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Early discharge and home intervention reduces unit costs after total hip replacement: results of a cost analysis in a randomized study

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Abstract Total hip replacement (THR) is a common and costly procedure. The number of THR is expected to increase over the coming years. Two pathways of postoperative treatment were compared in a randomized study. Fifty patients from two hospitals were randomized into a study group (SG) of 27 patients receiving preoperative and postoperative education programs, as well as home visits from an outpatient team. A control group (CG) of 23 patients received "conventional" rehabilitation augmented by a stay at a rehabilitation center if needed. All costs for the two groups both in hospitals and after discharge were collected and analyzed. On average total costs for the SG were $8,550 and $11,952 for the CG, a 28% cost reduction. Total inpatient costs were $5,225 for the SG and $6,515 for the CG. In a regression analysis the group difference is statistically significant. Adjusting for changes in the Oxford Hip Score gives effective costs (C/E). The ratio of the SGs C/E to the CGs is

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0.60. That is a cost-effectiveness gain of 40%. A shorter hospital stay augmented with better preoperative education and home treatment appears to be more effective and costs less than the traditional in hospital pathway of treatment.

Keywords Cost-effectiveness analysis · Total hip replacement · Home intervention

JEL Classifications D61 · I12 · C21

Introduction

Total hip replacement (THR) is a costly procedure even if the costs vary in different parts of the world. The mean cost as calculated during the years 1997–2001 was highest in the USA, almost $12,900 and over $6,000 in Canada (Antoniou et al. 2004). In Europe the hospital costs of TRH was $9,000 during the same period in Belgium (Scheerlinck et al. 2004). In Finland the mean costs of a THR was $8,200 in 2002 (Räsänen et al. 2007). During the last few decades the number of total hip replacement (THR) operations has steadily increased in Iceland up to 133 per 100,000 at present, and the annual need for primary THR in the country is expected to increase by one third, from 221 operations in 1996 to 300 in 2015 (Ingvarsson et al. 1999). Orthopedic surgeons are under pressure to reduce costs for THR (Metz and Freiberg 1998). So-called clinical pathways are an attempt to standardize the treatment in order to better economize with available hospital resources. The implementation of such pathways has resulted in a 31% shorter hospital stay on average and cost reduction of 11% for THR (Kim et al. 2003). In this study a comparison of total costs between an established clinical routine and a new concept based on preoperative education and postoperative home intervention after a shortened hospitalization is evaluated with respect to costs. The between-group variation that cost-effectiveness analyzes focus on is validated by means of a regression analysis that adjusts for factors that can affect outcome.

Patients and methods

Study design and selection of patients

The study started at the University Hospital Landspitalinn in Reykjavik in December 1997. At the beginning of April 1999 the first patient included in the study was operated on at Akranes Hospital. The last patient to enter the study was operated on at Akranes in December 2000.

Patients on the waiting list for primary hip replacement at Landspitalinn University Hospital in Reykjavik and at Akranes Hospital were invited to participate. Patients diagnosed as having osteoarthosis of the hip, rheumatoid arthritis, primary segmental collapse of the femoral head, and changes after developmental diseases and hip trauma, all of whom had been living in their own home, were included. Patients with primary hip fracture, metastastatic tumors, and dementia were excluded. Summary statistics of sample are presented in Table 1.

The CG was treated according to the contemporary routine with the exception of being asked to fill in a general questionnaire the day before the operation and 2, 4 and 6 months after the operation.

The SG patients were invited to participate in a preoperative training session about 1 month before the planned operation. They answered the questionnaire 2–3 weeks before the operation and 2, 4 and 6 months after the operation. A physiotherapist and/or an occupational

