Chapter 5.
A cost-minimisation study of alternative discharge policies after hip fracture repair

Summary

It is widely assumed that health care costs can be reduced considerably by providing care in appropriate health care institutions without unnecessary technological overhead. This assumption has been tested in a prospective study. Conventional discharge after hip fracture surgery was compared with an early discharge policy in which patients were discharged to a nursing home with specialised facilities for rehabilitation. We compared costs for both strategies from a societal perspective, using comprehensive and detailed data on type of residence and all kinds of medical consumption during a 4-month follow-up period.
As expected, early discharge reduced the hospital stay (with 13 days, $p = 0.001$). More patients were discharged to a nursing home (76% versus 53%). Total medical costs during follow-up were reduced from an average of € 15,338 to € 14,281, representing relatively small and not significant savings ($p = 0.3$). There are two explanations for this unexpected result. First, hip fracture patients were relatively cheap while in hospital. Hence nursing home costs almost equalled hospital costs per admission day. Second, compared to the conventionally discharged group early discharged patients received more medical procedures during the first post-operative days. We conclude that: 1) early discharge shifted rather than reduced costs; 2) the details of costing have a major influence on the cost-effectiveness of alternative discharge policies.

5.1 Introduction

Health technology assessment (HTA) is employed to optimise medical treatment in an economic way. Distinction is made between cost-effectiveness analysis (CEA) and cost-minimisation analysis (CMA). CEAs deal with the question whether new or additional treatment provides value for money compared to conventional treatment. In CMAs it is studied to what extent less intensive treatment is worthwhile regarding medical outcomes. It is assumed that optimising the chain of care can reduce health care costs, for instance by replacing more expensive health care institutions with cheaper ones, without worsening medical outcomes. We performed a prospective study to compare the societal costs of a conventional discharge policy after hip

fracture repair with the costs of an early discharge policy in which patients were rehabilitated in a specialised nursing home as example of a CMA.
Hip fracture incidence is rising exponentially with age. All over the world ageing has important consequences for costs of treatment and rehabilitation [1-6]. The main part of the rehabilitation process is completed in the first 4 months after hip fracture with estimated costs of around US$ 11,000 per patient [7-8]. Since a substantial part of these costs (50%) is made in the orthopaedic department of the hospital several strategies have been described to shorten hospital stay [8]. These strategies include joint orthopaedic-geriatric rehabilitation [9-10] and hospital-at-home schemes [11]. Because functional outcome is expected to be similar, cost-effectiveness of early discharge depends on costs, and boils down to cost-minimisation.
Shortening the length of the hospital stay could be expected to generate substantial cost savings, even with a similar total stay within institutions such as nursing homes and homes for the elderly, because of the higher costs per hospital day. Early discharge is also attractive because it provides possibilities for reducing backlogs and the waiting period for hip surgery. Potential drawbacks of early discharge, apart from medical outcomes, regard an unjustifiable shift to informal care and high capacity costs for the continuous availability of nursing home beds.
Although several prospective studies reported costs of hip fracture, few described the consequences of a change in treatment program [7, 12-14]. We compared the costs between a conventional discharge policy and a strategy in which patients were discharged earlier to a nursing home after day five of admission, if medically possible. We checked for equivalence of medical outcome in terms of functional status and cognitive performance. Costs were studied in detail, since there are indications that costs are highest during the first post-operative days, and decrease thereafter [15]. Using average charges or even average costs per hospital day would lead to an overestimate of the real costs per hospital admission, and by consequence to an overestimation of potential cost savings.

5.2 Data and methods

We performed a prospective study in a university and a general hospital in Rotterdam, the Netherlands. A "before and after" study design was chosen. Randomisation of patients was not considered feasible since the change from conventional discharge to early discharge arrangements required such organisational adjustments that both service models could not be offered simultaneously.

Patients, procedures and medical outcomes

Between October 1996 and October 1998 we invited for participation in both hospitals all patients, aged 65 years and older, with a fresh hip fracture. Excluded were patients with a hip fracture due to metastatic cancer or as part of a multi-trauma. The first 130 eligible patients formed the conventional discharge group of which 102 patients (78%) consented to participate in the study. Early discharge was proposed to the next 124 eligible patients, of whom 106 (85%) consented to participate. There were no clear differences in age and sex between participants and non-participants although slightly more non-participants lived at home before admission (85% versus 60%).

