

# Predictors of noninstitutionalized survival 1 year after hip fracture

## A prospective observational study to develop the Marburg Rehabilitation Tool for Hip fractures (MaRTHi)

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### Abstract

Hip fractures are frequent fractures in geriatric patients. These fractures have great socioeconomic implications because of the significantly higher risk of mortality and institutionalization. The aim of this study was to develop a prognostic tool to predict survival without institutionalization within 1 year after hip fracture.

A total of 402 hip fracture patients aged >60 years (84% community-dwelling) were included in a prospective observational cohort study. Multiple regression analyses determined independent predictors for noninstitutionalized 1-year survival. Finally, the Marburg Rehabilitation Tool for Hip fractures (MaRTHi) was developed based on these independent predictors.

Of the 312 patients who were followed up for 1 year, 168 (54%) survived noninstitutionalized, 104 (33%) died, and 40 (13%) lived in nursing homes. Independent predictors for patients' noninstitutionalized survival included the American Society of Anesthesiologists (ASA) score [ASA 1 or 2: odds ratio (OR)=7.828; 95% confidence interval (CI)=2.496–24.555 and ASA 3: OR=8.098; 95% CI=2.982–21.993 compared with ASA 4 or 5], the Mini Mental State Examination upon admission to the hospital (OR=7.365; 95% CI=2.967–18.282 for 27–30 compared with 0–10), patients' age (OR=2.814; 95% CI=1.386–5.712 for 75–89 y and OR=2.520; 95% CI=0.984–6.453 for 90–99 y compared with 60–74 ys), and prefracture EQ-5D (OR=2.163; 95% CI=1.119–4.179 for EQ-5D >0.80 compared with <0.60). The area under the receiver-operating characteristic curve was 0.756 (95% CI=0.703–0.809), and the sensitivity analysis yielded a MaRTHi score that ranged from 0 to 12 points.

The MaRTHi score is the first instrument to predict noninstitutionalized survival with only 4 variables. In addition to 3 well-known factors influencing outcome (age, comorbidities, and cognitive ability), prefracture health-related quality of life was identified as an independent predictor of noninstitutionalized survival. Further studies must be conducted to validate the MaRTHi score and define cutoff scores. Health-related quality of life seems to be an important patient-reported outcome measurement and may play a role in determining patient prognosis.

**Abbreviations:** ASA = American Society of Anesthesiologists, AUC = area under the curve, BI = Barthel Index, BMI = body mass index, CCI = Charlson Comorbidity Index, CI = confidence interval, GDS = Geriatric Depression Scale, HHS = Harris Hip Score, HrQoL = health-related quality of life, IADL = instrumental activities of daily living, MaRTHi = Marburg Rehabilitation Tool for Hip fractures, MMSE = Mini Mental State Examination, NHFS = Nottingham Hip Fracture Score, OR = odds ratio, ROC = receiver-operating characteristics, SD = standard deviation.

**Keywords:** hip fracture, geriatric trauma, geriatric fracture, outcome mortality, MaRTHi score

Editor: Tuck Yean Yong.

Funding was received for analysis of the data and development of the MaRTHi score from the University Hospital Giessen and Marburg.

The authors have no conflicts of interest to disclose.

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Medicine (2017) 96:37(e7820)

Received: 14 January 2016 / Received in final form: 17 July 2017 / Accepted: 27 July 2017

<http://dx.doi.org/10.1097/MD.00000000000007820>

### 1. Introduction

Hip fractures nearly always occur because of a combination of falls and osteoporosis. The incidence of these fractures is increasing due to the demographic transition. The current incidence rate is 350/100,000 per year in developed countries.<sup>[1]</sup> Despite medical progress and increasingly sophisticated treatment algorithms, these fractures are still associated with high mortality rates<sup>[2]</sup> and a decline in function.<sup>[3]</sup> Therefore, hip fractures not only have considerable implications for patients, but also lead to a serious socioeconomic burden<sup>[4]</sup> (e.g., due to admission into nursing homes).<sup>[5]</sup>

An estimation of patients' prognosis during the early treatment period for hip fractures is important for not only patients but also their relatives and health care providers. For treating physicians such a prognostic tool would be helpful to timely anticipate the development of various complications and could help to adjust the individual treatment strategies.

