Surgery for herniation of a lumbar disc in Sweden between 1987 and 1999
AN ANALYSIS OF 27 576 OPERATIONS

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The National Inpatient Register and the Swedish Death Register were linked to determine the incidence of surgical intervention, the trends and characteristics of the patients, the death rate and the pre- and post-operative admissions for herniation of a lumbar disc based on comprehensive national data between 1987 and 1999.

There were 27 576 operations which were followed cumulatively for 155 249 years, with a median of 6.0 years. The mean annual rate of operation was 24 per 100 000 inhabitants, the median age of the patients was 42 years. The 30-day death rate was 0.5 per 1000 operations. The rates of re-operation at one and ten years were 5% and 10%, respectively, decreasing significantly (40%) with time. The mean length of stay decreased from nine to five days. Patients who had been in hospital because of a previous spinal disorder had a significantly higher risk of readmission.

Sciatica is a common disorder but only a few patients require surgery for herniation of a lumbar disc. One cross-sectional study found a lifetime incidence of sciatica of about 40% while that of disc surgery was 1% to 2%.1 In Sweden, the frequency of operations for disc herniation was 20 per 100 000 inhabitants a year from the mid-1950s until 1980.2 In the UK, the corresponding level was 10 per 100 000 inhabitants per year, in Finland 40, and in the USA 70, respectively.3,4 Regional differences within a country have also been noted with an eightfold variation between different areas of the USA.5

Most earlier studies on surgery for disc herniation have been based on selected patient groups, either from different regions or different hospitals or those belonging to certain healthcare insurance programmes. The characteristics and mortality of patients undergoing operation have been described in elderly patients, based on data from Medicare.6,7 National longitudinal data of the incidence and trends or rates of mortality have not been published, nor have details of the pre-operative or post-operative use of healthcare facilities by the patients.

Our aim was to determine the incidence of surgical intervention in patients with herniation of a lumbar disc, the trends and characteristics of the patients, the death rate and the pre- and post-operative admissions based on comprehensive national data from Sweden between 1987 and 1999.

Patients and Methods
Sweden (population 8.9 million) has a national healthcare system based on county councils which are administratively independent and is divided into six geographical regions. It is mainly funded by local taxes. The private hospital sector is small and provides only elective care. Since 1964, the Swedish National Board of Health and Welfare has compiled data on individual hospital discharges in the National Inpatient Register,8 and since 1987 all Swedish hospitals have participated. A national registration number uniquely identifies every resident of Sweden and each medical record contains data of each admission, including surgical procedures performed (coded according to the Swedish Classification of operations and major procedures,6 6th edition, and Classification of surgical procedures10 from 1997), and the diagnoses at discharge (coded according to the Swedish version of the International classification of diseases, ninth revision (ICD9)11 between 1987 and 1996 and tenth revision (ICD10) from 1997).12

All patients discharged from hospital between 1987 and December 1999 who had undergone surgery for herniation of a lumbar disc were retrieved from the National Inpatient Registry by procedure codes. Since these procedure codes were applicable for several conditions, only patients having a primary diagnosis of herniation of a disc in the thoracic and lumbar spine were included. This left a study
Pre- and post-operative admissions

Re-operations

2301 re-operations in 2079 patients (8.2%)

![Diagram](image)

Fig. 1

Pre- and post-operative admissions in surgery for herniation of a lumbar disc in Sweden (27 576 operations in 25 247 patients including re-operations).
of 27,576 operations in 25,247 patients (Table I). For each patient undergoing operation all pre- and post-operative admissions (the stay in hospital) for spinal pathology (ICD9 720-724, ICD10 M46-M50) were retrieved and merged (Fig. 1).

The length of stay was calculated from the day of admission to the day of discharge. The duration was categorised into four groups of 0 to 3, 4 to 7, 8 to 14 and >14 days, respectively. The calendar year of discharge was categorised into four different periods, 1987 to 90, 1991 to 93, 1994 to 96, and 1997 to 99. The stay in hospital before and after operation was analysed as to the frequency and the diagnoses, including re-operations, which were defined as a further operation for disc herniation. The time to re-admission after the initial operation was calculated from the day of discharge. The time between admissions before the initial operation was calculated from the day of admission for that procedure. Pre-operative admissions were categorised by frequency into four groups of 0, 1, 2 and ≥3 admissions.

