Prognosis and institutionalization of frail community-dwelling older patients following a proximal femoral fracture: a multicenter retrospective cohort study

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Abstract
Summary Hip fractures are a serious public health issue with major consequences, especially for frail community dwellers. This study found a poor prognosis at 6 months post-trauma with regard to life expectancy and rehabilitation to pre-fracture independency levels. It should be realized that recovery to pre-trauma functioning is not a certainty for frail community-dwelling patients.

Introduction Proximal femoral fractures are a serious public health issue in the older patient. Although a significant rise in frail community-dwelling elderly is expected because of progressive aging, a clear overview of the outcomes in these patients sustaining a proximal femoral fracture is lacking. This study assessed the prognosis of frail community-dwelling patients who sustained a proximal femoral fracture.

Methods A multicenter retrospective cohort study was performed on frail community-dwelling patients with a proximal femoral fracture who aged over 70 years. Patients were considered frail if they were classified as American Society of Anesthesiologists score \( \geq 4 \) and/or a BMI \(< 18.5 \text{ kg/m}^2 \) and/or Functional Ambulation Category \( \leq 2 \) pre-trauma. The primary outcome was 6-month mortality. Secondary outcomes were adverse events, health care consumption, rate of institutionalization, and functional recovery.

Results A total of 140 out of 2045 patients matched the inclusion criteria with a median age of 85 (P25–P75 80–89) years. The 6-month mortality was 58 out of 140 patients (41%). A total of 102 (73%) patients experienced adverse events. At 6 months post-trauma, 29 out of 120 (24%) were readmitted to the hospital. Out of the 82 surviving patients after 6 months, 41 (50%) were unable the return to their home, and only 32 (39%) were able to achieve outdoor ambulation.

Conclusion Frail community-dwelling older patients with a proximal femoral fracture have a high risk of death, adverse events, and institutionalization and often do not reobtain their pre-trauma level of independence. Foremost, the results can be used for realistic expectation management.

Keywords Community-dwelling · Elderly · Geriatric · Hip fracture · Prognosis · Proximal femoral fracture

Introduction

Proximal femoral fractures are a serious public health issue in the older patient. The injury has major consequences with regard to mortality, morbidity, and health-related quality of life (HRQoL) [1–5]. Furthermore, recovery to pre-fracture functioning is lengthy and often unsuccessful [6, 7]. Mortality rates for the frailest patients with a proximal femoral fracture are as high as 36–55% after 6 months, and recovery to pre-trauma mobility is as low as 10–20% [7–10].

The degree of frailty greatly determines the prognosis [11, 12].
In the Netherlands, 92% of the adults aged over 75 years and 65% of adults aged over 90 years are community-dwelling, but while they live independently, it is estimated that up to one-third can be considered frail [13]. Due to progressive aging, the number of proximal femoral fractures in patients aged over 65 years is expected to rise with another 69% between 2012 and 2040 [14]. With 75% of the patients sustaining a proximal femoral fracture being community-dwelling, a stark rise in frail community-dwelling patients is to be expected [15].

Remarkably, the prognosis of frail community-dwelling patients is relatively unknown. Current studies addressing the prognosis of patients with a proximal femoral fracture do not separately address frail community-dwelling older patients but focus on institutionalized patients or highly heterogeneous study populations which include high proportions of non-frail patients [16]. In addition, these studies mostly focus on patients aged over 65 years old without addressing the effect of frailty and, in case they do account for frailty, they do not address the specific prognosis of community-dwelling patients [12, 17–23]. It has been suggested previously that future studies on older patients with a proximal femoral fracture should focus on certain subpopulations to further elucidate the relation between certain demographic factors and functional and survival outcomes [24].

A clear overview of the specific prognosis on frail community-dwelling older patients is needed to properly inform patients and their relatives of the often challenging recovery period ahead. Detailed knowledge on the prognosis will aid in realistic expectation management, better informed decision making, health care planning, and advance care planning in the community and create more awareness about the significant impact of the injury for this patient population.

This multicenter retrospective cohort study assessed the prognosis of a specific group of frail community-dwelling older patients who sustained a proximal femoral fracture with regard to mortality, adverse events, health care consumption, and functional outcome.

Method and materials

A multicenter retrospective analysis of frail community-dwelling older patients who sustained a proximal femoral fracture that were presented to three large teaching hospitals (Northwest Clinics, St. Antonius Ziekenhuis, or Ziekenhuis-groep Twente) between January 1, 2018 and September 30, 2019 was performed. Patients were identified based on diagnosis-related group (DRG; in Dutch DBC 218; hip fracture).

