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Published in:
Injury

DOI:
10.1016/j.injury.2021.04.044
10.1016/j.injury.2021.04.044

Publication date:
2021

Injury xxx (xxxx) xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

A comprehensive multidisciplinary care pathway for hip fractures better outcome than usual care?

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ARTICLE INFO

Article history:
Accepted 12 April 2021
Available online xxx

Keywords:
Standardized care pathway
Hip fractures
Frail elderly
Orthogeriatrics
NTR3171

ABSTRACT

Introduction: Hip fracture surgery is among the most performed surgical procedures in elderly patients. Mortality rates are high, however, and patients often fail to live independently following a hip fracture. To improve outcome, multidisciplinary care pathways have been initiated, but longer-term results are lacking. Aim of this study was to compare functional outcome and living situation six months after hip fracture treatment with and without a care pathway.

Patients and methods: A multicentre prospective controlled trial was conducted with three hospitals: in one hospital patients were treated with a care pathway, in the other hospitals patients received usual care. All patients aged ≥ 60 years with a hip fracture were asked to participate. Besides basic characteristics, health-related quality of life (EQ-5D) and performance scores of activities of daily living (Katz Index and Lawton IADL) were assessed. Differences in scores were analysed using linear regression. Propensity score adjustment was used to correct for differences between the care pathway and the usual care group. Missing data were imputed.

Results: No differences in rate of return to prefracture ADL level were found between patients in the care pathway group and the usual care group. The percentage of participants in the same situation as before the fracture was the same in both treatment groups (81%). There were no significant differences in quality of life, activities of daily living or mortality (15% vs 10%, $p = 0.17$), but hospital stay in the care pathway group was significantly shorter (median 7 vs 10 days).

Discussion: Treatment of elderly patients with a hip fracture is commonly organised in care pathways. Although short-term advantages are reported, positive effects on longer-term functional results could not be proven in our study. This study confirmed a shorter hospital stay in the care pathway group, which potentially may lead to a reduction in costs.

Conclusions: Functional outcome and living situation six months after a hip fracture is the same for patients treated with or without a care pathway.

Introduction

Worldwide, a growing number of frail elderly persons suffer hip fractures and need surgical treatment. As life expectancy is growing globally, the incidence of these fractures will keep rising [1]. These hip fractures comprise femoral neck fractures as well as trochanteric fractures.

Treatment of a hip fracture is almost uniformly surgical, leading to an in-hospital stay of several days to weeks, often followed by transfer to a rehabilitation centre. Postoperatively a large portion of the patients, especially the frail elderly, are not able to return to their homes because of increasing dependency resulting from deteriorated physical functioning [2]. This leads to reduced quality

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https://doi.org/10.1016/j.injury.2021.04.044

of life and a large economic burden for society. Also serious is the one-year mortality after hip fracture, which is around 30% [3]. To cope with this growing epidemic, multidisciplinary care pathways and orthogeriatric units have been initiated in recent decades in order to improve outcomes for patients and reduce this economic burden [4].

The extent of these pathways varies, ranging between a single consultation with a geriatrician to full comprehensive care pathways, describing the care for these patients from arrival at the emergency room until the end of rehabilitation, with involvement of various care professionals. Short-term outcomes of care pathways are promising. First, results reported usually involve a reduction in waiting time for the operation [5–8], which is a significant prognostic factor for mortality and morbidity. Second, a reduction in number of complications is described in the majority of studies [9–11], although not all support these findings [12,13]. Further, hospital stay and postoperative mortality are often reduced [12–17].

Whether these care pathways also result in improved physical and ADL functioning and quality of life in the long term has not been established yet [13,18]. Hence the aim of this study was to investigate the functional outcome and living situation of elderly patients after a hip fracture, following a comprehensive care pathway compared to usual care. It was hypothesised that utilisation of a comprehensive care pathway will lead to 15% or more patients recovering to prefracture levels of ADL functioning at six months compared with patients receiving usual care.

This study has been approved by the Institutional Review Board of University Medical Center Groningen and is registered in the Dutch trial register (NTR3171).

