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ORIGINAL ARTICLE

Predictors of long-term survival after hip fractures?—5-year results of a prospective study in Germany

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Abstract

Summary The incidence of hip fractures is increasing due to demographic transition. Data on long-term survival and influencing factors are sparse. Our prospective observational study with 395 patients shows a survival of 38% after 5 years. Significant risk factors were male gender, higher age, lower Barthel Index, lower Charlson Comorbidity Score, lower Mini-Mental State Examination, and delirium during hospitalization.

Purpose The incidence of hip fractures is increasing due to demographic transition. Until now, they are associated with poor results and high mortality rates. Data on long-term survival and influencing factors are sparse. Therefore, a prospective observational study was conducted.

Methods Patients ≥ 60 years with hip fracture were included in this prospective study between 2009 and 2011. Demographic parameters, as well as ASA Score, pre-fracture Barthel Index and EQ-5D, Mini-Mental State Examination, Charlson Comorbidity Score, fracture type, type of surgical treatment, place of discharge, and arising complications were registered. Outcome parameter was survival during a 5-year follow-up period.

Results A total of 539 patients attended to our emergency room during the period of recruitment. The recruitment rate was 75%. A total of 402 patients were included; 7 were lost to follow-up, and 152 (38%) survived the study period. The mortality was more than 25% in the first year after fracture. Subsequently, it was between 7 and 9% per year. In the multivariate analysis, significant risk factors for dying were male gender ($p = 0.002$), higher age ($p < 0.001$), lower Charlson Comorbidity Score ($p = 0.033$), lower Barthel Index ($p = 0.024$), lower Mini-Mental State Examination ($p = 0.002$), and occurrence of delirium during hospitalization ($p = 0.008$).

Conclusion Our results confirm poor results of geriatric patients after hip fracture. While early results might be influenced by optimal fracture care, long-term results seem to be determined by not changeable patient factors. Nevertheless, more than one third of surviving patients after 5 years justify the elaborate treatment algorithms for these fragile patients.

Keywords Hip fracture · Mortality · 5-year mortality · Risk factors · Geriatric patient

Introduction

As a result of demographic change, the number of fractures in geriatric patients is increasing. The most important fractures in this setting are hip fractures. In 2016, more than 148,000 patients (age ≥ 70 years) received inpatient treatment of the diagnosis proximal femoral fracture in Germany [1].

Among other authors investigating hip fracture–associated mortality in different populations, Haentjens et al. described the risk of all-cause mortality during the first 3 months, five to eight times higher compared with the general population [2]. Following the first year after hip fracture, Omsland et al. reported the mortality in Norwegian inhabitants to be 21% in women compared with 33% in men [3]. The mortality declines during the following years after surgery [3]. There are different studies with contrary conclusions regarding the long-term mortality. Camurcu et al. stated the 5-year survival rate of 5.6% (95% CI 2.3–12.5%) in patients after hemi-arthroplasty

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for unstable intertrochanteric fracture [4], while Frost et al. reported a relative survival rate of 0.59 (95% CI 0.48–0.68) [4, 5].

Only little is known about predictable characteristics regarding the 5-year mortality. Furthermore, the already existing data present inconsistent results. According to Camurcu et al., there are three predictors for 1-year mortality: the American Society of Anaesthesiologists Score (ASA Score) (<3 vs. ≥ 3), number of systemic comorbidities (<3 vs. ≥ 3), and the duration of postoperative immobilization (1 vs. ≥ 2 days) [4]. In contrast to Camurcu et al., other authors claim that age and/or gender are additional relevant prognostic factors [3, 6, 7]. Besides the ASA Score and gender, Bliemel et al. evaluated the pre-fracture EQ-5D index, Mini-Mental State Examination (MMSE) as additional predictors for 1-year survival rate [8]. Generally, there is one point all authors agree to: Hip fractures are associated with reduced life expectancy [3, 5, 6].

The aim of this study was to evaluate the 5-year survival rate of hip fracture and to identify influencing factors for 5-year survival.

