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## Direct medical costs of traumatic thoracolumbar spine fractures

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**Background** The costs and cost-effectiveness of treatment of thoracolumbar fractures are poorly known.

**Methods** We estimated the costs of hospital care and outpatient visits for patients with traumatic thoracolumbar spine fractures.

**Results** Stable fractures without neurological deficits were treated nonoperatively and the costs were EUR 5,100. Unstable fractures without neurological deficits were treated either nonoperatively, with an average of 29 hospitalization days and average cost of EUR 12,500 (86% of which represented hospitalization costs), or operatively with 24 hospitalization days and average cost of EUR 19,700 (48% of which represented hospitalization costs and 42% surgery costs). Unstable fractures with neurological deficits were usually operated (average costs EUR 31,900).

**Interpretation** For all patients, the costs of hospitalization days were the main cost driver. Although the length of stay for patients with unstable fractures and without neurological deficit who were treated operatively was shorter than for patients treated nonoperatively, the total costs were higher due to the additional costs of surgery. Surgical treatment must therefore be shown to give a better outcome in order to outweigh the costs. Future research should focus on the cost-effectiveness of operative and nonoperative treatment of patients with unstable vertebral fractures who have no neurological deficits, and take indirect costs and quality of life into account.

The management of thoracolumbar fractures remains controversial. Several studies have shown that operative treatment has advantages (Gotzen et al. 1992, Yazici et al. 1996, Dai 2002), while other studies have shown that nonoperative treatment can be a safe and effective alternative (Chow et al. 1996, Seybold et al. 1999, Shen and Shen 1999, Shen et al. 2001). Instability and neurological deficit influence the choice of treatment method. At the emergency department of the VU University Medical Center (VUmc), vertebral fractures have been classified according to Denis (1983) and neurology according to Frankel et al. (1969). Nonoperative treatment included bed rest and mobilization in a spinal orthosis; surgery, depending on characteristics of the fracture(s) and the patient, included decompression and stabilization (Patka et al. 1997).

In the Netherlands, the total medical costs of spinal accidents were estimated to be EUR 22 million for 1997; the average costs per patient were approximately EUR 4,100 (Meerding et al. 2000).

Few studies have addressed the costs of treatment of traumatic thoracolumbar fractures. We estimated the direct costs of operative and nonoperative treatment for patients with traumatic thoracolumbar fractures.

## Methods

### Patient data

Using the hospital information system, we selected all patients admitted to the VU University Medical Center (VUmc) with traumatic thoracolumbar spine fractures (ICD9-codes 805.2–805.5 and 806.2–806.5) between January 1997 and January 2002. For the 256 patients initially selected, all discharge letters were gathered. Information on type of fracture (stable or unstable), presence of neurological deficit and treatment (operatively or nonoperatively) were reported in the discharge letters. All discharge letters were checked to see that all patients really had had traumatic thoracolumbar fractures and had been treated entirely at the VUmc and not at other hospitals. If information in the discharge letter was unclear, the full medical record was reviewed. After this selection, 56 patients were excluded due to incomplete data ( $n = 39$ ), outpatient treatment instead of hospital admission ( $n = 4$ ), admission due to nontraumatic fracture ( $n = 9$ ), and vertebral fractures outside the thoracolumbar region ( $n = 4$ ). The management information system of the VUmc provided demographic data and quantities of resources used at the patient level.

### Costs

Direct costs include all costs directly related to the treatment of thoracolumbar fractures. Costs of hospital care and outpatient visits were estimated by using the bottom-up method: at the patient level, quantities of resources were assessed and multiplied by unit costs to find the total cost for each patient. Unit costs represent the financial value of 1 unit, for example 1 hospitalization day. The unit costs were estimated according to the Dutch guidelines for cost analysis in health care research and were calculated from a societal perspective for the year 2001 (Oostenbrink et al. 2002). When unit costs were not available for 2001, but were available for previous years, a correction was made. Tariffs were used when cost prices were not available or obtainable. The main cost categories were identified by examining the management information system: hospitalization, laboratory tests, blood products, radiology, physical therapy, operation, outpatient visits, spinal orthosis and cast.