Table 1 Summary statistics of sample and groups

	Sample (50 obs.)			Study group (27 obs.)			Control group (23 obs.)		
	Mean	Std. dev.	NAs	Mean	Std. dev.	NAs	Mean	Std. dev.	NAs
Age	67.92	9.33	0	69.07	6.41	0	66.57	11.91	0
Q0–Q2–Q4	28–69–86			52–69–81			28–69–86		
Gender	0.48	0.50	0	0.48	0.51	0	0.48	0.51	0
Retired	0.62	0.49	0	0.59	0.50	0	0.65	0.49	0
Living alone	0.32	0.47	0	0.26	0.45	0	0.39	0.50	0
Pre-op OHS	34.65	7.23	2	33.11	7.54	0	36.62	6.45	2
Q0–Q2–Q4	23.00–34.60–52.00			23.00–31.00–52.00			26.00–35.00–47.00		
Hospital	0.58	0.50	0	0.67	0.48	0	0.48	0.51	0
BMI deviation	6.87	4.47	1	7.77	4.64	0	5.77	4.08	1
Q0–Q2–Q4	0.28–6.52–19.30			0.28–7.62–19.30			0.62–5.60–15.31		
Workburden	0.32	0.47	0	0.30	0.47	0	0.35	0.49	0
Complication	0.20	0.40	0	0.15	0.36	0	0.26	0.45	0
Year	1998.92	0.90	0	1998.70	0.82	0	1999.17	0.94	0
Q0–Q2–Q4	1997–1999–2000			1997–1999–2000			1997–1999–2000		
Effect	17.50	7.64	4	18.89	8.55	0	15.53	5.75	4
Q0–Q2–Q4	5.00–17.50–38.00			5.00–17.00–38.00			5.00–18.00–23.00		
Hospital stay	8.00	3.43	0	6.07	1.59	0	10.26	3.66	0
Q0–Q2–Q4	4–7–17			4–5–10			5–10–17		

Continuous variables are presented with quantiles, i.e. min, median and max

therapist provided the preoperative information and training. During the training patients were informed in detail about postoperative rehabilitation and received training in exercise, which they should perform before and after the operation. Patients were made familiar with various helping aids used postoperatively and equipped with these devices already prior to the operation. They also received an illustrated information brochure including information on how to exercise and behave after the operation. In both hospitals and in both groups routine cemented implants (Chanley at Akranes and Howse in Reykjavik) were used in the operation.

When a patient in the study group was discharged from the ward the physiotherapist or occupational therapist accompanied the patient home if needed. The nurse administered daily anti-thrombosis injections, changed wound dressings, removed skin stables and assisted in the care of the patient as long as it was needed. During the first days after homecoming the physiotherapist or occupational therapist visited the patient as often as needed (median number of times 4, range 2–9) to ensure that the rehabilitation scheme was followed.

Health evaluation

When entering the study the patients were asked to fill in a general questionnaire. As an outcome measurement for utility in this study the Oxford Hip Score (OHS) (Dawson et al. 1996) was used. It contains 12 questions divided in two subscales, pain and functional impairment. Each question has five response categories that are summed to produce subscale scores from 6 to 30. Higher scores indicate worse pain and functional impairment. It was developed and validated specifically to assess function and pain in relation to the hip. The OHS was also the scoring system found to be most consistent on the outcome in the study (Siggeirsdottir et al.

2005) and to be the easiest to apply to the results of the study as far as patient satisfaction was concerned.

Cost evaluation

Costs are evaluated from the societal point of view. The cost of a procedure is determined by the quantity of resources used and their unit price. Estimation of quantity of resources used is based on data collected for each patient during his or her treatment. A unit price is then assigned to it, and opportunity costs considered. The price level is standardized to eliminate effects of inflation by applying 1999 prices to all units. Thus, all results are according to the price level in 1999, converted from ISK to USD using the 1999 PPPs for GDP from OECD in order to eliminate country specific price level.

Cost figures are categorized based on who bears the cost and sub-categorized by resource type. Costs are partly paid either by the patient, the state-run hospitals and rehabilitation centers or the State Social Security Institute (SSI)—SSI covers most of the outpatient costs not paid by the patient.