Patients and methods

A total of 539 patients attended to our emergency room during the period of recruitment. The recruitment rate was 75%. A total of 402 patients (aged ≥ 60 years) were included in this prospective single-center observational study. All patients suffered from a hip fracture (ICD-10 S72.0-72.2) and were surgically treated with internal fixation, hemi-arthroplasty, or arthroplasty. Exclusion criteria were multiple traumas (injury severity score ≥ 16) and malignancy-related fractures. The period of recruiting lasted from April 1, 2009, until September 30, 2011. The last follow-up examination took place in November of 2016. We obtained the approval by the Ethics committee of the University of Marburg (AZ 175/08). Each patient or their legal representative gave their written informed consent.

Survival

For the present analysis, we used survival data in a follow-up period of 5 years after index fracture. A survival curve was created with time periods of 12 months.

Baseline and treatment data/influencing factors

The following baseline data were documented from all patients at the beginning of index hospital stay: age, gender, Mini-Mental State Examination (MMSE) [9], pre-fracture Barthel Index [10], Charlson Comorbidity Score (CCS) [11], residential status, ASA Score [12], EQ5D [13].

During index stay in hospital, the following data were collected: type of fracture (fractures were classified in intracapsular femoral neck fractures (stable and unstable), trochanteric fractures (stable and unstable), and subtrochanteric fractures), surgical procedure, place of discharge after hospital, and the arising of complications. The types of complications occurring during the index hospital stay were classified by the "Clavien-Dindo classification." Grade 1 complication stands for any deviation from the normal without the need of pharmacological treatment (except for antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy) or surgical, endoscopic, and radiological interventions. Grade 2 complication is represented by pharmacological treatment with drugs other than such allowed in grade 1. Grade 3 complications require surgical, endoscopic, or radiological intervention. Grade 4 complications are life-threatening complications. The death of a patient is classified as grade 5 complication [14]. Data regarding the survival of the patients was collected at the local registration offices.

Data management and statistics

Data were collected in a Filemaker database (FileMaker Inc., Santa Clara, CA). Double entry with a plausibility check was performed to ensure data quality. IBM SPSS statistics 22 (Statistical Package for the Social Science, IBM Corporation, Armonk, NY) was used for the statistical analysis. Data were presented as means, standard deviations, and frequencies. With bivariate analysis, differences between both groups (survivors vs. non-survivors) were analyzed. Dichotomous variables were analyzed with Fisher's exact test. The Shapiro-Wilk test was used to test for the normal distribution of numerous variables. Accordingly, for these variables the Mann-Whitney test or the Kruskal-Wallis test was used. Finally, out of all parameters, those variables that were independently associated with long-term survival after hip fracture were identified with multiple regression analysis. We chose backward stepwise selection. Inclusion criterion to enter was $p < 0.1$ and $p > 0.05$ to exit.

Results

A total of 395 patients were re-examined 5 years after surgery. Seven patients were lost to follow-up. The detailed patient distribution is shown in the flow chart. Of all included patients, 6.3% ($n = 25$) died during hospitalization, 28.4% ($n = 102$) of the patients died within the first year, 9.4% ($n = 37$) in the second, 6.8% ($n = 27$) in

