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HIP FRACTURES IN OLDER PATIENTS: TRAJECTORIES OF DISABILITY AFTER SURGERY

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Abstract: *Background:* Hip fracture in older patients often lead to permanent disabilities and can result in mortality. *Objective:* To identify distinct disability trajectories from admission to one-year post-discharge in acutely hospitalized older patients after hip fracture. *Design:* Prospective cohort study, with assessments at admission, three-months and one-year post-discharge. *Setting and participants:* Patients ≥ 65 years admitted to a 1024-bed tertiary teaching hospital in the Netherlands. *Methods:* Disability was the primary outcome and measured with the modified Katz ADL-index score. A secondary outcome was mortality. Latent class growth analysis was performed to detect distinct disability trajectories from admission and Cox regression was used to analyze the effect of the deceased patients to one-year after discharge. *Results:* The mean (SD) age of the 267 patients was 84.0 (6.9) years. We identified 3 disability trajectories based on the Katz ADL-index score from admission to one-year post-discharge: 'mild'- (n=54 (20.2%)), 'moderate'- (n=110 (41.2%)) and 'severe' disability (n=103 (38.6%)). Patients in all three trajectories showed an increase of disabilities at three months, in relation to baseline and 80% did not return to baseline one-year post-discharge. Seventy-three patients (27.3%) deceased within one-year post-discharge, particularly in the 'moderate'- (n=22 (8.2%)) and 'severe' disability trajectory (n=47 (17.6%)). *Conclusions:* Three disability trajectories were identified from hospital admission until one-year follow-up in acutely hospitalized older patients after hip fracture. Most patients had substantial functional decline and 27% of the patient's deceased one-year post-discharge, mainly patients in the 'moderate'- 'and severe' disability trajectories.

Key words: Older, hip fracture, disability, trajectories.

Introduction

Hip fracture is often a fatal event in older people; approximately 30% die within twelve months post-discharge (1, 2) and of those who survive, many patients experience permanent disabilities (3). The incidence of hip fractures increases substantially with age. Incidence rates of 22 and 24 per 100.000 people for male and female at 50 years towards 630 and 1289 per 100.000 people for male and female at 80 years of age have been reported (4). One year after hip surgery, 29-50% of older patients do not reach pre-operative levels of physical functioning (3, 5).

Well-known risk factors for permanent disability after hip fracture are premorbid functional status, higher levels of physical disability at the time of admission to the hospital, presence of dementia, delirium, co- and multimorbidity, type of surgery and older age. Not only the hip fracture itself, but also prolonged hospitalization after surgery contribute to disability (5-9). These risk factors also influence the rehabilitation strategies and the improvement and adaption in daily activities. However, not all older patients after hip surgery show a similar development of physical disability over time and study populations are heterogeneous (9).

Some studies detected distinct disability trajectories in older patients after hip fracture (3, 10, 11) although the number of included patients with hip fracture was limited or the primary focus of these studies was on fall incidents. Identification of different disability trajectories in hospitalized older patients after a hip fracture might provide specific starting points of personalized rehabilitation as well as palliative care at post-hospital discharge.

Therefore, the aim of the study was to identify distinct disability trajectories from admission to one-year post-discharge in acutely hospitalized older patients (≥ 65 years of age) after a hip fracture, whereas the second aim was to study mortality in relation to disability trajectories.

Methods

Design and setting

A prospective study was performed, including older patients with a hip fracture who were admitted from 2004-2009 to the Academic Medical Center (AMC) Amsterdam, the Netherlands, a 1024-bed tertiary university teaching hospital. The Medical Ethics Committee of the AMC approved the study, and the patients or proxies provided written informed consent before inclusion.

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Subjects

Patients were eligible to participate if they were ≥ 65 years of age and were acutely admitted with a hip fracture to the orthopedic or traumatology wards. Patients were excluded if 1) no informed consent was given 2) the physician indicated that the patient was too ill to participate, 3) transfer to the intensive care unit or coronary care was indicated or 4) inability to speak or understand the Dutch language.

