Timing of surgery for sciatica

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ONE-YEAR COST UTILITY RESULTS

Cost-utility analysis of prolonged conservative care versus early surgery in patients with sciatica caused by lumbar disk herniation

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ABSTRACT

Background: Controversy exists on how long sciatica patients should receive conservative therapy before surgery is offered.
Methods: In a randomized controlled trial, patients with 6-12 weeks of sciatica caused by lumbar disk herniation received either six months of prolonged conservative care (n=142) or early surgery (n=141). One-year quality-adjusted life years (QALYs) and societal costs were estimated from patient-reported utilities (British and US EuroQol, Short Form 6D and Visual Analogue Scale) and cost diaries (health care, patient and productivity costs).
Results: Compared to prolonged conservative care, early surgery provided faster recovery, with a QALY gain of 0.044 according to the British EuroQol (95 %CI 0.005 to 0.083), 0.032 according to the US EuroQol (95 %CI 0.005 to 0.059), 0.024 according to the Short Form 6D (95 %CI 0.003 to 0.046) and 0.032 according to the visual analogue scale (95 %CI -0.003 to 0.066). From the health care perspective, early surgery provided higher costs ($2,020 difference; 95 %CI $935 to $3,099), with a cost-utility ratio of $46,000 (95 %CI $15,000 to $478,000) per QALY. From the societal perspective, savings on productivity costs led to a negligible cost difference ($-13; 95 %CI $-4,475 to $4,449).
Conclusions: Faster recovery from sciatica makes early surgery more likely to be cost-effective than prolonged conservative care. The estimated difference in health care costs was acceptable and was compensated by the difference in absenteeism. For a willingness to pay of $50.000 or more per QALY, early surgery need not be withheld for economic reasons.

Introduction

Since the natural history of sciatica is favorable, international consensus has been that surgery should be offered only if symptoms persist after a period of conservative treatment.[117] However, the optimal timing of disk surgery has not been scientifically established.[45;46;128] In a randomized controlled trial, we compared early surgery to six months of prolonged conservative care.[118;129] The trial showed faster recovery after early surgery, but without any difference after a year.

Several economic evaluations have compared surgical procedures[130-133] or non-surgical types of care.[134-137] The two economic evaluations that compared surgery to conservative care suggested favorable cost-effectiveness for surgery, but used either extensive modeling[93] or a case-control design.[138] As a result, the cost-effectiveness of early surgery for sciatica is yet unestablished.[139] We therefore conducted a cost-utility analysis for our randomized controlled trial, comparing observed one-year quality-adjusted life years (QALYs) to observed one-year societal costs, to determine whether the faster recovery after early surgery is attained at reasonable costs.

Methods

Patients participated in a multi-centre randomized controlled trial (ISRCT 26872154), comparing six months of prolonged conservative care to early surgery.[118] The Medical Ethics Committees of the nine participating hospitals approved the study and all participating patients gave written informed consent.

A total sample size of 280 patients was chosen, sufficient to detect a three-point difference on the Roland Disability Questionnaire for Sciatica.[114] Between November 2002 and February 2005, 283 patients were enrolled, without clinically or statistically significant baseline differences between both randomization groups (Table 1).[129]

Patients and treatment

Eligible patients were 18 to 65 years of age, with a radiologically confirmed disk herniation, and lumbosacral radicular syndrome that had lasted for 6 to 12 weeks. Patients presenting with cauda equina syndrome, muscle paralysis, or insufficient strength to move against gravity were excluded. Other exclusion criteria were the occurrence of another episode of symptoms similar to those of the current episode during the previous 12 months, previous spine surgery, bony stenosis, spondylolisthesis, pregnancy, or severe coexisting disease.