Patients were eligible for inclusion if they were aged ≥ 70 years old, sustained a proximal femur fracture after a low-impact injury, and were considered frail. The term frail implied that at least 1 of the following characteristics was present: classified as American Society of Anesthesiologists (ASA) score ≥ 4 and/or a body mass index (BMI) < 18.5 kg/m² and/or Functional Ambulation Category (FAC) of ≤ 2 pre-trauma (meaning that they require (intermittent) assistance of a person for safe ambulation) [25]. We choose to define patients that could be considered frail based on the mentioned criteria because of the retrospective nature of the study and other forms of established frailty assessments could not be performed. Comorbidities [26, 27], decreased BMI [28], and decreased mobility [29] have been described in previous literature as predictors for adverse outcomes after surgery.

Patients with fractures due to metastasis, periprosthetic fractures, and concomitant proximal femoral, pelvic, or other low extremity fractures in the previous 3 months prior to the injury or with a delayed presentation to the ED of ≥ 7 days post-trauma were excluded.

Outcome measures and data collection

All outcomes were ascertained via retrospective hospital chart reviewing in combination with data from the Dutch Hip Fracture Audit (DHFA) from the participating centers. The DHFA is a nationwide permanent hip fracture registry with a 3-month follow-up. Data were collected according to a pre-defined case report form.

The primary outcome measure was the 6-month mortality rate post-trauma. Secondary outcome measures were adverse events, health care, readmission, residency, functional outcome, and activities of daily living (ADL) dependency during the 6-month follow-up period. Health care consumption was measured by length of stay, number of (para)medic consultations, the requirement of intensive care admission, readmissions, and outpatient clinic follow-up. Furthermore, the use of antipsychotic drugs, the use of physical restraints to prevent adverse events, and the number of blood transfusions were recorded. Functional outcome was measured with the pre-fracture mobility score (PMS) and was measured at admission, at hospital discharge, and at 3 months and 6 months post-trauma. ADL dependency was measured via the Katz Index of Independence in Activities of Daily Living (Katz ADL) score at admission and after 3 months.

The following patient, fracture, and treatment characteristics were collected: age, sex, BMI, ASA grade, Charlson comorbidity index (CCI) [30], FAC score pre-trauma, PMS, Katz ADL score, pre-trauma level of home care assistance with ADL, nutritional assessment (Short Nutritional Assessment Questionnaire (SNAQ) or Malnutrition Universal Screening Tool (MUST) score), fracture types, additional injuries, time to surgery, type of treatment, and type of anesthesia. These characteristics were also used to identify risk factors for mortality, inability to return to their own home, and unsuccessful rehabilitation (not regaining pre-fracture
PMS) after 6 months. Death before regaining previous mobility or returning to home was regarded as not regaining pre-trauma PMS or institutionalization at the 6-month follow-up. No data was gathered for excluded patients in this study as no consent or waiver was provided to allow analysis of these patients.

**Statistical analysis**

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 24.0 (SPSS, Chicago, IL, USA). The results were reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [31]. No data imputation was used to replace missing values. Normality of continuous data was tested with the Shapiro–Wilk test. Continuous data, which were all non-parametric, were shown as median and quartiles. Categorical data were reported as numbers and frequencies. Univariate comparison was done using the Mann–Whitney U test or chi-square test or Fisher’s exact test, as applicable. Risk factors for mortality, institutionalization, and unsuccessful rehabilitation after 6 months were performed using logistic regression analysis and reported as OR with corresponding 95% confidence interval. As it is important to predict these factors early in the process, only patient characteristics and fracture type were considered in this analysis. Since the level of home care and the Katz ADL score are closely related, as is fracture type and surgical treatment, only the level of home care and fracture type were included in the analysis. Parameters that showed a p value <0.10 in the univariate logistic analysis were included in a multiple logistic regression model with backward selection to identify predictors. The p value for statistical significance was set at p < 0.05.

**Results**

In total, 140 out of 2045 (7%) patients with a proximal femoral fracture who were admitted within the study period matched the inclusion criteria. The median age at trauma was 85 (P25–P75 80–89) years. Eighty-seven (62%) patients were female. Baseline characteristics are summarized in Table 1. Half of the patients received home care for support for performing ADL, with a median of daily visits of home care of 2 (P25–P75 2–3). Most falls occurred in the domestic setting (n = 125; 89%).

