The societal costs of femoral neck fracture patients treated with internal fixation

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Mini abstract

The study rationale was to provide a detailed overview of the costs for femoral neck fracture treatment with internal fixation in the Netherlands. Mean total costs per patient at two years follow-up were €19,425. Costs were higher for older, less healthy patients. Results are comparable to internationally published costs.

Abstract

Purpose: The aim of this study was to provide a detailed overview of the cost and healthcare consumption of patients treated for a hip fracture with internal fixation. A secondary aim was to compare costs of patients who underwent a revision surgery with patients who did not.

Methods: The study was performed alongside the Dutch sample of an international randomized controlled trial**,** concerning femoral neck fracture patients treated with internal fixation. Patient characteristics and healthcare consumption were collected. Total follow-up was two years. A societal perspective was adopted. Costs included hospital costs during primary stay and follow-up, and costs related to rehabilitation and changes in living situation. Costs were compared between non-revision surgery patients, implant removal patients, and revision arthroplasty patients.

Results: A total of 248 patients were included (mean age 71 years). Mean total costs per patient at two years follow-up were €19,425. In the non-revision surgery patients total costs were €17,405 (N=137), in the implant removal patients €10,066 (N=38), and in the revision arthroplasty patients €26,733 (N=67). The main contributing costs were related to the primary surgery, admission days, physical therapy, and revision surgeries.

Conclusions: The main determinant was the costs of admission to a rehabilitation center/nursing home. Costs were specifically high in elderly with comorbidity, who were less independent pre-fracture, and have a longer admission to the hospital and/or a nursing home. Costs were also higher in revision surgery patients. The two years follow-up costs in our study were comparable to published costs in other Western societies.

Keywords: costs, healthcare consumption, internal fixation, hip fracture, femoral neck fracture

Introduction

The worldwide incidence of hip fractures is increasing from an estimated 1.26 million patients per year in 1990, 1.6 million in 2000, to an estimated 4.5-6.3 million by 2050 [1-3]. Accordingly, the incidence of hip fractures in the Netherlands increased from 7,614 per year in 1981 to 21,000 per year in 2010 [4, 5]. Globally, the annual estimated worldwide direct and indirect costs of hip fractures amounted to $34.8 billion in 1990, and are expected to rise to an estimated $131 billion by 2050 [2].

Detailed information on healthcare costs are gaining importance as the burden of health care costs threatens to exceed the financial resources available. It is therefore necessary to focus on options to cut down health care expenses. Costs of hip fracture treatment should receive attention, as hip fractures account for over two third of all hospital admission days due to fractures, the incidence is increasing worldwide, and hip fracture treatment leads to substantial costs. In the Netherlands, the total costs of hip fractures amounted to €13.600 per patient in 1999 [6]. This was a crude estimate of costs based on national databases and registrations, concerning costs of hip fracture patients, treated with various implants and prostheses. A number of studies compared the costs of treatment with internal fixation with costs of treatment with arthroplasty [7-13]. These studies demonstrated either similar or higher costs for patients treated with internal fixation, ranging from €13,000 to €57,197 per patient after a two-year follow-up period (Table 1). Comparison between the studies is impeded however by the differences in follow-up period and in the costs that were studied. In some studies costs were confined to in-hospital health care costs, whereas other studies also included costs caused by rehabilitation or changes in living situation. The studies are often based on limited patient numbers. It is therefore likely that the presented costs are not all a correct estimation of the actual costs involved. To the best of our knowledge, detailed analysis

of the costs of internal fixation for hip fractures in the Netherlands has never been performed. In the Netherlands, hip fracture care pathways are implemented in an increasing number of hospitals, promoting early mobilization, early hospital discharge, and rehabilitation in a specialized nursing home department or at home. These pathways are designed to optimize patient care and health care cost.

The aim of this study was to provide a detailed overview of the costs of patients with a femoral neck fracture treated with internal fixation. A societal perspective was adopted, including costs of health care and costs incurred outside health care. This information can be used for economic evaluations. A secondary aim was to compare costs of patients who underwent a revision surgery with patients who did not, to study the burden of extra costs caused by revision surgeries.

Patients and Methods

This cost study was a cohort study performed alongside the Dutch sample of the FAITH trial (Fixation using Alternative Implants for the Treatment of Hip fractures, NCT00761813), an international randomized controlled trial concerning femoral neck fracture patients treated with internal fixation. The study was approved by the local medical research ethics committee.