Early surgery was scheduled within 2 weeks after randomization and only cancelled if spontaneous recovery occurred before the date of surgery. Prolonged con-

Table 1. Baseline characteristics*

	Prolonged conservative (n=142)	Early surgery (n=141)
Age (yr)	43 (10)	42 (10)
Male sex	68%	63%
Quetelet index	26 (4)	26 (4)
Duration of Sciatica in weeks	9.5 (2.1)	9.4 (2.4)
Sick Leave	82%	76%
Positive straight leg-raising test†	73%	71%
Positive crossed straight leg-raising test†	49%	50%
Sensory loss	90%	87%
Dermatome anaesthesia	23%	22%
Muscle weakness	70%	66%
Knee tendon reflex difference	36%	38%
Ankle tendon reflex difference	75%	53%
Finger-ground distance (cm)	35 (17)	33 (16)
Patient-reported visual analogue scales		
VAS leg pain‡	64 (21)	67 (28)
VAS back pain‡	31 (28)	34 (30)
VAS leg and back pain‡	58 (20)	61 (22)
VAS general health§	46 (25)	47 (25)
Roland Disability score¶	16 (4)	17 (4)

* Averages (SD) or percentage of patients. There were no statistically significant differences between both randomization groups on any of the baseline characteristics.

† Lasègue's sign was defined positive if the examiner observed a typically dermatomal area of pain reproduction and pelvic muscle resistance below a unilateral 60 degrees angle provocative straight leg raising, and crossed positive if the same experience was noted raising the other leg below 90 degrees.

‡ The intensity of pain was indicated on a 100 millimeter visual analogue scale (VAS), with 0 representing no pain and 100 the worst pain ever experienced.

§ General health was indicated on a 100 millimeter visual analogue scale (VAS), with 0 representing the worst imaginable health and 100 the best imaginable health.

¶ The Roland Disability Questionnaire for Sciatica is a disability scale that measures functional status in patients with pain in the leg or back. Scores range from 0 to 23, with higher scores indicating worse functional status.

servative care was provided by the general practitioner. If sciatica persisted 6 months after randomization, microdiskectomy was offered. Increasing leg pain not responsive to medication and progressive neurological deficit were reasons for performing surgery earlier than 6 months. All patients were advised to resume their regular jobs when they were able, depending on the nature of their work.

Utilities and QALYs

Utilities represent the valuation of the quality of life of the patients, on a scale from zero (as bad as death) to one (perfect health). Patients described their quality of life using the EuroQol classification system (EQ5D),[105] from which British (EQ5D-UK) and US (EQ5D-US) utilities were calculated.[106;140] Similarly, patients reported their quality of life using the Short Form 36 (SF36), from which Short Form 6D (SF6D)

utilities were calculated.[141] Both EQ5D and SF6D provide societal valuations, which is preferred for economic evaluations from a societal perspective. In addition, we obtained valuations by the patients themselves, using a visual analogue scale (VAS) ranging from 0 (worst imaginable health) to 100 (perfect health). VAS values were transformed to a utility scale,[142] using the power transformation $1-(1-VAS/100)^{1.61}$. EQ5D and VAS measurements were obtained at -2, 0, 2, 4, 8, 12, 26, 38, and 52 weeks after randomization. SF36 measurements were obtained less frequently, at -2, 8, 26, and 52 weeks after randomization. For the EQ5D, SF36 and VAS measurements, 4 %, 5 % and 5 % of the items were missing, respectively, and were imputed using the rounded average within the same randomization group at the same time. Average utility during each separate quarter and during the entire year (QALYs) were calculated from the area under the utility curves.

Costs

Costs during the one-year follow-up period were estimated from the societal perspective. Because of the limited time horizon, costs were not discounted. Costs were converted to US dollars, at price level 2006 (€ 1 = $1.153).[143]

Using cost diaries, patients reported hospitalizations, visits (specialists, general practitioner, physical therapy, paramedical professionals, and alternative health care), homecare, paid domestic help, informal care, medication and aids (like crutches), out-of-pocket expenses because of the hernia (like swimming) and hours of absenteeism. Diaries were scheduled to be handed in at 2, 4, 8, 12, 26, 38, and 52 weeks after randomization. The 26 (9 %) patients that did not return any cost diary were equally distributed over both randomization groups ($P = 0.98$), but were less likely to have been operated ($P < 0.001$). Selective non-response was corrected for by multiply imputing cost data from patients that did return cost diaries (from the same randomization group and with the same surgical status).[144] For patients that did return cost diaries, the diaries covered 97 %, 91 %, 83 % and 84 % of the first to fourth quarter, respectively. Periods of time that were not covered by a cost questionnaire were imputed with the closest available diary from the same patient.

