10$.

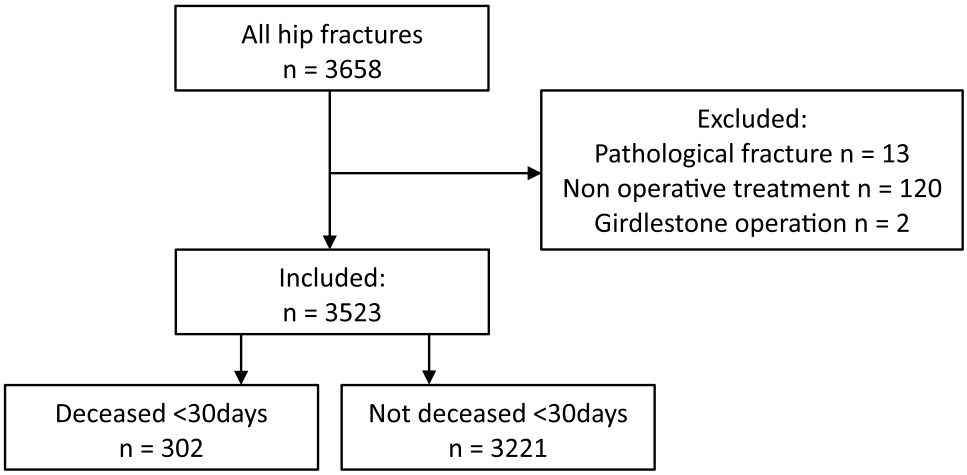

Figure 1 Flow chart of included patients.

Missing data in covariates were completed by multiple imputation with chained equations (m = 100 imputation datasets). The data were incomplete for 10 variables. Of the following variables, more than 5% of the data were missing: albumin on admission (46%), walking aid (7%), KATZ-ADL (19%), SNAQ score (10%), underweight (29%) and admission ward (13%). Details of the multiple imputation procedure can be found in Appendix 1. Statistical analyses were performed using Stata version 15.2 (StataCorp, College Station, X, USA), and all statistical tests were two-sided with a significance level of $p < 0.05$. Mortality rates were established and displayed using the Kaplan–Meier estimator (Figure 2).

Ethics

The study protocol was approved by the local ethics committee (L2017044, Toetsingscommissie Wetenschappelijk Onderzoek Rotterdam (TWOR), Rotterdam, Trial registration number NL8313). Due to the absence of any changes in the standard practice of care and a high percentage of cognitive dysfunction among the patients, the local ethics committee determined that patients' consent to review their medical records was not required. All patient data were collected anonymously, and all protocols were conducted in compliance with the Declaration of Helsinki. No external funding was used for this study.

The "strengthening the reporting of observational studies in Epidemiology" (STROBE) guidelines were used to ensure the reporting of this study.[20]

Results

Baseline and Perioperative Factors

In total, 3523 patients were analyzed of which 302 patients (8.6%) deceased within 30 days after hip fracture surgery. A Kaplan–Meier analysis of 30-day mortality is shown (Figure 2). An extensive overview of the univariable analysis of the baseline and perioperative factors are presented in Tables 1 and 2 respectively.