Patients and methods

A prospective controlled trial was conducted in the northern Netherlands. All patients aged 60 years and older with a hip fracture, treated at University Medical Center Groningen (UMCG), Ommelander Hospital Winschoten (OHW) or Martini Hospital (MH, a general teaching hospital) in 2012 and 2013 were considered eligible [19]. Patients were allocated to these hospitals on the basis of bed availability, patients' preference, and proximity. Patients with multi-trauma injuries (thoracic and/or abdominal) were excluded. Also excluded were patients who were unable to fill in questionnaires, understand the Dutch language, or give informed consent. Patients with dementia or cognitive impairment were included, when they had close relatives helping them to fill in the questionnaires, provided these relatives gave their informed consent and the patient agreed. The study protocol has been previously described [19].

Patients admitted to UMCG formed the treatment group and were treated with a comprehensive care pathway. This pathway was a collaboration between the departments of traumatology, orthopaedics, geriatrics and anaesthesiology, together with two nursing homes with a geriatric rehabilitation department. The pathway comprised all interventions and procedures from arrival at the emergency room onwards. An important component of the pathway is a dedicated operating room time slot on the morning after admission. Patients transported to MH and OHW formed the control group and received usual care. These hospitals did not have a geriatrician available, and there was no specific care pathway for patients with a hip fracture. The design of the study and the comprehensive care pathway have been published previously [19].

Measurements

Measurements were taken preoperatively, perioperatively, and at six weeks and three and six months postoperatively. Preoperative demographic data, preoperative diagnosis, height, weight, body mass index (BMI) and ASA classification were recorded. Hip fractures were classified as femoral neck fractures (dislocated or not dislocated) and trochanteric fractures (AO comprehensive classification 31.A.1; 31.A.2; 31.A.3). Surgical time, blood loss and perioperative and postoperative complications were documented, including in-hospital mortality.

Self-reported limitations in activities of daily living (ADL) were measured with the Katz Index, limitations in instrumental activities of daily living (IADL) with the Lawton IADL scoring list [20,21]. The Katz Index is based on an evaluation of patients' functional dependence or independence in six functions of ADL: bathing, dressing, going to the toilet, transferring, continence and feeding. Each function is scored on a 3-point scale, ranging from 0 (no assistance/full independence) to 2 (receives assistance). The Lawton IADL scoring list is an evaluation of patients' abilities in eight activities: using the telephone, transportation, shopping, preparing food, housekeeping, doing laundry, responsibility for their own medications, and handling finances. Each activity is scored on a dichotomous scale (1: ability to do at least part of the activity, or 0: inability to do the activity). The sum of these scores forms the Lawton IADL score, ranging from 0 (fully dependent) to 8 (high functioning, independent).

Health-related quality of life was measured using the EQ-5D-3L (EQ-5D™ Dutch© 1990 Euroqol Group) [22]. The EQ-5D comprises five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension is divided into three degrees of severity: no problem, some problems, and major problems. The Dutch tariff was used [23] to produce a score ranging from 0 to 1, with 0 indicating the worst imaginable health and 1 the best imaginable health.

The Katz index, Lawton IADL scoring list and EQ-5D were assessed at hospital admission to determine the situation before the fracture, and at six weeks and six months after surgery. Beside these scores, the living and independence situation of the patient was assessed six months after surgery and compared to the prefracture situation.

Walking ability and medical complications were assessed at the outpatient clinic at six weeks and six months after surgery. Patients who were not able to visit the outpatient clinic were contacted by phone or email, or visited at home by a research assistant.

Sample size

Sample size calculation was based on the assumption that more patients treated with the comprehensive care pathway would recover to prefracture levels or do better in terms of ADL, compared with patients receiving usual care. A difference of at least 15% of patients reporting a Katz score at six months follow-up that was at least as good as the pre-injury score was considered clinically relevant. In order to detect this 15% difference with 80% power at a significance level of 0.05 (one-sided), 130 patients were needed for the comprehensive care pathway and 130 for usual care [19].

Statistical analysis

During the inclusion period, the number of eligible patients from OHW was too small to further analyse. The decision was therefore made to continue the data analysis without data from OHW.

Imputation

Given our frail elderly patient group, the dataset contained a substantial number of incomplete observations. The percentage of

missing values per variable ranged from 0% to 42%. To improve validity of the statistical conclusions, we used a combination of donor-based [24,25] and multiple [26–28] imputation. Donor-based imputation takes imputation values from a donor dataset that contains complete observations and has characteristics similar to the incomplete observations of the recipient dataset.