Various factors influencing mortality after hip fracture have been identified. They include higher age, male sex, comorbidities, impaired prefracture function, reduced mobility, and cognitive

impairment.<sup>[4,6–8]</sup> Cognitive impairment has also been associated with nursing home admission.<sup>[5]</sup> Based on the different outcome predictors, scoring systems that predict 30-day, 1-year, and long-term mortality were developed and validated.<sup>[9–12]</sup> They are limited by their complexity or their limited predictive value. In addition, they only consider mortality as target parameter. Survival without admission to a nursing home could be considered successful recovery after a hip fracture and therefore could be a relevant endpoint.

The present study aimed to identify variables that independently influence patients' outcome in terms of survival without admission to a nursing home 1 year after hip fracture. Finally, based on these variables, a scoring system should be developed to predict noninstitutionalized 1-year survival before surgical treatment to account for patients who are at risk for a predicted inferior outcome.

## 2. Methods

### 2.1. Patients

Patients with hip fractures (WHO S72.0-72.2) aged  $\geq 60$  years, who were admitted to our level-one trauma center, were prospectively enrolled between April 1, 2009 and September 30, 2011. Patients with malignancy-related fractures and polytrauma (Injury Severity Score  $\geq 16$ )<sup>[13]</sup> were excluded. The study was approved by the institutional review board of the University Marburg (reference number 175/08). All patients or their legal representatives provided written informed consent for participation in the study.

### 2.2. Baseline data

Baseline information included patient demographic data [e.g., sex, age, prefracture residential status, nursing care level, and body mass index (BMI)], type of fracture (femoral neck, trochanteric, or subtrochanteric), hemoglobin level and blood coagulation on admission, American Society of Anesthesiologists (ASA) score,<sup>[14]</sup> and Charlson Comorbidity Index (CCI).<sup>[15]</sup>

### 2.3. Hospital stay

During hospitalization, the surgical procedure (internal fixation or joint replacement), time to surgery (interval between admission and surgery), and functional outcome at discharge as measured by the Harris Hip Score (HHS)<sup>[16]</sup> and Tinetti Test were recorded<sup>[17]</sup> for all patients surviving the acute care period.

### 2.4. Questionnaires

Prefracture health-related quality of life (HrQoL), activity level, depression, and cognitive ability were examined by trained study staff upon admission.

HrQoL was measured using the EQ-5D instrument.<sup>[18]</sup> The EQ-5D consists of 2 parts: a questionnaire and a thermometer-like visual analogue scale (EQ VAS). The questionnaire contains the following 5 dimensions: mobility, self-care, typical activities, pain/discomfort, and anxiety/depression. Each dimension has 3 levels of severity (1: no problems; 2: moderate problems; 3: severe problems), resulting in 243 possible health states for the patient. The EQ-5D index was calculated using the lean model of the scoring algorithm for the German population.<sup>[19]</sup> The index takes values ranging from 0 (worst HrQoL) to 1 (best HrQoL). In addition, patients rated their health status on the EQ VAS with

scores ranging from 0 (worst imaginable health state) to 100 (best imaginable health state). With both instruments, patients were asked to complete a retrospective assessment of their HrQoL before fracture occurrence. The results in the EQ-5D index were categorized as  $>0.80$ , 0.61 to 0.80, and  $\leq 0.60$ .

The prefracture activity level was assessed by the Barthel Index (BI) according to the Hamburg Classification Manual.<sup>[20]</sup> This questionnaire contains 10 items with values from 0 to 15. The full BI ranges from 0 (lowest activity level) to 100 points (highest activity level). In addition, the prefracture instrumental activities of daily living (IADLs) were documented.<sup>[21]</sup> Patients were asked about 8 domains of daily living, such as shopping, housekeeping, and transportation, with 8 points denoting the highest amount of daily living activity and 0 points indicating the lowest level of daily living activity.