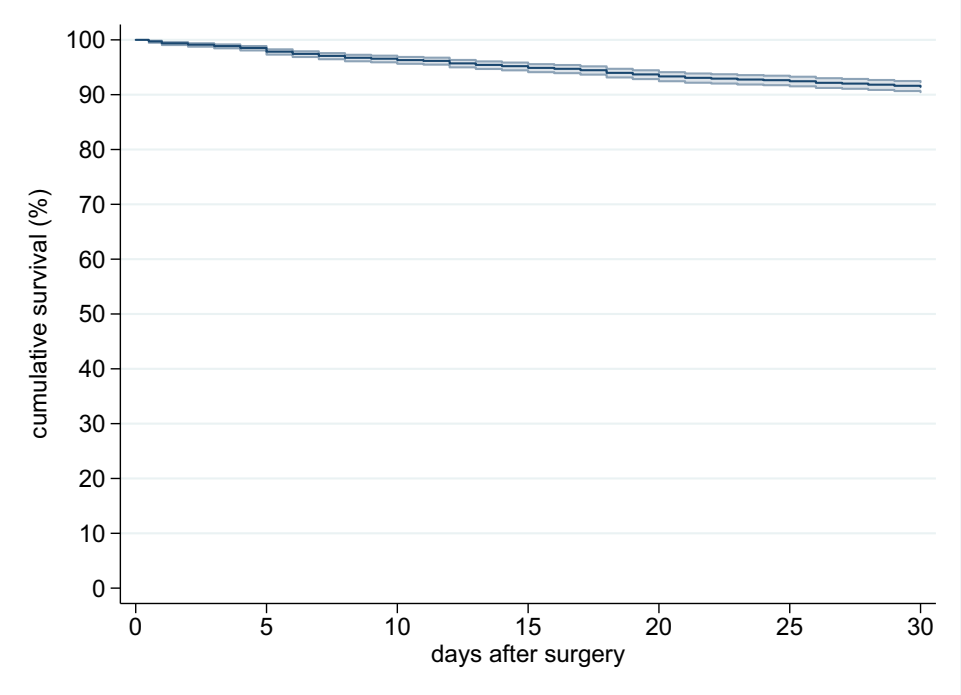

Figure 2 Kaplan–Meier curve of the 30-day mortality rates after Hip fracture surgery. Blue line: survivors' function, with 95% CI.