The multiple imputation was used under the assumption that the missing data were missing at random. With IVEware (Imputation and Variance Estimation Software, version 0.3) [29] and SAS software, the imputation step was carried out using PROC MIXED and predictive mean matching. IVEware is a collection of routines written under various platforms and packaged to perform multiple imputations, variance estimation and, in general, draw inferences from incomplete data. To reduce sampling variability from the imputation process, 24 imputed datasets were created [30]. In the model a distinction was made between categorical and continuous variables.

As donor dataset we used that the dataset of Embrace (*SamenOud* in Dutch). Embrace focuses on outcome measures for quality of care, use of care and costs [31]. To this end, more than 1000 participants aged 75 years or older completed a survey at home. Embrace was conducted between 2015 and 2016 in a rural population in the northern Netherlands. Prior to the imputation, the variables of the Embrace dataset (donor) and the dataset of this study (recipient) were equated for name and, if applicable, number of categories (coding of the categories included). To that end, scores on each item of the Katz Index were recoded from a 3-point scale (no assistance/little assistance/assistance) to a 2-point scale (no assistance/assistance), leading to a maximum score on the Katz Index of 6 points. A similar procedure was followed for the Lawton IADL scoring list. The item 'laundry' was omitted because the donor dataset did not include a similar item, leading to a maximum score of 7 points instead of 8 points.

Data were analysed using IBM SPSS Statistics for Windows (version 23.0, IBM Corp., Armonk, NY, USA). Descriptive statistics were used to describe the main characteristics of the study population. Normally distributed data were analysed with Student's T-tests, non-normally distributed data with Mann-Whitney U-tests. Differences in frequencies were analysed with Pearson chi-square tests. To assess differences in rate of return to prefracture Katz Index score and prefracture living situation at six months postoperatively, logistic regression analysis was used: the Katz Index score was dichotomised, where a difference of -1, 0 or 1 points between the prefracture and six-month Katz Index score was considered to indicate no change in ADL score and a score of 2 or more points lower on the KATZ index at six months was considered a decline in ADL functioning. Differences in scores on the Katz Index, Lawton IADL list and EQ-5D were analysed using linear regression. Propensity score adjustment was used in the regression analyses. The propensity score is the likelihood of being assigned a certain treatment given the observed covariates. Propensity scores were calculated based on the following prefracture variables: age, gender, living situation, comorbidities classified by ASA and medication use. The propensity score was added to the analyses as an independent variable. SAS software were used to calculate the propensity score (version 9.2, SAS Institute Inc., Cary, NC, USA).

Results

The treatment group included 188 patients and the control group 169 patients. The population characteristics are summarised in Table 1. The baseline patient characteristics did not differ between the two groups. In the control group the percentage of femoral neck fractures was higher, so the implant choice differed slightly from the implants used in the treatment group. In the control group more patients had spinal anaesthesia (85 vs 27%; $p \leq 0.001$) and the operation time was shorter than that for the treatment group (median 60 (range 24–151) vs 87 (range 30–298) minutes; $p \leq 0.001$). Hospital stay was significantly shorter in the treatment group (median 7 (range 2–38) vs 10 (range 3–62) days; $p \leq 0.001$) .

Within the six-month follow-up 45 patients (13%) died: 28 patients (15%) in the treatment group and 17 (10%) in the control group; this difference is not statistically significant ($p = 0.17$). At six months postoperatively, 81 patients (23%) were lost to follow-up: 41 patients (22%) from the treatment group and 40 (24%) from the control group.

The hypothesis that at least 15% more patients in the group treated with the comprehensive care pathway would reach at least the same Katz Index score six months after surgery as before the hip fracture was not confirmed (56 vs 63%, Table 2). Logistic regression analysis on pooled data after multiple imputation showed no statistical differences ($p = 0.47$, OR = 0.76 (95%CI 0.36 – 1.60)) in rate of return to prefracture Katz Index between the care pathway and the usual-care group.

Secondary endpoints of the study were outcome in terms of ADL as measured with the Katz Index, IADL with the Lawton IADL scoring list, quality of life with the EQ-5D, and living situation six months postoperatively. Based on the original, non-imputed data, the three reported scores after six months and the percentage of patients that returned to their prefracture living situation were not different between the treatment and the control group (Table 3).