Patients with conventional discharge stayed longer in hospital for rehabilitation than early discharged patients. The treatment consisted of physical therapy, which was given two times per day by the hospitals' physical therapists under supervision of the ward physicians. Early discharge was implemented by a discharge protocol that started five days postoperatively. Administrative procedures were speeded up and the number of beds available on the rehabilitation ward of the participating nursing home was increased. Physical therapists, occupational therapists and social workers were involved in the rehabilitation process, supervised by a physician trained in geriatric medicine.

Clinical equivalence was checked for functional outcome and cognitive status using the Rehabilitation Activities Profile (RAP) and the Mini Mental State Examination (MMSE) [16, 17]. The RAP is based on the International Classification of Impairments, Disabilities and Handicaps (ICIDH) and measures disabilities in communication, mobility and personal care.

Costs: methods

Costs were studied from a societal perspective using a bottom-up methodology [18]. First, real costs were estimated based on a detailed measurement of investments in manpower, equipment, materials, housing and overhead. Fees and charges were only used in case of uncommon interventions and standard laboratory analyses. Second, all medical costs were included as well as the costs borne by the patient and the family, for instance costs of informal care and travelling. Costs of absence from work and related productivity losses were not taken into account, because all patients were old and retired from work.

Costs were calculated for the participating centres only. Hospital costs were estimated separately for a general and an academic hospital. Early discharge increased the proportion of patients discharged to a specialised rehabilitation ward of one particular nursing home. This nursing home had the disposal of a specialised rehabilitation ward with 30 beds. Because this ward existed already when our study started, we did not consider the investment costs of such a specialised rehabilitation ward. All capacity related costs were allocated to bed days using the real investments in the past and annual production figures. These figures included the occupation of nursing home beds. So the availability costs of these beds were discounted in the average costs per inpatient day.

We calculated integral costs per patient. All medical costs during a certain period were included, although from a differential point of view – comparison of the two discharge strategies – some items were not relevant. For these items, including hip surgery itself, we used charges instead of real cost estimates.

We distinguished six categories of care (Table 1): 1) inpatient days (in hospitals, nursing homes and elderly homes); 2) nursing provided by professional nurses (in hospitals, nursing homes and at home); 3) health practitioner activities (physicians, therapists and other); 4) medical procedures (therapeutic, diagnostic and laboratory); 5) travelling (ambulance, taxi and other); and 6) informal care and other costs as meal service at home and adjustment of the housing conditions.

Costs were estimated for a 7-month period, 3 months pre-operatively and 4 months post-operatively. We distinguished seven periods based on the location of the patient: 1) before hospital admission; 2) from admission to day five after hip surgery; 3) from day 6 until discharge form hospital; 4) nursing home; 5) elderly home; 6) home; 7) readmission to hospital or nursing home. For each period we calculated total costs per patient for the six categories mentioned before.

Costs were calculated by multiplying the volumes of health care use with the corresponding unit prices and are reported in 1998 Euros. Discounting was not relevant because of the limited time horizon.

Costs: volume of health care use

The volume of health care was observed in much detail. A research assistant registered for each patient the number of inpatient days, the time needed for nursing, care and therapy as well as the time spent by physicians and other health practitioners per admitted patient. Nursing time was registered in the patient files by the nurses

Table 1
Cost categories and data used in cost calculations

Cost category	Parameter	Data collection volume of care			Cost estimate (unit price)
		hospital registry	study registry	question naire	
Inpatient days					
hospital	days		*		real costs
nursing home	days		*		real costs
elderly home	days		*		real costs
Nursing					
hospital	minutes		*		real costs
nursing home	minutes		*		real costs
home care	minutes			*	real costs
Health practitioners					
physician (inpatient)	minutes		*		real costs
physician (outpatient)	visits		*		real costs
general practitioner	visits			*	fees
physical therapist	minutes		*		real costs
psychologist / social worker	visits		*	*	real costs
other health professionals	visits		*	*	fees
Medical procedures					
hip surgery	number by type (3)		*		charges
other therapy	number by type (30)	*			charges
X-ray hip	number			*	charge
X-ray thorax	number			*	charge
other radiology	number by type (30)	*			charges
laboratory	number by type (125)	*			charges
Travelling					
ambulance	rides			*	charge
taxi	rides			*	charge
other	rides			*	real costs
Informal care and other costs					
informal care	minutes			*	shadow price
day care (hospital)	number			*	charge
day care (nursing home)	number			*	charge
other costs	various			*	various

in the hospitals and the nursing homes. The research assistant took care of the completeness of the data. She also interviewed all caregivers about their time investments per patient and furthermore registered the type of hip surgery, the number of X-rays and the number of outpatient visits to physicians and general practitioners. Detailed information on medical consumption in hospital was derived from the hospital information systems of the participating hospitals. These data included medical interventions other than hip replacement (30 categories), radiology (30 categories) and laboratory analyses (125 types). Data on nursing time and costs of home care were obtained from the largest provider covering 65% of the included patients. Data on outpatient care were collected by questionnaires.
Medical consumption in hospital and nursing home was registered on a daily basis. Discharged patients were visited by the research assistant one month after inclusion and at the end of the follow-up period. She assisted the patients with questionnaires on medical consumption. If needed, for instance because demented people could not answer the questions, the research assistant gathered information from personnel in the nursing home or elderly home in which the patients lived, or otherwise from the relatives of patients at home.