Operation and hospital cost are estimated per individual in the sample, based on information reported by the hospital medical staff, acquired from the hospital administration, hospital tariffs, and technical reports on the subject matter. The operation cost, for patients operated on in Reykjavik, are estimates given in the technical report by Halldorsdottir and Herbertsdottir (2000). The Akranes Hospital administration provided their corresponding estimates. Both estimates entail overall operation cost, such as implants, material, staff, pharmaceutical, cost of housing, overhead etc. Inpatient hospital cost is calculated as the length of stay times daily cost in addition to eventual cost related to incidence of patient specific complications. For patients staying in Reykjavik the hotel cost is based on estimates in the technical report by Halldorsdottir and Herbertsdottir (2000). Similarly, for patients in Akranes the cost is based on estimates provided by the Akranes Hospital administration. Both hospitals regularly update the daily patient costs since these cost figures are paramount for reimbursement from the state. These cost figures include costs related to nursing, food, medications, lab tests, cleaning, cost of housing, overhead and so forth. Measures were taken to account for the fact that the first days are more expensive than later days, except when a patient is re-admitted. This was done, in accordance with estimates, using a formula weighting inpatient costs for the first days.

$$f(t) = \alpha + \beta \cdot t + \varepsilon \quad C \equiv \alpha + \beta \quad \beta \equiv 0.85 \cdot C \tag{1}$$

where C is the estimated average inpatient cost per day utilized to define α and β, t is length of stay and ε is cost due to inpatient complication etc. The weight given to the daily hotel cost is estimated based on descriptions of costs accruing per day in the technical report by Halldorsdottir and Herbertsdottir (2000). The additional cost due to individual specific complication reported by the medical staff is based on hospital tariffs (Sigurdardottir 2003).

Accrued costs for control group patients related to stays at convalescence homes. Expenses are partly paid by the State and partly by the patient himself, depending on which institution (of three possible) was used.

The cost database also included expenses accrued due to visits to GPs and specialists, as well as expenses related to visits to physiotherapists and occupational therapists (Sigurdardottir 2003). The patient foots part of that bill. The same procedure applied to home visits by physiotherapists and occupational therapists except that an estimated cost of travel for the providers was added. Expenses related to services of registered nurses was based on the number of visits and the negotiated nurse wage, assuming a fixed number of hours per visit and standardized length of travel if the patient was visited at home.

The database included information on pharmaceuticals use according to type and cost. Expenses related to pharmaceuticals administrated as a consequence of the hip treatment was identified and accounted for, as were expenses related to X-rays, electrocardiograms and blood samples (Sigurdardottir 2003).

Furthermore, care was taken to correctly account for job-loss of employed persons due to the operation and convalescence. The wage rate used to estimate job loss is the median wage as reported by Statistics Iceland. In estimating the opportunity cost for unemployed, retired or other non-workers we followed the approach taken in transport studies and assume the pecuniary cost of time lost to be half of the mean wage rate according to Mohring et al. (1987).

Length and cost of travel was also accounted for. When patients were transported by private car, the cost was estimated by employing the reimbursement tariff that the Ministry of Finance uses when compensating state employees for use of own car.

Economic evaluation and statistics

An economic evaluation should compare cost and consequences of two or more alternatives. A cost-effectiveness analysis (CEA) was conducted for the economic evaluation of total hip replacement and home therapy. CEA is utilized when a single effect is under consideration, using natural units for valuation of consequences. Cost accrued is related to level of success and compared across procedures. It has been customary to subdivide costs into direct, indirect and intangible cost in the literature on economic evaluation. In this paper we avoid this, as advised by Drummond et al. (2005), and divided the costs into the three categories; operation and inpatient costs, outpatient costs paid by the state and direct patient costs.

The difference of 6 months post-op OHS less their pre-op score (OHS gain) is used as a measure of effect. Four patients are for various reasons missing either value, and are thus excluded from effectiveness calculations. Note that this causes a minor distinction between the reported average cost in the cost- and CEA results. The CEA measure used is the average patient cost per OHS gained for each group (C/E).

$$C_i/E_i = \frac{1}{N_i}\sum_{n=1}^{N_i}\frac{C_{in}}{E_{in}} \quad i = SG, CG \quad N_{SG} + N_{CG} = N \tag{2}$$

The difference, C/E of the CG less that of the SG, is the C/E gain or loss by implementing the new procedure. But for two reasons the C/E results are also further broken up into pre-op OHS ranges. Firstly, it gives an intuitive insight into cost in relation to condition. And secondly, since the OHS scale is ordinal by construction since it is created to rank patients by the seriousness of their condition. By breaking the OHS up we are able to measure similar groups within the sample.