Table 1 Univariable Analyses of Risk and Prognostic Baseline Factors

Variable	All Patients (n=3523) n (%)	Deceased <30 days (n=302) n (%)	Not Deceased <30 days (n=3221) n (%)	Odds Ratio (95% CI)	P-value
Age					
– <60 (ref.)	215 / 3523 (6)	2 / 302 (0.7)	213 / 3221 (6)	–	–
– 61–70	369 / 3523 (10)	13 / 302 (4)	356 / 3221 (11)	3.89 (0.87–17.40)	0.076
– 71–80	905 / 3523 (26)	49 / 302 (16)	856 / 3221 (26)	6.10 (1.47–25.27)	0.013
– 81–90	1540 / 3523 (44)	163 / 302 (54)	1377 / 3221 (43)	12.61 (3.10–51.22)	<0.001
– 91–100	485 / 3523 (14)	73 / 302 (24)	412 / 3221 (13)	18.87 (4.59–77.64)	<0.001
– >100	9 / 3523 (0.2)	2 / 302 (0.7)	7 / 3221 (0.2)	30.43 (3.73–248.38)	0.001
Male Gender	1172 / 3523 (33)	154 / 302 (51)	1018 / 3221 (32)	2.25 (1.78–2.86)	<0.001
ASA score					
– 1 and 2 (ref.)	1275 / 3523 (36)	34 / 302 (11)	1241 / 3221 (39)	–	–
– 3 and 4	2248 / 3523 (64)	268 / 302 (89)	1980 / 3221 (61)	4.94 (3.43–7.11)	<0.001
CCI (mean ±SD)	4.7 ± 1.8	5.5 ± 1.4	4.6 ± 1.8	1.31 (1.23–1.40)	<0.001
NHFS (mean ±SD)	4.5 ± 1.7	5.7 ± 1.7	4.4 ± 1.7	1.86 (1.70–2.04)	<0.001
Missing	66 (2)	4 (1)	62 (2)	–	–
Medical history					
– Atrial fibrillation	659 / 3523 (19)	67 / 302 (22)	592 / 3221 (18)	1.27 (0.95–1.68)	0.106
– Cardiac valve disease	246 / 3523 (7)	28 / 302 (9)	218 / 3221 (7)	1.41 (0.93–2.13)	0.104
– Cerebrovascular accident	407 / 3523 (12)	42 / 302 (14)	365 / 3221 (11)	1.26 (0.90–1.78)	0.182
– COPD	416 / 3523 (12)	48 / 302 (16)	368 / 3221 (11)	1.47 (1.06–2.03)	0.022
– Decompensation cordis	242 / 3523 (7)	34 / 302 (11)	208 / 3221 (6)	1.84 (1.25–2.70)	0.002
– Dementia	804 / 3523 (23)	137 / 302 (45)	667 / 3221 (21)	3.18 (2.50–4.05)	<0.001
– Diabetes Mellitus	664 / 3523 (19)	71 / 302 (24)	573 / 3221 (18)	1.42 (1.07–1.88)	0.014
– Malignancy in < 20 years	524 / 2736 (19)	44 / 224 (20)	480 / 2512 (19)	1.03 (0.73–1.46)	0.846
– Myocardial infarction	320 / 3523 (9)	37 / 302 (12)	283 / 3221 (9)	1.45 (1.01–2.09)	0.046
– Parkinson	169 / 3523 (5)	18 / 302 (6)	151 / 3221 (5)	1.29 (0.78–2.13)	0.324
– Previous hip fracture surgery	353 / 3523 (10)	32 / 302 (11)	321 / 3221 (10)	1.07 (0.73–1.57)	0.727
– TIA	314 / 3523 (9)	31 / 302 (10)	283 / 3221 (9)	1.19 (0.80–1.76)	0.389
Anticoagulation use					
– No anticoagulation use (ref.)	1782 / 3523 (50)	124 / 302 (41)	1658 / 3221 (51)	–	–
– PAI	977 / 3523 (28)	92 / 302 (31)	885 / 3221 (28)	1.39 (1.05–1.84)	0.022
– VKA / DOAC	660 / 3523 (19)	76 / 302 (25)	584 / 3221 (18)	1.74 (1.29–2.35)	<0.001
– Combination	104 / 3523 (3)	10 / 302 (3)	94 / 3221 (3)	1.42 (0.72–2.80)	0.308
Polypharmacy (>4 medications)	1942 / 3523 (55)	202 / 302 (67)	1740 / 3221 (54)	1.72 (1.34–2.21)	<0.001
Immunosuppression	233 / 3523 (7)	16 / 302 (5)	217 / 3221 (7)	0.77 (0.46–1.31)	0.337
Albumin on admission (g/L) (median (IQR))	38 (34–41)	35.5 (32–39)	38 (34–41)	0.95 (0.93–0.98)	<0.001
Missing	1631 (46)	134 (44)	1497 (46)	–	–
GFR on admission (median (IQR))	70 (51–85)	56 (39–76)	71 (53–85)	0.98 (0.97–0.98)	<0.001
Missing	21 (1)	0 (0)	21 (1)	–	–
Hb on admission (median (IQR))	8 (7.2–8.6)	7.6 (6.8–8.3)	8 (7.3–8.6)	0.70 (0.63–0.79)	<0.001
Missing	11 (1)	0 (0)	11 (1)		
Residential status					
– Home (reference)	2433 / 3464 (70)	127 / 293 (44)	2306 / 3171 (73)	–	–
– Semi-independent nursing home	262 / 3464 (8)	30 / 293 (10)	232 / 3171 (7)	2.35 (1.54–3.57)	<0.001
– Nursing home	769 / 3464 (22)	136 / 293 (46)	633 / 3171 (20)	3.90 (3.02–5.05)	<0.001
Walking aids					
– None (reference)	2002 / 3275 (61)	102 / 265 (39)	1900 / 3010 (63)	–	–
– Rollator	1158 / 3275 (35)	144 / 265 (54)	1014 / 3010 (34)	2.65 (2.03–3.45)	<0.001
– Wheelchair / mobility scooter / No functional mobility	115 / 3275 (4)	19 / 265 (7)	96 / 3010 (3)	3.69 (2.17–6.27)	<0.001
KATZ-ADL (mean ±SD)	1.86 ± 2.19	3.00 ± 2.3	1.76 ± 2.1	1.27 (1.19–1.34)	<0.001
Missing	657 (19)	64 (21)	593 (18)	–	–

(*Continued*)

Table 1 (Continued).

