Guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine. 
Part 3: assessment of economic outcome

**Recommendations**

_Standards._ There is insufficient evidence to recommend a standard for assessment of economic outcome following lumbar fusion for degenerative disease.

_Guidelines._ There is insufficient evidence to recommend a guideline for assessment of economic outcome following lumbar fusion for degenerative disease.

_Options._ It is recommended that valid and responsive economic outcome measures be included in the assessment of outcomes following lumbar fusion surgery for degenerative disease. Return-to-work rates and termination of disability compensation are two such measures. It is recommended that cost analyses related to lumbar spinal fusion include perioperative expenses as well as expenses associated with long-term care, including those incurred in both the operative and nonoperative settings.

**Rationale**

Lumbar fusion is commonly performed as an adjunct to the surgical treatment of patients with low-back pain due to degenerative lumbar disease. Using data from the National Hospital Discharge Survey, both Deyo, et al., and Davis observed a dramatic increase in the frequency of lumbar fusion procedures in the 1980s. Lumbar fusion has been undertaken in the setting of degenerative disc disease, spinal stenosis, spondylolisthesis, and degenerative scoliosis and is commonly supplemented with internal fixation involving a variety of devices. As the frequency and complexity of lumbar fusion surgery increases, there is a tendency for costs and complication rates to follow. In a time of contracting hospital resources, it is important to understand the economic impact of lumbar fusion. The purpose of this review is to examine the economic impact of lumbar fusion for degenerative lumbar spine disease assessed by cost, complication rates, and rates of reoperation. These expenses of lumbar fusion must be contrasted with the return-to-work rate and the potential for improved productivity following treatment. These end points will be examined as economic outcome measures following lumbar fusion.

**Search Criteria**

A computerized search of the National Library of Medicine database of the literature published between 1966 and 2001 was performed. A search using the subject heading “lumbar fusion” yielded 3708 citations. The following subject headings were combined: “lumbar fusion and outcomes.” Approximately 204 citations were acquired. Only citations in English were selected. A search of this set of publications with the key words “employment status,” “mortality,” “medical care costs,” “cost containment/com-
disease, it is important to examine the economic impact of fusion procedures in the treatment of degenerative spine.

Northern US (four/100,000) and the western US (35/100,000), which reflects regional variations in the frequency of lumbar surgery per-100,000 people. Similarly, the authors reported significant regional variations in the spinal fusion procedures performed during this period. These regional variations may reflect the relative prevalence of degenerative spine disease in these regions, as well as differences in the availability of spine surgery services.

In addition to a 200% increase in the use of spinal fusion procedures, benefits from treatment may include an overall improvement in function, an increased return-to-work rate, and/or improved patient satisfaction. The expenses of the procedures are the measured costs of the surgery, the devices implanted, and operative time. Other measurable outlays include the cost of complications and time and expenses associated with reoperation. Deyo and colleagues examined data concerning lumbar spinal disease and lumbar fusion from the National Hospital Discharge Survey between 1979 and 1987. In addition to a 200% increase in spinal fusion procedures performed during this period, the authors reported significant regional variations in the performance of lumbar fusion procedures as reflected by a ninefold regional variation in frequency between the northeastern US (four/100,000) and the western US (35/100,000). Because of the increasing incidence of lumbar fusion procedures in the treatment of degenerative spine disease, it is important to examine the economic impact of lumbar fusion as a specific outcome measure.

**Scientific Foundation**

One of the more difficult results to ascertain following a medical or surgical treatment is economic outcome. Typical medical economic analyses seek to ascertain whether a given treatment-related benefit accrues in light of the expenditures required to provide that treatment. With regard to lumbar fusion procedures, benefits from treatment may include an overall improvement in low-back pain and function, an increased return-to-work rate, and/or improved patient satisfaction. The expenses of the procedures are the measured costs of the surgery, the devices implanted, and operative time. Other measurable outlays include the cost of complications and time and expenses associated with reoperation. Deyo and colleagues examined data concerning lumbar spinal disease and lumbar fusion from the National Hospital Discharge Survey between 1979 and 1987. In addition to a 200% increase in spinal fusion procedures performed during this period, the authors reported significant regional variations in the performance of lumbar fusion procedures as reflected by a ninefold regional variation in frequency between the northeastern US (four/100,000) and the western US (35/100,000). Because of the increasing incidence of lumbar fusion procedures in the treatment of degenerative spine disease, it is important to examine the economic impact of lumbar fusion as a specific outcome measure.