Depression was evaluated using the 15-item short form of the Geriatric Depression Scale (GDS), and its value ranged from 0 (not depressed) to 15 (highly depressed).<sup>[22]</sup>

Cognitive ability was assessed using the Mini Mental State Examination (MMSE).<sup>[23]</sup> The MMSE has standardized instructions and examines attention, memory (i.e., orientation, recall of words, recognition of sentences, and drawings), and initiation and maintenance of verbal and motor responses. Individual points are assigned to the subscales, with a total score of 30 points representing optimal performance. In accordance with the German guidelines for dementia, the results of the MMSE were categorized as “no cognitive impairment” (27–30 points), “mild dementia” (20–26 points), “moderate dementia” (10–19 points), or “severe dementia” ( $<10$  points).<sup>[24]</sup>

### 2.5. Follow-up examination and definition of endpoint

Patients were followed up for 12 months after the fracture. Patients or their relatives were largely interviewed during home visit or visits in the hospital. In some patients telephone interviews were conducted. We defined a composite endpoint consisting of the patient's survival without living at a nursing home 12 months after the fracture. Patients who died in hospital were included in the analysis.

### 2.6. 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. The data are presented as the mean, SD, and range.

### 2.7. Selection of predictor variables

Correlational analysis was performed on all potential variables to identify relevant predictor variables of noninstitutionalized survival at the 12-month follow-up. The variables considered were selected due to their significance in previously published research and expert opinions regarding the importance and practicability of assessment in a hospital routine. Univariate logistic regression analysis was then performed on all selected variables. The included variables were age, sex, fracture location, residential status before fracture, nursing care level, prefracture BI and IADL, prefracture GDS, ASA score, prefracture EQ-5D index, CCI, MMSE on admission, hemoglobin level and blood coagulation on admission, BMI, type of surgical treatment, and HHS and Tinetti Test at discharge.

**2.8. Development of the scoring system**

Data from all patients at the 12-month follow-up were used to develop the scoring system. An automated stepwise forward multivariate logistic regression analysis was computed to create the score. Significant variables from the univariate analyses (age, sex, ASA score, CCI, prefracture BI, MMSE on admission, prefracture EQ-5D) were considered as potential predictors in the multivariate analysis. The *P* value for entry into the model was .05 and for removal was .1. Noninstitutionalized survival at 12 months postfracture was entered as a dichotomous-dependent variable, and the independent predictor variables were entered as covariates. Continuous predictor variables were split into categories to create a more clinically practicable score. The cutoff points of each variable were determined based on previous studies and fitness during the analysis. The final coefficients for a more practical scoring tool were developed by converting the  $\beta$ -coefficients from the multivariate analysis into a point system, multiplying them by 2, and rounding them to the nearest whole number. The sum of the coefficients represents the individual risk score.

The goodness-of-fit of the score was assessed using Hosmer–Lemeshow statistics, and Nagelkerke’s *R*<sup>2</sup>. receiver-operating characteristic (ROC) curves were used to assess the sensitivity of the score.

**3. Results**

A total of 402 patients with hip fractures were included in this observational study. This baseline population had a mean age of 81±8 years with 293 (73%) female and 109 (27%) male patients. The most frequent fracture types were femoral neck fractures (n=195), followed by trochanteric fractures (n=186) and 21 subtrochanteric fractures. Median ASA score was 3 (range 1–5). Out of these patients, 90 (22%) were lost to follow-up or had incomplete datasets. Thus, 312 patients (78%) were

analyzed (Fig. 1). The characteristics of both the analyzed patients and dropouts are shown in Table 1.

**3.1. Mortality**

The in-hospital mortality was 8% (N=25/402). Eighty-two of the 312 patients (26%) died in the first 6 months after trauma, and 104 patients (33%) died within 1 year after trauma.

**3.2. Patients living in a nursing home**

Sixty-six (16%) of the 402 patients and 55 (18%) of the 312 patients who completed a follow-up lived in nursing homes before their fracture. Thirty (54%) patients died in the first year after trauma. Twenty-three (42%) patients still lived in the nursing home after 1 year, whereas 2 (4%) patients improved their living situation and could be discharged from the nursing home. Seventeen patients who were living in a community setting before the trauma were admitted to a nursing home in the 1-year period after the trauma.

**3.3. Noninstitutionalized survival after 12 months**

Finally, 168 of the 312 (54%) patients survived for at least 1 year after trauma in a noninstitutionalized setting.

**3.4. Predictors of survival without nursing home admission**

Age, MMSE, CCI, EQ-5D Index before fracture, BI before fracture, and ASA score were significantly associated with patients’ outcome in the univariate analysis (Table 2).