Variable	All Patients (n=3523) n (%)	Deceased <30 days (n=302) n (%)	Not Deceased <30 days (n=3221) n (%)	Odds Ratio (95% CI)	P-value
SNAQ					
– 0 (reference)	2355 / 3183 (74)	178 / 274 (65)	2177 / 2909 (75)	–	–
– 1–2	401 / 3183 (13)	41 / 274 (15)	360 / 2909 (12)	1.39 (0.97–1.99)	0.069
– ≥3	427 / 3183 (13)	55 / 274 (20)	372 / 2909 (13)	1.81 (1.31–2.49)	<0.001
Underweight (BMI<18,5)	187 / 2491 (8)	22 / 191 (12)	165 / 2300 (7)	1.68 (1.05–2.70)	0.030

Note: Bold: categories.

Abbreviations: ASA, American Society of Anesthesiology; CCI, Charlton Comorbidity Index; NHFS, Nottingham hip fracture score; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack; PAI, Platelet aggregation inhibitor; VKA, Vitamin K antagonist; DOAC, direct oral anticoagulants; GFR, glomerular filtration rate in mL/min/1.73m^2; Hb, hemoglobin in mmole/L; KATZ-ADL, Katz Index of Independence in Activities of Daily Living; SNAQ, Short Nutritional Assessment Questionnaire; BMI, body mass index.

Table 2 Univariable Analysis of Risk Factors, Prognostic Perioperative Factors

Variable	All Patients (n=3523) n (%)	Deceased <30days (n=302) n (%)	Not Deceased <30days (n=3221) n (%)	Odds Ratio (95% CI)	P-value
Fracture					
– Femoral neck fracture (ref.)	2491 / 3523 (71)	210 / 302 (70)	2281 / 3221 (71)	–	–
– Trochanter fracture	1032 / 3523 (29)	92 / 302 (30)	940 / 3221 (29)	1.06 (0.82–1.37)	0.640
Surgery					
– DHS/FNS (ref.)	237 / 3523 (7)	6 / 302 (2)	231 / 3221 (7)	–	–
– Cannulated screws	78 / 3523 (2)	5 / 302 (2)	73 / 3221 (2)	2.64 (0.78–8.89)	0.118
– Gamma-nail	1035 / 3523 (29)	93 / 302 (31)	942 / 3221 (29)	3.80 (1.64–8.79)	0.002
– Hemiarthroplasty	2052 / 3523 (58)	198 / 302 (65)	1854 / 3221 (58)	4.11 (1.80–9.37)	0.001
– Total hip replacement	121 / 3523 (4)	0 / 302 (0)	121 / 3221 (4)	N/A	N/A
Time to surgery (median (IQR))	19 (13–26)	20 (14–33)	19 (13–25)	1.00 (1.00–1.00)	0.884
Missings	7 (1)	1 (1)	6 (1)	–	–
Moment of the week					
– Week days (ref.)	2543 / 3523 (72)	209 / 302 (69)	2334 / 3221 (72)	–	–
– During weekend	980 / 3523 (28)	93 / 302 (31)	887 / 3221 (28)	1.17 (0.91–1.51)	0.228
Moment of the day					
– Daytime (8.00–18.00) (ref.)	3087 / 3523 (88)	265 / 302 (88)	2822 / 3221 (88)	–	–
– Night time (18.00–8.00)	436 / 3523 (12)	37 / 302 (12)	399 / 3221 (12)	0.99 (0.69–1.41)	0.945
Anaesthesia					
– Spinal (ref.)	3074 / 3510 (88)	266 / 302 (88)	2808 / 3208 (88)		
– General	436 / 3510 (12)	36 / 302 (12)	400 / 3208 (12)	0.95 (0.66–1.37)	0.782
Anatomical approach					
– Anterolateral (ref.)	1785 / 2157 (83)	172 / 197 (87)	1613 / 1960 (82)	–	–
– MI anterolateral	372 / 2157 (17)	25 / 197 (13)	347 / 1960 (18)	0.68 (0.44–1.04)	0.077
Surgery time (mean ±SD)					
– < 45 min	1217 / 3518 (35)	108 / 302 (35)	1109 / 3216 (35)	1.06 (0.83–1.37)	0.629
– 45–90 min (ref.)	2078 / 3518 (59)	174 / 302 (58)	1901 / 3216 (59)	–	–
– > 90 min	226 / 3518 (6)	20 / 302 (7)	206 / 3216 (6)	1.06 (0.65–1.72)	0.812
Hb loss (mmole/l) (mean ±SD)	1.42 ± 0.89	1.45 ± 0.94	1.42 ± 0.89	1.03 (0.91–1.19)	0.604
Missings	93 (3)	15 (5)	78 (2)	–	–