**Costs, Complications, Hospitalizations, and Reoperations**

Malter and colleagues performed a population-based study of patients who underwent lumbar surgery for degenerative disease in Washington state in 1988. The study was not prospective, nor was it clear that all patients were eligible for all therapies. Using diagnosis and procedure codes from the Washington State Department of Health's computerized system, the authors obtained data on 6376 patients of whom 1041 underwent lumbar fusion. Rates of reoperation, complications, and associated costs (in 1988 US dollars) were examined through the next 5 years. The complication rates associated with lumbar arthrodesis procedures were 18% compared with a 7% complication rate following lumbar surgery without arthrodesis (chi-square test, p < 0.001). The LOS was significantly longer for fusion-treated patients (7 days compared with 5.1 days; p < 0.001). In 1988 dollars, hospital costs averaged $7101 per patient treated with fusion and $4161 per patient treated without fusion (p < 0.001). These authors examined reoperation rates to determine if fusion reduced the need for repeated lumbar surgery within 5 years. Reoperation rates were significantly lower among those treated with lumbar fusion (RR 1.1; 95% CI 0.9–1.3) and those not. Because the indications for surgery were not examined, the only conclusions that could be drawn from this study were that lumbar fusion procedures are associated with increased costs and complications.

Using similar methods and a hospital discharge registry in Washington state, Deyo and colleagues examined 18,122 hospitalizations for lumbar surgery between 1986 and 1988. The majority (84%) of cases requiring surgery involved spinal stenosis or disc displacement. Excluded were cases involving malignant lesions, infection, or fractures. Approximately 15% of patients in this cohort underwent arthrodesis in addition to decompression. The reported mortality rate was less than 1%. The complication rate was 17.4% among patients treated with fusion compared with a 7.6% rate for those with lumbar disease treated surgically without fusion (chi-square test, p < 0.0005). The LOS among patients who were treated with fusion was approximately 7.6 days compared with 5.4 days for those who did not undergo fusion (p < 0.0005). In 1986 to 1988, the cost of hospitalization was $6491 for fusion-treated patients compared with $3793 for patients treated surgically without fusion (p = 0.0005). Logistic-regression models were used to examine the risk of complications or prolonged hospitalization and indicated that the RR for a complication or prolonged hospitalization with any type of lumbar fusion procedure was 2.7 (95% CI 1.5–4.9). The lack of information regarding the indications for surgery and the clinical outcome following surgery limit the usefulness of this information.

Deyo, et al., examined lumbar surgery data for 1985 obtained from the Health Care Financing Administration for all Medicare recipients, excluding those on Medicare for chronic renal failure or Social Security Disability. Using ICD-9-CM diagnosis and procedure codes, data were accrued on the frequency of lumbar surgery performed with or without fusion and the incidence of associated complications. The study was not undertaken prospectively nor was it certain that all patients were eligible for all therapies. Specific data were obtained for 6-week mortality rates, requirements for assisted living, and the need for blood transfusion. An economic analysis was completed for LOS and cost. These data were compared with similar data from 1 year prior to 4 years after the study date. A study population of 27,111 patients was obtained of whom 1524 (5.6%) underwent lumbar fusion. For patients treated surgically with fusion, the mean hospital costs (1985 US dollars) were $10,091 compared with $6754 for patients treated without fusion (chi-square test, p < 0.0005). A logistic regression was completed to determine RR and (95%) CIs for several variables. In the fusion group, the RR was 1.9 (95% CI 1.6–2.2) for the presence of complications, 5.8 for blood transfusion (5.2–6.6), 2.0 for 6-week mortality (1.2–3.4), and 2.2 for discharge to a nursing home (1.7–3.0). This cohort study revealed that lumbar surgery with fusion was more expensive and