### Statistics

Differences between operative and nonoperative treatment were evaluated for patients with unstable fractures who had no neurological deficits. We used unpaired Student's *t*-tests for continuous data and Chi-square tests for dichotomous data. Two-sided *p*-values of  $< 0.05$  were regarded as significant. Because costs typically have a skewed distribution, differences in costs cannot be analyzed statistically by parametric methods. Instead, the bootstrap method (Efron and Tibshirani 1993) was used to test the statistical significance of differences in costs and to calculate confidence intervals of these differences. Bootstrapping is a data-based simulation method and uses the observed distribution of the cost data. Patients are randomly drawn from the study population with replacement. The number of randomly chosen patients is usually the same as the number of patients in the study population. The difference in costs is statistically significant if 0 is not included in the 95% confidence interval. An analysis of variance (ANOVA) was performed to identify factors influencing the average costs for patients with unstable vertebral fractures who had no neurological deficits. All statistical analyses were performed using SPSS for Windows version 10.1 (SPSS Inc.).

## Results

### Patient data

About two-thirds of the patients with unstable fractures who had no neurological deficits were treated operatively (Table 1). Patients treated surgically were on average younger (mean 39, versus mean 54,  $p = 0.003$ ) and had suffered high-impact fractures more often (77% versus 50%,  $p = 0.02$ ) than patients treated nonoperatively. High-impact fractures included traffic accidents, falls from a great height, and sporting accidents.

### Costs

In patients with unstable fractures who had neurological deficit and who were treated nonoperatively, 86% of the total costs comprised costs of hospitalization days (Table 2). For patients treated operatively, hospitalization comprised 48% of the total costs and surgery accounted for 42%. 14 patients were readmitted during the study period: 11

Table 1. Characteristics of patients with traumatic thoracolumbar fractures admitted to the Vumc, 1997–2001

	Stable	Unstable Neurological deficit		Total
		Absent	Present	
No. of patients	110	76	14	200
Gender: male (fraction)	56 (0.51)	41 (0.54)	7 (0.5)	104 (0.52)
Average age (range)	50 (15–91)	44 (18–84)	35 (22–53)	46 (15–91)
Level of fracture(s)				
thoracic	46	23	5	74
lumbar	58	49	8	115
both	6	4	1	11
Cause of fracture(s)				
Traffic accident	29	14	2	45
Fall in/around the house	54	21	4	79
Fall from a height	7	21	8	36
Sporting accident	16	17	0	33
Jammed between obstacles	2	3	0	5
Not reported	2	0	0	2
Other injuries	33	18	9	60
Discharge type				
Home	98	65	6	169
Rehabilitation center	0	5	8	13
Nursing home	12	2	0	14
Psychiatric institution	0	3	0	3
Died	0	1	0	1
Surgical treatment	1	52	13	66

Table 2. Unit prices, resource quantities and average costs for patients with traumatic thoracolumbar fractures admitted to the Vumc, 1997–2001.

Resource quantity	Stable		Unstable, without ND				Unstable with ND								
	Nonoperative		Operative		Nonoperative		Operative		Nonoperative		Operative				
	Unit price EUR	n	cost	range	n	cost	range	n	cost	range	n	cost	range		
HD	356	109	10.5	(2–38)	14	24	29.3	(3–62)	52	24	(13–60)	64	13	36.1	(22–67)
HD normal care	356	108	9.9	(0–35)	13	24	28.4	(3–61)	52	22.4	(11–59)	64	12	28.1	(0–64)
HD special care	573	14	0.3	(0–6)	1	6	0.7	(0–4)	17	0.7	(0–6)	0	8	2.5	(0–9)
HD intensive care	1221	3	0.2	(0–17)	0	2	0.2	(0–4)	8	0.9	(0–15)	0	5	5.5	(0–41)
Conv. radiography	96	69	1.5	(0–21)	7	18	2.5	(0–8)	48	7.3	(0–24)	2	12	13.2	(0–73)
CT-scans	98	22	0.23	(0–2)	0	4	0.2	(0–2)	21	0.5	(0–2)	2	1	0.2	(0–3)
Physical therapy/h	50	95	5.6	(0–289)	11	23	16.4	(0–61)	49	12.4	(0–37)	43	13	21.5	(8–38)
Outpatient visits	78	85	2.7	(0–10)	7	20	3.5	(0–8)	46	3.3	(0–10)	1	9	3.2	(0–11)
Costs, mean (SD)															
hospitalization			4.0	(2.9)	5.2	(0)	10.7	(7.4)	9.4	(5.2)	22.8	(0)	18.1	(13.3)	
surgery			0	(0)	9.0	(0)	0	(0)	8.3	(3.7)	0	(0)	11.4	(5.4)	
other costs			11	(0.5)	1.8	(0)	1.7	(0.8)	1.9	(1.0)	1.7	(0)	2.4	(1.8)	
Total costs			5.1	(3.1)	16.0	(0)	12.5	(7.9)	19.7	(8.1)	24.5	(0)	31.9	(18.3)	