Population

In the Netherlands 14 hospitals participated and enrolled 250 consecutive patients in the period between February 2008 and August 2009. Patients were eligible if they (1) were adults aged ≥50 years, (2) had a radiologically confirmed femoral neck fracture (*i.e.*, either undisplaced fracture, or displaced fracture in ASA 1-2 patients (American Society of Anesthesiologists classification) aged 50-80 years with a fracture that could be reduced closed), (3) had a low energy fracture without other major trauma, and (4) were ambulatory pre-fracture (with or without aid). Patients were excluded if they (1) had a fracture not suitable for internal fixation (*e.g,.* pathological fracture, rheumatoid arthritis, or osteoarthritis), (2) had associated major injuries of the lower extremities, (3) had retained hardware around the hip, (4) had an infection around the hip, (5) had a bone metabolism disorder other than osteoporosis, (6) were moderately or severely cognitively impaired pre-fracture, (7) had dementia or Parkinson's disease severe enough to compromise the rehabilitation process, or (8) were not likely to be able to complete follow-up.

Treatment and follow-up

All patients had medical optimization before surgery. Patients with undisplaced fractures were treated within seven days of presentation, patients with displaced fractures within two days. Patients were treated with internal fixation (*i.e.*, either two or three cancellous screws or a sliding hip screw). Early mobilization was encouraged, with weight bearing as tolerated. Post-operative osteoporosis screening and treatment was recommended in all patients. Follow-up measurements were performed at 2 weeks, 10 weeks, 6 months, 9 months, 12 months, 18 months, and 24 months after the primary surgery.

Cost measurement

The study adopted a societal perspective including the following costs: (1) hospital costs during the primary stay, (2) hospital costs during follow-up including cost of hip-related adverse events and revision surgeries, and (3) non-hospital costs of rehabilitation and aids. (Table 2). Data on resource use were collected prospectively at the scheduled follow-up contacts and at the close-out visits at the end of the study. Use of hospital resources was collected in the study case report forms (items are listed in supplemental Table 1), and from the patient's hospital file. The latter had 100% capture. These data were supplemented with data from a patient self-administered questionnaire, a customized version of the 'Trimbos and iMTA questionnaire on Costs associated with Psychiatric illness' (Tic-P), which has been validated for use in healthcare cost studies [14,15]. An English version of the original Tic-P is available online [16].The questionnaire included questions on stay in a rehabilitation center or nursing facility, number of contacts with the medical specialist and physical therapist, medication and the use of aids (*e.g.*, walker, crutches, and wheelchair). The total number of consumption units per cost category per patient was multiplied by the unit prices. The unit prices (anno 2010) for all cost categories are presented in Table 2. The costs for use of the operating room, including cost for personnel, anesthesia, and overhead costs, as well as

implant and general equipment costs were calculated based on data derived from one of the participating academic hospitals and three regional hospitals, and one surgical equipment and implant firm. Means were calculated and considered a realistic estimation of the average prices in the participating sites.

For most other healthcare resources reference cost prices were derived from the Dutch manual on cost research, methods and standard costs in economic healthcare evaluations (17). Costs from 2008 and 2009 were adjusted to 2010 terms using the national consumer price index. Unit prices for radiologic and other diagnostic procedures were taken from the NZa (Nederlandse Zorgautoriteit; Dutch Healthcare Authority) which are assumed to provide a good indication of the actual costs. Medication costs were calculated using standard medication prices as described by the CVZ (College voor zorgverzekeringen; Health Care Insurance Board), online available on www.medicijnkosten.nl (Supplemental Table 2). The costs for the use of several aids (*i.e.*, crutches, walker, or extra facilities at home) were obtained from at a home care firm that is representative of the Dutch market. These costs were used as an estimation of the actual costs for the use of aids in all participating patients, as these costs are fairly standard and will not vary to a large extent across the country. Costs of aids were calculated according to the annuity method, applying an interest rate of 4.5% and a 10-year write off period.

Over 90% of the study population consisted of retired elderly. Consequently, the indirect costs due to productivity losses were considered less relevant for this population and a minor contribution to the overall costs in this study, and were excluded. Costs of home care were also excluded from the analyses. Most elderly patients that received home care were not capable of estimating the amount of hours that they received home care. Moreover, it was impossible to discriminate home care due to the hip fracture from home care for other medical reasons. Reliable cost calculations were therefore impossible. Costs of osteoporosis screening

and treatment were included, but not presented as a separate group: costs of a DEXA scan were included in radiology/diagnostic studies costs, costs of visits to an osteoporosis specialist were included in outpatient clinic visits costs, and costs for osteoporosis treatment were included in medication costs.