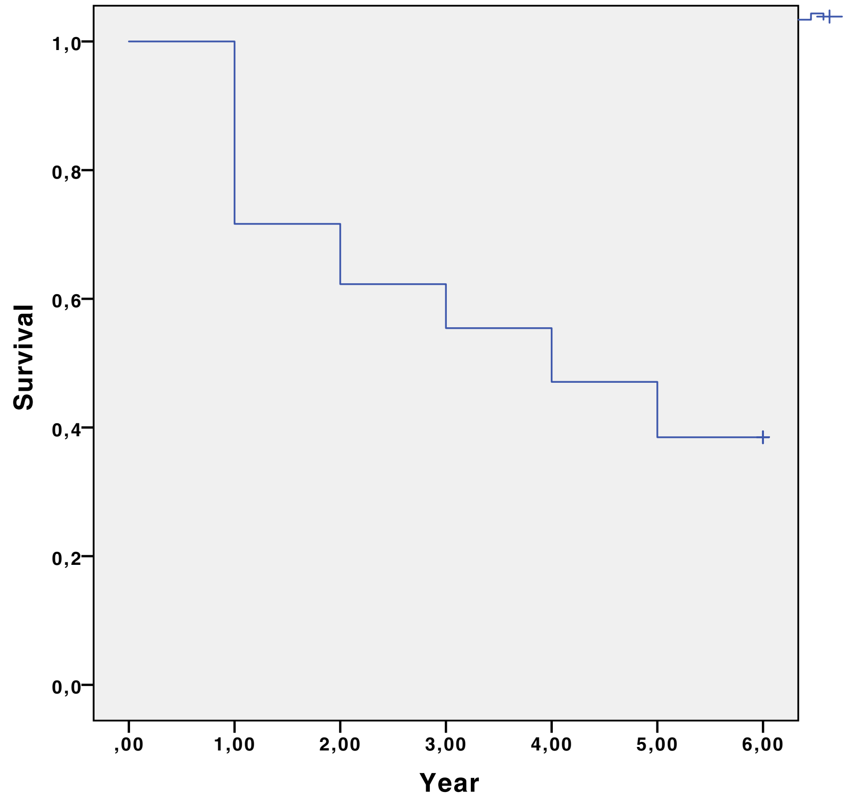

Fig. 1 Kaplan-Meier curve showing survival during the first 5 years after hip fracture. The highest mortality was detected during the first year. In the following years, it stayed on a constant level

the third, 8.4% ($n = 33$) in the fourth, and 8.6% ($n = 34$) in the fifth. Five years after surgery, 152 patients (38.5%) survived, and 243 were dead (61.5%) (Figs. 1 and 2).

Annual mortality

Taking a close look on the annual mortality in a gender-specific way, mortality in women decreases in year two (11%) and three (9%), and rises again after year four (17%) and five (16%). Men show a similar trend; the mortality decreases in year two (20%), three (17%), and four (9%), and rises again in year five (28%) (Table 5).

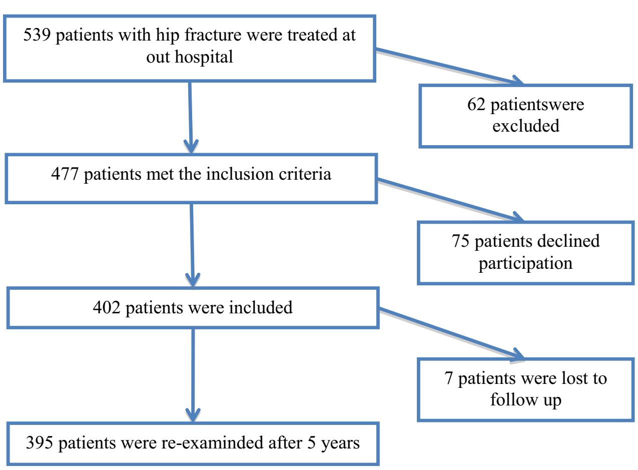

Fig. 2 Flow chart representing the patient distribution

Baseline characteristics

The mean age of the patients was 81 years (95% CI 80–82). Compared with the deceased patients, survivors were younger (Table 1). 72% ($n = 286$) of the patients were females and 28% ($n = 109$) males. The relative survival ratio was higher in females 39% ($n = 152$) than in males 27% ($p = 0.003$) (Table 1).

Residential status

Patients in a nursing home had a significantly ($p < 0.001$) lower chance to survive the investigation period than patients that lived in their own homes. Out of the 16% ($n = 65$) of the patients living in a nursing home, only 14% survived the observation period of 5 years compared with 43% of patients that were not living there (Table 1).

Charlson Comorbidity Score and ASA Score

The ASA Score ($p < 0.001$) and the CCS ($p < 0.001$) show a significant association on the mortality. Survivors had a CCS of 1.66 (95% CI 1.37–19.6). Patients that died during observation period had a CCS of 2.86 (95% CI 2.55–3.18) (Table 1).