Data collection

Trained research nurses were part of the geriatric consultation team (consisting of at least one clinical nurse specialist and one geriatrician) and visited all patients with a hip fracture on the first day after hospital admission. After the patient, or the proxy in case of cognitive impairment (Mini Mental State Examination score of 20 or lower), provided informed consent, the nurse performed a comprehensive geriatric assessment. Clinical characteristics were collected at hospital admission (T0), three months (T1) and twelve months (T2) post-discharge. At hospital admission this was a personal interview, at three and twelve months post-discharge a telephone assessment was performed. First we checked in the electronic medical record if the patient was deceased. If so, the date of death was denoted. Patients who were alive were interviewed by phone. The scores of the tests were administered as well as the living situation

Primary and secondary outcome

Disability in activity daily living (ADL) was our primary outcome of interest and was measured with the modified Katz ADL index score at hospital admission, three and twelve months post-discharge. At admission the patient or proxy was asked about the situation two weeks prior to hospital admission to assess premorbid ADL functioning. The modified Katz ADL index score measures limitations of patients in the domains of physical activities of daily living (ADL) and instrumental activities of daily living (IADL). The modified Katz consists of fifteen items (13). The first six items of the modified Katz are equal to the items of the Katz-ADL index and assess the ability of an individual to independently bath, dress, use a toilet, transfer to and from a chair, the use of incontinence products and the ability to eat without help. The other items address whether a person needs help to use a telephone, to go shopping, to prepare food, to perform household tasks, to travel, to take medication, to handle own finances, brushing and combining hair or shaving and whether one needs help walking about. Each item was scored as independent (0) or dependent (1). The maximum score of dependency is fifteen. In this study disability was defined as a loss of at least one point on the Katz ADL index score. The modified Katz questionnaire has shown to be valid and reliable (14, 15).

Covariates

Cognition: Patients were screened on global cognitive impairment, measured with the 11-item Mini Mental State Examination (MMSE). Based on the number of correct responses, the MMSE provides a total score ranging from 0 to 30. A score less than 24 denote cognitive impairment (16) and patients were categorized in two groups (cognitive impairment yes/no). Patients with a score of 21 points or higher were interviewed themselves. When the score was between 16-20 points, indicating moderate global cognitive impairment, the score was crosschecked with their primary proxy. In case of disagreement, the response of the proxy was scored. Below or equal to 15 points, data were obtained from the proxy.

Delirium: Delirium was scored at baseline using the Confusion Assessment Method (CAM), a simple, valid and reliable tool for the detection of delirium in multiple clinical- and research settings (17).

Comorbidity: The Charlson Comorbidity Index (CCI) was used at baseline and assesses the number and severity of comorbidities. The score on the CCI has an index range from 0-31, with a higher score indicating a higher number of comorbidities and more severe co-morbidities. The method of classifying comorbidity provides a simple, applicable and valid method of estimating risk of death from comorbid disease for use in longitudinal studies (18).

In addition mean age, marital status, living arrangement, length of stay in hospital (LOS) body mass index (BMI) were assessed.

Statistical methods

To identify homogeneous subgroups of patients with distinct disability as measured by the Katz, latent class growth analysis (LCGA) was used. LCGA estimates each participant's probabilities for membership in a specific subgroup, with assignment to a specific trajectory based on the highest probability for membership. We used PROCTRAJ in SAS software (19). The Bayesian information criterion (BIC) was used whether each trajectory was best fit by intercept only or by linear, quadratic or cubic terms. The final model was evaluated by using average posterior probabilities of class membership; an average value of 0.9 or higher within each trajectory was considered as an excellent fit, and less than 0.7 was considered poor (20). A sensitivity analysis was performed to evaluate the effect of missing data on the estimations for the missing data. In this analysis all missing data were excluded and the remaining data were used to identify trajectories.

After performing the LCGA analysis, subgroups were identified and the relevant descriptive statistics were generated on age, gender, marital status, living arrangement, years of education, comorbidity, Katz score, cognition, LOS and BMI. The differences between the subgroups and the differences within the groups for baseline, three months and twelve months were calculated by ANOVA. LCGA were performed using SAS software. Cox regression analysis was performed to investigate