Statistical analysis

Analyses were performed using SPSS (version 16.0, SPSS Inc., Chicago, IL, USA). Missing values for cost items were replaced using multiple imputation following the predictive mean matching method, using ten imputations. Means and standard deviations (SD) were calculated. Costs were calculated in the total population and in three subgroups (1) patients who did not require a revision surgery, (2) patients who had their implant removed (without any other revision surgery), and (3) patients who underwent one or multiple revision surgeries. Group 2 consisted of patients with a successfully healed fracture. Patients who had other, less common, revision surgeries (*i.e.*, replacement of implant by other implant, shorter screw, or revision to gamma nail) were not included in these subgroup-analyses. Costs between the subgroups were compared with a one-way ANOVA. Post-hoc comparisons using independent samples student T-tests were performed.

Results

Demographic description of patients

Of the 649 consecutive femoral neck fracture patients treated in the study period, 294 patients were eligible following the inclusion and exclusion criteria for this study, of which 250 were randomized (Figure 1). Two patients could not be followed; one patient turned out not to have a femoral neck fracture and one patient withdrew consent immediately after randomization.

The study group had a mean age of 71 years (SD 10) and 60% was female. Patients were relatively healthy and independent pre-fracture. Prior to the fracture only 3% of the patients were institutionalized and 13% used an aid for mobilization. Thirteen percent had severe comorbidities (*i.e.*, ASA>2). The most common comorbidities were hypertension (42%), cardiac disease (21%), or pulmonary disease (16%). Forty-six percent of the fractures was displaced (*i.e.*, Garden III-IV) and 35% was a Pauwels 3 fracture.

Treatment and clinical outcome

Patients were admitted to the hospital during 7 days on average. After discharge, 22% percent of the patients rehabilitated in a nursing home, whereas 72% of the patients were able to go home. An adverse event occurred in 101 patients (41%), of whom 12 patients had an implant- or surgery-related adverse event, and 13 patients sustained a wound infection. Other adverse events were a urinary tract infection, delirium, or various non-hip related adverse events, which were all infrequent (*i.e.*, less than 10 patients each). In 38 patients (15%) the implant was removed after the fracture had healed because of persisting implant-related complaints. A revision to an arthroplasty occurred in 67 patients (27%), of which 45 patients received a total hip arthroplasty. Out of 67 patients that had a revision to arthroplasty, the revision had been performed in 52 patients by one year follow-up, in 36 patients by six months follow-up, and

in 23 patients by ten weeks follow-up. The main reason for the revision surgery was the occurrence of avascular necrosis and/or non-union. The mean follow-up was 25.5 months (SD 6.1).

Costs

An overview of the costs is shown in Table 3. Most costs were generated in the first treatment year. The total mean costs per patient at 10 weeks follow-up amounted to €9,781 (SD € 6,909). The costs in this primary treatment phase were mainly related to the primary surgery (mean €1,313; SD € 497), the hospital admission days (mean €4,322; SD €3,104), and the admission days in a rehabilitation center or skilled nursing facility after hospital discharge (mean €2,735; SD €5,226).

At one year follow-up, the total mean costs per patient were €16,379 (SD €17,319), €6,598 more than at 10 weeks follow-up. The total mean costs per patient in the second year of follow-up amounted €3,046. The total mean costs per patient after two years were on average €19,425 (SD €24,200). The main contributing cost categories in the first and second year of follow-up were similar: (1) the costs related to the admission days in a rehabilitation center or skilled nursing facility (*i.e.*, €7,452 per patient in the first year and €1,973 in the second year), (2) the costs related to physical therapy at home or in an outpatient physical therapy clinic (*i.e.*, €1,354 per patient in the first year and €496 in the second year), and (3) the costs of revision surgery and related hospital admission days (*i.e.*, €512 per patient in the first year and €195 in the second year). In 5 patients, there were extremely high costs for the primary hospital admission (*i.e.*, more than €10,000), mainly due to a prolonged length of stay. In three patients this was caused by multiple adverse events and revision surgeries, and an admission to the ICU. In two patients, no reason could be found for the prolonged length of stay. Radiologic studies and other diagnostic studies (*i.e.*, €544; SD 343) and out-patient

clinic visits (*i.e.*, €452; SD 267) contributed more than one percent to the total treatment costs of the patients at two years follow-up (Figure 2).

At two years follow-up, the costs were highest for patients who underwent a revision to arthroplasty (total mean costs per patient €26,733; SD €24,151) (Table 4). Costs per patient were lowest for patients who did not require revision surgery; €17,405 (SD €25,842). Patients who had had their implant removed had lower costs (total mean costs per patient €10,066; SD €5,484; P 0.001). These differences were seen throughout all follow-up moments.