Table 1 Baseline characteristics at the time of admission to hospital

Moment of admission to hospital	All ($n = 395$)	Deceased ($n = 243$; 62%)	Survivors ($n = 152$; 38%)	p value
Age (years)				< 0.001
Mean	81 (SD 8.3)	84 (SD 7.8)	78 (SD 7.8)	
95% CI	80–82	83–85	76–79	
Gender				0.003
Male	109 (28%)	80 (73%)	29 (27%)	
Female	286 (72%)	163 (57%)	123 (43%)	
Residential status				< 0.001
No nursing home	330 (84%)	187 (57)	143(43%)	
Nursing home	65 (16%)	56 (86%)	9 (14%)	
ASA Score				< 0.001
1	5 (1%)	2(40%)	3 (60%)	
2	72 (18%)	33 (46%)	39 (54%)	
3	252 (64%)	153 (61%)	99 (39%)	
4	44 (11%)	41 (93%)	3 (7%)	
5	2 (1%)	2 (100%)	0 (0%)	
Charlson Comorbidity Score	2.40 (95% CI 2.17–2.63)	2.86 (95% CI 2.55–3.18)	1.66 (95% CI 1.37–19.6)	< 0.001
Barthel Index				< 0.001
Mean	80 (SD 24.4)	73 (SD 25.9)	90 (SD 17.6)	
95% CI	77–82	70–76	87–93	
EQ5D				< 0.001
Mean	0.70 (SD 0.29)	0.66 (SD 0.30)	0.77 (SD 0.27)	
95% CI	0.67–0.73	0.62–0.70	0.73–0.82	
MMSE score				< 0.001
Mean	20 (SD 9.14)	18 (SD 9.59)	25 (SD 6.47)	
95% CI	19–21	17–19	24–26	

Barthel Index, EQ5D, and MMSE

Survivors had a significantly higher pre-fracture Barthel Index 90 (95% CI 87–93) vs. 73 (95% CI 70–76) points ($p < 0.001$), EQ5D 0.77 (95% CI 0.3–0.82) vs. 0.66 (95% CI 0.62–0.70) ($p < 0.001$), and a higher MMSE scores, showing 25 vs. 18 points ($p < 0.001$) (Table 1).

Type of fracture

Six percent of the patients had a not displaced fracture of the femoral neck, and 42% had a displaced fracture of the femoral neck. Sixteen percent of the patients presented with a not displaced, and 16% of the patients had a stable trochanteric fracture. Further, 30% of patients obtained an instable trochanteric fracture and 5% a subtrochanteric fracture. There was no statistically significant difference between the different types of fractures ($p = 0.920$). The mortality of patients presenting with fracture of the femoral neck (not displaced) was 58%, 62% in patients with displaced femoral neck fractures, 57% in patients presenting with stable trochanteric fractures and 64% in the unstable trochanteric fracture's cohort, and finally, 62% in the subtrochanteric fractures collective (Table 2).

Treatment of the fracture

Fifty-nine percent of the patients were treated with an internal fixation, and 41% were treated by arthroplasty. The way the fracture was treated had no significant effect on the mortality ($p = 0.753$). Sixty percent of the patients treated with osteosynthesis had died after 5 years compared with 63% treated by arthroplasty.

Discharge from hospital

There was a significant difference in dismission of patients after the acute care treatment ($p = 0.010$). Patients that went to a nursing home had a higher mortality (77%) compared with patients that went to a geriatric rehabilitation (57%) (Table 2).

Table 2 Characteristics during time of hospitalization

Period in hospital	All ($n = 395$)	No. of deceased	No. of survivors	p value
Type of fracture				0.920
Fracture of the femoral neck (not displaced)	24 (6%)	14 (58%)	10 (42%)	
Fracture of the femoral neck (displaced)	167 (42%)	104 (62%)	63 (38%)	
Trochanteric fracture (stable)	65 (16%)	37 (57%)	28 (43%)	
Trochanteric fracture (unstable)	118 (30%)	75 (64%)	43 (36%)	
Subtrochanteric fracture	21 (5%)	13 (62%)	8 (38%)	
Surgical Procedure				0.753
Osteosynthesis	235 (59%)	143 (60%)	92 (39%)	
Prosthesis	160 (41%)	100 (63%)	60 (38%)	
Dismissal after hospital				< 0.010
Rehabilitation	249 (63%)	142 (57%)	107 (43%)	
Nursing home	51 (13%)	39 (77%)	12 (24%)	
Clavien-Dindo classification for complications				
Complication II				0.489
Yes	110 (28%)	71 (65%)	39 (36%)	
No	285 (72%)	172 (60%)	113 (40%)	
Complication III				0.632
Yes	46 (12%)	30 (65%)	16 (35%)	
No	349 (88%)	213 (61%)	136 (39%)	
Complication IV				0.100
Yes	20 (5%)	16 (80%)	4 (20%)	
No	375 (95%)	227 (61%)	148 (40%)	
Time till surgery (hours)	18 (95% CI 17–19)	18 (95% CI 16–20)	17 (95% CI 15–19)	0.729
Time at hospital (days)	14 (95% CI 13–14)	13 (95% CI 13–15)	14 (95% CI 13–14)	0.954
Delirium (Cam-ICU)				< 0.001
Yes	202	158 (78%)	44 (22%)	
No	174	68 (39%)	106 (61%)	