**Facture and treatment characteristics**

Displaced femoral neck fractures were the most frequent fracture type (Table 2). In 26 (19%) patients, there were concomitant traumatic injuries or clinical abnormalities

| Characteristic          | Total (n = 140) |
|-------------------------|-----------------|
| Age (years)             | 140 85 (80–89)  |
| Sex (female)            | 140 87 (62%)    |
| BMI (kg/m²)             | 138 21.5 (17.9–25.0) |
| CCI                     | 140 3 (2–5)     |
| Dementia                | 140 27 (19%)    |
| Mobility                |                 |
| FAC 2                   | 140 6 (4%)      |
| FAC 3                   | 140 6 (4%)      |
| FAC 4                   | 140 48 (34%)    |
| FAC 5                   | 140 80 (57%)    |
| PMS                     |                 |
| Freely mobile without aids | 140 39 (28%)    |
| Mobile outdoors with 1 aid | 5 (4%)         |
| Mobile outdoors with 2 aids or frame | 67 (48%) |
| Never outside without help | 28 (20%)       |
| No functional mobility  | 140 1 (1%)      |
| Mobility                |                 |
| Bed-chair transfer      | 140 1 (1%)      |
| Few steps (AR < 10 m)   | 140 9 (6%)      |
| Mobile (AR ≥ 10 m)      | 140 130 (93%)   |
| History of falling in last 6 months (yes) | 139 89 (64%) |
| Home care prior to trauma (yes) | 140 69 (49%) |
| Katz ADL score          |                 |
| 0                       | 137 70 (51%)    |
| 1                       | 16 (12%)        |
| 2                       | 25 (18%)        |
| 3                       | 14 (10%)        |
| 4                       | 5 (4%)          |
| 5                       | 5 (4%)          |
| 6                       | 2 (2%)          |
| ASA score               |                 |
| ASA II                  | 140 12 (9%)     |
| ASA III                 | 45 (32%)        |
| ASA IV                  | 83 (59%)        |
| Malnutrition (SNAQ or MUST ≥ 1) | 129 54 (39%) |
| Hb (mmol/L)ᵇ            | 140 7.4 (6.7–8.3) |
| Creatinine (µmol/L)ᵇ    | 140 83 (63–114) |

Data are presented as median (P25–P75) or as n (%)

*BMI* body mass index, *FAC* Functional Ambulatory Category, *AR* action radius, *CCI* Charlson comorbidity index, *PMS* prefracture mobility score, *Katz ADL* Katz Index of Independence in Activities of Daily Living, *ASA* American Society of Anesthesiologists, *Hb* hemoglobin, *SNAQ* Short Nutritional Assessment Questionnaire, *MUST* Malnutrition Universal Screening Tool

ᵃNumber of patients for whom data were available

ᵇHemoglobin mmol/L to g/DL conversion multiply by factor 1.61

ᶜCreatinine µmol/L to mg/DL conversion divide by factor 88.4
in the pre-operative screening (such as urinary tract infections and electrolyte abnormalities). Initially, 132 patients opted for surgical management. Non-operative management (NOM) was primarily opted for by eight (6%) patients due to the high perioperative risks of mortality related to cardiac comorbidities or poor health status. Due to clinical deterioration during the pre-operative waiting period, 6 additional patients (5%) who primarily opted for surgery were no longer considered suitable candidates for operative treatment.

In total, 126 (90%) patients were treated surgically and 14 (10%) were managed non-operatively. Seventy-four (59%) patients were operated on within 24 h after ED admission. The median time to surgery was 21 h (P_{25}–P_{75} 15–32). Spinal anesthesia was performed in 54 (43%) patients.

### Mortality

Within 6 months post-trauma, 58 (41%) patients died. Twenty (14%) patients died during the index hospital stay. For operatively treated patients (n = 126), the 30-day, 3-month, and 6-month mortality rates were 15% (n = 19), 27% (n = 34), and 35% (n = 44), respectively, with a median time to death of 39 days (P_{25}–P_{75} 15–73). All patients who were eventually managed non-operatively died within 30 days (n = 14) with a median time to death of 5 days (P_{25}–P_{75} 3–8). Ten non-operatively treated patients (71%) died during the hospital stay.

### Adverse events

A total of 216 adverse events occurred in 102 patients (73% of total) during the study period. Table 3 shows an overview of adverse events. In total, 25 surgery-related adverse events occurred in 20 (14%) patients. Nine reoperations were registered in 6 patients (4% of total) within the study period. Delirium (n = 34; 24%), pneumonia (n = 34; 24%), pressure ulcers (n = 23; 17%), and urinary tract infections (n = 24; 17%) were the most common adverse events. Three-quarters of the adverse events occurred during the primary hospital stay. In addition, 7 (5%) patients required physical restraints to prevent adverse events and 54 (39%) patients had a blood transfusion. Forty-six (33%) patients were given antipsychotic drugs during admission. Significantly more patients required transfusion in the pertrochanteric/subtrochanteric fracture group than in the femoral neck fracture group (49% vs 30%, p = 0.025).