Discussion

The total mean costs per femoral neck fracture patient treated with internal fixation were €16,379 at one year follow-up and €19,425 at two years follow-up. This is slightly higher than the €13,600 estimated in 1999 from national database records, including similar cost categories (cost corrected for inflation €17,478, using http://statline.cbs.nl) [6]. One should realize that the costs presented include crude costs only, excluding hospital overhead costs and taxes, as is usual for economic analyses. This should be taken into account when calculating budgets.

The cost estimates in our study are comparable with previous studies from Western societies, although other studies usually did not incorporate all cost categories that were included in the present study. This may indicate that the hip fracture care pathways as implemented in the Netherlands promoting early mobilization, early hospital discharge, and rehabilitation in a specialized nursing home department or at home lead to limited costs. The costs in our study are even >50% lower than published costs in 2010 and 2012 for Norway (Table 1) [7-13]. Differences can be explained by several factors. The Norwegian studies involved older patients, all suffering from displaced fractures, and who were more often institutionalized pre-fracture, and less mobile without an aid pre-fracture, with more severe comorbidity (including the cognitively impaired). All patients were treated in a university hospital, which induces higher costs in general. Additionally, the unit costs per admission day to the hospital and to a nursing home were higher in Norway. The revision surgery rate in our study was comparable with previously published rates and will therefore not have influenced differences in costs between our study and previously published cost data [8, 13, 18-20].

The main determinant in the total costs was the costs for admission to a rehabilitation facility or nursing home. However, these costs may represent an overestimation of the actual

cost related to the hip fracture. It is difficult to determine if the hip fracture was the only reason for temporary or permanent stay in a nursing home. Especially in elderly patients this is usually multifactorially influenced by general condition, other comorbidities or fractures, and the availability of informal care. Another important determinant was the costs for the primary hospital admission, similar as reported in other studies. In our study, the length of stay was shorter than in some other studies [8, 11, 12]. This distribution of costs in the Netherlands seems an effect of the hip fracture care pathways described above. Other determinants that substantially contributed to the total costs were the costs for primary surgery (7%) and the costs for physical therapy in the out-patient clinic (10%). Reducing the amount of physical therapy should not be a focus to reduce costs, as intensive physical therapy has proven to benefit patient outcomes and independency [21]. Most costs were generated in the first year. In the second year only 16% of the costs were generated. A two years follow-up was considered sufficient, as it is known that most interventions, treatments and rehabilitation of the targeted patient population will take place in that period [19]. A subset of patients, however, will become permanent nursing home residents after their hip fracture, thereby extending their societal costs beyond the two years time span. This may not only be caused by the hip fracture, as discussed above.

As expected, costs were highest for patients who underwent a revision to arthroplasty. After two years, the costs per patient were on average €9,328 per patient higher than for the patients that did not require revision surgery. This amount is in agreement with previous data, and is attributed to additional costs for surgery, hospital admission, and rehabilitation [8]. Baseline characteristics of the patients that underwent a revision to arthroplasty (*i.e.,* age, comorbidity, and pre-fracture living status and mobility) were similar as for patients that did not. Costs were lowest for patients who had their implant removed after fracture healing. This may seem unexpected, as the implant removal is associated with costs for the surgical

intervention. Patient selection is the most likely explanation for the relatively low costs. The implant removal patients were younger, healthier, more independent and mobile pre-fracture. They therefore probably required less care and rehabilitation, generating less costs. Their superior pre-fracture mobility and hence perhaps higher rehabilitation goals may also be an indication for their implant removal. Within the patient group that did not have a revision surgery, no potential factors were correlated with higher costs other than the previously mentioned patient characteristics (*i.e.*, age, ASA score and mobility pre-fracture).

Our study has some limitations. As the population was relatively young, healthy, and independent pre-fracture, the presented costs may not be representative for all hip fracture patients. Moreover, not all cost categories related to hip fracture care were included. Costs of home care, informal care, and transport could not be reliably reproduced by patients. These costs are however expected not to contribute significantly to the total costs, compared with the costs that were included. Societal costs due to productivity losses were also excluded, but these are not expected to contribute significantly as well as these patients are older and mainly retired. Taking these limitations into account, the presented costs are probably an underestimation of the actual costs involved, especially for the patients that rehabilitated at home. However, the current study is one of few studies analyzing costs of hip fracture treatment with internal fixation in detail, including both hospital costs and costs of the rehabilitation process. Another strength of our study is the sample size, being the highest of all studies published until now.