As described earlier, there was no difference between the two hospitals after multiple imputation (Table 4): logistic regression analysis showed no statistically significant differences in return to prefracture living situation (Regression coefficient: 0.06; $p = 0.87$; OR: 1.06 (95% CI: 0.53–2.10). Linear regression analysis showed no statistically significant differences in scores on the EQ-5D, Katz Index and Lawton IADL scoring list between the two hospitals.

Discussion

This study found no differences in rate of return to prefracture ADL functioning levels between patients treated with a comprehensive care pathway and patients treated with usual care six months after surgical treatment of a hip fracture. No statistically significant differences were found in terms of ADL/IADL functioning and quality of life at six months following surgical treatment of a hip fracture either. A statistically significant difference was found in hospitalisation time, which was shorter in the comprehensive care pathway group.

Evidence of the benefit of a comprehensive care pathway in the long term is sparse. One study was found that reported no differences in complications and readmission rates one year after multidisciplinary and usual treatment of hip fractures [32]. The literature is also rather limited when it comes to functional results. Prestmo et al. reported a better mobility score four months after hip fracture treatment in patients treated with a comprehensive care pathway and a longer upright time of about 30 min./day one year after a hip fracture [33,34]. However, they included only fit elderly patients, which is not a representative sample of the elderly population with a hip fracture. The average hip fracture patient is a frail elderly person. One way to demonstrate this frailty is the quality of life patients attribute to themselves as expressed with the EQ-5D. The average score on the EQ-5D in the Dutch population at the age of 80 is between 0.83 for women and 0.90 for men [35]. In our study, mean EQ-5d six months after hip fracture treatment was 0.69, which indicates a much lower health-related quality of life of hip fracture patients compared to their peers in the Dutch population.

A recent retrospective study showed significantly more participants from the comprehensive group returning to their premor-

Table 1
Characteristics of the study population.

	Total (N = 357)	Intervention (N = 188)	Control (N = 169)	P-value
Age (years)[a]	79 (9)	78 (10)	80 (9)	0.12
Gender[b]				0.09
Male	126 (35)	74 (39)	52 (31)	
Female	231 (65)	114 (61)	117 (69)	
ASA classification[b]				0.75
1	26 (7)	14 (7)	12 (7)	
2	163 (46)	82 (44)	81 (48)	
3	159 (45)	86 (46)	73 (43)	
4	9 (2)	6 (3)	3 (2)	
Medication[b]				0.56
No medication	64 (18)	36 (19)	28 (17)	
Medication	291 (82)	152 (81)	139 (83)	
Prefracture living situation[b]				0.10
Independently	160 (45)	91 (50))	69 (42)	
Independently, with help of others	127 (36)	56 (31)	71 (43)	
Assisted living facility	42 (12)	24 (13)	18 (11)	
Nursing home	17 (5)	11 (6)	6 (4)	
Fracture type[b]				0.008
A1	31 (9)	22 (12)	9 (5)	
A2	59 (17)	34 (18)	25 (15)	
A3	41 (12)	28 (15)	13 (8)	
Femoral neck, non-displaced	57 (16)	23 (12)	34 (20)	
Femoral neck, displaced	169 (47)	81 (43)	88 (52)	
Type of anaesthesia[b]				≤0.001
Spinal	195 (55)	51 (27)	144 (85)	
General	162 (45)	137 (73)	25 (15)	
Type of implant[b]				0.005
Total hip arthroplasty	26 (7)	14 (7)	12 (7)	
Hemiarthroplasty	129 (36)	60 (32)	69 (41)	
Dynamic hip screw	80 (22)	50 (27)	30 (18)	
Intramedullary nail	95 (27)	56 (30)	39 (23)	
Cannulated screws	25 (7)	6 (3)	19 (11)	
Other	2 (1)	2 (1)	–	
Operation time (minutes)[c]	72 (24 – 298)	87 (30 – 298)	60 (24 – 151)	≤0.001
Hospital stay (days)[c]	8 (2 – 62)	7 (2 – 38)	10 (3 – 62)	≤0.001

Intervention = UMCG, Control 2 = MZ.
Data presented as:
[a] Mean (SD)
[b] N (%)
[c] Median (range).

Table 2
Katz Index at six months at least as good as prefracture situation. Pooled results after multiple imputation.