Costs: unit prices and cost calculation

Unit prices for inpatient days were estimated as real, basic costs per day using detailed information from the financial accounts of the hospitals, nursing homes and homes for the elderly that participated in the study. These estimates included overhead and indirect costs but excluded all direct costs that were analysed separately. Hence nursing costs and cost of all diagnostic and therapeutic interventions and laboratory examinations, as well as all costs of health practitioners that are normally included in average day prices were calculated separately. We calculated average costs per hospital day for each patient in the study population by summing up all costs per category of health care use. For readmissions in hospitals and nursing homes, partly not participating in the study, no detailed data on health care use per inpatient day were available. For these readmissions we therefore used all-in average prices per inpatient day.
The salary schemes of hospitals and other health care suppliers were used to estimate costs per hour for each type of care giver. Taxes, social securities and vacations were all included, as well as the costs for the time that could not be assigned to individual patients.

In the Netherlands a detailed 'fee for service' system is used for the remuneration of medical interventions and diagnostic procedures. For these categories we used the fees as a proxy of real costs. There are several reasons for not calculating real costs. First, the hip surgery as such was not the focus of our study but the discharge strategy after surgery. Second, the list of diagnostic procedures is long, but total costs are relatively small and the Dutch charges for laboratory procedures can be seen as a good proxy of real cost [19].
Bottom-up cost estimates were made. In this paper we will reverse the order of presentation. First, estimates on average costs at aggregate level are presented, and the cost differences between conventional and early discharge analysed (using the Mann-Whitney U test). Second, we show detailed figures for different periods and categories.

Explanatory factors

This paper will also deal with a number of explanatory factors, including age, number of comorbidities, cognitive status, functioning before fracture, residence before admission and costs before admission. These factors were tabulated to indicate the major determinants of health care costs within this population. These factors were further analysed with multiple linear regression.

5.3 Results

Patient characteristics

The baseline characteristics of the two groups of patients were similar (Table 2). Patients averaged 83 years of age, were predominantly female (79%) and most of them were living without partner (74%). All patients could walk before fracture, most of them without assistance or walking aids. The RAP score averaged 9.6 for all patients with small, not statistically significant differences between conventionally and early discharged patients. Many patients (41%) were institutionalised before fracture, and 94% had one or more comorbid conditions at time of hospital admission.

Medical outcomes

Medical outcomes at 4 months after hip fracture repair were equivalent for conventionally and early discharged patients. Nearly 20% of all patients died, with no

Table 2
Characteristics of conventionally and early discharged hip fracture patients

	Discharge policy		Total
	conventional (n=102)	early (n=106)	(n=208)
Demography			
Median age (years)	83	84	84
25th – 75th percentile (years)	77 – 88	79 – 90	78 – 89
Men/women	16/84%	26/74%	21/79%
With/without partner	24/76%	27/73%	26/74%
Residence before fracture			
Nursing home	16%	14%	15%
Home for the elderly	27%	25%	26%
Own home	57%	61%	59%
Walking ability			
Not	0%	0%	0%
With help	3%	5%	4%
With walking frame	26%	23%	24%
With crutches	8%	17%	12%
Without walking aids	64%	56%	60%
RAP score (0 – 36)	9.3	9.9	9.6
Fracture type			
Cervical	43%	51%	47%
Trochanteric	49%	47%	48%
Sub-trochanteric	8%	2%	5%
Number of comorbidities			
0	6%	6%	6%
1	27%	24%	25%
2	20%	29%	25%
3	30%	26%	28%
4 and more	17%	15%	16%
Average number	2.4	2.2	2.3