Regression analysis with cost data as dependent variable is performed, assuming the log-normal distribution. It reveals both real cost gain/loss after adjusting the data for factors affecting the cost accumulation and to what extent these factors affect the cost. There are twelve factors that could possibly be of relevance in the regression models. The indicator variable, *Group* is assigned the value zero for a person in the study group, one for a person in the control group. The variable *Age* is the age of the patient. The indicator variable *Gender* is assigned the value one if the patient is male and zero if female. The indicator variable *Retired* is assigned the value one if the individual has left the labour force. The indicator variable

Living alone is assigned the value one if the patient is the only person in the household The variable *Pre-op OHS* reports the result of the OHS test prior to the operation. The indicator variable *Hospital* is assigned the value one for the University hospital in Reykjavik and zero for Akranes hospital. *BMI deviation* is the numerical deviation of the body mass index from 22.5, the middle of the assumed ideal range. The indicator variable *Workburden* is one if the patient is or has been a manual laborer. The indicator variable *Complication* is assigned one if the patient suffered any medical complications. The year the operation was performed is split into indicator variables, leaving 1997 out. In addition, the squared form of the three continuous variables *Age*, *Pre-op OHS* and *BMI deviation* are added to counter non-linear relationships. That makes a total of 17 variables including the intercept, as shown in Eq. 3, for the fully adjusted, or general, model in the regression analysis.

$$\begin{aligned} \ln(\mathit{Total\ Cost}) = \alpha &+ \beta_1 \mathit{Group} + \beta_2 \mathit{Age} + \beta_3 (\mathit{Age})^2 + \beta_4 \mathit{Gender} + \beta_5 \mathit{Retired} \\ &+ \beta_6 \mathit{Living\ Alone} + \beta_7 \mathit{Pre\text{-}op\ OHS} + \beta_8 (\mathit{Pre\text{-}op\ OHS})^2 \\ &+ \beta_9 \mathit{Hosptial} + \beta_{10} \mathit{BMI\ deviation} + \beta_{11} (\mathit{BMI\ deviation})^2 \\ &+ \beta_{12} \mathit{Workburden} + \beta_{13} \mathit{Complication} + \beta_{14} \mathit{Year}1998 \\ &+ \beta_{15} \mathit{Year}1999 + \beta_{16} \mathit{Year}2000 \end{aligned} \tag{3}$$

The other model presented is the specific version of the model, shown in Eq. 4, which serves to further confirm the relationship in the cost-effectiveness analysis.

$$\ln(\mathit{Total\ Cost}) = \alpha + \beta_1 \mathit{Group} + \beta_2 (\mathit{pre\text{-}op\ OHS})^2 \tag{4}$$

In addition, marginal effects, $\mathrm{dE}[Y]/\mathrm{d}X$, with their respective standard deviation, are presented. The marginal effects of real variables are calculated using the Delta method, and the exact minimum variance unbiased estimate (van Garderen and Shah 2002) for the binary indicator variables.

Results

Table 2 describes the cost components for the two groups studied. The average total cost per patient in the SG is \$8,550, while it is \$11,952 in the CG. That is on average \$3,402 less per patient, or a 28% cost reduction. The difference in cost is predominantly due to a shorter hospital stay and to home intervention instead of a stay at a convalescent home. The difference in inpatient hospital cost between the groups makes for more than half the total. For outpatient costs the greatest difference between the groups is due to home intervention instead of convalescent home.

For the CEA each individual's improvement needs to be taken into account. The higher the individual's pre-op score, the greater the gain in OHS. The benefit increase is somewhat greater for the study group. The cost-effectiveness gain is the average of cost per OHS gain for the SG minus that for the CG. The OHS gain is the patient's 6 months post-op OHS less the pre-op OHS. On average the patients in the SG cost \$627 per OHS gained, while patients in the CG cost \$1,054. That is a \$427 reduction in effective cost, or a cost-effectiveness gain of 40%. The resulting cost-effectiveness figures are shown in Table 3.