**D. K. Resnick, et al.**

J. Neurosurg: Spine / Volume 2 / June, 2005
## TABLE 1
Summary of studies involving assessment of economic outcome after lumbar spinal surgery

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Class</th>
<th>Description</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunturi, et al., 1979</td>
<td>III</td>
<td>133 patients underwent lumbosacral fusion w/ 118 FUs including 2 deaths. Costs were calculated in 1976 US dollars based on periop hospitalization &amp; FUs. Benefit was defined as the time over the mean FU (4.8 yrs) for which the patient was employed &amp; was calculated based on mean salary during this period. Data provided from HCFA on these patients from 1 yr preop to 4 yrs postop. 27,111 patients were studied of whom 5.6% (1534) received lumbar fusion. Hospitalizations examined for complications, mortality at 6 wks, need for blood transfusion, &amp; requirements for assisted living. Economic analysis was complete for LOS &amp; costs.</td>
<td>The cost/benefit ratio for lumbosacral fusion was 1:2.9 w/ the cost in 1976 US dollars as $5569 &amp; benefit as $16,075. Lumbosacral fusion in a selected population has a positive cost/benefit ratio.</td>
<td>A greater economic cost of fusion in the Medicare population. Lumbar fusion is associated w/ greater morbidity, mortality, &amp; use of hospital resources in older adults. No clear cohort of lumbar degenerative population defined for cost comparison.</td>
</tr>
<tr>
<td>Deyo, et al., 1991</td>
<td>III</td>
<td>All Medicare recipients undergoing lumbar op in 1985. Data provided from HCFA on these patients from 1 yr preop to 4 yrs postop. 27,111 patients were studied of whom 5.6% (1534) received lumbar fusion. Hospitalizations examined for complications, mortality at 6 wks, need for blood transfusion, &amp; requirements for assisted living. Economic analysis was complete for LOS &amp; costs.</td>
<td>For the fusion group, RR w/ 95% CI for complications was 1.9 (1.6–2.2), blood transfusion 5.8 (5.2–6.6), mortality 2.0 (1.2–3.4), assisted living 2.2 (1.7–3.0) (p &lt; 0.05). These results were consistent w/ spinal stenosis &amp; spondylolisthesis w/ hospital costs of $10,091 (fusion) vs $6754 (w/o) in 1985 dollars &amp; a significantly shorter LOS (p &lt; 0.05 in each category).</td>
<td>Patients who undergo fusion in a broad population are more apt to have longer LOSs w/ greater complication rates &amp; utilization of healthcare resources. No clear cohort of lumbar fusion population defined for cost comparison.</td>
</tr>
<tr>
<td>Deyo, et al., 1992</td>
<td>III</td>
<td>18,122 hospitalizations for lumbar spine op (84% involved spinal stenosis or disc displacement) from 1986–1988. 15,280 surgeries w/o arthrodesis &amp; 2785 included arthrodesis. Hospitalizations examined for complications. Economic analysis was complete for LOS &amp; costs.</td>
<td>~15% of patients underwent arthrodesis. The complication rate was 17.4% w/ fusion &amp; 7.6% w/o (p &lt; 0.0005). The LOS was 7.6 days w/ fusion &amp; 5.4 w/o (p &lt; 0.0005). The cost in 1986–1988 dollars was $6491 w/ fusion &amp; $3793 w/o (p &lt; 0.0005). No details were given for mortality.</td>
<td>Employment was 16, 32, &amp; 49% over 1, 2, &amp; 3 yrs. It was less likely to occur in this cohort than historical controls (RR = 0.66, 0.88, &amp; 0.93) at 1, 2, &amp; 3 yrs; 25% required reop &amp; instrumentation doubled this risk.</td>
</tr>
<tr>