Table 3
Medical outcomes at 4 months after hip fracture repair

	Discharge policy		Total
	conventional	early	
Status at 4 months	(n=102)	(n=106)	(n=208)
Died	20%	19%	20%
Hospital	0%	0%	0%
Nursing home	28%	26%	27%
Home for the elderly	17%	14%	15%
Own home	36%	41%	38%
Walking ability	(n=82)	(n=86)	(n=168)
Not	15%	21%	19%
With help	10%	8%	9%
With walking frame	42%	37%	39%
With crutches	7%	14%	10%
Without walking aids	27%	20%	23%
RAP score (0 – 36)	14.5	14.9	14.7
MMSE score (0 – 29)	20.8	20.6	20.7

RAP = Rehabilitation Activities Profile (higher figures indicate worse health status)
MMSE = Mini-Mental State (higher figures indicate better cognitive status)

difference between both groups (Table 3). These results are consistent with the findings reported in literature [20-23]. Differences in residence (nursing home, home for the elderly and own home), walking ability, RAP score and MMSE were small and not statistically significant ($p < 0,05$ Mann Whitney U test).

Inpatients days and type of residence during 4-month follow-up

Early discharged patients stayed an average of 13.5 days less in hospital than conventionally discharged patients (12.7 versus 26.2 days, Table 4). The total time spent in a health care institution, however, was the same for both groups (75.7 days for

early discharged and 79.3 days for conventionally discharged patients). The main cause was the longer average stay in nursing homes of the early discharged group (46.4 versus 34.7 days).

Table 4 also shows the destination of patients at discharge from hospital. Most patients in the early group were discharged to a nursing home for rehabilitation (76%). Conventionally discharged patients were rehabilitated in hospital and discharged after their (longer) hospital stay, relatively more frequently to their own home or an home for the elderly compared to early discharged patients (42% versus 23%). Nevertheless, a good 53% of the patients in the conventional group were discharged to a nursing home, which is high given that before fracture only 16% of these patients lived in a nursing home.

At four months after hip fracture, these differences in residence had completely disappeared. Most patients lived in their own homes (36% and 41% among the conventionally and early discharged group, respectively, Table 3), although the number remained low compared to the living situation before fracture (57% and 61% respectively, Table 2).

Table 4
Average number of inpatient days in hospital, nursing home and elderly home, and discharge arrangements.

	Discharge policy	
	conventional (n=102)	early (n=106)
Inpatient days		
hospital	26.2	12.7
nursing home	34.7	46.4
elderly home	16.5	12.2
readmission to hospital / nursing home	1.9	4.4
Total days in institutions	79.3	75.7
Destination at discharge		
died in hospital	6%	0%
nursing home	53%	76%
elderly home	17%	9%
own home	25%	14%

Costs per patient

Average costs during the 4 months after incidence of hip fracture amounted to € 14,281 for early discharged patients, which was € 1,057 less compared to conventionally discharged patients (€ 15,338, Table 5). Unfortunately the cost savings were not statistically significant (p = 0.315). There was a wide variation in costs within both groups. Among conventionally discharged patients costs at 25th – 75th percentiles were € 3,511 – € 18,144. The variation among early discharged patients was somewhat smaller (€ 3,986 – € 16,968). It is not clear however, whether the statistic insignificance was caused by the large variation or the absence of a true difference. It is assumed that the effects of early discharge might be different for patients in different groups. We distinguished between patients living at home and patients living in an health care institution before fracture, and two equal groups based on the RAP score using the median as cut-off value. People living at home had significant (p < 0.001) lower costs compared to people in health care institutions (€ 12,925 versus € 17,567). These people seem more eligible for early discharge. Compared to conventional discharge, average costs in this group decreased by nearly € 2,100 (p = 0.313) due to early discharge. Opposite, average costs among people living in institutions increased (€ 864; p = 0.764), mainly due to a higher number of medical interventions in the post-operative days (see below). Similar results apply to RAP scores. Costs for people with low RAP scores (0 – 9) were on average € 4,535 lower compared to people with RAP scores >10 (p < 0.001). Average costs among people with lower RAP scores (better functional status) decreased substantially by early discharge (€ 3,351; p = 0.036), while for people with high RAP scores average costs increased (€ 1,006; p = 0.694).

Table 5 shows that early discharge causes a shift in costs from hospital to nursing home. Hospital costs were reduced by € 2,812 (p < 0.001), nursing home costs increased on average by € 1,290 (p < 0.001). The conventionally discharged patients incurred 47% of costs in the hospital, 33% in the nursing home, 12% in the home for the elderly and 6% at home. For early discharged patients these figures were respectively 31%, 44%, 10% and 5%. These figures exclude readmissions in hospital or nursing home. Because early discharged patients have a greater chance of readmission, this can bias the results in favour of early discharge. Table 5 shows a cost difference of € 952, resulting almost entirely from readmissions to hospital. When these costs are included the savings in hospital costs per early discharged patient decrease to around € 1,800. A second important shift in costs shown in table 5 regards an

increase of hospital costs during the first days after surgery among early discharged patients. Compared to the conventionally discharged group, average costs increased by € 399 ($p < 0.01$). Apparently the prospect of a short hospital stay cause physicians to speed up diagnostic and laboratory procedures. More or less substantial differences existed for the periods outside hospital and nursing home. These differences, however, neither reached statistical significance nor changed the general finding that the cost savings achievable with early discharge were limited.