In order to calculate the risk of re-operation or readmission with regard to age, gender, period, length of stay, and admission within two years before surgery, only operations between January 1, 1987 and December 31, 1999 were included. This was to minimise the risk that the initial operation was actually a re-operation after a procedure before 1987. This secondary analysis included 22,261 (88.2%) of the patients. Of these, 3,278 (14.7%) were readmitted for a back disorder and 1,702 (7.6%) had a further operation.

To analyse the risk of dying after surgery we linked information on the date of death and the underlying causes of death from the Swedish Death Register to the National Inpatient Register, using the personal identification number. The underlying causes of death were coded by the ICD9 and ICD10 classifications.

The date of operation was not recorded in the National Inpatient Register during the period of study. The time at risk of dying was therefore calculated as the difference between the date of admission, death or the end of follow-up (December 31, 1999), whichever occurred first, assuming that the patient had undergone surgery within one day of being admitted. Patients dying in hospital were also included. To ascertain that all patients could be followed for at least 30 and 90 days after the initial operation, this part of the analysis included only patients operated on between January 1, 1987 to and including November 31, 1999 or September 1999, respectively.

**Statistical analysis.** Descriptive analyses of the characteristics of all patients and deaths within 30 and 90 days after admission were performed with regard to age, gender, discharge diagnosis, time period, underlying cause of death, and time of death after admission. Exact 95% confidence intervals (CI) for the overall death rate were calculated. The annual number of operations performed for disc herniation in Sweden and the regional distribution of operations per 100,000 inhabitants were correlated with the total population of Sweden from 1987 to 1999.

The absolute risks of re-operation and re-admission related to a back disorder were assessed using the Kaplan-Meier method. Cox regression multivariable analyses were carried out to assess the time to the first re-operation and the time to first re-admission. The variables included in these models, and their categorisations are given in Tables II and III. The results are presented as hazard ratios (HR) with 95% CI and with likelihood ratio tests for the overall significance of each of the variables included in the model. In the analysis of time to first re-admission we chose to censor the follow-up at re-operation. The reason for this was that the patterns of risk factors for the two end-points were quite different. If re-operations were included in re-
admissions the effects, particularly for length of stay and prior hospitalisations, were diluted. The option of including re-operation as a time-dependent covariable in the analyses of time to re-admission was considered, but for simplicity of interpretation we instead chose to censor follow-up at re-operation and to restrict the analysis to assessing risk factors for re-admission after the first operation. All analyses were performed using the SAS package system (SAS, Cary, North Carolina).16

Results

The patients were followed cumulatively for 155 249 years with a median 6.0 years (quartile range (QR) 3.3 to 8.8). Their median age was 42 years (QR 34 to 50) throughout the period of study. Most patients (46.5%) were between 35 and 49 years of age. A slight male predominance was evident (58%) (Table I). The median length of stay after operation for a herniated disc decreased from nine to five days between 1987 and 1999 (Fig. 2).

![Fig. 2](length_of_stay_for_surgery_for_herniation_of_a_lumbar_disc_in_sweden_1980_to_1999_box_plot_of_age_each_box_including_the_central_50_percent_of_all_length_of_stay_each_year_25_percent_isoutlined_with_1.5_time_quartile_range_the_lines_in_boxes_indicate_the_median_values.)

Table III. The risk of re-admission without operation as a function of age, gender, period, length of stay and pre-operative admissions in 3278 re-admissions in 22 261 patients with herniation of a lumbar disc