ND neurological deficits, HD hospitalizations days.

patients for removal of the osteosynthetic material, 2 patients due to an infection of the material and 1 for pain and neurological symptoms. Removal of osteosynthetic material is not a standard procedure;

thus, the costs are presented separately. The mean costs of readmission related to vertebral fractures in these 14 patients were EUR 15,200 (SD 21,000; range 1,600–69,000).

Table 3. Average direct costs for patients with unstable fractures who have no neurological deficits, and the influence of other injuries on the costs (EUR × 10<sup>3</sup>)

	Nonoperative n	Nonoperative average costs <sup>a</sup>	Operative n	Operative average costs <sup>a</sup>	Operative versus nonoperative <sup>a</sup>
All patients	24	12.5 (7.9)	52	19.7 (8.1)	7.2 (3.3–11.7)
Patients with other injuries	7	18.6 (7.3)	11	24.4 (11.0)	5.8 (-2.3–15.1)
Patients without other injuries	17	9.9 (6.8)	41	18.3 (6.6)	8.4 (3.8–13.9)
Other injuries versus no other injuries <sup>a</sup>		8.7 (0.7–19.5)		6.1 (0.02–12.8)	

<sup>a</sup> Mean (SD or 95% confidence interval)

### Subgroup analysis

The presence of other injuries influenced the costs ( $p < 0.05$ ). (Exact  $p$ -value). Patients with other injuries had significantly higher costs compared with patients with vertebral fractures only (Table 3). Other injuries do increase the costs of the treatment, but they do not increase the difference in cost between operative and nonoperative treatment.

### Discussion

Hospitalization was the main cost driver. The length of stay may be influenced by different factors, for example the presence of other injuries, complications such as decubitus, deep venous thrombosis or pulmonary complications, or treatment protocols varying from 6 weeks of bedrest to early mobilization. Even though unit prices tend to differ between different hospitals and countries, the absolute costs of treatment may vary but the main cost driver is not expected to differ. Two other studies have reported costs for treatment of traumatic thoracolumbar fractures (Hitchon et al. 1998, Wood et al. 2003). The estimated average costs in the first study were higher than the costs in our study, and patients treated operatively had 7 more hospitalization days on average, while the study of Wood et al. (2003) reported fewer hospitalization days. Unit prices may have been higher in both of these studies, which would explain the difference in costs. Since unit prices and other resource quantities were not presented in the studies, comparison is difficult.

Not all costs were included in our study. For example, direct medical costs after discharge such as costs of homecare, medication and visits to a

general practitioner and physiotherapist, and the indirect costs of work absenteeism were not considered. This reflects the limitations of our data source, the hospital information system. Given the considerable costs of admission, it is not very likely that direct medical costs after discharge would add substantially to the total costs. However, the costs of work absenteeism and disability could have a major effect, especially since many of our patients were likely to have been employed. Thus, it is probable that the total costs of vertebral fractures are considerably greater than estimated.

Information on the effectiveness, cost-effectiveness and cost-utility, including health-related quality of life measurements, of interventions is important but still lacking. Also, in clinical practice and in the scientific literature, indications vary—and thus the degrees of effectiveness of different treatment options are difficult to compare. High-quality randomized controlled trials with an economic evaluation—and including costs of productivity loss—are urgently required to allow evaluation of the effectiveness and cost-effectiveness of operative versus nonoperative treatment of patients with unstable traumatic thoracolumbar fractures but no neurological deficits.

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