Costs up to 3 months before admission amounted to € 4,517 in the conventional group and € 4,705 in the early group. After correcting for this pre-admission costs, the adjusted costs difference after hip fracture increased slightly to € 1,162 ($p = 0.25$). The costs caused by hip fracture in addition to the costs of care the patients received before the fracture, were estimated at € 9,316 for conventionally discharged and € 8,008 for early discharged patients.

Table 5
Average costs (€, 1998) per patient by period and discharge policy, cost difference between early and conventional discharge

Period	Discharge policy		Difference (early – conventional)		
	conventional (n=102)	early (n=106)	Average	95% CI	p-value
Before fracture (3 months)	€ 4,517	€ 4,705	€ 188	[-1,022 – 1,397]	p = 0.65
Hospital	7,235	4,423	-2,812	[-4,048 – -1,576]	p < 0.001
- until 5 days after surgery	(2,665)	(3,064)	(399)	[160 – 637]	p = 0.003
- from day 6 until discharge	(4,570)	(1,359)	(-3,211)	[-4,392 – -2,029]	p < 0.001
Nursing home	4,990	6,280	1,290	[-424 – 3,004]	p = 0.017
Elderly home	1,767	1,436	-331	[-1,360 – 699]	p = 0.34
Home	847	692	-155	[-708 – 397]	p = 0.54
Readmission in hospital or nursing home	498	1,450	952	[-140 – 2,043]	p = 0.047
Total costs after fracture	15,338	14,281	-1,057	[-3,164 – 1,051]	p = 0.32

CI = confidence interval

Costs per inpatient day

Average costs per inpatient day are shown in Table 6. These figures are based on the real medical consumption as registered in the study. The first 5 hospital days immediately after surgery were more expensive than later days due to more nursing time, more supervision by physicians and additional diagnostic and laboratory procedures. Average hospital costs for early discharged patients were higher than for conventionally discharged patients, as explained before. Average costs per inpatient day in nursing homes (about € 140) and homes for the elderly (about € 100) were substantially lower in comparison with hospitals.

In the Dutch health care system inpatient days are remunerated on daily basis by charges that represent average costs over all patients. These charges do not differentiate between types of care other than IC-units versus common nursing wards. Charges per hospital day vary among general and university hospitals from € 235 until € 350 [19]. Our detailed cost estimates show higher costs for the first post-operative days and lower costs for the remainder of the hospital stay. Hence, early discharge seems unprofitable from the perspective of hospital financing. It must be noted, however, that most of the included interventions and examinations can be charged separately.

Table 6
Average costs and charges paid by the health care system (€, 1998) per inpatient day in hospital and nursing home

	Real costs in study population				Charges in the Dutch health care system (€)
	Conventional discharge		Early discharge		
	Average costs (€)	CI (95%)	Average costs (€)	CI (95%)	
Hospital					235 – 350
- until day 5 after surgery	422	[206 – 638]	456	[91 –821]	-
- from day 6 until discharge	237	[-14 – 488]	264	[58 – 470]	-
Nursing home	143	[72 – 214]	134	[75 – 193]	130
Elderly home	101	[50 – 152]	119	[50 – 188]	60

CI = confidence interval

Costs by categories

Table 7 shows the average costs per patient by category, period and discharge policy. Costs before fracture were mainly incurred in the categories inpatient days, care, informal care and other costs, with only slight differences between both discharge groups. Total costs after hip fracture could mainly be attributed to inpatient days (50%, € 7,200) and nursing (30%, € 4,000). Costs for health practitioners (physicians, physical therapists and other) were limited to only 6 – 7% of total costs. This figure excludes hip surgery and all other medical procedures including diagnostic and laboratory assessment, that represented 12% of total costs. On aggregate level differences between both discharge policies were rather limited. Major differences were only observed in average costs from day 6 until discharge for inpatient days in hospital (lower costs for early discharge) and nursing home (higher costs for early discharge). The shorter stay in hospital and longer stay in nursing home explain this finding. Costs of medical procedures shifted to the first 5 days after surgery in the early discharge group, as mentioned before.