Table 3 shows the CEA results divided by patient's pre-op OHS intervals ranging 7 points. The average cost is lower for the SG in all intervals, and varies less than for the CG. The SG gained considerably more post-op than the CG measured by a drop in OHS which changed proportionally to the pre-op score. This is reflected in much greater cost-effectiveness gain

Table 2 Results of the cost evaluation in USD

Source of cost	Study group			Control group		
	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Healthcare sector						
Op. in Akranes	1,292			1,292		
Op. in Reykjavik	3,462			3,462		
Total op-cost	2,739	3,462	1,043	2,330	1,292	1,109
Hospital cost Akranes	2,838	2,481	763	5,218	4,891	1,172
Hospital cost Reykjavik	2,310	2,041	517	3,058	2,830	877
Total Hospital cost	2,486	2,079	647	4,185	4,087	1,501
Total cost in hospital	*5,225*	*5,504*	*989*	*6,515*	*6,292*	*1,018*
Cost of readmission	0			226	0	448
Convalescence home	–	–	–	1,261	650	1,581
GP and specialists	51	39	35	79	37	81
Nurse and ph.therap.	63	3	173	140	0	282
Nurse at home	146	124	63	–	–	–
Ph.therap. at home	221	201	113	–	–	–
Pharmaceuticals	2	0	7	5	0	26
Lab tests	11	0	24	33	0	66
Traveling	1	0	4	5	0	17
Total post-op gov. cost	*496*	*392*	*244*	*1,748*	*1,315*	*1,733*
Total healthcare cost	5,720	5,870	1,047	8,263	8,025	2,215
Patient						
Convalescence home	–	–	–	477	0	616
GP and specialists	29	10	78	37	0	85
Nurse and ph.therap.	11	7	7	15	10	14
Pharmaceuticals	10	0	21	7	0	14
Lab tests	5	0	9	8	0	12
Productivity loss	2,627	1,976	2,139	2,843	1,976	2,161
Traveling	148	132	50	302	428	234
Total patient cost	2,830	2,188	2,191	3,689	3,307	2,292
Grand total cost	8,550	8,135	2,409	11,952	11,407	3,202

Mean cost, standard deviation (SD) and median cost for the study group and control group respectively. Values converted according to OECDs 1999 GDP-PPP

Table 3 Number of patients and average of cost, OHS gain and C/E for the SG and CG, with the ratio C/E of SG over CG, divided by patient's pre-op OHS intervals ranging 8 points, and total

Pre-op OHS	Number		Cost		OHS gain		C/E ratio		Ratio
	SG	CG	SG	CG	SG	CG	SG	CG	
23–30	12	4	9,007	11,312	11.8	10.8	854	1,143	0.75
31–38	8	7	9,502	12,364	22.6	16.4	431	1,093	0.39
39–46	6	7	9,053	15,977	25.0	18.0	451	895	0.50
47–54	1	1	20,151	16,858	38.0	11.0	530	1,533	0.35
23–52	27	19	9,577	13,710	18.9	15.5	627	1,054	0.60

for the SG than the CG. This is shown in the last column of Table 3 as the ratio of the SGs C/E to the CGs.

Regression analysis statistics of the adjusted and unadjusted models, general and specific, is summarized in Table 4. The variables *Group* and *Pre-op OHS* have a significant effect on total cost below the 5% level in the specific model. Other variables are not significant at that level. Hence, we also report a specific version of the models where the other variables are left

Table 4 Semi-logarithmic regression models results with marginal effects

	Specific model				General model			
	Estimate	Std. Error	dE[Y]/dX	Std. Error	Estimate	Std. Error	dE[Y]/dX	Std. Error
Intercept	9.027	0.104***	90,384	1,037	9.847	1.306***	99,477	13,195
Group[a]	−0.274	0.068***	−2,787	594	−0.325	0.081***	−3,345	697
Age					0.004	0.030	58	85
Age^2					0.000	0.000		
Gender[b]					0.102	0.092	993	982
Retired					−0.154	0.118	−1,651	1,116
Living Alone					0.156	0.081†	1,594	905
Pre-op OHS					−0.070	0.052	135	54
$(\text{Pre-op OHS})^2$	0.000	0.000***	163	46	0.001	0.001		
Hospital[c]					0.146	0.095	1,415	1,016
BMI deviation					−0.025	0.028	−37	103
$(\text{BMI deviation})^2$					0.002	0.002		
Workburden					−0.213	0.111†	−2,126	962
Complication					0.003	0.088	−11	890
Year 1998					0.088	0.193	708	2,032
Year 1999					0.159	0.200	1,419	2,165
Year 2000					0.158	0.213	1,406	2,341
R^2	0.453				0.636			
$adjR^2$	0.429				0.448			
AIC	−139.269				−130.786			
RESET	1.308	df = (2, 43)	0.281		0.996	df = (2, 29)	0.382	
Shapiro-Wilk	0.981		0.606		0.965		0.155	
Jarque-Bera	0.864	df = 2	0.649		1.406	df = 2	0.495	
Breuch-Pagan	3.169	df = 2	0.205		9.065	df = 16	0.911	