In the Dutch funding system, individual hospitals set diagnosis-treatment prices for disk surgery, to facilitate competition and price containment. From the prices available from 75 different centers, we excluded the 5 % highest and lowest prices. The remaining prices ranged from $3,799 to $5,481, with an average of $4,445. To introduce a cost structure dependent on the duration of hospital stay, the average price was converted to $2,618 per hospitalization plus $433 per hospitalization day.[145;146] With an average hospital stay of 3.7 days, and adding the costs of related specialist visits, this renders average costs per hospitalization equal to the average diagnosis-treatment price.

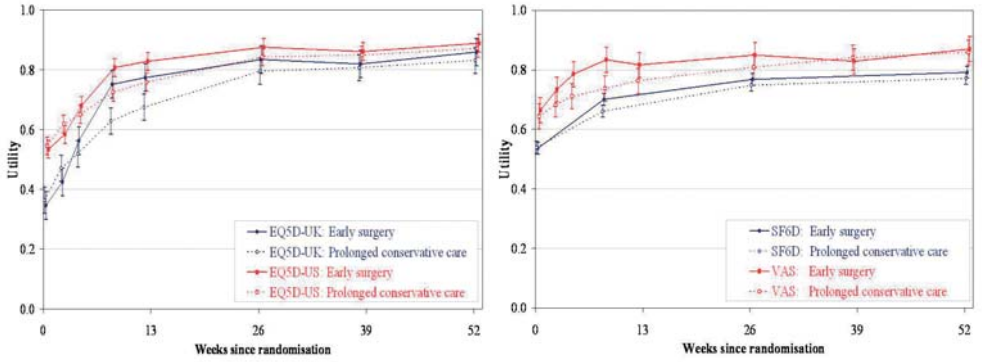

Figure 1. Utility, according to the EQ5D (British and US), SF6D and VAS

Table 2. Average utility and QALYs, according to the EQ5D (British and US), SF6D and VAS

	Prolonged conservative (n=142)	**Early surgery (n=141)**		
	Average (SD)	Average (SD)	Difference	P Value*
EQ5D-UK				
1st quarter	0.57 (0.22)	0.63 (0.18)	0.062	0.01
2nd quarter	0.74 (0.20)	0.81 (0.21)	0.067	0.006
3rd quarter	0.80 (0.18)	0.83 (0.21)	0.025	0.28
4th quarter	0.82 (0.19)	0.84 (0.18)	0.021	0.35
QALYs	0.73 (0.16)	0.78 (0.17)	0.044	0.03
EQ5D-US				
1st quarter	0.69 (0.15)	0.73 (0.13)	0.042	0.01
2nd quarter	0.80 (0.14)	0.85 (0.14)	0.049	0.003
3rd quarter	0.85 (0.13)	0.87 (0.15)	0.021	0.20
4th quarter	0.86 (0.14)	0.88 (0.13)	0.015	0.34
QALYs	0.80 (0.11)	0.83 (0.12)	0.032	0.02
SF6D				
1st quarter	0.63 (0.10)	0.66 (0.10)	0.030	0.01
2nd quarter	0.72 (0.11)	0.75 (0.11)	0.026	0.04
3rd quarter	0.75 (0.13)	0.77 (0.12)	0.020	0.19
4th quarter	0.77 (0.12)	0.79 (0.13)	0.020	0.18
QALYs	0.72 (0.09)	0.74 (0.09)	0.024	0.03
VAS				
1st quarter	0.72 (0.19)	0.79 (0.16)	0.069	0.001
2nd quarter	0.79 (0.20)	0.84 (0.20)	0.046	0.05
3rd quarter	0.83 (0.20)	0.84 (0.20)	0.012	0.62
4th quarter	0.85 (0.19)	0.85 (0.18)	0.000	0.99
QALYs	0.80 (0.15)	0.83 (0.14)	0.032	0.07

* Unequal-variance t-tests

For other health care, Dutch standard prices were used, designed to represent societal costs and to standardize economic evaluations.[145-148] Costs from the health care perspective are reported including the patients' time[148] and travel costs,[146] which on average accounted for 17 % of the total health care costs. Reported hours of absenteeism during the one-year follow-up period were valued according to the human capital method, at standard costs ranging from $19 per hour for younger women to $46 per hour for older men.[146]

Analysis

According to protocol, the base case analysis compared societal costs to QALYs based on the British EQ5D-UK. Sensitivity analyses were performed on the use of different utility measures (EQ5D-US, SF6D or VAS) and on the included cost categories (health care perspective or only the hospitalization for disk surgery). All analyses followed the intention-to-treat principle.