Explanatory factors

Relationships between several variables and average costs per patient are shown in Table 8. The difference between patients admitted to the general or to the university hospital was € 1,219 ($p = 0.26$) with higher costs for the university hospital. A larger number of co-morbid conditions, diminished cognitive status, deteriorated functioning before fracture, increased costs before admission, the presence of diagnosis dementia and the pre-fracture residency in a home for the elderly or nursing home were all associated with increased costs. In a multivariable analysis, the pre-fracture residency in an elderly home, the number of comorbidities, functioning before fracture (RAP score) and dementia were the most important explanatory factors for costs after fracture.

5.4 Discussion

We compared two discharge policies after hip fracture repair. Because the patients in both groups had on average the same characteristics before fracture and medical outcomes were equivalent, it was possible to perform a cost-minimisation analysis (CMA). We found that early discharge of hip fracture patients from hospital led to a limited, statistically non-significant reduction of total costs. We used a detailed calcu-

Table 7
Average costs (€, 1998) per patient by period, cost category and discharge policy

Period	Inpatient days		Nursing		Health practitioners		Medical procedures		Travelling		Informal care and other		Total costs per patient			
	conv	early	conv	early	conv	early	conv	early	conv	early	conv	early	conventional		early	
Before fracture	2,516	2,492	1,115	1,261	73	85	0	0	0	4	812	863	4,517		4,705	
Hospital																
-until 5 days after surgery	763	821	505	479	107	124	1,268	1,615	23	25	0	0	2,665	(17%)	3,064	(21%)
-from day 6 until discharge	2,330	675	1,350	293	212	74	566	150	113	169	0	0	4,570	(30%)	1,359	(10%)
Nursing home	2,518	3,414	2,008	2,163	421	633	0	0	28	62	15	8	4,990	(33%)	6,281	(44%)
Elderly home	1,125	829	571	529	45	40	0	0	14	3	12	35	1,767	(12%)	1,436	(10%)
Home	0	0	285	324	73	104	0	0	18	27	472	237	847	(6%)	692	(5%)
Readmission	477	1,437	-	-	-	-	-	-	21	13	0	0	498	(3%)	1,449	(10%)
Total costs after fracture	7,213	7,176	4,717	3,787	858	975	1,833	1,765	217	299	499	280	15,338	(100%)	14,281	(100%)
(Share)	(47%)	(50%)	(31%)	(27%)	(6%)	(7%)	(12%)	(12%)	(1%)	(2%)	(3%)	(2%)	(100%)		(100%)	

- Not available (costs included in inpatient days).

Table 8

Average costs (€, rounded to hundreds, 1998) per patient according to explanatory factors

Predictive factor	Costs per patient		Number of patients	Significance of difference
	€	Confidence Interval (95%)		
Hospital				
general hospital	14,100	[200 – 28,100]	90	p = 0.26
university hospital	15,300	[-600 – 31,200]	118	
Age in years				
65-79	14,100	[-2,400 – 30,600]	67	p = 0.26
80-89	14,900	[-600 – 30,300]	101	
>= 90	15,800	[4,300 – 27,400]	40	
Number of co-morbidities				
0	6,700	[-1,500 – 14,900]	12	p = 0.002
1	13,600	[-1,600 – 28,900]	53	
2	15,200	[1,200 – 29,200]	51	
3	17,000	[1,100 – 33,000]	59	
4 and more	15,000	[2,000 – 28,000]	33	
MMSE-score after 1 week				
missing	15,500	[2,900 – 28,100]	18	p < 0.001
0-12	18,300	[2,700 – 34,000]	48	
13-18	15,400	[3,200 – 27,700]	30	
19-22	16,300	[2,400 – 30,200]	31	
23-29	11,700	[-2,900 – 26,400]	81	
Dementia				
no	13,900	[-700 – 28,400]	166	p = 0.001
yes	18,400	[3,000 – 33,800]	42	
RAP cmp-score before fracture				
0 – 4	12,200	[-2,400 – 26,800]	78	p < 0.001
5-14	15,100	[1,600 – 28,600]	68	
15-36	17,800	[2,400 – 33,100	62	
Residence before fracture				
home	12,900	[-1,800 – 27,600]	124	p = 0.001
elderly home	17,700	[6,300 – 29,200]	53	
nursing home	17,300	[-700 – 35,300]	31	
Costs before fracture				
< _ 4,540	12,800	[-1,800 – 27,300]	116	p < 0.001
> _ 4,540	17,400	[3,100 – 31,700]	92	
Discharge policy				
conventional discharge	15,300	[100 – 30,600]	102	p = 0.32
early discharge	14,300	[-700 – 29,300]	106	

lation method to estimate real costs from a societal perspective. Therefore we were able to present estimates of costs in different categories and for different periods after hip fracture. Hence it was possible to observe some important shifts in costs. Finally, we identified a number of explanatory factors for costs after fracture.