In conclusion, the total mean costs per femoral neck fracture patient treated with internal fixation were €16,379 at one year follow-up and €19,425 at two years follow-up. These costs are comparable with costs published from previous studies in Western societies. The hip fracture care pathways implemented in the Netherlands promoting early mobilization, early

hospital discharge, and rehabilitation in a specialized nursing home department or at home, seem successful and contributory to limiting health care costs. Highest costs are generated by patients who underwent a revision to arthroplasty. This reinforces the importance of attempting to reduce the potentially avoidable risk of a revision surgery by a careful selection of patients for internal fixation, not only for medical reasons, but also economical reasons.

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Tables

Table 1. Studies describing the costs of treatment of femoral neck fracture patients with internal fixation

Author	Country	N	Follow-up	Average costs per patient
Iorio *et al.* (2001)	US	123	2 yrs	€27,474[a]
Haentjens *et al.* (2003)	Belgium	14	1 yr	€15,255 [a]
Rogmark *et al.* (2003)	Sweden	36	2 yrs	€18,564 [a]
Johansson *et al.* (2006)	Sweden	78	2 yrs	€13,100
Alolabi *et al.* (2009)	Canada	61	1 yr	€12,977 [a]
Frihagen *et al.* (2010)	Norway	112	2 yrs	€47,186
Waaler Bjørnelv *et al.* (2012)	Norway	86	2 yrs	€57,197

[a] US Dollars were converted to Euros using year-specific exchange rates (www.statistics.dnb.nl)

Table 2. Sources and unit costs (2010) of healthcare resources

Cost categories	Unit	Source of consumption data	Source of valuation	Unit price (€)
Hospital costs – primary stay				
Emergency department visit	Visit	Hospital registry	Cost manual[1]	152.92
Radiology/Diagnostic studies				
X-ray	X-ray	Hospital registry	NZa[2]	51.63
CT-scan pelvis	CT-scan	Hospital registry	NZa[2]	227.22
MRI scan pelvis	MRI scan	Hospital registry	NZa[2]	261.47
Ultrasound	Ultrasound	Hospital registry	NZa[2]	82.09
DEXA scan	DEXA scan	Hospital registry	NZa[2]	109.22
Skeletal scintigraphy	Scintigraphy	Hospital registry	NZa[2]	185.37
Surgery				
Surgeon	Hour	Study registry (Case report Form)	Cost manual[1]	137.22[a] / 104.31[b]
Operating room*	Hour	Study registry (Case report Form)	Hospital/industry data[3]	560.94[a] / 704.51[b]
Additional costs after hours	Hour	Study registry (Case report Form)	Hospital/industry data[3]	75.36[a]/ 94.65[b]
Equipment and implant				

Cancellous screws	Operation	Study registry (Case report Form)	Hospital/industry data[3]	490.30
Sliding Hip Screw	Operation	Study registry (Case report Form)	Hospital/industry data[3]	504.91
Admission days	Day	Study registry (Case report Form)	Cost manual[1]	440.53[a] / 582.31[b]
Hospital costs – follow-up				
Radiology/Diagnostic studies				As described above
Out-patient clinic visits	Visit	Hospital registry + patient questionnaire[§]	Cost manual[1]	130.64[a] / 64.81[b]
Adverse events				
Medication**	Dose per day	Hospital registry + patient questionnaire[§]	CVZ[4]	N.A.
Emergency department visit	Visit	Hospital registry	Cost manual[1]	152.92
Admission days	Day	Study registry (Case report Form)	Cost manual[1]	440.53[a] / 582.31[b]
Revision surgery				
Surgeon	Hour	Study registry (Case report Form)	Cost manual[1]	137.22[a] / 104.31[b]
Operating room*	Hour	Study registry (Case report Form)	Hospital/industry data[3]	560.94[a] / 704.51[b]
Equipment and implant				
Hemiarthroplasty	Operations	Study registry	Hospital/industry data[3]	1685.64
Total Hip Arthroplasty	Operations	Study registry	Hospital/industry data[3]	1722.39

	Gammanail	Operations	Study registry	Hospital/industry data[3]	1241.51
	Extended gammanail	Operations	Study registry	Hospital/industry data[3]	1258.39
	Implant removal	Operations	Study registry	Hospital/industry data[3]	53.16
	Soft tissue debridement	Operations	Study registry	Hospital/industry data[3]	25.29
	Antibiotic beads	Operations	Study registry	Hospital/industry data[3]	567.79
	Antibiotic spacer	Operations	Study registry	Hospital/industry data[3]	496.26
Admission days		Day	Study registry (Case report Form)	Cost manual[1]	440.53[a] / 582.31[b]
Medication***		Dose per day	Hospital registry + patient questionnaire[§]	CVZ[4]	N.A.
Costs related to rehabilitation / changes in living situation					
Rehabilitation center/Nursing home					
	Elderly home	Days	Patient questionnaire[§]	Cost manual[1]	91.14
	Nursing home	Days	Patient questionnaire[§]	Cost manual[1]	241.03
	Rehabilitation clinic	Days	Patient questionnaire[§]	Cost manual[1]	344.32
Home nursing day		Hours	Patient questionnaire[§]	Cost manual[1]	35.44
Physical therapy (outpatient)					