Depending on the willingness to pay (WTP) for obtained effectiveness, a strategy is cost-effective compared to an alternative strategy if it has a better average net benefit (WTP × QALYs - Costs). Given the statistical uncertainty of cost and QALY differences, cost-effectiveness acceptability curves graph the probability that a strategy is cost-effective, as a function of WTP. Confidence intervals for cost-utility ratios were calculated as those WTP values for which the difference in net benefit was not statistically significantly different.[149] To facilitate multiple imputation techniques, group differences were statistically analyzed using standard unequal-variance t-tests.

Result

Utilities and QALYs

According to the EQ5D, the valuation of quality of life two weeks after randomization was somewhat worse for early surgery than for prolonged conservative care (Figure 1). Other than that, the utility measures were almost consistently better after early surgery than after prolonged conservative care. The largest utility difference was 0.123 (95 %CI 0.061 to 0.185), according to the EQ5D-UK, 8 weeks after randomization.

QALYs during all four quarters and according to all four utility measures were consistently more favorable after early surgery (Table 2). Both the first and the second quarter showed statistically significant differences on all four utility measures. Likewise, over the entire first year, early surgery provided significantly (EQ5D-UK, EQ5D-US and SF6D) or marginally significantly (VAS) better QALYs. The QALY difference amounted to 0.044 according to the EQ5D-UK (95 %CI 0.005 to 0.083),

Table 3. Average health care costs and societal costs per patient (in US $)

	Prolonged conservative (n=129)		Early surgery (n=128)		Difference	
	Volume*	Costs	Volume*	Costs	Costs	P Value†
Hospitalization for disk surgery						
1st quarter	20%	743	88%	3,639	2,896	<0.001
2nd quarter	13%	689	2%	351	-338	0.05
3rd quarter	6%	396	0%	145	-251	0.11
4th quarter	3%	155	1%	210	55	0.67
Total (SD)	40%	1,983 (3,735)	89%	4,345 (3,509)	2,362	<0.001
Physical therapy						
1st quarter	82%	533	90%	630	97	0.15
2nd quarter	63%	359	60%	261	-98	0.10
3rd quarter	52%	289	46%	159	-131	0.01
4th quarter	35%	177	33%	120	-57	0.24
Total (SD)	89%	1,358 (1,577)	92%	1,170 (1,068)	-188	0.26
Other hospitalizations	4%	70	1%	12	-58	0.17
Neurologist	0.7	99	0.7	104	5	0.84
Neurosurgeon	1.1	158	1.5	235	76	0.007
Other specialists	0.2	26	0.5	48	23	0.17
General practitioner	4.3	179	2.6	111	-69	0.006
Other paramed. professionals	0.3	20	0.2	15	-5	0.59
Alternative care	0.4	28	0.2	21	-7	0.79
Home care	4.8 h	149	2.6 h	77	-72	0.53
Pain medication	86%	88	87%	36	-52	0.001
Other medication	22%	12	32%	14	2	0.82
Aids	16%	57	21%	60	3	0.95
Total health care costs						
1st quarter		1,800		4,728	2,929	<0.001
2nd quarter		1,205		732	-472	0.02
3rd quarter		803		399	-404	0.03
4th quarter		421		388	-32	0.80
Total (SD)		4,228 (4,706)		6,248 (4,303)	2,020	<0.001
Paid domestic help	1.5 h	17	3.1 h	36	18	0.26
Informal care	25.2 h	306	71.2 h	867	561	0.04
Out-of-pocket	12%	24	13%	126	102	0.18
Productivity costs						
1st quarter	193 h	7,383	224 h	8,098	714	0.42
2nd quarter	117 h	4,533	76 h	2,519	-2,013	0.004
3rd quarter	67 h	2,582	46 h	1,505	-1,077	0.05
4th quarter	39 h	1,478	31 h	1,140	-339	0.50
Total (SD)	416 h	15,976 (17,810)	377 h	13,261 (14,303)	-2,715	0.18
Total non-health care costs (SD)		16,324 (17,891)		14,290 (14,943)	-2,034	0.33
Total societal costs						
1st quarter		9,357		13,305	3,948	<0.001
2nd quarter		5,816		3,543	-2,273	0.005
3rd quarter		3,453		2,108	-1,345	0.04
4th quarter		1,925		1,582	-343	0.55
Total (SD)		20,552 (20,104)		20,538 (16,157)	-13	1.00

* Percentage of patients, number of visits, or number of hours
† Unequal-variance t-tests, correcting for selective non-response using multiple imputation

0.032 according to the EQ5D-US (95 %CI 0.005 to 0.059), 0.024 according to the SF6D (95 %CI 0.003 to 0.046) and 0.032 according to the VAS (95 %CI -0.003 to 0.066).