Table 1
Baseline clinical characteristics of study population

Variable	Total (n=267)	Mild disability (n=54)	Moderate disability (n=110)	Severe disability (n=103)	P-value
Age in years mean (SD)	84.0 (6.9)	78.7 (6.2)	84.3 (5.9)	86.5 (6.3)	NS
Gender n (% male)	65 (24.3)	17 (31.5)	24 (21.8)	24 (23.3)	NS
Living alone n (%)	197 (73.8)	34 (12.7)	85 (31.9)	78 (29.2)	P < 005
Independent living n= (%)	186 (70.0)	53 (19.8)	87 (32.6)	46 (17.2)	P < 0.05
Years of education (> 6th year) mean (SD)	9.5 (3.6)	10.8 (4.1)	9.1 (3.1)	8.7 (3.6)	NS
Charlson comorbidity index[a] mean (SD)	6.2 (2.1)	6.1 (13.8)	6.1 (3.2)	6.4 (2.0)	NS
Impairments in ADL and IADL[b] mean (SD)	6.1 (3.9)	1.5 (1.4)	5.0 (2.1)	9.7 (3.0)	P < 0.05
Cognitive impairment[c] mean (SD)	20.7 (7.5)	26.3 (2.9)	23.2 (5.0)	14.0 (7.4)	P < 0.05
Delirium[d] n (%)	89 (33.3)	3 (1.1)	20 (7.4)	66 (24.7)	P < 0.05
Dementia[e] n (%)	109 (40.8)	22 (20.2)	44 (40.4)	43 (39.4)	P < 0.05
Body Mass Index[f] Mean (SD)	24.5 (4.1)	24.7 (4.2)	24.9 (4.2)	23.6 (4.0)	NS

Abbreviations: SD, Standard Deviation; NS, Not Significant; P-value, probability value; ADL = Activity Daily Living; IADL = Instrumental Activities Daily Living; a. Charlson comorbidity index range 0-31; b. Katz ADL range 0-15; c. Mini Mental State Examination (MMSE) range 0-30; d. Confusion Assessment Method (CAM) range 0-28; e. Measured by questionnaire on cognitive decline (IQCODE); f. Body Mass Index (BMI) = square of the body height in kg/m^2

the effect of disability upon dying after one-year post-discharge, adjusted for age, gender and cognition. All analysis were performed in SPSS version 22. The Cox regression model was adjusted for age, gender and cognition. Also other analyses were done with SPSS. P-values < 0.05 were considered statistically significant.

Results

Study population

A total of 267 patients were included in the study with a mean age (standard deviation (SD)) of 84.0 (6.9) years, 21% was male and 56% lived independently. Baseline characteristics are presented for the distinct subgroups and consisted of 54 patients (20%) in the 'mild' disability group, 110 (41%) in the 'moderate' disability group and 103 (39%) patients in the 'severe' disability group respectively (Table 1). At baseline the subgroups were significantly different with regard to marital status, living arrangements, deceased within one-year post-discharge, length of stay (LOS), ADL disability and cognition.

Disability trajectories

Three disability trajectories were identified from admission to one-year post-discharge, classified as 'mild'-, 'moderate'- and 'severe' disability. The three disability trajectories differed already at baseline and this difference continued in the course over time (Table 2). Patients in the 'mild' disability group had a mean (standard deviation (SD)) admission score of 1.5 (1.4) on the modified Katz). The score of 1.5 increased at three months post-discharge to 3.7 (2.5) and improved at twelve-months post discharge to 2.4 (1.9) (p-value < 0.05). Trajectory 2 was classified as 'moderate' disability (mean (SD) score of 5.0 (2.1) at admission, with a significant increase towards 8.0 (2.4) at three months and 7.8 (2.3) one-year post-discharge (p-value < 0.05). Finally, trajectory 3 was identified as 'severe' disability (mean (SD) score 9.7 (3.0) at admission with a significant increase towards 13.2 (1.6) at three months and 12.9 (2.2) at one-year post-discharge (p-value < 0.05).

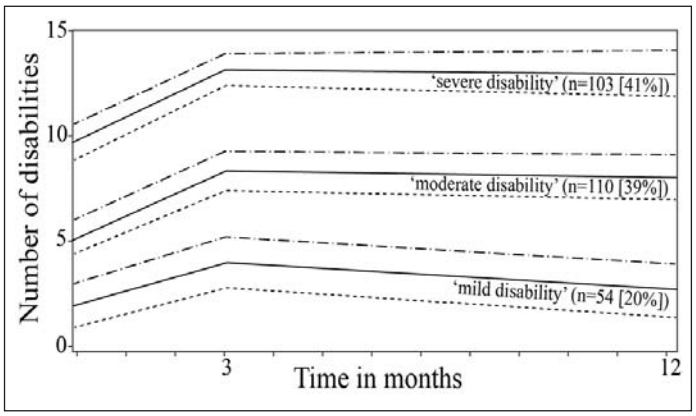
At admission patients in the 'mild' disability trajectory compared to the 'moderate'- and 'severe' disability trajectories lived significantly more often independently together with a wife or husband, less often had cognitive impairment and had a shorter length of stay (respectively for the 'mild'- 'moderate'- and 'severe' disability trajectories with a mean (SD) of 10.3 (6.3), 15.0 (11.1) and 19.7 (25.6)) days in hospital after surgery, whereas the amount of comorbidities, age, gender, years of education and BMI was not found to be significantly different between the trajectories (Table 1).