### Health care consumption

The median length of stay was 9 days (IQR 6–14). Patients were often managed by multiple disciplines. A total of 578 (para)medic specialisms other than the primary treating (orthopedic) trauma surgeon were consulted during the index admission (median of 4 consultations per patient (IQR 3–5)). Patients were comanaged by geriatricians in all but two patients. In total, 36% of the patients were screened and/or treated by a cardiologist, 21% by internists, 18% by an anesthesiologist (for judgment if patients were operable), 13% by a pulmonologist, 10% by a neurologist, 10% by an intensive care physician, and 7% by a urologist. A physical

| Table 2 Fracture characteristics and management in the non-operative and operative groups |
|---------------------------------|---------------------------------|
| Characteristic                  | Total (n = 140)                 |
| Fracture type                   | n*                             |
| Femoral neck                   | 140 74 (53%)                   |
| Garden 1–2                     | 19 (26%)                       |
| Garden 3–4                     | 55 (74%)                       |
| Pertrochanteric                | 61 (44%)                       |
| AO 31-A1                      | 20 (33%)                       |
| AO 31-A2                      | 37 (61%)                       |
| AO 31-A3                      | 4 (7%)                         |
| Subtrochanteric               | 5 (4%)                         |
| Concomitant injuries/clinical abnormalities | 140 26 (19%) |
| Management strategy            | n*                             |
| Operative                      | 126 (92%)                      |
| Non-operative                  | 14 (9%)                        |
| Time to surgery                | n*                             |
| < 24 h                         | 126 74 (59%)                   |
| 24–48 h                        | 40 (32%)                       |
| ≥ 48 h                         | 12 (10%)                       |
| Anesthesia type                | n*                             |
| General                        | 126 72 (57%)                   |
| Spinal                         | 54 (43%)                       |
| Implant                        | n*                             |
| Osteosynthesis                 | 126 13 (9%)                    |
| HA                             | 49 (35%)                       |
| THA                            | 1 (1%)                         |
| IMN                            | 54 (39%)                       |
| Extended IMN                   | 8 (6%)                         |
| Girdlestone                    | 1 (1%)                         |
| Duration of surgery (min)      | 126 70 (49–92)                 |
| Nerve block                    | 140 14 (10%)                   |
| Mobilization policy            | n*                             |
| Full weight bearing            | 131 120 (92%)                  |
| Partial weight bearing         | 4 (3%)                         |
| Non-weight bearing             | 7 (5%)                         |
| HLOS (days)                    | 140 9 (6–14)                   |

Data are presented as number (%) or as median (P_{25}–P_{75}). h hours, HA hemiarthroplasty, THA total hip arthroplasty, IMN intramedullary nail, min minutes, HLOS hospital length of stay

*Number of patients for whom data were available
a therapist was involved in 92% of the patients, a dietitian in 61%, occupational therapist in 9%, speech therapists in 9%, and spiritual caregivers in 13%. The palliative care team was involved in 15% of the cases of which 13 out of 21 consults were requested in surgically treated patients. In total, 17 (12%) patients required admittance in the post-anesthesia care unit, intensive care unit, or cardiac care unit.

**Hospital care use post-discharge**

Out of the 120 patients who survived to discharge, 33 (28%) were readmitted to the ED, and 29 (24%) were readmitted to the hospital during the study period. Reasons for hospital readmission are displayed in Table 3.

Sixty of the 120 (50%) patients revisited to the hospital for an outpatient follow-up. In 41 (68%) patients, this was for a regular follow-up with the surgeon, in 10 (17%) patients because of adverse symptoms or follow-up of adverse events, and in 9 (15%) patients for a combination of both.