Health care costs

Of the patients randomized to receive early surgery, 89 % indeed received disk surgery during the first year, compared to 40 % for the patients randomized to receive prolonged conservative care (Table 3). Four and one percent, respectively, had recurrent sciatica leading to a second surgical intervention during the first year. The difference in disk surgery resulted in a $2,362 cost difference (95 %CI $1,494 to $3,229).

The higher surgery costs after early surgery were partly compensated for by statistically significant savings on general practitioner visits, physical therapy in the third quarter, and pain medication. Still, over the entire first year, total health care costs after early surgery remained significantly higher in comparison to prolonged conservative care, with a cost difference of $2,020 (95 %CI $935 to $3,099) per patient.

Societal costs

Of the non-health care costs, the use of informal care after early surgery was statistically significantly higher than after prolonged conservative care. Also, productivity costs were somewhat higher in the first quarter, but were lower in later quarters (statistically significant in the second and third quarter). The total difference in absenteeism was 39 hours per patient (95 %CI -67 to 144), in favor of early surgery, with an associated difference in productivity costs of $2,715 (95 %CI $-1,257 to $6,685). After one year, 6 % of the early surgery patients reported being disabled, compared to 4 % after prolonged conservative care (difference 2 %; 95 %CI -4 % to 7 %). The total non-health care costs after early surgery were lower than after prolonged conservative care, with a total statistically non-significant difference of $2,034 (95 %CI $-2,025 to $6,086). This difference was similar in size to the opposite difference in health care costs, resulting in a negligible difference in total societal costs of $-13 (95 %CI $-4,475 to $4,449), slightly in favor of early surgery.

Cost-utility analysis

In the base case analysis, comparing societal costs to QALYs based on the British EQ5D-UK, both costs and QALYs were in favor of early surgery. As a result, early surgery was preferred to prolonged conservative care, regardless the willingness to pay per QALY. The same holds true for the other utility measures (EQ5D-US, SF6D and VAS), but with somewhat smaller QALY differences.

From the health care perspective or taking only the costs for disk surgery hospitalizations into account, the higher health care costs were no longer compensated by

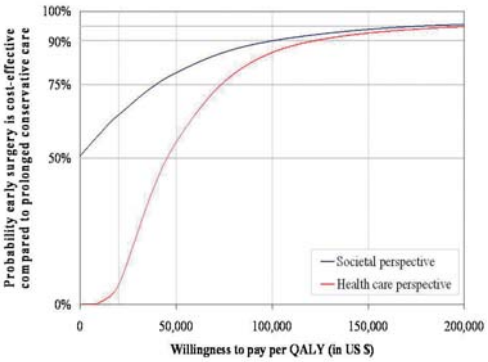

Figure 2. Cost-effectiveness acceptability curves (according to the British EQ5D-UK)

productivity costs. The estimated cost-utility ratios were $46,000 (95 %CI $15,000 to $478,000) and $54,000 (95 %CI $24,000 to $516,000) per QALY, respectively. A commonly used rule-of-thumb classifies costs as *definitely acceptable* up to $20,000 per QALY, as *acceptable* up to $50,000 per QALY, and as *possibly acceptable* up to $100,000 per QALY.[150] According to this rule, the higher health care costs for early surgery are classified as acceptable.

Uncertainty about cost-effectiveness was considerable, primarily because the difference in QALYs was only just statistically significant. Given the statistical uncertainty of the cost and QALY differences, the *probability* that early surgery is cost-effective, compared to prolonged conservative care, varies with the willingness to pay per QALY (Figure 2). From the health care perspective, this probability was 55 % at $50,000 per QALY and was 86 % at $100,000 per QALY. From the societal perspective, these probabilities increased to 79 % and 90 %, respectively.