The multivariate analysis showed 4 variables that were independent predictors of a patient’s noninstitutionalized survival: age, MMSE, ASA score, and EQ-5D (Table 3). The most important predictor was a low ASA score with an odds ratio (OR) of 7.828 (95% confidence interval (CI)=2.496–24.555) for

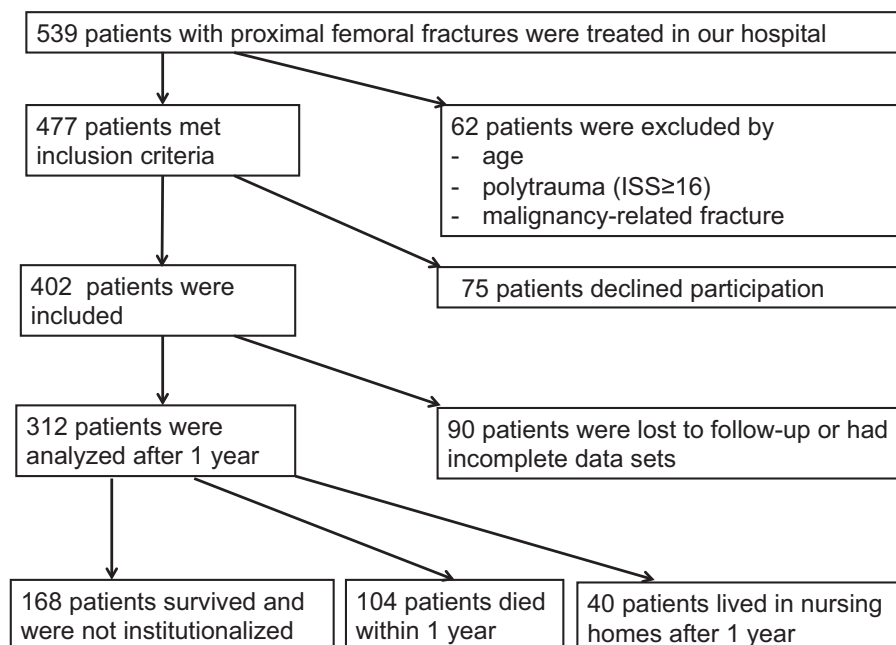


Figure 1. Flow chart of the study. ISS=Injury Severity Score.

**Table 1****Baseline data of the analyzed patient cohort compared with dropouts.**

	Study population with 1 y follow-up (n=312)	Dropouts (n=90)	P
Age, y (mean ± SD)	81 ± 8 Median 83; range 60–99	80 ± 8 Median 81; range 60–99	.199
Sex			
Male	92 (29%)	17 (19%)	.046
Female	220 (71%)	73 (81%)	
Fracture location			
Femoral neck	148 (47%)	47 (52%)	.547
Trochanteric	146 (47%)	40 (44%)	
Subtrochanteric	18 (6%)	3 (3%)	
ASA score	2.9 ± 0.6 Median 3; range 1–5	2.8 ± 0.5 Median 3; range 1–4	.088
ASA 1 or 2			.062
ASA 3	58 (19%)	19 (21%)	
ASA 4 or 5	197 (63%) 42 (14%)	62 (69%) 4 (4%)	
EQ-5D Index	0.70 ± 0.29 Median 0.8; range –0.21 to 1.0	0.71 ± 0.29 Median 0.8; range –0.14 to 1.0	.912
Prefracture BI	79 ± 25 Median 90; range 0–100	83 ± 22 Median 95; range 0–100	.149
Prefracture CCI	2.5 ± 2.4 Median 2; range 0–12	1.9 ± 1.8 Median 1.5; range 0–12	.009
MMSE score	20 ± 10 Median 23; range 0–30	22 ± 8 Median 24.5; range 0–30	.020
No cognitive impairment (27–30)	97 (31%)	35 (39%)	.279
Mild dementia (20–26)	104 (33%)	30 (33%)	
Moderate dementia (10–19)	53 (17%)	16 (18%)	
Severe dementia (<10)	55 (18%)	9 (10%)	
Prefracture residential status			
Community-dwelling	256 (82%)	79 (88%)	.405
Living in a nursing home	55 (18%)	11 (12%)	

ASA=American Society of Anesthesiologists, BI=Barthel Index, CCI=Charlson Comorbidity Index, MMSE=Mini Mental State Examination.