Physical therapy	Session	Patient questionnaire[§]	Cost manual[1]	36.46
Mensendieck / Cesar therapy	Session	Patient questionnaire[§]	Cost manual[1]	35.45
Use of aids				
Crutches	Day	Patient questionnaire[§]	Home care firm[5]	0.07
Walker	Day	Patient questionnaire[§]	Home care firm[5]	0.08-0.14
Wheelchair	Day	Patient questionnaire[§]	Home care firm[5]	0.25
Electric scooter	Day	Patient questionnaire[§]	Home care firm[5]	0.66
Extra bed	Day	Patient questionnaire[§]	Home care firm[5]	1.15
Extra toilet facilities	Day	Patient questionnaire[§]	Home care firm[5]	0.09-0.19
Extra shower facilities	Day	Patient questionnaire[§]	Home care firm[5]	0.09-0.17

N.A.; Not applicable

Reference unit costs anno 2010 were used, or costs were adjusted to 2010 costs using the national consumer price index.

*Including operating room personnel, anesthesia, and overhead costs. **Mainly antibiotics. ***Hip fracture related medication only (*i.e.*, pain medication and osteoporosis medication; see Supplemental Table 2 for details).

[§] Patient questionnaire; Customized version of the 'Trimbos and iMTA questionnaire on Costs associated with Psychiatric illness'.

[1] Cost manual; Manual on cost research, methods and standard costs in economic healthcare evaluations, version 2010 (17), [2] NZa; Nederlandse Zorgautoriteit (Dutch Healthcare Authority) standard costs. [3] Hospital/industry data; costs were requested from one academic hospital, three regional hospitals, and one surgical equipment and implant firm. Means were calculated and used as an estimation of the real costs in all participating sites. [4] CVZ; Standard prices were used as described by the CVZ (College voor zorgverzekeringen; Health Care Insurance Board), online available on www.medicijnkosten.nl. [5] Home care firm; costs of aids were requested from a home care firm and costs per day were calculated based on the calculated daily annuity. These costs were used as an estimation of the real costs in all participating patients.

[a] Academic hospital, [b] General hospital.

Table 3. Mean costs of femoral neck fracture patients treated with internal fixation (N=248)

Cost categories	Cost until 10 weeks (€)	Costs until 1 year (€)	Costs until 2 years (€)
Hospital costs – primary stay			
Emergency department visit	152 (152-152)	152 (152-152)	152 (152-152)
Radiology/Diagnostic modalities	243 (207-361)	243 (207-361)	243 (207-361)
Surgery	1,313 (793-2,506)	1,313 (793-2,506)	1,313 (793-2,506)
Admission days	4,322 (1,762-9,287)	4,322 (1,762-9,287)	4,322 (1,762-9,287)
Total	6,031 (3,392-11,090)	6,031 (3,392-11,090)	6,031 (3,392-11,090)
Hospital costs – follow-up			
Radiology/Diagnostic modalities	212 (103-472)	441 (127-981)	544 (207-1,163)
Out-patient clinic visits	134 (65-261)	370 (165-792)	452 (194-1,023)
Adverse events	39 (0-45)	54 (0-111)	128 (0-697)
Revision surgery	154 (0-1500)	512 (0-2,117)	707 (0-2,287)
Medication	30 (0-112)	88 (0-324)	157 (0-555)
Total	568 (168-1,989)	1,465 (378-4171)	1,988 (480-4,838)
Costs related to rehabilitation /			

changes in living situation			
Rehabilitation center/Nursing home	2,735 (0-15,076)	7,452 (0-39,991)	9,425 (0-46,308)
Physical therapy (outpatient)	418 (0-1006)	1,354 (231-3,169)	1,850 (292-4,752)
Use of aids	28 (5-104)	76 (5-245)	131 (5-466)
Total	3,181 (27-15,782)	8,883 (487-41,743)	11,406 (540-51,300)
Total costs	9,781 (3,993-24,203)	16,379 (4,977-52,339)	19,425 (5,237-58,874)

Costs are presented as cumulative mean costs at each follow-up moment with 95% confidence interval between brackets.