Note: Marginal effects are not applicable for the quadratic form of a variable when the level is also included
Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '†' 0.1 ' ' 1
[a] Group is 0 for control group and 1 for study group
[b] Gender is 0 for female and 1 for male
[c] Hospital is 0 for the Akranes hospital and 1 for the University hospital in Reykjavik

out. By moving a patient from the CG to the SG would result in a reduction of $2,787 in the specific model, but of $3,345 in the general model adjusting for other factors. Both results are compatible with our findings reported above. Hence, the regression analysis strongly supports that the design and the implementation of the study does not bias results, which might be of concern as the number of participants in the study is not high.

Discussion

In a recent study from the USA the hospital costs for a primary routine THR was $24,170 and the mean hospital stay was 5.6 days (Bozic et al. 2005). Our results appear to indicate that shortening hospital stays down to 5 days and transferring parts of the treatment to the patient home is more cost-efficient than the usual pathway which also includes a stay at a convalescent home in some cases.

Home exercise programs in order to prevent falls have also been found to be cost effective (Robertson et al. 2001) indicating that home treatment as such might be beneficial to patients. There have been doubts that hospital at home treatment reduces hospital stay and lowers costs

(Hughes et al. 1997). In some instances a cost increase has even been noted but improvements in quality of life has also been observed among patients participating in such programs (Hughes et al. 2000). No reduction in costs has been reported for postoperative rehabilitation in patients after total hip or knee replacement whereas hospital at home was more expensive after hysterectomy and for chronic obstructive lung diseases (Shepperd et al. 1998). Other studies have shown a 22% cost reduction after 31% fewer hospital days when treating patients recovering after joint replacements (Kim et al. 2003). There seems to be no doubt that THR is beneficial to the patients' health- related quality-of-life (Ethgen et al. 2004).

During the inpatient period lower total inpatient hospital costs in the SG are explained by fewer ward days. The average cost for the operation itself was somewhat higher in the SG which is due to that fewer operations in the SG are performed at Akranes, which had lower unit cost for the operation. Age and gender have been associated with cost-effectiveness after THR (Chang et al. 1996). Neither variable has any association with the cost or effectiveness in our study.

The cost difference between the two hospitals might be to some extent due to differences in cost estimates, but the hospitals do differ in size and location. The University Hospital Landspitali is a comparatively large teaching hospital located in the capital, while Akranes hospital is a small unit in a small community. The cost of the operation itself is the single most expensive factor in the pathway, about one half of the total inpatient costs, one third of the total costs for both groups. The extra costs of longer hospital stays and convalescence home stays, are the largest contributors to this difference. Overall about 60% of the costs in our study were sustained while in hospital. In a Canadian study about 90% of the costs were incurred during an average hospital stay of 11.4 days (Laupakis et al. 1994) indicating that a longer hospital stay tends to absorb most of the postoperative costs. During the immediate postoperative period the cost for the home treatment in the SG was more than outweighed by the cost for convalescent homes incurred in the CG. These costs together with costs for transports to and from the convalescent home were also the major factor in higher direct patient costs in the CG.

There are always several aspects to the claimed economical gain in studies like this. On the one hand there is the outright monetary gain: on the other is the non-pecuniary gain, which includes some kind of a treatment effectiveness measurement. In our case the OHS turned out to be a useful measurement of effectiveness. When taking improvement in OHS into account the cost reduction increases from 28% for the normative costs up to 45% for the effective costs. Thus we claim when taking into account better improvement in the SG that even more benefits are to be expected than those usually revealed by changes in pecuniary costs only. The effect of shorter hospital stay on function, pain and quality of life (QOL) differ between the two groups. The OHS for the SG was significantly better after 2 months ($p = 0.032$), and the difference remained more or less constant throughout the study (Siggeirsdottir et al. 2005). From these combined results the conclusion can be drawn that patients in the SG were far less costly per health gained.