**Table 2****Results of the univariate logistic regression analysis for 1-year survival without admission to nursing home.**

Variable	Value	OR	95% CI	P
Age, y	60–75	1.431	0.685–2.992	.048
	76–89	2.085	1.118–3.890	
	≥90			
Sex	Female	1.596	0.978–2.604	.061
	Male			
Fracture location	Trochanteric	1.148	0.726–1.816	.440
	Subtrochanteric	1.895	0.675–5.316	
	Femoral neck			
ASA score	ASA 1 or 2	10.571	3.825–29.220	<.001
	ASA 3	8.071	3.251–20.036	
	ASA 4 or 5			
Prefracture Charlson score	<2	2.098	1.318–3.338	.002
Prefracture Barthel Index	≥2			<.001
	>80	3.400	2.128–5.433	
	≤80			
MMSE score	No cognitive impairment (27–30)	7.593	3.580–16.103	<.001
	Mild cognitive impairment (20–26)	5.303	2.562–10.977	
	Moderate dementia (10–19)	1.383	0.599–3.194	
	Severe dementia (<10)			
EQ-5D Index	>0.80	2.383	1.379–4.119	<.001
	0.61–0.80	1.205	0.637–2.279	
	≤0.60			
Type of surgical treatment	Internal fixation	1.117	0.709–21.759	.632
	Prosthesis			

ASA=American Society of Anesthesiologists, CI=confidence interval, MMSE=Mini Mental State Examination, OR=odds ratio.

**Table 3****Results of the multivariate logistic regression analysis for 1-year survival without admission to nursing home.**

Variable	Value	Coefficient	OR	95% CI	Prognostic score
ASA score	ASA 1 or 2	2.058	7.828	2.496–24.555	4
	ASA 3	2.092	8.098	2.982–21.993	4
	ASA 4 or 5				0
MMSE score	No cognitive impairment (27–30)	1.997	7.365	2.967–18.282	4
	Mild cognitive impairment (20–26)	1.621	5.060	2.198–11.648	3
	Moderate dementia (10–19)	0.094	1.099	0.432–2.797	0
	Severe dementia (<10)				0
Age, y	76–89	1.035	2.814	1.386–5.712	2
	≥90	0.924	2.520	0.984–6.453	2
	60–75				0
EQ-5D Index	>0.80	0.771	2.163	1.119–4.179	2
	0.61–0.80	–0.498	0.608	0.281–1.316	0
	≤0.60				0
Constant		–3.973			0–12

ASA=American Society of Anesthesiologists, CI=confidence interval, MMSE=Mini Mental State Examination, OR=odds ratio.

ASA 1 or 2 and an OR of 8.098 (95% CI=2.982–21.993) for ASA 3 to survive noninstitutionalized compared with ASA 4 or 5. The second factor was a higher MMSE score on admission (OR=7.365; 95% CI=2.967–18.282 for 27–30 points in MMSE compared with 0–10 points). Regarding patient age, the probability for noninstitutionalized survival was greatest for patients between 75 and 89 (OR=2.814; 95% CI=1.386–5.712) years, followed by 90- to 99-year-old patients (OR 2.520; 95% CI=0.984–6.453) compared with patients from 60 to 74 years old. Finally, the prefracture EQ-5D Index predicts patients' outcome after 1 year. However, only an EQ-5D of >0.80 was a significant predictor compared with the values <0.60, with an OR of 2.163 (95% CI=1.119–4.179).

### 3.5. Development of the Marburg Rehabilitation Tool for Hip fractures

Based on the four independent predictors, we built the Marburg Rehabilitation Tool for Hip fractures (MaRTHi) score with a range from 0 to 12 points. The ROC curve of the MaRTHi score for the noninstitutionalized survival of geriatric hip fractures 1 year after trauma has an area under the curve (AUC) of 0.756 (95% CI=0.703–0.809;  $R^2=0.329$ ; Fig. 2).