	Total (N = 312)	Intervention (N = 160)	Control (N = 152)
Return to prefracture Katz Index			
No	127	71 (44%)	**56 (37%)**
Yes	185	89 (56%)	**96 (63%)**

Data presented as N (%).
Intervention = UMCG, Control = MZ.

Table 3
Return to prefracture living situation, Katz Index, Lawton IADL scoring list and EQ-5D at 6 months postoperatively. Original data.

	Total (N = 231)	Intervention (N = 119)	Control (N = 112)	P-value
Return to prefracture living situation[a]				0.91
No	44	23 (19)	21 (19)	
Yes	187	96 (81)	91 (81)	
Katz index score[b]	0 (0–6)	0 (0–6)	0 (0–6)	0.70
Lawton score[b]	3 (0–7)	3 (0–7)	3 (0–7)	0.97
EQ-5D score[b]	0.69 (-0.17–1.00)	0.71 (-0.06–1.00)	0.69 (-0.17–1.00)	0.88

Intervention = UMCG, Control = MZ.
Data presented as:
[a] N (%)
[b] median (range).

Table 4
Return to prefracture living situation, Katz Index, Lawton IADL scoring list and EQ-5D at 6 months postoperatively. Pooled results after multiple imputation.

	Total (N = 312)	Intervention (N = 160)	Control (N = 152)
Return to prefracture living situation[a]			
No	55	28 (18)	27 (18)
Yes	257	132 (82)	125 (82)
Katz Index	2(0–6)	2(0–6)	2(0–6)
Lawton IADL scoring list[b]	3(0–7)	3(0–7)	3(0–7)
EQ-5D score[b]	0.67(-0.17–1.00)	0.69(-0.13–1.00)	0.61(-0.17–1.00)
	Regression coefficient (95% CI)	P-value	
Katz Index	-0.19 (-0.60–0.22)	0.37	
Lawton IADL scoring list	-0.10 (-0.58–0.38)	0.68	
EQ-5D	-0.01 (-0.09–0.06)	0.70	

Reference group: Intervention hospital
Intervention = UMCG, Control=MZ.
Data presented as:
[a] N (%)
[b] Median (range)

bid situation, but did not report functional scores [36]. Full functional recovery in ADL activities after hip fracture surgery was reported to range between 40% and 70% [37–39]. Although the Katz Index and Lawton Scoring list are widely used, a norm value for the Dutch elderly population is not known. In our study the median Katz Index was 0 and the median Lawton scoring list 3. This means that six months after a hip fracture most people are independent in ADL activities and able to do about half of IADL activities alone or with a little help. This score is probably about the same in the general population. With increasing age, it is known that ADL can be done independently for a relatively long time, followed by cognitive IADL (telephone, medication); IADL requiring adequate physical functioning (travel) declines sooner [40].

The most important positive predictor was prefracture ambulatory status [37]; perhaps this is also an important explanation for our finding no differences in functional outcome, as the prefracture ambulatory status was the same in both groups. Negative predictors for achieving ADL recovery are reported to be comorbidities, cognitive status and non-weight-bearing after the operation; only this last factor is surgeon-dependent [38,39]. Full weight bearing has become more common in the last decade; it is known from clinical experience and the literature that partial weight bearing is almost impossible for elderly patients, while the outcome is the same or better if early full weight bearing is allowed [41,42]. Perhaps the limited evidence of the long-term benefits of comprehensive care pathways, as found in this study, is due to these factors: prefracture ambulatory status is an immutable fact, and nowadays most people are allowed full weight bearing after hip fracture surgery.

There is extensive literature on short-term results. After introducing a care pathway for hip fractures, time to operation and hospital stay are generally shorter, and complication and mortality rates tend to be lower [6,9,12,13,43]. The reduction in mortality rate is not uniform, as recently shown [44,45]. In a cohort study of more than 17,000 hip fracture patients Sepehri et al. showed that general mortality and reoperation rates did not decrease after introducing a care pathway [44]. Our short-term results are in line with these findings, which include no differences in mortality rate and a significantly shorter hospital stay. This reduction in hospitalisation time is remarkable, and may be largely attributed to the good collaboration between the hospital and nursing homes with rehabilitation facilities. This reduction cannot be explained by a difference in waiting time for the operation. The Dutch Health and Youth Care Inspectorate imposes every hospital to operate on patients with a hip fracture within one calendar day after admittance, unless medical conditions make this impossible. This guideline is strictly followed by both hospitals.