Table 4. Costs of patients without revision surgery, patients who had an implant removal, and patients who required revision surgery

	No revision surgery (N=137)	Implant removed* (N=38)	Revision surgery to arthroplasty (N=67)	P-value
Costs until 10 wks	9,371 (3,970-24,339)	6,967 (3,394-19,322)	11,549 (5,125-29,762)	0.003
Costs until 1 year	14,438 (4,824-45,211)	8,723 (4,434-19,735)	22,498 (8,052-73,307)	<0.001
Costs until 2 years	17,405 (4,953-58,865)	10,066 (4,843-26,731)	26,733 (9,465-80,029)	0.001

Costs are presented as cumulative mean costs at each follow-up moment with standard deviations between brackets.

Differences between the three groups were compared with a one-way ANOVA. Post-hoc comparisons using independent samples student T-tests were performed and indicated that all subgroups had significant differences in costs at all follow-up moments (*i.e.*, P<0.005).

Six patients were excluded from the subgroup analyses as these patients all had other, less common, revision surgeries (*i.e.*, replacement of implant by other implant, shorter screw, or revision to gamma nail)

* This group consisted of patients that healed successfully.

Figures

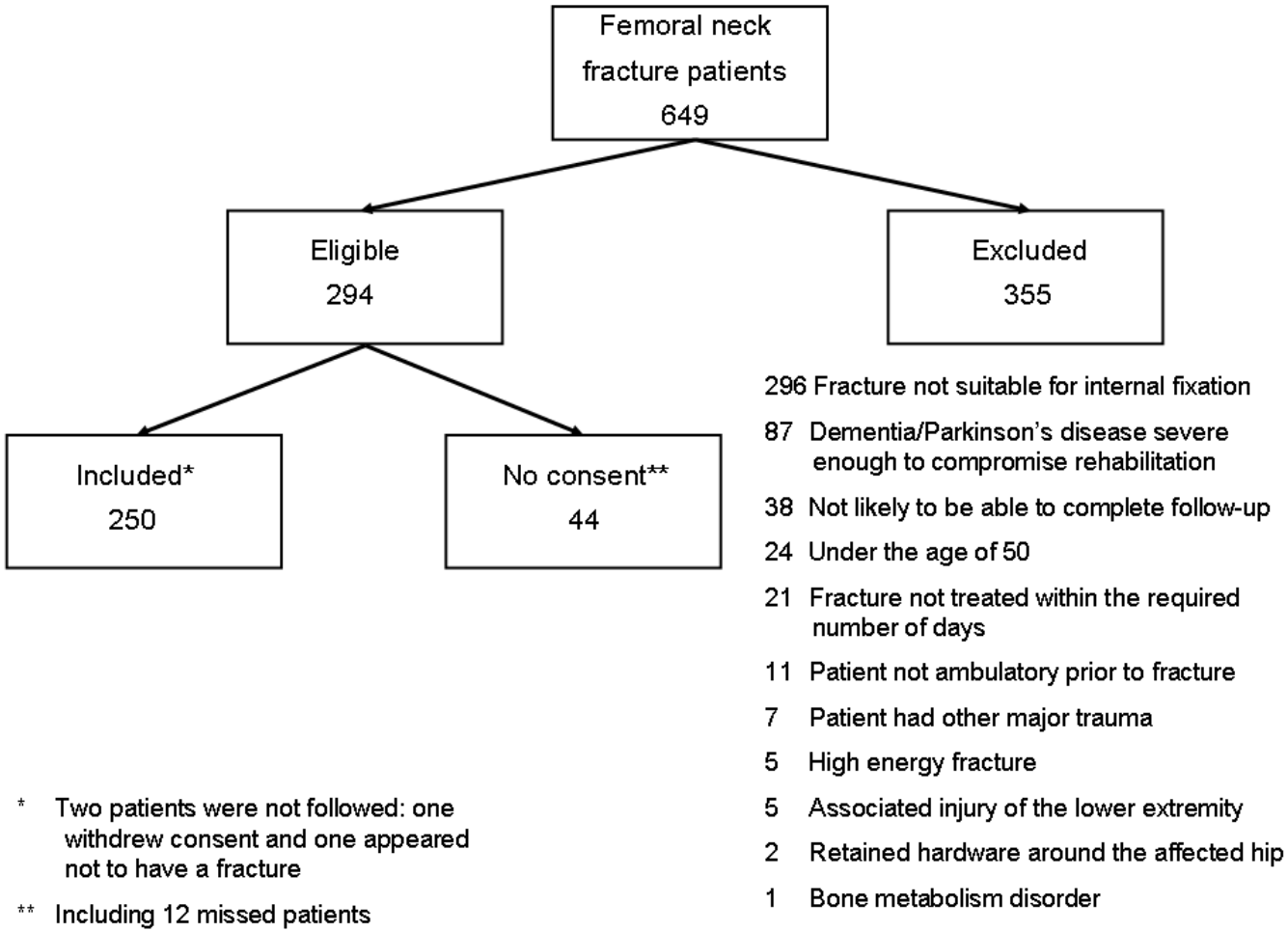

Figure 1. Flowchart of patients participating in the study

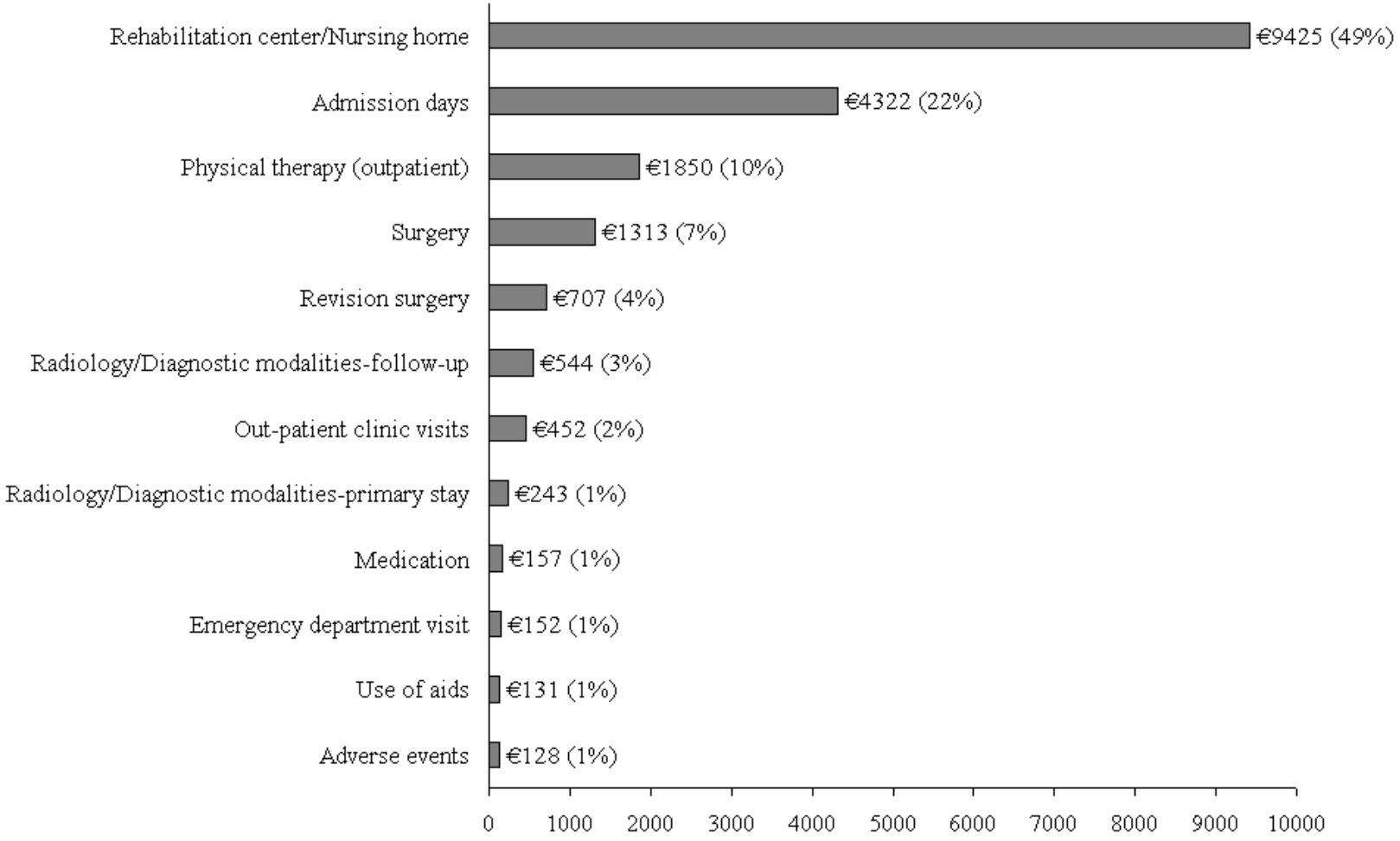

Figure 2. Relative contribution of various cost categories to the total treatment costs of patients until two years follow-up.