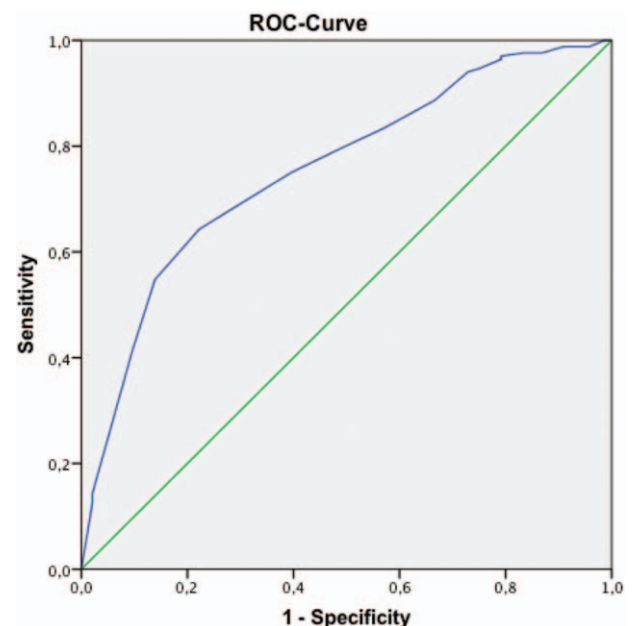
## 4. Discussion

In this observational study, we sought factors that independently predict survival after hip fracture without living at a nursing home, which is considered to be favorable for both patients and health care providers. We were able to build a score to predict noninstitutionalized survival 1 year after a fracture based on 4 factors (age, comorbidities, cognitive ability, and prefracture health-related quality of life).

Several prognostic scores for geriatric hip fracture patients have already been developed. The Nottingham Hip Fracture Score (NHFS), the Sembo Score, and the POSSUM system consider mortality (e.g., after 30 d or 12 mo) to be the outcome of interest.<sup>[9,12,25]</sup> In our opinion, an adequate treatment result is achieved if patients not only survive the first year after hip fracture but also maintain their independence. Thus, in contrast to previous studies, we defined a composite endpoint that consists of survival without being admitted to a nursing home. This is only a surrogate parameter for patient independence because some

patients may be cared for in their own houses. However, home care is likely less serious in the patient's view and also of less socioeconomic importance compared with nursing home admission. Even though patients who lived in a nursing home before the fracture had an increased probability to live in a nursing 1 year after fracture, some patients improved and were able to return to community during the follow-up period. Therefore, we decided to include also the nursing home inhabitant in this study.

The most important predictor in our cohort was a lower ASA score, with an OR of 7.828 for ASA 1 or 2 patients compared with ASA 4 or 5 patients. However, ASA 3 patients had nearly the same OR as ASA 1 or 2 patients (Table 3). Dawe et al also found only ASA 4 and 5 to be independent outcome factors.<sup>[25]</sup> Therefore, the predictive power of the ASA score is likely low when patients with mild systematic diseases (ASA 2) are compared with patients with severe systematic diseases (ASA



**Figure 2.** Receiver-operating characteristics (ROC) curve of the prognostic score for 1-year noninstitutionalized survival after hip fracture. Area under the curve (AUC)=0.756.



3). The ASA score itself is not part of the NHFS or POSSUM system. However, the NHFS considers the number of comorbidities and the presence of malignancy, whereas only the latter is included in POSSUM.<sup>[9,12]</sup> Dawe et al also found nonoperative management to be a significant risk factor for mortality rate following a hip fracture. However, this variable was not considered in our analysis because in the study period examined, all patients were treated surgically without exception. Creatinine, which was a marginal significant parameter in the study of Dawe et al, was not considered in our study.

Cognitive ability was the second most important factor in our score (Table 3). A recent meta-analysis demonstrated cognitive impairment as one of the key indicators for mortality after hip fracture.<sup>[7]</sup> In addition, Schaller et al demonstrated an association between cognitive impairment and nursing home admission.<sup>[5]</sup> According to these findings and our own results, cognitive ability has been a part of previous scoring systems for hip fracture patients.<sup>[9,25]</sup> Interestingly, it plays only an inferior role in the NHFS<sup>[9]</sup> and is not included in the POSSUM system.<sup>[12]</sup> In summary, given the importance of cognitive ability, assessing cognitive ability must become part of the clinical routine. Furthermore, efforts must be made to develop treatment paths designed for demented patients to improve their rehabilitation after fracture. These pathways should be embedded in orthogeriatric care programs. Although orthogeriatric care programs seem not to be effective in reducing delirium or cognitive impairment,<sup>[26]</sup> they seem to have a positive effect on outcome in general<sup>[27]</sup> and on mobility in particular.<sup>[28]</sup>