CEA has been very popular to date (Drummond et al. 2005) and one of its most common forms is the calculation of the cost-effectiveness ratio ($\Delta C / \Delta E$). It can easily be seen from Table 2 that here it would be $ -1229. However, since the OHS gain is utilized as measure of effect it was considered irrelevant—the figure has no intuitively interpretable meaning in this content. The ratio of the SGs C/E to the CGs (which is also referred to as the cost-effectiveness ratio) gives a more intuitive measure.

The regression approach can be used to deduce more information. One could ask how the post-operation OHS is affected by the various variables reported (including the pre-operation score). The OHS index is ordinal in nature while many of the other measures included in our study are cardinal. Hence, one would expect the relationship between these variables to be highly non-linear. We have however concentrated on the cost of improving patient OHS score rather than explain determinants of post-operation OHS score. The regression analysis model shows the robustness of our data. For the specific model the R^2 and adjusted R^2 are 0.45 and 0.43, respectively, indicating the degree of explanation. Which can be interpreted as; that almost half of the variation in cost is explained by the model.

As is evident in the CEA the new treatment dominates the established one. The regression analysis reveals that the difference in cost among the individuals has only relevant association between groups and in connection with their health status prior to the operation. This serves to confirm that the CEA model used is relevant and without interference from sample characteristics. What the cost results depend on is that the added cost due to the preoperative education and postoperative home intervention are lower than the saved cost from shorter hospital stay, added risk of reinstatement, the absence of stay at a convalescence home and for nurse and physiotherapist. These figures, readily attainable from Table 2, are $368 and $3,744, respectively. Arguably the added traveling costs might be included here, but since it depends on circumstances we can disregard it for transferability. Thus, for the cost relevant in this scenario to exceed that of the conventional it needs to be more than ten times greater. Even disregarding the cost of convalescence home as circumstantial it needs to be greater than five times that.

The outlines methods of economical calculations has been drawn by Faulkner et al. (1998). Our calculations are well within these, making us believe that our methods and conclusions are valid. Already in the early 1980s the foundations of calculating hospital costs were subjected to criticism. Jönsson and Lindgren (1980) defined five fallacies in estimating the economic gains of early discharge. However, we consider that our study meets the criteria outlined by the authors.

Usually the first days are the most expensive, mainly because of the operation, which takes place on the first or second day. In our study we separated the cost of the operation from the rest of the inpatient hospital costs in order to get more comparable figures. Moreover, we weighted the first days in hospital as 15% more expensive than the following days. According to our calculations it was the hospital costs and the stay at a rehabilitation unit, not the costs related to the operation that contributed to the main difference during hospitalization in the groups in our study.

A reduction in the length of stay may not necessarily reduce the waiting lists correspondingly. A shorter hospital stay can hamper productivity by lack of operating capacity. According to our experience the lack of hospital beds was responsible for the waiting lists both at Akranes and in Reykjavik.

In our study we also kept track of spending in the primary care sector and found no evidence that costs were offset by the primary care sector. We found out that the care provided there was far cheaper than care at a hospital or a rehabilitation unit.

In our study the home rehabilitation team carried a considerable part of the burden for the care of the patients in order to offload the care input of the patient's family and friends.

The SG did not suffer more complications than the CG and were more confident and had better quality of life than the CG. Shortening hospital stay did not endanger welfare and the health of the patient (Siggeirsdottir et al. 2005).

Similar calculations to ours were used for estimating a novel approach for shortening hospital stay in Boston, also resulting in costs savings due to shorter stay (Gregory et al. 2003). It is therefore reasonable to assume that shorter hospital stay as demonstrated in our study could be applicable to other diseases.

The results of this study indicate that a shorter hospital stay augmented by pre-operative education and home treatment is not only effective, it also requires fewer resources to conduct. Shortening the period spent in hospital after THR might therefore be used to increase the efficiency of the ward with the possibility of shortening waiting lists.

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