Total costs: early discharge versus conventional discharge

Contrary to our expectations, early discharge did not significantly reduce costs. This was mainly due to the shift of costs from hospital to the nursing home. The total number of inpatient days in all institutions together was almost the same within both groups, and costs per day in a nursing home differed little from costs in hospital after the first 5 days post-operative. During the first days in hospital, the costs were initially high due to hip surgery, diagnostic and other medical procedures and intensive post-operative care, but subsequently decreased substantially [13].
Although the reduction in hospital stay by the early discharge programme was larger than in some Australian studies [7, 12, 24], we did not observe significant cost savings. Adjustment for costs incurred before hip fracture did not change this outcome. Some analyses, however, demonstrated that costs savings among people with good (low) RAP scores and for people being referred from their own homes were much greater and more significant.
Cost savings in the Australian studies resulted from a shorter hospital stay and were relatively modest (about € 650 per patient [7, 12]) or only reached statistical significance when costs per recovered patient were calculated separately [7]. We found a difference of € 1,057 per patient in favour of the early discharge programme but the cost savings were not statistically significant. It was not clear, whether the low level of statistic significance was caused by the large variation or a real absence of a difference. Another cost-cutting strategy was early discharge of patients to a 'hospital-at-home' scheme [13]. Again, the savings resulted from shorter stays in orthopaedic and geriatric wards, while costs at home did not increase substantially. The hospital-at-home scheme, however, was only suitable for about 40% of total patients in this study, while in another part of England only 18% of patients fitted the selection criteria [22].
In Sweden, the substitution of hospital care by geriatric care resulted in a cost increase of 12% [14]. In that study, the number of hospital days was approximately halved by earlier discharge to geriatric wards.

Hospital and incremental costs

Hospital costs in our study (€ 7,235 for conventionally discharged patients and € 4,432 for early discharged patients) fitted well within the range of costs reported by others. These range from € 3,600 – 8,400 in Great Britain [13, 15, 25], € 5,300 – 8,700 in Sweden [8, 14, 26] to € 10,300 in the United States [27]. Costs during the 4-month follow-up are more difficult to compare. Our estimate of € 15,000 is high compared to Borquist's estimate for Sweden (€ 10,700) [8], which, however, only included patients coming from home.
We estimated costs in the three months before fracture at € 4,600. Incremental costs attributable to hip fracture were therefore € 9,300 for conventionally discharged and € 8,000 for early discharged patients. These figures are in line with the € 8,600 of additional costs during the first year after hip fracture reported by De Laet for the Netherlands [28] and with the estimate of € 8,910 by Cameron et al. [7]. Others, however, found much higher figures: € 12,000 – 14,000 for the United States in 1993 [27] and € 17,000 in Sweden in 1994 [29]. This difference may partly be explained by higher hospital costs and more admissions to geriatric departments and nursing homes in the latter two studies.

Explanatory factors

The most important explanatory factors were the pre-fracture residency, the number of comorbidities, level of functioning (RAP score) before fracture and dementia. These factors also explain survival, which influences the cost estimates. For example, patients with dementia incurred higher costs, while their survival was worse compared to non-demented patients. On average, for surviving and deceased patients we estimated costs at € 15,300 and € 12,700 respectively.
The higher costs among institutionalised patients are in line with data from Sweden [29] but were not demonstrated in Scotland [15]. We could not confirm the relation with type of fracture or gender that was reported by Borquist [8].

Explanations for the disappointing cost savings

Owing to the detailed cost analyses available, we are able to provide some explanations for the disappointing cost reduction. First, comorbidity played an important role in our study population. People were old and had multiple diseases (Table 2). Comorbidity was an important explanatory factor for high costs (Table 8). The large