Complications classified by Clavien-Dindo

Complications during the index hospital stay were analyzed and afterwards classified using the "Clavien-Dindo" classification. The arising of complications was accompanied with a higher mortality rate although this was not statistically significant. Sixty-five percent of patients who had a type 2 complication died within the first 5 years after surgery, while only 40% of the deceased patients showed retrospectively this type of complications ($p = 0.489$). Type 3 complications occurred in 12% of all cases. The amount of patients with a type 3 complication in deceased and not deceased cohort showed no statistically significant difference (65% vs. 61%, $p = 0.632$). Type 4 complication took place in 5% of all patients. After 5 years, 80% of these patients were dead compared with 61% without this complication ($p = 0.100$) (Table 2).

Occurrence of postoperative delirium during inpatient stay

A total of 202 (51%) patients were detected suffering from postoperative delirium during clinical course. Patients that suffered postoperative delirium had a significant higher mortality (78%) compared with patients without signs of delirium during clinical course (39%) ($p < 0.001$) (Table 2).

Time till surgery time at hospital

Time till surgery as well as time spent at hospital had no significant effect on the long-term mortality (time till surgery $p = 0.729$; time at hospital $p = 0.954$). The mean value of "time till surgery" of all patients was 18 h (95% CI 17–19 h). In total, patients spent 14 days (95% CI 13–14 days) in hospital (Table 2).

Table 3 Multivariate analysis of independent factors for surviving 5 years after hip fracture

	B (regression coefficient)	OR (odds ratio)	95% of OR	*p* value
Sex (reference male)	0.864	2.373	1.239–4.545	*0.009*
Age	− 0.071	0.931	0.898–0.966	*< 0.001*
Barthel Index before fracture	0.020	1.021	1.003–1.102	*0.024*
MMSE	0.049	1.050	1.001–1.102	*0.047*
Charlson Comorbidity Score	− 0.146	0.864	0.758–0.985	*0.028*
Period of hospitalization	− 0.029	0.971	0.922–1.023	0.268
Delirium	− 0.773	0.462	0.260–0.818	*0.008*

The multivariate analysis showed seven different variables that were independently associated with 5-year survival after hip fracture. Six of those seven were significant variables: lower age, male, higher MMSE during initial hospital, higher Barthel Index before, and the occurrence of delirium (*p* values in italics)

Multivariate analysis

The multivariate analysis showed seven different variables that were independently associated with 5-year survival after hip fracture (Table 3). Six of those seven were significant variables: lower age ($p < 0.001$; *B* 0.071; odds ratio (OR) 0.931), male gender ($p = 0.009$; *B* 0.864; OR 2.373), higher MMSE during initial hospital ($p = 0.047$; *B* 0.049; OR 1.050), higher Barthel Index before fracture ($p = 0.024$; *B* 0.020; OR 10121), CCS ($p = 0.028$; *B* 0.146; OR 0.864), and the occurrence of delirium ($p = 0.008$; *B* 0.773; OR 0.462).

Discussion

The aim of this study was to evaluate the 5-year survival after a hip fracture. In addition, the study aimed to identify predictive survival factors that may occur both at hospital admission and during clinical treatment.