(*Continued*)

Table 2 (Continued).

Variable	All Patients (n=3523) n (%)	Deceased <30days (n=302) n (%)	Not Deceased <30days (n=3221) n (%)	Odds Ratio (95% CI)	P-value
Admission ward					
– Trauma / orthopaedic surgery (ref.)	1632 / 3070 (53)	106 / 246 (43)	1526 / 2824 (54)	–	–
– Geriatric trauma unit	1100 / 3070 (36)	116 / 246 (47)	984 / 2824 (35)	1.70 (1.29–2.23)	<0.001
– Other	338 / 3070 (11)	24 / 246 (10)	314 / 2824 (11)	1.10 (0.70–1.74)	0.683
Delirium postoperative	617 / 3523 (18)	95 / 302 (31)	522 / 3221 (16)	2.37 (1.83–3.08)	<0.001
Hematoma postoperative	270 / 3417 (8)	15 / 286 (5)	255 / 3131 (8)	0.62 (0.37–1.07)	0.085
Pneumonia postoperative	310 / 3523 (9)	75 / 302 (25)	235 / 3221 (7)	4.20 (3.13–5.63)	<0.001
Re-operation	110 / 3523 (3)	7 / 302 (2)	103 / 3221 (3)	0.72 (0.33–1.56)	0.403
Urinary tract infection postoperative	257 / 3523 (7)	27 / 302 (9)	230 / 3221 (7)	1.28 (0.84–1.94)	0.251
Wound infection postoperative	134 / 3523 (4)	9 / 302 (3)	125 / 3221 (4)	0.76 (0.38–1.51)	0.435

Abbreviations: DHS, Dynamic hip screw; FNS, Femoral neck system; N/A, not available; MI, minimal invasive; Hb, Hemoglobin.

Multivariable Analysis

The multivariable analysis prior to backward selection (all variables from univariable analysis with $p < 0.10$ and risk factors from literature) is available in Appendix 2. A multivariable analysis of the remaining factors associated with 30-day mortality after hip surgery is shown (Table 3). Significant independent prognostic risk factors for the 30-day mortality after multivariable analysis, were age 90–100 years (OR = 4.6, 95% CI: 1.07–19.98, p = 0.041) and above 100 years (OR = 11.3, 95% CI: 1.28–100.26, p = 0.029), male gender (OR = 2.6, 95% CI: 1.97–3.33, p < 0.001), ASA 3 and ASA 4 (OR = 2.1, 95% CI: 1.44–3.14, p < 0.001), medical history of dementia (OR = 1.7, 95% CI: 1.25–2.36, p = 0.001), decreased albumin level (OR = 0.94, 95% CI: 0.92–0.97, p < 0.001), decreased GFR (OR = 0.98, 95% CI: 0.98–0.99, p < 0.001), residential status of nursing home (OR = 2.0, 95% CI:

Table 3 Multivariable Analysis of Factors Associated with 30-Day Mortality After Backward Selection