variation in costs between patients within both groups also indicate that hip fracture is but one cause of health care costs. People were old and needed care for different diseases and disorders. The total number of inpatient days was on average the same for both groups, irrespective whether the care was supplied by a hospital or a nursing home. In some sub-group analyses it was demonstrated that cost savings among people living at home and with better RAP scores were much greater.
Second, during the hospital days immediately after surgery the number and costs of medical interventions and examinations was higher among the early discharged group. Apparently hip fracture patients need a certain amount of medical procedures, mainly diagnostic and laboratory, which can not simply be skipped. Early discharge resulted in a concentration of medical procedures during the first post-operative days, which partially cancelled out its potential benefits. In addition the early discharged patients received more physical therapy in nursing home than the conventionally discharged received in hospital. This also decreased the cost difference between both groups.
Third, we confirmed that hospital costs per inpatient day decrease after day five. Shortening the hospital stay will always save the less costly days. Calculations that do not reckon with this phenomenon will overestimate the potential savings. The use of charges would even increase the difference, since for hip fracture patients the Dutch charges exceed real hospital costs but remain under real costs in nursing homes and homes for the elderly (Table 6).
The cost savings were disappointing, because they did not reach statistical significance, and we therefore could not reject the hypothesis that there were no savings at all. Furthermore the estimated savings, whether statistically significant or not, seemed to be small because the expectations were much higher. On the other hand, 7% saving might have a large economic impact since hip fracture incidence is quite high. Given the equivalence of medical outcomes one might argue that the estimated cost savings are not disappointing at all.

Opportunity costs

Most early discharge schemes are not set up with the single aim of reducing costs. An other important objective is to free orthopaedic surgical beds for other hip fracture patients. If the freed beds are indeed used for elective surgery of new patients, total costs from a societal perspective would increase. Health benefits, however, would also increase, because waiting lists reduce and more patients can be treated

in the same period. In our study three to four beds were free for other admissions in each of the two participating hospitals. With an average stay of 13 days it is theoretically possible to treat an additional 100 patients per hospital. These benefits can be considered as the opportunity costs of conventional discharge.

Real costs in the real world

We estimated real costs in the setting of the study. In the real world things might be different. It is assumed that early discharge causes a shift from formal to informal care. We could not confirm this assumption. Costs of informal care were relatively low. Costs among early discharged patients were rather lower than higher, although the difference reached not statistical significance. The large number of inpatient days plays an important role here. On average patients, whether early discharged or not, remained more than half of the 4-month study period in a health care institution. At the end of this period 54% of all patients stayed in a nursing home or elderly home, an increase of one third compared to the situation before fracture.
In our study the investment and capacity costs of a specialised rehabilitation ward in a nursing home were rather low. The ward already existed at onset of study, and due to an efficient planning of patients the occupation of this ward was high. Investment costs and capacity costs were integrated in the average costs per admission day. In real life, costs will be higher if specialised wards must be newly built. Capacity costs can also become high, if the ward is too large for an efficient occupation of beds, or too small for an efficient employment of physical therapists and other personnel. National application of early discharge would therefore require a careful planning of rehabilitation wards.

Limitations of the study

Our study has some limitations. First, the sample size was relatively small (102 and 106 patients). The difference in hospital stay (13 days), however, should have been large enough to show any clear economic advantage of the early discharge programme.
Second, the design was not randomised and it is possible that some variables such as the duration of hospital stay and discharge destination changed during the study independently from the intervention. The before and after design is most appropriate for these kind of studies, but has some specific drawbacks. It is likely that physicians become more familiar with the new discharge policy during the study period.

To analyse such an effect, we tested whether the first 53 patients in the early discharge group had higher hospital costs than the second 53 patients. Average hospital costs for patients in the first group amounted to € 4,573. Average costs in the second group were approximately 9% lower (€ 4,273), indicating the existence of a learning effect. The difference, however, did not reach statistical significance ($p = 0.122$).

Third, it is difficult to generalise the results for patients living in other countries because geriatric rehabilitation and long-term care of the elderly differ between countries. The rehabilitation ward of a Dutch nursing home probably compares best with a geriatric rehabilitation ward in a hospital or a Skilled Nursing Facility in the US.

5.5 Conclusions

This study shows that the details of costing highly influence the outcomes in a cost-minimisation analysis. Costs shifted from hospital to the nursing home because total institutional length of stay was similar and there was only a small difference in costs per inpatient day between hospital and nursing home. This latter phenomenon was caused by the relatively less intensive care of hip fracture patients among the hospital population and relatively more intensive care compared to other people in nursing and elderly homes. Furthermore, the early discharge regime evoked a concentration of diagnostic procedures in the few days prior to discharge, resulting in higher average costs that cancelled out some of the potential savings. For people with better health status before fracture the possibilities for early discharge and the potential savings seem to be better.

Our study emphasises the importance of a detailed cost analysis based on real resource use. Standard charges or average all-in prices would raise expectations about cost savings that can not be realised. This conclusion is not limited to our study or other early discharge studies but has relevance for the whole field of cost analysis in health care.

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