| Characteristic | Total (n = 140) |
|---------------|----------------|
| **Adverse events** | |  
| Total number | 216 |
| Patients with an AE | 102 (73%) |
| Adverse events per patient | 1 (0–2) |
| Multiple adverse events (≥2) | 65 (46%) |
| Time to adverse event (days) | 5 (3–15) |
| **General AE** | |  
| Delirium | 34 (24%) |
| Multiple deliria | 2 (1%) |
| Pneumonia | 34 (24%) |
| Pressure ulcer | 24 (17%) |
| Urinary tract infection | 24 (17%) |
| Retention bladder | 13 (9%) |
| Gastrointestinal | 7 (5%) |
| COPD exacerbation | 5 (4%) |
| Fracture after recurrent fall | 3 (2%) |
| Infection of unknown origin | 3 (2%) |
| CVA | 2 (1%) |
| Erysipelas cellulitis | 2 (1%) |
| Severe dehydration kidney dysfunction | 2 (1%) |
| Sudden death of unknown origin | 2 (1%) |
| Morphine intoxication | 1 (1%) |
| Perioperative peroneal nerve paralysis | 1 (1%) |
| Serotonin syndrome | 1 (1%) |
| Transfusion reaction | 1 (1%) |
| **Cardiovascular AE** | |  
| Heart failure | 19 (14%) |
| Arrhythmia | 8 (6%) |
| Multiple arrhythmias | 1 (1%) |
| Myocardial infarction | 2 (1%) |
| **Surgery/fracture-related AE** | |  
| Deep wound infection | 6 (4%) |
| Superficial wound infection | 5 (4%) |
| Perioperative hemodynamic instability | 5 (4%) |
| Osteosynthesis failure malposition | 4 (3%) |
| Hemiarthroplasty dislocation | 2 (1%) |
| Rebleed | 2 (1%) |
| Progressive pain* | 1 (1%) |
| Reoperation | 6 (4%) |
| **Clavien-Dindo grade** | |  
| I | 33 (15%) |
| II | 134 (62%) |
| IIIa | 2 (1%) |
| IIIb | 8 (4%) |
| IV | 12 (6%) |
| IVa | 1 (1%) |
| IVb | 1 (1%) |
| V | 25 (12%) |
| **Reason for readmission** | |  
| Gastrointestinal | 5 (4%) |
| Sepsis other infections | 5 (4%) |
| Surgical material related AEs | 5 (4%) |
| Bleeding anemia | 4 (3%) |
| Cardiac | 3 (3%) |
| Pneumonia | 3 (3%) |
| Surgical site infection | 3 (3%) |
| Recurrent fall | 2 (2%) |
| Retention bladder | 2 (2%) |
| Delirium | 1 (1%) |
| Urine tract infection | 1 (1%) |
| Vascular comprised leg | 1 (1%) |
| Serotonin syndrome | 1 (1%) |
| **Residence when AE occurred** | |  
| Hospital | 165 (76%) |
| Out of hospital | 36 (17%) |
| During readmission | 15 (7%) |
| **Other undesirable events** | |  
| Antipsychotic drug use | 46 (33%) |
| Physical fixation | 7 (5%) |
| Blood transfusion | 54 (39%) |

Data are presented as n (%).

**AE adverse events, CVA cerebrovascular accident, COPD chronic obstructive pulmonary disease, ED emergency department**

*Initially non-operatively managed patients who were eventually operated on because of progressive pain and fracture dislocation

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Residency

Table 4 provides an overview of the residency, ADL (in)dependency, and mobility. Out of the 120 patients who survived the index submission, 105 (87%) were institutionalized at discharge. Most patients were discharged to a rehabilitation center (73% of the cases). Seven (8%) patients were discharged to a hospice and one patient with palliative care to his own home. At 3 months and 6 months post-trauma, one-third \( (n = 29) \) and 50% \( (n = 41) \) of the patients returned to their community home after hospital discharge, respectively. In total, 59 out of the 120 (49%) patients returned to their own home at any time during the 6-month study period.

Mobility and ADL (in)dependency

At hospital discharge, 42 (35%) patients were unable to ambulate. At 6 months post-trauma, 32 (39%) patients were able to achieve outdoor mobilization with or without aids versus 111 (79%) in the pre-fracture situation.

At discharge, only 14% \( (n = 17/120) \) regained their previous level of mobility. After 3 months, this was 39% \( (n = 35/89) \). After 6 months, only 29% \( (n = 24/82) \) of the patients still alive achieved a recovery to their pre-trauma PMS. In total, 39 out of the 140 patients (28%) regained their pre-trauma level of mobility at any time during the study period.

With regard to ADL, 36% of the patients who survived to 3 months regained their previous level of ADL (in)dependency. At 3 months, only 26 (30%) of the surviving patients lived completely ADL independent, compared to 70 (50%) at the pre-fracture level.