<table>
<thead>
<tr>
<th>Patients</th>
<th>Person years</th>
<th>Re-admissions</th>
<th>Hazard ratio (HR)</th>
<th>95% CI</th>
<th>p value*</th>
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</thead>
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<td>Age (yrs)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>≤39</td>
<td>9237</td>
<td>41 335.28</td>
<td>1340</td>
<td>1.00</td>
<td>Ref</td>
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<tr>
<td>40 to 49</td>
<td>6710</td>
<td>30 507.00</td>
<td>1058</td>
<td>0.999</td>
<td>0.921 to 1.084</td>
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<tr>
<td>50 to 59</td>
<td>3827</td>
<td>16 765.83</td>
<td>520</td>
<td>0.831</td>
<td>0.750 to 0.921</td>
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<tr>
<td>60 to 69</td>
<td>1687</td>
<td>7341.86</td>
<td>216</td>
<td>0.731</td>
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<td>70+</td>
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<td>144</td>
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<td>0.882 to 1.256</td>
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<tr>
<td>Male</td>
<td>12 938</td>
<td>58 467.78</td>
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<tr>
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<td>1147</td>
<td>1.00</td>
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<td>1989 to 90</td>
<td>3232</td>
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<td>26 897.38</td>
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<td>1997 to 99</td>
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<td>7753.37</td>
<td>454</td>
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<td>0.909 to 1.172</td>
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<td>Length of stay (days)</td>
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<td></td>
<td></td>
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<td>0 to 3</td>
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<td>0.738 to 0.921</td>
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<tr>
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<td>16 594</td>
<td>71 330.74</td>
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<tr>
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<td>21 802.75</td>
<td>846</td>
<td>1.429</td>
<td>1.317 to 1.549</td>
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<tr>
<td>2</td>
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<td>4395.65</td>
<td>223</td>
<td>1.870</td>
<td>1.626 to 2.150</td>
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<td>3-</td>
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<td>1163.29</td>
<td>113</td>
<td>3.318</td>
<td>2.741 to 4.016</td>
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<td>Total</td>
<td>22 261</td>
<td>98 692.42</td>
<td>3278</td>
<td></td>
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</tbody>
</table>

* likelihood ratio tests for the overall significance for each of the variables
The mean annual rate of operation was 24 per 100 000 inhabitants. The number of operations increased from 18 per 100 000 per year to 32 per 100 000 inhabitants in 1993, and then fell to 20 per 100 000 in 1999 (Fig. 3). There were only minor differences in the rate of operation between the geographical regions. Operations were carried out at multiple levels in 8.2% of the patients (Table I). The mortality during the first month after operation was low (0.5 per 1000 operations), and was lower among women than men (RR 0.60, 95% CI 0.51 to 0.70).

The most common underlying causes of death in patients dying within three months after operation were cardiovascular diseases (7/25), followed by accidents or suicide (6/25). A high proportion of spinal disorders (7/25) as a cause of death was apparent, but only two patients died from infections (2/25). Others (3/25) died from chronic obstructive bronchitis, diverticulitis, and lymphoma.

In the analyses of the risk of re-operation or re-admission with regard to age, gender, time period and length of stay we excluded patients operated on during the first two years of the period of study to ascertain that the initial operation actually was not a re-operation. Compared with patients younger than 40 years of age, those between 40 and 59 years had an increased risk of re-operation (Table II). However, the risk was lower among patients older than 60 years of age. The risk was 15% higher among women and a third higher for patients with a length of stay shorter than four days. The risk of re-operation fell significantly during each time period, and was 40% lower at the end of the study. Patients who had previously been admitted with spinal pathology were not at an increased risk of further operation.

The strongest risk factor for re-admission was pre-operative hospital admission for spinal symptoms (Table III) for which the risk increased significantly with the frequency of earlier hospital care. One of seven patients was re-admitted for spinal symptoms (14.7%) and 7.4% for further surgery. Patients aged between 50 and 69 years had a decreased risk of re-admission while in women it was significantly increased (RR 1.15, CI 1.07 to 1.23). The risk also varied with the length of stay of the initial operation. If the patient remained in hospital for more than one week after the initial operation the risk of re-admission because of a spinal disorder increased by 40%. If the length of stay was more than two weeks the risk of re-admission was increased by 80%. The risk of being re-admitted was constant over time.

Of the total cohort 78% were admitted to hospital once for the initial operation, 14.7% were re-admitted because of spinal symptoms and another 7.4% were re-admitted for reoperation. The rates of re-operation and re-admission at one year because of disc herniation were 5% and 10%, respectively, and after ten years 10% and 27% (Fig. 4).