Age was the third predictor. Patients between 75 and 89 years had the best 1-year outcome (Table 3). Nevertheless, in the same patient sample, increased age was not associated with higher in-hospital mortality rates.<sup>[29]</sup> In contrast, the Sernbo score, which predicts survival up to 1.5 years after femoral neck fracture, contains patient's age only as a dichotomous variable, with high risk for mortality for patients >80 years old.<sup>[25]</sup> According to our results and our clinical experience, there is no linear connection between age and mortality rate. Hip fracture at a relatively young age could be viewed as a surrogate parameter for poor general health conditions, which may, in turn, be responsible for poorer outcomes. However, very old age was associated with higher mortality and institutionalization in our study. This result is consistent with the above-mentioned meta-analysis, which found that age >85 years is an indicator for mortality,<sup>[7]</sup> and also consistent with the NHFS with a cutoff >85 years.<sup>[9]</sup>

Over the last few decades, HrQoL has become increasingly important as a patient-reported outcome measurement. The EQ-5D is a widely used questionnaire to measure HrQoL in geriatric patients. It has only 5 questions as well as visual analogue scale, making it easier to handle than the SF-36. The EQ-5D should be part of the core outcome set for hip fracture trials.<sup>[30]</sup> For the first time, we evaluated the predictive value of this HrQoL measurement for patient outcome after hip fracture. Out of several factors that were assessed, we were able to identify the prefracture EQ-5D Index as an independent predictor of noninstitutionalized survival. However, with an OR of 2.163 for EQ-5D 0.8–1.0 compared with EQ-5D ≤0.6, the predictive power was lower than the aforementioned independent predictors. In addition, the EQ VAS was not a predictor in our cohort. Prefracture mobility and self-care ability are not only part of the EQ-5D, but have also contributed to different current prognostic scores.<sup>[9,25]</sup> The EQ-5D summarizes these 2 factors. We recommend measuring a patient's HrQoL at various times to use it both as an important outcome evaluator and an outcome predictor.

#### 4.1. Limitations

Our study has several limitations. First, we included only a limited number of patients from a single center. Thus, we will conduct a multicenter trial with more patients to validate the MaRTHi score in the future. Second, the score has limited conclusiveness due to the AUC of 0.756 and  $R^2$  of 0.329. However, this score is of similar value as previous scores, though it only consists of 4 variables. Third, we noted many dropouts and some differences between the analyzed cohort and dropouts (Table 1), which weakens the conclusive power of our study. Unfortunately, many patients or their legal agents declined to be followed up, though they had initially agreed to participate in the study. The fourth limitation is the subjectivity of ASA scoring as part of the MaRTHi, though the ASA score is simple, widely used, and validated. Finally, with its 4 items using the MaRTHi might be too time-consuming for clinical practice, although we believe that the ASA score and some kind of cognitive test should be part of clinical routine. Therefore, only the EQ-5D would be extra work.

#### 5. Conclusions

Our study confirms results from previous studies showing poor outcomes after geriatric hip fracture. Only 54% of our patients survived the first year after hip fracture without being admitted to a nursing home. The MaRTHi is the first instrument to predict this outcome with only 4 variables. In addition to 3 well-known factors influencing outcome (age, comorbidities, and cognitive ability), prefracture HrQoL could be identified as an independent predictor of noninstitutionalized survival. The HrQoL seems to be not only a patient-reported outcome measurement but also of certain value in determining patient prognosis. Although the MaRTHi does not influence clinical decision-making at this time, it might be helpful in predicting patients' outcome in the future. Further studies must be conducted to validate the MaRTHi with these 4 items as well as to define cutoff values for this instrument.

#### Acknowledgments

The authors thank Lutz Waschnick, Natalie Schubert, Anna Waldermann, Kristin Horstmann, and Anne Hemesath, who contributed to the acquisition of data.

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