Predictors for mortality, institutionalization, and not regaining pre-fracture mobility

Univariate logistic regression showed that age (OR 1.07; 95% CI 1.01–1.12), ASA score of 4 (OR 3.47; 95% CI 1.65–7.27), PMS (mobile with aids [OR 2.04; 95% CI 0.88–4.71] and indoor confined [OR 2.73; 95% CI 1.00–7.48]), and patients who received home care prior to

### Table 4 Residency, ADL independency, and mobility of patients who survived to point of measurement

| Residency                              | Admission \( (n = 140) \) | Discharge \( (n = 120) \) | 3 months \( (n = 89) \) | 6 months \( (n = 82) \) |
|----------------------------------------|---------------------------|---------------------------|-------------------------|-------------------------|
| Home, without home care               | 71 (51%)                  | 1 (1%)                    | 23 (26%)                | 18 (22%)                |
| Home, with home care                  | 69 (49%)                  | 13 (11%)                  | 31 (35%)                | 23 (28%)                |
| Rehabilitation center                 | 0 (0%)                    | 88 (73%)                  | 9 (10%)                 | 1 (1%)                  |
| Retirement home                        | 0 (0%)                    | 2 (2%)                    | 6 (7%)                  | 3 (4%)                  |
| Nursing home                           | 0 (0%)                    | 7 (6%)                    | 17 (19%)                | 15 (18%)                |
| Hospice/hospital with palliative care | 0 (0%)                    | 9 (8%)                    | 0 (0%)                  | 0 (0%)                  |
| Missing                                | 0 (0%)                    | 0 (0%)                    | 3 (3%)                  | 22 (27%)                |
| Able to return to home                | n/a                       | 15 (13%)                  | 29 (33%)                | 41 (50%)                |
| Katz ADL score                         |                           |                           |                         |                         |
| 0                                      | 70 (50%)                  | n/a                       | 26 (30%)                | n/a                     |
| 1–2                                    | 41 (29%)                  | n/a                       | 12 (14%)                | n/a                     |
| 3–4                                    | 19 (14%)                  | n/a                       | 14 (16%)                | n/a                     |
| 5–6                                    | 7 (5%)                    | n/a                       | 19 (21%)                | n/a                     |
| Missing                                | 3 (2%)                    | n/a                       | 18 (20%)                | n/a                     |
| Retainment of Katz ADL score           | n/a                       | n/a                       | 32 (36%)                | n/a                     |
| PMS                                    |                           |                           |                         |                         |
| Freely mobile without aids            | 39 (28%)                  | 0 (0%)                    | 9 (10%)                 | 7 (9%)                  |
| Mobile outdoors with 1 aid            | 5 (4%)                    | 0 (0%)                    | 4 (5%)                  | 3 (4%)                  |
| Mobile outdoors with 2 aids or frame  | 67 (48%)                  | 26 (22%)                  | 22 (36%)                | 22 (27%)                |
| Mobile indoors, but never outside      | 28 (20%)                  | 52 (43%)                  | 22 (25%)                | 12 (15%)                |
| No functional mobility                | 1 (1%)                    | 42 (35%)                  | 17 (19%)                | 9 (11%)                 |
| Missing                                | 0 (0%)                    | 0 (0%)                    | 5 (6%)                  | 29 (35%)                |
| Retainment of PMS score               | n/a                       | 17 (14%)                  | 35 (39%)                | 24 (29%)                |

Data are presented as \( n \) (%) of patients who survived to the point of measurement

ADL activities of daily living, Katz ADL Katz Index of Independence in Activities of Daily Living, n/a not applicable, PMS prefracture mobility score

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the trauma (OR 2.14; 95% CI 1.08–4.26) were predictive for death within 6 months post-trauma with a $p$ value < 0.10 (Table 5). Multivariable analysis only identified ASA class 4 (OR 4.27; 95% CI 1.90–9.61) and age (OR 1.07; 95% CI 1.00–1.14) as significant predictors for death within 6 months. With regard to extrinsic factors, the type of

### Table 5 Logistic regression analysis for 6-month mortality, failure to return to own residency, and unsuccessful return to pre-trauma PMS score