Factor	OR	95% CI	p – value
Age			
– <60 (ref.)	–	–	–
– 61–70	2.10	0.45–9.73	0.341
– 71–80	2.31	0.54–9.93	0.260
– 81–90	3.52	0.83–14.91	0.088
– 91–100	4.62	1.07–19.98	0.041
– >100	11.32	1.28–100.26	0.029
Male gender	2.56	1.97–3.33	<0.001
ASA 3 and 4	2.12	1.44–3.14	<0.001
Dementia	1.72	1.25–2.36	0.001
Albumin on admission	0.94	0.92–0.97	<0.001
GFR on admission	0.98	0.98–0.99	<0.001
Residential status			
– Home (reference)	–	–	–
– Semi-independent nursing home	1.46	092–2.31	0.106
– Nursing home	2.03	1.44–2.87	<0.001
KATZ-ADL	1.09	1.01–1.16	0.018
Delirium postoperative	1.29	0.96–1.73	0.087
Pneumonia postoperative	2.41	1.72–3.38	<0.001

Abbreviations: ASA, American Society of Anesthesiology; GFR, glomerular filtration rate in mL/min/1.73m^2; KATZ-ADL, Katz Index of Independence in Activities of Daily Living.

1.44–2.87, p < 0.001), higher KATZ-ADL score (OR = 1.1, 95% CI: 1.01–1.16, p=0.018) and postoperative pneumonia (OR = 2.4, 95% CI: 1.72–3.38, p < 0.001).

Discussion

Falling incidents and subsequent hospital admissions have significant impact on cognitive and functional outcomes in hip fracture patients. Estimating the risk for 30-day mortality after hip surgery is important in the decision-making process regarding surgical intervention. Patients with a very short life expectancy after hip fracture surgery (<30 days) may benefit from a non-operative approach.[5] Accurate estimation of the risk profile for 30-day mortality is a crucial step in the treatment decision-making process.

In the FAMMI cohort, the observed 30-day mortality rate was 8.6%. Missing data is limited since collection is based on the national registration database, ensuring an adequate and complete reflection of the mortality outcomes. Previous literature has reported 30-day mortality rates ranging from 7.3% to 12.0%.[6–14] The relatively low mortality rate observed in our study can be attributed to the absence of age-based exclusions and the inclusion of all types of hip operations, including total hip replacement which is generally performed in relatively younger to patients.

Univariable Analysis

Univariable Analysis - Baseline Factors

The NHFS is a scoring system for predicting 30-day mortality after hip fracture surgery.[18] Higher NHFS are associated with a higher 30-day mortality.[6] The NHFS was significant after univariable analysis but was not associated with 30-day mortality after multivariable analysis. This is likely attributed to the adjustment in the multivariable analysis for several factors, also comprising the NHFS, such as age, gender, comorbidities and hemoglobin on admission. The association between mortality and a higher CCI is known.[8,13] While CCI showed significance in the univariable analysis, it did not remain significant in the multivariable analysis. Possibly due to the correction for confounding factors, such as age, ASA score and multiple comorbidities. To our knowledge, multivariable correction with the CCI has not been performed in previous literature.

After univariable analyses COPD, decompensation cordis, DM and myocardial infarction were significant factors associated with mortality. However, after backward selection none of these risk factors remained significant. This is probably due to adjustment for ASA score as a summative score for comorbidities. Our hypothesis is that ASA had a greater influence on mortality than the individual comorbidities. In a cohort study of Khan et al cardiac disease and COPD were associated with 30-day mortality in the univariable analyses, but only cardiac disease remained significant in the multivariable analysis.[14] However, they did not adjust for ASA score. Khan et al did not find an association between 30-day mortality and DM.[14] Congestive heart failure has been described in literature as a risk factor for in hospital mortality in univariable analyses.[21] However, myocardial infarction is not reported in much detail in the medical charts. Also, by itself, a history of myocardial infarction does not provide any information on the remaining heart function, which may be more relevant.

When conducting univariable analysis on other comorbidities separately, atrial fibrillation, cardiac valve disease, cerebrovascular disease, malignancy within the past 20 years, Parkinson's disease, previous hip surgery and transient ischemic attack (TIA) did not show any significant association with a higher 30-day mortality in the univariable analyses. A cohort study of Adunsky et al did not find a correlation between atrial fibrillation and 1-year mortality.[22] In previous literature severe aortic valve stenosis was not related to a higher 30-day mortality rate.[23] Cardiac valve disease, in general, represents a heterogeneous group of conditions, which likely explains its absence as a risk factor in our analysis.