Sensitivity analysis

At baseline, data of all patients were available. At three and twelve months data of 98 patients were missing. The majority of the missing data was due to the fact that 73 (27.3%) patients were deceased within one-year post-discharge. In order to evaluate the robustness of the trajectories sensitivity analysis was performed on the remaining 169 patients, without the patients with one or more missing data. The results of the sensitivity analysis showed the same disability trajectories with the initial analysis.

Figure 1

Trajectories of disability (mean and 95% confidence interval) measured by the modified Katz score in older hospitalized patients after hip fracture. Higher scores indicate worse outcome. Subgroup 1: 'mild' disability, subgroup 2: 'moderate' disability and subgroup 3: 'severe' disability. Measurements were at admission (baseline), at three months and twelve months after discharge from the hospital



Mortality

In total 73 (27.3%) patients were deceased within one-year post-discharge. In the 'severe' disability trajectory the number (percentage) of patients was 47 (17.6%), in the 'moderate' disability trajectory 22 (8.2%), and in trajectory 'mild' disability 4 (1.5%), respectively. At baseline the Katz-ADL score for deceased patients differed significantly of the non-deceased patients (mean score (SD): 8.3 (3.5) and 5.3 (3.8), respectively) (Table 3).

Compared to patients in the 'mild' disability group, patients in the 'moderate'- and 'severe' disability group had a three and respectively eight times higher risk of mortality at one-year post-discharge ((Hazard Ratio (HR)) 2.98; 95% CI, 1.03-8.66 and HR, 7.96; 95% CI, 2.87-22.09, respectively). Cognition affected the HR of the 'moderate' disability group (2.42; CI: 0.83-7.10) in the 'severe' disability group (2.96; CI, 0,92-9.53). Age and gender did not change the HR of the Hazard proportional model.

Discussion

The current study aimed to identify distinct disability trajectories from admission to one-year post-discharge in acutely hospitalized older patients (> 65 years of age) after hip fracture. We found three distinct disability trajectories ('mild', 'moderate', 'severe') from hospital admission to one-year post-discharge based on the modified Katz-ADL score in acutely hospitalized older patients after a hip fracture. Patients in the 'mild' disability trajectory almost completely returned to baseline functioning after one year, whereas patients in the 'moderate'- and 'severe' disability trajectories increased in disability until one-year post-discharge. The increase in disability in these trajectories was already achieved at three months and remained constant towards one-year post-discharge.

In total 73 patients (27.3%) died within one-year post-discharge, which is in line with the high overall mortality rates observed in other studies (1, 2). We found that patients in the 'moderate'- and 'severe' disability group had a three and eight times higher risk respectively of mortality at one-year post-discharge. Risk of dying was affected by cognition, with the strongest influence in the 'severe' disability group. This finding is inline with the review of Smith et al (20) and may be related to additional factors such as a poorer general health. The manner in which cognition influences the risk of dying in the disability subgroups during hospitalization is unclear. In future studies the important role of cognition should be explored more into depth with emphasizes on the relation to severity of disability.

Studies on disability trajectories in older patients after hip surgery are scarce (3, 10). In the study of Gill et al (10) four distinct recovery trajectories in older patients after fall incidents (no, little, gradual and rapid recovery) were identified. Patients were measured on a monthly basis before and after hospitalization. The study of Gill reported that the number of disabilities decreased in the first months after serious falls. Post-fall trajectories were consistently worse for hip fractures than for other serious injuries (such as rib- or pelvis fractures). In contrast, our study showed that the number of disabilities increased in the first three months and stabilized until one-year post-discharge. The difference in the first three months might be influenced by interviewing patients or proxy about

Table 2

Impairment in ADL measured with Katz in three subgroups

	Baseline* (T0)	3 months (T1)	12 months (T2)	P-value
Mild disability trajectory (n=54)	1.5 (1.4)	3.7 (2.5)	2.4 (1.9)	P < 0.05
Moderate disability trajectory (n=110)	5.0 (2.1)	7.9 (2.4)	7.8 (2.3)	P < 0.05
Severe disability trajectory (n=103)	9.7 (3.0)	13.1 (1.6)	12.9 (2.2)	P < 0.05
Total group (n=267)	6.1 (3.9)	8.9 (4.2)	7.8 (4.5)	P < 0.05