| Dependent variables and characteristics | Univariate | Multivariate |
|-----------------------------------------|------------|--------------|
| **6-month mortality**                   |            |              |
| Age (years)                             | 140        | 140          |
| ASA score (4 $\geq$ vs 2–3)             | 140        | 140          |
| Home care for ADL prior to trauma       | 140        | 140          |
| Sex (male)                              | 140        | 140          |
| BMI (kg/m²)                             | 138        | 140          |
| Malnutrition (SNAQ/MUST ≥ 1)            | 119        | 140          |
| Charlson comorbidity index              | 140        |              |
| Prefracture mobility score              | 140        |              |
| Independently mobile                    | 39         |              |
| Mobile with aids                        | 72         |              |
| Indoors confined                        | 29         |              |
| Fracture type (femoral head vs trochanteric/subtrochanteric) | 140        |              |
| **Failure to return to home**           |            |              |
| Age (years)                             | 140        | 140          |
| Sex (male)                              | 140        | 140          |
| BMI (kg/m²)                             | 138        | 140          |
| Malnutrition (SNAQ/MUST ≥ 1)            | 119        | 140          |
| ASA score (4 $\geq$ vs 2–3)             | 140        | 140          |
| Charlson comorbidity index              | 140        |              |
| Prefracture mobility score              | 140        |              |
| Independently mobile                    | 39         |              |
| Mobile with aids                        | 72         |              |
| Indoors confined                        | 29         |              |
| Home care for ADL prior to trauma       | 140        |              |
| Fracture type (femoral head vs trochanteric/subtrochanteric) | 140        |              |
| **Failure to regain pre-trauma PMS score** | 140  | 140         |
| Age (years)                             | 140        | 140          |
| ASA score (4 $\geq$ vs 2–3)             | 140        | 140          |
| Sex (male)                              | 140        | 140          |
| BMI (kg/m²)                             | 140        | 140          |
| Malnutrition (SNAQ/MUST ≥ 1)            | 119        | 140          |
| Charlson comorbidity index              | 119        | 140          |
| Prefracture mobility score              | 140        |              |
| Independently mobile                    | 39         |              |
| Mobile with aids                        | 72         |              |
| Indoors confined                        | 29         |              |
| Home care for ADL prior to trauma       | 140        |              |
| Fracture type (femoral head vs trochanteric/subtrochanteric) | 140        |              |

Data are shown as OR with corresponding 95% CI intervals

*BMI* body mass index; *SNAQ* Short Nutritional Assessment Questionnaire; *MUST* Malnutrition Universal Screening Tool; *ASA* American Society of Anesthesiologists

*Included the multivariable regression analysis

Bold $p$-values indicate statistical significance
associated with mortality compared to surgery (surgery was no longer found to be statistically significant). When these patients were excluded, the effect of delayed surgery was no longer found to be statistically significant (p = 0.574).

With regard to institutionalization at 6 months, univariate logistic regression showed that age (OR 1.13; 95% CI 1.07–1.20), pre-fracture PMS (mobile with aids [OR 4.50; 95% CI 1.95–10.40] and indoors confined [OR 5.91; 95% CI 2.04–16.06]), and patients who received home care prior to the trauma (OR 5.09; 95% CI 2.44–10.60) were predictive factors (Table 5). Multivariate analysis only identified age (OR 1.09; 95% CI 1.02–1.16) and patients receiving home care for ADL prior to trauma (OR 2.60; 95% CI 1.01–6.68) as significant predictors for failing to return to their previous residency.

With regard to not regaining pre-fracture PMS, univariate logistic regression showed that only age (OR 1.06; 95% CI 1.01–1.13) and ASA class 4 (OR 2.72; 95% CI 1.12–5.95) were predictive factors (Table 5). In multivariate analysis, age (OR 1.06; 95% CI 1.01–1.13) and ASA class 4 (OR 2.72; 95% CI 1.25–5.95) remained to be significant predictors.

### Discussion

The results of this study show that the prognosis of frail community-dwelling older patients with a proximal femoral fracture is generally poor. Despite multidisciplinary efforts of rehabilitation and significant health care consumption, one-third of the patients do not recover with regard to their pre-trauma PMS, high mortality rates are found, and only half of the patients who survived till hospital discharge returned home within 6 months post-trauma.

This suggests that these community-dwelling patients are at a crossroads; they either make a timely recovery to their pre-trauma functioning or are able to return to home or they experience progressive clinical deterioration with unsuccessful rehabilitation with a high risk of mortality. Presumably, for those patients who are physically frail, a proximal femoral fracture disturbs the delicate equilibrium of their residual-independent mobility and could provoke a downwards spiral.

This study corroborates and extends the current increasing evidence of the poor prognosis of frail older patients with a proximal femoral fracture, whereas previous studies describing mortality in Dutch patients with a proximal femoral fracture aged over 65 years have shown mortality rates of 17.7% after 1 year, 23% for patients aged between 65 and 89, and 43% of patients aged ≥ 90 after 1 year; the mortality rate for this specific study was much higher (44% at 6 months) [19, 32]. This excess mortality is most likely attributable due to the frailty of the patient population as previous studies have already shown an increased risk of adverse outcomes in frail patients [11, 12, 21–23]. In addition, the risk of mortality of the average 84-year-old resident in 2020 in the Netherlands is about 7.6% per year, reiterating the significant effect of a proximal femoral fracture and frailty on the prognosis [33].