In line with our results, previous literature reported no correlation between prior cerebrovascular accident or TIA and in-hospital or 1-year mortality after hip fracture surgery.[24] While a past malignancy has been associated with a higher 1-year mortality,[25] it is not known as a factor associated with 30-day mortality.[14] There is no clear consensus on whether Parkinson's disease is related to 1-year mortality after hip surgery.[26,27]

Lower hemoglobin on admission has been reported to be a risk factor for 6 months and 1-year mortality after multivariable analyses.[28] Based on the data of this study, hemoglobin on admission did not appear to influence the 30-day mortality. Nevertheless, hemoglobin on admission was included as a variable in several short-term mortality prediction models, such as the NHFS and the Brabant Hip Fracture Score.[18,29]

Poor pre-fracture walking ability has been associated with a higher 30-day mortality rate after hip fracture surgery.[14] Our univariable analysis initially confirmed this finding. However, after controlling for residential status and KATZ-ADL, this variable was no longer significant. The walking ability attributed to underlying frailty. However, the waling ability probably has a weaker correlation with mortality in comparison with residential status and KATZ-ADL.

Cachexia has been described in the literature as a risk factor for mortality at 3 months and 1 year after hip fracture surgery.[30] Borge et al did not find an association between 30-day mortality after multivariable analyses and BMI.[8] In this study, underweight and a higher SNAQ score were significantly more common in the group that died within 30 days. However, after multivariable analysis, there was no significant difference in 30-day mortality. Contrary to these two factors, albumin remained significant after multivariable analysis. This suggest that albumin is a stronger predictor for mortality than underweight and a higher SNAQ score.

Univariable Analysis - Perioperative Factors

In line with the results of our study, current literature reported no different mortality based on the type of the hip fracture.[8] After univariable analysis, a gamma nail and a hemiarthroplasty were associated with a higher 30-day mortality in comparison with osteosynthesis and total hip replacement. This difference disappeared after multivariable analysis. Hypothetically, this may be because gamma nails and hemiarthroplasties are generally used for the older population.

Time to surgery was not a significant factor associated with 30-day mortality. Literature reports varying results with respect to time to surgery and mortality.[6,9,10,13,31] The patients in this study underwent surgery with a median time to surgery of 19 hours after admission. The median time to surgery was longer in the literature that found an association with 30-day mortality.[9,10,13] In line with previous literature the timing of the operation during the day and during the week was not associated with a higher 30-day mortality in this study.[6,32] Our study did not find an association between 30-day mortality and the type of anesthesia. This result aligns with a recent clinical trial of Li et. al.[33]

Univariable Analysis - Complications

Gottschalk et al demonstrated a strong association between postoperative delirium and mortality after univariable analysis; however, this did not persist in a multivariable model.[34] This finding is consistent with the analyzes of this study. Hypothetically frail elderly people with many comorbidities are more likely to develop delirium. These factors were also included in the multivariable analysis and are probably stronger predictors.

A (deep) wound infection is a known risk factor for 90-days and 1-year mortality after hip fracture surgery.[35,36] We did not find a correlation between a wound infection and 30-day mortality. Hypothetically, this absence of correlation may be due to the time it takes for a wound infection to develop after surgery. If a patient survives until a wound infection develops, in general he will not die within 30-days after surgery.

Multivariable Analysis

Based on results of the multivariable analysis in this study, we identified several significant independent prognostic risk factors for 30-day mortality after hip fracture surgery: age above 90 years, gender male, ASA 3 and ASA 4, medical history of dementia, decreased albumin, decreased GFR, residential status in nursing homes, higher KATZ-ADL score, and postoperative pneumonia.

Multivariable Analysis – Baseline Factors

Higher age and male gender are well-established risk factors for 30-day mortality.[2,8,9,13] The results of the uni- and multivariable analysis are in line with previous literature. Age was categorized into different groups, revealing an elevated risk of 30-day mortality for patients aged 90 years and above compared to those under 60 years of age.