Abbreviations: ADL, Activity Daily Living; P-value: Probability value; *Katz was measured at baseline 2 weeks prior to hospital admission

Table 3
Baseline clinical characteristics of the deceased versus non-deceased

Variable	Total (n=267)	Non deceased (n=194)	Deceased (n=73)	P-value
Age in years (mean (SD))	84.0 (6.9)	83.3 (6.5)	85.8 (7.4)	NS
Gender n= (% male)	65 (24.3)	43 (22.2)	22 (30.1)	NS
Impairments in ADL and IADL[a]	6.1 (3.9)	5.3 (3.8)	8.3 (3.5)	P < 0.05
Cognitive impairment[b]	20.7 (7.5)	22.2 (6.3)	16.1 (8.8)	NS

Abbreviations: SD, Standard Deviation; NS, Not Significant; P-value, probability value; ADL = Activity Daily Living; IADL = Instrumental Activities Daily Living; a. Katz ADL range 0-15; b. Mini Mental State Examination (MMSE) range 0-30

their abilities two weeks prior to hospital admission. The number of disabilities in our study at baseline might be an underestimation at hospital admission, which could affect the course of disability in the first months.

Within patients with a hip fracture, identification of disability trajectories may have implications for clinical practice. It can be suggested that the three disability trajectories may lead to a more personalized approach. In patients in the 'mild'- and 'moderate' disability trajectories a interdisciplinary rehabilitation (including exercise) management might be indicated to prevent deterioration and to improve their functional performances. In patients within the 'severe' disability trajectory, due to the high number of deceased patients, palliative care might be indicated. Tseng et al (3) concluded in their study that distinct trajectories of functional recovery could serve as useful outcome measures in clinical research and practice.

De Morton et al (22) concluded that an interdisciplinary intervention including exercises might increase the proportion of patients discharged to home and reduce length and cost of hospital stay of acutely hospitalized older patients. Exercise goal setting and discharge planning in combination with patient contact time during hospitalization might improve effectiveness of the interventions. However, only few trials with a focus on exercises for this specific group were available in the literature review of the Morton et al (22). Based on our results and the results of Gill et al and Morton et al, it can be hypothesized that highest effects of exercise interventions are to be expected in the first three months after surgical intervention. It could be of clinical importance to identify the presence of sarcopenia because loss of muscle mass may occur quickly after hip fracture (23).

Our study has some limitations that need to be considered when interpreting the results. First, in this prospective cohort study in older patients, data were missing on a substantial group of patients. These missing data were due to high mortality rates and loss of data due to various other reasons such as loss of forms at the wards. The missing data might have an effect on the outcome of three disability trajectories, and therefore we performed a sensitivity analysis. No differences were found when patients with missing data were excluded from analysis. Secondly this study was able to detect subgroups and trajectories based on functional ability in daily life but the number of patients in each group was limited. However, the three disability trajectories showed robustness, which means that the groups were homogeneous, and had the same course of disability. Thirdly, the study was only performed in a Dutch tertiary university teaching hospital where the number of patients with complex needs is rather high. The high number of patients in the 'moderate' and 'severe' disability trajectories can be explained by the high number of patients with complex needs, which may limit the generalizability of the results. Fourthly there is no specific information available about the place where patients were transferred to and stayed during the time of the study. Also there is limited information about the rehabilitation strategies during the observation time. Moreover the living situation and rehabilitation during the observation time could have affected the course of disability. Finally, data in present study were collected between 2004-2009 where medical interventions were different from current interventions. Surgical techniques have been improved; early rehabilitation within a multidisciplinary team is more common nowadays. This might have affected the results, although osteosynthesis and hip replacement in surgery is still used in the same way as before.

Conclusion

In conclusion older patients with hip fracture exhibit different degrees of functional recovery from hospital admission towards one-year follow-up: three disability trajectories from hospital admission towards one-year follow-up in acutely hospitalized older patients after a hip fracture were identified. Most patients had substantial decline and 27% of the patient's deceased one-year post-discharge. Future studies on rehabilitation management of older patients within the three disability trajectories are indicated. Patients in the 'moderate'- and 'severe' disability group had a three to eight times higher risk of mortality at one-year post-discharge.

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Ethical standard: The Medical committee of the AMC approved the research.

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