DISCUSSION

Our randomized controlled trial compared early surgery to six months of prolonged conservative care, in patients with a lumbosacral radicular syndrome that had lasted for 6 to 12 weeks.[118] The trial showed faster pain relief and perceived recovery after early surgery, but without any difference after a year.[129] In both randomization groups, about 95 % of patients reported complete or near complete disappearance of symptoms. Likewise, the utility measures reported here, showed a faster recovery after early surgery, with a largest utility difference of 0.123 at 8 weeks. The total QALY difference was estimated at 0.044, which is the equivalent of a life prolongation of 16 days in perfect health.

In the economic evaluation, we studied whether the faster recovery after early surgery was attained at reasonable costs. The difference in health care costs was estimated at $2,020 and mostly consisted of the difference in surgery costs. This difference is relatively small, because with prolonged conservative care, 40 % of the patients still underwent surgery because complaints increased or persisted after six months. Partly due to increased absenteeism directly after surgery, the observed total difference in absenteeism in favor of early surgery was only 37 hours. Still, this limited difference in productivity costs was sufficient to compensate for the difference in health care costs. As a result, from the societal perspective, early surgery was preferred on both QALYs and costs. From the health care perspective, the cost-utility ratio was estimated at $46,000 per QALY. From both perspectives, albeit with considerable uncertainty, early surgery was more likely to be cost-effective than prolonged conservative care, according to the current economic threshold of $50.000 or more per QALY.[150] Nevertheless, if a well-informed patient prefers conservative care, there is no health-economic reason to opt for early surgery, since surgery does not reduce costs and the QALY difference was relatively small.

Although the two earlier economic evaluations by Malter[93] and by Hansson[138] reported favorable cost-utility for disk surgery too, our results differ from theirs in a number of ways. Firstly, our observed QALY difference of 0.044 is considerably smaller. Based on the trial by Weber,[125] Malter's modeled a tenfold larger difference of 0.43 QALY, of which 0.10 QALY in the first year. Weber's control patients took longer to improve than our control patients, which is probably due to the more frequent disk surgery in our trial. Hansson estimated a 0.327 QALY difference, but this estimate was based on two measurements only, after 28 days and 2 years, which makes it impossible to estimate the course over time. Secondly, Malter's assumed average charge for disk surgery was considerably higher than our price ($11,930 versus $4,445). Yet, our price is similar to the cost estimate used by Hansson ($4,685) and to Malter's alternative HMO costs ($5,170), which Malter considers a better estimate of the true surgery costs. Thirdly, in our trial, the initial absenteeism due to surgery was compensated by lower absenteeism during the rest of the year, whereas in Hansson's study it was compensated by less frequent permanent disability. We did not find a difference in permanent disability, which may be due to the more frequent surgery in our control group or due to Hansson's non-randomized case-control design.

Our study has a number of limitations. Firstly, our Dutch setting may differ from other settings, both with respect to health care and labour. Like in the United States, surgery rates in the Netherlands are relatively high.[46] In settings with lower surgery rates, patients in the control group would be less likely to receive surgery, which might lead to larger QALY and cost differences, with an as yet unknown influence on the cost-utility ratio. Secondly, the duration of follow-up was only one year. How-

ever, the similarity of our randomization groups after one year makes group differences beyond the first year improbable in our trial. Thirdly, as patients were inevitably aware of which randomization group they were in, their reported utilities and costs may have been influenced by their treatment preference. Finally, some may consider the number of cross-overs in our study a limitation: 40 % of the patients randomized to receive prolonged conservative underwent disk surgery at any time during the first year. Compared to other recent randomized trials, our number of cross-overs was similar to the trial by Österman[66] and considerably less than the trial by Weinstein.[48;49] More importantly, we do not think that cross-overs are a limitation: our analysis does not evaluate surgery itself, but compares a strategy of early surgery to a strategy of prolonged conservative care. That persistent or increasing complaints cause some patients to cross-over, is part of clinical reality and should therefore also be part of the economic evaluation.

In conclusion, faster recovery from sciatica makes early surgery more likely to be cost-effective than prolonged conservative care, in patients with 6 to 12 weeks of sciatica caused by lumbar disk herniation. The estimated difference in health care costs was acceptable and was compensated by the difference in absenteeism. For a willingness to pay of $50.000 or more per QALY, early surgery need not be withheld for economic reasons.