In summary, the evaluation of our study group showed that only 38% of hip fracture patients survived the 5-year observation period. Our cohort had the highest mortality rate within the first year after fracture (28.4%). It then decreased, but varied over the next 5 years (Table 4). The explanation for the high perioperative mortality can probably be seen in the high postoperative burden on a fragile geriatric organism in the first months on the one hand and in the postoperative weakened immune system, medication with accompanying symptoms, and a lower degree of mobility on the other hand. However, due to the multi-morbid nature of the patient population and the plurality of possibilities, there is no significant evidence to explain this. On average, however, the mortality rate of the study population is also higher compared with the general population. The mortality rate of 83–86 elderly women in the general population is 6–9% compared with the mortality rate of women 2–5 years after proximal femur fracture in our study 9–16%. Similarly, the mortality rate of 83–86 elderly men in the general population is 8–12% compared with the mortality rate of men 2–5 years after proximal femur fracture; here, the mortality rate in our study cohort was 9–28% (Table 5) [15].

In the following, the individual results of our study will be discussed in the context of the literature.

This single-center study included 395 patients with hip fractures. Five years after hip replacement, only 27% of male patients were alive, as opposed to 39% of female patients. Our cohort study has shown that on the one hand, more women suffer from hip fractures but on the other hand, the mortality rate in men is higher. Comparing the recently published data, this trend is consistent with our results [3, 5, 16]. Other authors showed a survival rate of 5 years after a hip fracture of 22 to 63% [17–19]. If one compares the mortality of hip fractures and ischemic heart diseases, it is astonishing to see a 5-year mortality rate after a hip fracture (62%) that is even higher. For example, Taylor et al. reported a 5-year mortality rate after ischemic heart disease of 52% in a study group of > 50,000 patients. This fact underscores the enormous economic but also individual prognostic significance of hip fractures in today's steadily aging society [20].

Our study showed that age, sex, residential status, ASA score, Barthel Index, EQ5D, Charlson Comorbidity Score, and MMSE are significant influencing factors at the time of hospital admission. Some of these results are confirmed by recently published literature [3, 21, 22]. Two years after the operation of an osteoporotic hip fracture, Aranguren-Ruiz

Table 4 Mortality of men and women throughout the observation period (referring to the entire study population)

	During hospitalization	1st year	2nd year	3rd year	4th year	5th year
Women	6% ($n = 16$)	24% ($n = 69$)	8% ($n = 24$)	6% ($n = 18$)	10% ($n = 29$)	8% ($n = 23$)
Men	8% ($n = 9$)	39% ($n = 43$)	12% ($n = 13$)	8% ($n = 9$)	4% ($n = 4$)	10% ($n = 11$)

Table 5 Annual mortality (referring to the patients that were still alive in that period)

	1st year	2nd year	3rd year	4th year	5th year
Women	24% (n = 69)	11% (n = 24)	9% (n = 18)	17% (n = 29)	16% (n = 23)
Men	39% (n = 43)	20% (n = 13)	17% (n = 9)	9% (n = 4)	28% (n = 11)

et al. have demonstrated in patients over 65 years of age a high age, a low Barthel Index, male sex, and a high risk of anesthesia as risk factors for an increase in mortality [22]. Male gender was also presented as a risk factor by various other authors [3], in contrast to Sofu et al., who could not show any significant context in this respect [21]. The differences in the current literature may be due to the different study structures and study periods. Furthermore, age in years is still often given as a relevant risk factor for mortality after a geriatric hip fracture. Older people have a lower life expectancy the older they get; this must of course be included in any evaluation. Accordingly, our study, as well as most of the results of other authors, shows a significant influence of age on mortality 5 years after hip fracture [5, 16, 23]. However, it must be pointed out here that, viewed in detail, it is not necessarily age per se that is responsible for a poorer outcome today, but the frailty associated with it [24, 25].

In line with this, a high ASA Score ($p < 0.001$) and Charlson Comorbidity Score ($p < 0.001$) as well as a low MMSE ($p < 0.001$) were associated with a significantly increased mortality rate. Despite different study intervals, similar results have already been published by Tosteson et al., González Quevedo et al., and some others [21, 26–28]. This shows, as expected, that people with severe comorbidities, who additionally suffer from cognitive deficits, have a worse postoperative outcome in terms of survival. To limit our data, we must add that the MMSE was carried out at the time of admission to the hospital. One has to consider that this exceptional situation could have an influence on the result of the MMSE. Without these influencing factors, however, there is currently no other way to determine a preoperative value without screening the patient before the event.