The treatment of patients with a proximal femoral fracture typically entails hospitalization followed by an often lengthy rehabilitation period [34]. However, this rehabilitation period can be intensive while a return to previous levels of functioning is not a certainty. In addition, (temporary) institutionalization for community reintegration is often required. This pattern was also the case in our study, as the rate of institutionalization at discharge was almost 90%. Similar rates of institutionalization of approximately 70% and 85% in community-dwelling patients were found by previous studies in their cohorts [35, 36]. Despite the attempts of institutionalized rehabilitation, return to previous levels of functioning is not a given fact as results showed that approximately one-third did not return to their pre-trauma level of mobility and approximately 25% of the surviving patients were not mobile outdoors at 6 months post-trauma. Among others, Mariconda et al. [37] reported unsuccessful recovery of 43% after 1 year. These data and our key findings are in concordance with other current literatures [20, 32, 38].

As reported by Brown et al. [39], improvement of functioning following a proximal femoral fracture mainly occurs within the first 3 months. After this period, only minimal improvements can be expected [39]. This timeframe of recovery was also reflected in the data in our study. This stresses the importance of early mobilization and an early start of the rehabilitation process which mainly entails adequate pain control and the prevention of postoperative adverse events that hamper mobilization.

This retrospective study had some limitations. Important factors such as (HR)QoL, self-perceived level of recovery, pain, fear of falling, and other dimensions (e.g., social support) were not assessed. Furthermore, due to the retrospective nature of this study, no information on mobility and residence was available if patients did not revisit the hospital, died in the follow-up period, or had missing data in the 3-month dataset in the DHFA. In addition, frailty criteria based on validated frailty scales or indices could not be used to identify frail patients within the study period due to the retrospective nature of this study. Although the described cohort formally cannot be described as frail, only a specific subset of community-dwelling older patients was included that represented only 7% of the total patient population with
a proximal femoral fracture within the study period. The poor outcomes of this specific group were poor, and therefore, the described cohort is very likely to feature a high degree of frailty and was therefore labeled as frail. In addition, the separate indicators for frailty (comorbidities, BMI, and decreased mobility) have been described as separate risk factors for poor outcomes and are easily reproducible and quantifiable.

Even though this cohort is one of the larger cohorts featuring frail community-dwelling patients, multivariable logistic regression analysis was limited due to sample size and by the fact that only the frailest patients were included in this analysis. The multivariable analysis should therefore be interpreted with caution. Prediction of definitive institutionalization remains difficult. Previous data from the DHFA in the Netherlands showed that age, pre-fracture PMS, pre-morbid Katz ADL score, surgical treatment, ASA score, type of anesthesia, history of dementia, and cotreatment by a geriatrician were early independent predictors for institutionalization [40].

Despite these limitations, this study is unique in the way that it addresses a specific subpopulation of frail community-dwelling patients with a worse prognosis than described in previous studies addressing community-dwelling patients based on age or other frailty indicators [5, 11, 12].

The findings have several implications. First, the results of this study can be used especially for realistic expectation management and aid in better decision making, since there is a high chance of unfavorable outcomes in this patient group. Realistic expectations by patients or caregivers will most likely result in higher treatment satisfaction and clearer goals of care. It must be made clear that recovery to previous levels of functioning is often not likely. Second, it is very important to identify those patients who are unlikely to (re)obtain mobility and survive to a longer term, not only to provide realistic expectations but also to timely engage in end-of-life conversation. Treatment options should be openly discussed for those at high risk of not regaining mobility with consequent institutionalization and for those at high risk of adverse events with the reduced quality of life, ADL dependence, and the discomfort that it presumably results in. In this small subgroup within an already selected patient population, it should be questioned if surgery, or in case of postoperative clinical deterioration an intensive rehabilitation program, is the best treatment option depending on their goals of care and motivation. However, this only accounts for a very small subset of patients as a significant proportion of the surviving patients make a clinical recovery. Lastly, because of the high rate of institutionalization at discharge, requests for a transfer to a rehabilitation setting or ADL assistance should be timely arranged in this specific patient group to prevent unnecessary delays in transfers and unnecessary occupation of hospital beds.

### Conclusion

Frail community-dwelling older patients with a proximal femoral fracture have a high risk of death, adverse events, and institutionalization and often do not reobtain their pre-trauma level of mobility and independence at 6 months post-trauma. Foremost, the results can be used for realistic expectation management, improved shared decision making, advance care planning in the community, and health care planning.

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### Data Availability
Relevant anonymized data on individual patients for meta-analysis purposes can be provided upon reasonable request to the corresponding author.

### Declarations

**Ethics approval** This study has been exempted by the Medical Research Ethics Committee of VU University Medical Center according to article 7 of the Medical Research Involving Human Subjects Act (ref. no. 2019.578). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Conflicts of interest** None.

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