In our study more patients in the comprehensive care pathway group had general anaesthesia. Questions could arise if this difference in the percentage of patients operated on with spinal anaesthesia could be of influence on the end result. However, until now the literature is not unambiguous about the advantages and disadvantages of spinal and general anaesthesia in hip fracture patients [46].

The final conclusion about comprehensive care pathways for hip fracture patients is that these pathways probably lead to better care and are cost-effective. Although differences in long-term functional results are not statistically significant, the extra effort of the medical personnel working collaboratively leads to a reduction in complications, which is a qualitative improvement, and shorter hospital stay.

Besides the introduction of care pathways, several national guidelines on hip fracture treatment have been updated in recent years; most guidelines on hip fractures now recommend performing the surgery as early as possible, thus reducing waiting times for the operation [47–51].

The overall mortality rate after hip fractures seems to have dropped in recent decades, independently of the introduction of a comprehensive care pathway, probably thanks to better treatment regimens [52,53]. In various recent reports, the introduction of a care pathway did not result in significantly lower one-year mortality [54,55], which is consistent with our results.

One of the explanations for the lack of literature on long-term results of comprehensive care pathways may be the patient group itself. Because of their high mortality rate, high percentage of cognitive decline and limited mobility it is very difficult to have a representative group for long-term follow-up. It is also questionable what can be defined as ‘long term’ in this population. Most of the recovery, physically and mentally, usually occurs in the first four months after surgery; only small improvements in function have been seen afterwards [56–58]. Moreover, it is likely that the longer the follow-up period is chosen, the larger the loss to follow-up. Because patients were routinely scheduled to visit the outpatient clinic six months after the fracture, we chose this period as duration of follow-up, expecting only minimal improvements after this period. In this period of six months, we experienced all the problems typical for the study population, as shown by the number of missing values, which we addressed by the following measures.

In order to achieve a high rate of follow-up measurements, patients who were not able to visit the outpatient clinic were contacted by phone, mail or email, or even visited by a member of the research team. Still, the proportion of missing data was high and might be considered a weakness of this study. As mentioned before, this is a problem with all studies on this particular subject

in this population. After debating the results and missing values, two measures were taken. As published in the article about the design of this controlled trial [19], we planned to conduct this study at three hospitals – one of them Ommelander Hospital Winschoten (OHW), a smaller hospital in the same region. Regrettably, OHW's number of patients included and properly registered was too low for the data to be used, therefore the data analysis was conducted with data from the two larger teaching hospitals.

Secondly, the decision was made to impute data from a donor database with a patient group with comparable baseline characteristics, except for hip fracture. Multiple imputations were performed. This technique has been used before and proven useful in studies with missing data to reduce bias and increase precision of results [59]. The use of this innovative technique, by using a donor database for imputation, solidifies the results of this study.

Next to the imputation technique, propensity score matching was used, according to the plans described in the design paper [19]. At the beginning of this project a randomised controlled trial (RCT) was planned, randomising patients on the spot to different hospitals, with or without a care pathway. A pilot study for the randomisation was conducted; with a participation rate of only 9% we concluded that randomisation in this patient category was not feasible, so the design was changed into the present non-randomised controlled trial. To mimic an RCT as much as possible, propensity score matching was introduced [60,61]. Propensity was estimated on the prefracture baseline characteristics as previously described. By using these statistical techniques, shortcomings of research methods like inability to conduct a randomised controlled trial can be largely bypassed.

We were not able to find statistically significant differences in Katz Index score or living situation. This raises the question as to whether the Katz Index, although frequently used and recommended for use in the elderly population [62] – also in hip fracture patients – is the best method to measure ADL function. Perhaps it is not sensitive enough to detect subtle differences in ADL functioning, and its responsiveness is reported to be questionable.

Conclusions

Six months after a hip fracture, no statistically significant differences in functional outcome exist between patients treated with or without a comprehensive care pathway, as measured by the Katz Index score, Lawton IADL scores, living situation, and quality of life using the EQ-5D.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

We thank Klaske Wynia, formerly with the Department of Health Sciences, Community and Occupational Medicine of University Medical Center Groningen for enabling use of the Embrace project database to input data.

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