Both residential status ($p < 0.001$) and Barthel Index ($p < 0.001$) showed a significant impact on 5-year mortality. Considering that people with a lower Barthel Index are more likely to live in a nursing home and that people in a nursing home are often correspondingly more multi-morbid than a comparable group of people living in their own home; these results are not surprising [29]. Similar results have already been published by Caldararo for other diseases. They analyzed the database of the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) and compared patients living in a nursing home with those not living in a nursing home in terms of the postoperative outcome of the five most common non-occurring inpatient procedures. They proved life in a nursing home as an independent risk factor for several complications and mortality [30].

We were also able to show that the occurrence of delirium during the index hospital stay had a significant influence on the long-term survival of the patients. It appears to serve as a surrogate parameter for the fragility of these patients. For this reason, special attention should be paid to these patients. This has now been confirmed by several studies from various disciplines that have investigated the massive influence of postoperative delirium on mortality [31, 32].

Discharge management also had an influence on long-term survival. Patients who were discharged into a nursing home had a significantly higher mortality rate than patients who were able to carry out rehabilitation. For this reason, we should try to offer postoperative rehabilitation to as many patients as possible.

No significant effects on long-term survival were found when comparing characteristics occurring during hospitalization (surgical procedure, type of complications, time to surgery, and length of stay in hospital). There was also no significant difference in "time to surgery" as 95% of operations were performed in the first 18 h after hospital admission. This is in line with the recommendation of the "AWMF" guidelines and various other authors. Bohm et al., Simunovic et al., and many other studies have already shown that surgery within 48 h reduces the risk of mortality [33–35].

In our study, patients were treated with either internal fixation or arthroplasty. No significant difference in long-term survival could be observed here ($p = 0.753$). In contrast to our results, Guerra et al. postulated that different surgical methods have a significant influence on mortality after hip fractures. They presented that the use of a dynamic hip screw is associated with a significantly increased chance of survival for a long time, compared with the use of other implants in a follow-up of 1 year [16]. Other authors could not replicate these results. Ribeiro, for example, showed no significant effect of the type of surgery on mortality after hip fracture in a 1-year follow-up [36, 37]. Studies that evaluate a similarly long investigation period do not exist; therefore, the comparison can only be made restrictively.

In addition, we conducted a multivariate analysis. Factors that had a significant influence on long-term survival included age, sex, MMSE during initial phase, Barthel Index before fracture, CCS, and the occurrence of delirium. Since a large part of these factors cannot be influenced by our actions, more attention should be paid to the factors to be influenced. Strategies to prevent delirium and maintain mobility (rehabilitation) should be taken into account. Furthermore, primary prevention in the sense of maintaining everyday competence (Barthel Index) should also be taken into account. Prevention of pre-existing conditions is to be emphasized as a social task of the health care system. Together, this can enable us to identify these vulnerable patients and improve their long-term outcomes.

However, there are some limitations to our study. First, we involved only a limited number of patients from a single center. Only selected parameters were evaluated and some factors such as the Barthel Index had to be collected retrospectively. The prospective data collection, the high number of evaluated variables, and the integration of patients into this study are to be mentioned with reference to the strengths of this study.

Our results confirm poor results in geriatric patients after hip fractures. Nevertheless, more than one third of the surviving patients after 5 years justify the complex treatment algorithms for these fragile patients. While early results may be influenced by optimal fracture care, long-term results appear to be determined by non-variable patient factors. It should also be noted that specific data on fracture-prevention strategies and osteoporosis treatment performed during the 5-year follow-up period are lacking, although these factors may have further affected the outcome of our patients. After multivariate analysis, the independent risk factors for long-term mortality were gender, age, Barthel Index, CCS, and MMSE. We therefore conclude that these characteristics should be assessed at admission to predict the potential mortality rate and ensure more intensive care for these patients, for example, in collaboration with other departments.

Compliance with ethical standards

The study has been approved by the Ethics committee of the University of Marburg. Informed consent was obtained from all individual participants included in this study.

Conflict of interest None.

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