**Discussion**

Our national study shows a mean annual incidence of surgery for herniation of a lumbar disc during the period of study of 24/100 000 inhabitants/year. The ten-year rate of re-operation was 10% and this decreased between 1987 and 1999. Female gender and the length of stay in hospital were associated with higher risks of re-operation. Pre-operative admission for spinal disorders and women had a higher risk of re-admission. The 30-day mortality rate was low at 0.5 per 1000 operations.

The incidence of surgery for disc herniation increased during the late 1980s to a peak of 31/100 000 in 1993 and subsequently decreased to 20/100 000 in 1999. According to Nachemson,² the incidence of disc herniation in Sweden has not changed since the mid 1950s and an average of 20 patients per 100 000 inhabitants are operated on each year. This figure is steady over decades but can differ during shorter periods. The increase in surgery at the end of the
1980s and the early 1990s may have been because of an increase in the number of trained spinal surgeons and the introduction of new operative techniques. Males comprised 58% of the total, this figure being confirmed by the Swedish National Register for Lumbar Spine Surgery. The length of stay after surgery for disc herniation decreased from nine to five days between 1987 and 1999. Atraumatic surgery, better peri-operative care, more efficient organisation when in hospital and a decreased number of hospital beds may explain this. The rates of re-operation after disc surgery vary from 3% to 15%. In our study, over the ten-year period 10% of the patients underwent multiple operations for disc herniation, but over this time the rate of re-operation decreased by 40%. The time trend was very similar to that of primary operation, although the relative risk of re-operation decreased significantly. The indications for surgery have become more clearly defined and spinal surgeons are better at choosing on whom to operate. The standard of operative surgery has improved and become better defined. The decrease in re-operation may also be due to improvement in post-operative diagnosis. There is a better understanding of the nature of persistent radicular pain. MRI allows more accurate delineation of the anatomy after operation in the presence of scar tissue which will influence the indication for re-operation. The low median age of 42 years of the patients in our study explains the low occurrence of death by 30 days after operation of 0.5 per 1000 operations. This is lower than that previously published of 0.9 per 1000. The death rate at 30 days per 1000 operations in surgery for spinal stenosis and in total hip joint replacement are 3.5 and 2.9 per 1000 operations, respectively. The latter two diagnostic groups have a median age at least 20 years above that of disc herniation, thus explaining the associated higher risk of death. Women had a 40% lower risk of dying. The gender differences in our study could be due to confounding factors. Men may have more co-morbidity or negative lifestyle factors such as smoking. We were not able to assess this. There are other reports of a significantly higher one-year cumulative mortality in men than in women undergoing operations on the lumbar spine. Most of the patients, 78.7%, had only one admission to hospital with a small group of patients accounting for most re-admissions. A Finnish population study concluded that lumbar disc disease leading to admission to hospital presents early. In our study the patients with several hospital admissions before the initial operation probably had other pathophysiological mechanisms involved causing their disability or had other co-morbidities or negative factors of lifestyle which interfered with the outcome in terms of re-admissions. The rate of re-admission did not decrease during the period of the study. In Sweden the number of hospital beds available has decreased by 30% during this time but the rate of re-admission has not decreased. This small subgroup of patients may reach a low level of quality of life or dependency which in turn leads to admission to hospital to reduce the pain or discomfort. Women had a higher risk of re-admission, while age was not a correlative factor. The risk also varied with the length of stay of the initial operation. Patients with long lengths of stay had a higher risk of re-admission. They may have had other problems which made them more sensitive to their spinal disorders and therefore requiring longer stay in hospital. This is the largest analysis of surgery for disc herniation based on a national population to date. It also reviews the mortality rate. We were able to follow all discharges after surgery for disc herniation in Sweden during a period of 13 years, with a complete follow-up. Misclassification of the date of death is unlikely since the reporting to the Swedish Death Register is virtually complete and is of high quality. The ICD 9 classification does not distinguish between disc herniation in the thoracic spine and the lumbar spine, while the ICD 10 classification has a specific code for each anatomical region. Procedures on the thoracic spine are rare in Sweden. It is therefore unlikely that inclusion of these could have had a major impact on the results. The inpatient register which we used does not include outcome data and therefore we could not determine the success of the procedure. A life-quality measurement instrument such as the SF36 or Euroqol is now prospectively collected in the Swedish National Register for Lumbar Spine Surgery and may be available for a future study. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References

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