ASA remains a significant independent prognostic risk factors for 30-day mortality after multivariable analysis. ASA appears to outperform the assessment of individual comorbidities separately in predicting 30-day mortality. Consequently, comorbidities found to be significant in univariable analyses, such as DM, COPD, and decompensation cordis, were eliminated during backward selection. A higher ASA score has been mentioned in previous literature as a risk factor for 30-day mortality.[6]

Based on our study results and a recently published meta-analysis, the medical history of dementia demonstrated a substantial influence on 30-day mortality after a hip fracture.[11] Even after adjusting for ASA, age, and residential status in our analysis, dementia remained strongly associated with 30-day mortality.

In line with previous literature, we found albumin to be an independent prognostic risk factor for 30-days mortality.[8,9,12] Neither underweight nor SNAQ scores yielded statistical significance after backward selection in our analyses. These findings suggest that albumin may be a stronger predictor than these two factors. Previous literature did not perform multivariable analyses with both albumin and BMI and SNAQ.[8,9,12] Additional research is needed gain more insight in the role of albumin within hip fracture patients. In the future, a low level of albumin could be used to consult a dietician in patients with a hip fracture in addition to underweight and high SNAQ scores.

GFR has been mentioned in literature as a risk factor for respectively in-hospital and over-all mortality with respective thresholds of below 60 and 30.[37,38] Our findings of the multivariable analyses demonstrate that a decreased GFR, considered as a continuous factor, correlates with an elevated risk of 30-day mortality following an hip fracture. If the reduction in GFR is present, intervention and correction may be feasible and potentially averting short-term mortality.

Patients living in a nursing home have a higher risk of 30-day and 1-year mortality after hip fracture surgery.[14,39] The multivariable analysis of this study showed that residents of a nursing home had a higher risk for 30-day mortality. The hip fracture and subsequent surgery could be perceived as a factor or an event that disturbs the frail balance in already vulnerable patients. The vulnerability and higher long-term mortality is also evident in patients with a lower KATZ-ADL.[40]

Multivariable Analysis - Complications

Pneumonia following hip fracture surgery has been reported as a serious complication and is related with a higher 30-day mortality rate.[15,16] In the FAMMI cohort study, a pneumonia after hip fracture surgery was strongly associated with a higher 30-day mortality rate after uni- and multivariable analysis. Implementing preventive measures, such as nebulization and pulmonary physiotherapy may reduce 30-day mortality in the hip fracture patient.

Strengths

This study examined which clinical factors were associated with 30-day mortality after hip fracture surgery. The strength of this study is that we were able to examine a large cohort of hip fracture patients with detailed description of baseline and perioperative factors in a prospective hip fracture database, thereby preventing selection bias. The cohort is representative of the target population, which increases the external validity of the findings. The data on the primary outcome measure, 30-day mortality, was complete and adequate. Finally, we had a large population with over 300 cases in the primary outcome measure, which provides statistical power. This consequently allowed for the incorporation of 30 distinct variables within the multivariable analysis.[41]

Limitations

The study is observational, thus definitive causal relationships cannot be established: only factors that are strongly associated with 30-day mortality could be found. Secondly, due to its observational nature, it is not a standardized study, and confounding may still exist despite the multivariable analysis. Furthermore, this study is an observational cohort study based on patients' medical charts, which means that unreported data is not included in our analysis. However, due to careful status research and follow-up, the amount of missing data has been very limited (Appendix 1). Additionally, we excluded the most fragile patients who were treated non-operatively, because we wanted to investigate the risk factors for 30-day mortality after hip fracture surgery. Excluding the frailest patients, could influence the results compared to previous studies in literature.

Conclusion

A high mortality rate in patients after acute hip fracture surgery is known. Factors that are associated with an increased mortality are age above 90 years, male gender, ASA 3 and ASA 4, medical history of dementia, decreased albumin, decreased GFR, residential status of nursing home, higher KATZ-ADL score and postoperative pneumonia.

Data Sharing Statement

on request.

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.

Consent for Publication

see consent to participate

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