<td>Franklin, et al., 1994</td>
<td>III</td>
<td>388 patients as Workers’ Compensation system in Washington state (1986–1987) who underwent fusion. Patient satisfaction studied along w/ economic recovery by patient. Simple satisfaction survey examined back/kg pain, QOL, decision to undergo op, &amp; employment at 2 yrs.</td>
<td>Employment was 16, 32, &amp; 49% over 1, 2, &amp; 3 yrs. It was less likely to occur in this cohort than historical controls (RR = 0.66, 0.88, &amp; 0.93) at 1, 2, &amp; 3 yrs; 25% required reop &amp; instrumentation doubled this risk.</td>
<td>Employment as an economic indicator may be used as an outcome measure but other control groups should be considered.</td>
</tr>
<tr>
<td>Katz, et al., 1997</td>
<td>III</td>
<td>272 patients w/ degenerative lumbar stenosis. Surgery: decompression (194), decompression w/ arthrodesis (37), &amp; decompression w/ arthrodesis/fixation (41). Outcomes assessed w/ respect to walking capacity, back/leg pain, satisfaction, health status (SF-36), &amp; hospital cost.</td>
<td>Individual surgeon was predictor for arthrodesis. Hospital costs of arthrodesis/fixation were highest w/ $18,495 (arthrodesis), $25,914 (arthrodesis/fixation) (p &lt; 0.0001). No reliability given for walking, satisfaction, or health status.</td>
<td>Hospital costs of arthrodesis/fixation are highest w/ no clear defined benefit. Arthrodesis alone showed improved relief of lumbago at 6 &amp; 24 mos w/o reliability. Significant variability introduced by surgeon choice for arthrodesis.</td>
</tr>
<tr>
<td>Malter, et al., 1998</td>
<td>III</td>
<td>6376 patients had op for lumbar degenerative disease (1041 for op including arthrodesis, 5335 for op w/o arthrodesis). Economic analysis of hospitalization.</td>
<td>Complication rate: 18% (arthrodesis) to 7% (none) (p &lt; 0.001). Hospital costs greater w/ fusion ($7101 &amp; $4161 in 1988 dollars) (p &lt; 0.001). Reop rate similar between groups, RR 1.1 (95% CI 0.9–1.3).</td>
<td>The economic costs of lumbar arthrodesis in the setting of stenosis, disc displacement, spondylolisthesis, &amp; degeneration are greater. No clear cohort of lumbar degenerative patients used for comparison.</td>
</tr>
<tr>
<td>Kuntz, et al., 2000</td>
<td>III</td>
<td>A cost-effectiveness study of laminectomy, laminectomy w/ noninstrumented fusion, &amp; laminectomy w/ instrumented fusion. Outcome was assessed at 6 mos &amp; long term &amp; based on prior reports. Periop complications &amp; reop rates were all based on prior reports.</td>
<td>The QALYs &amp; costs were calculated &amp; found to be $56,500 for laminectomy w/ noninstrumented fusion compared w/ laminectomy alone. Instrumented fusion was substantially higher ($3,112,800). Improved outcome w/ instrumentation (90 vs 80%) reduced the relative cost of fixation.</td>
<td>The costs of arthrodesis/fixation are highest w/ no clear defined benefit. Arthrodesis alone showed improved relief of lumbago at 6 &amp; 24 mos w/o reliability. Significant variability introduced by surgeon choice for arthrodesis.</td>
</tr>
<tr>
<td>Sommer &amp; Hedlund, 2000</td>
<td>III</td>
<td>111 patients w/ spondylolisthesis who underwent fusion (77) or exercise (34). Patients were randomized to these groups if they had ≥ 1 yr of pain/symptoms. Evaluation was completed at 1 &amp; 2 yrs using the DRI, a satisfaction survey (much better, better, unchanged, worse; would you repeat op?), &amp; RTE.</td>
<td>The fusion &amp; exercise groups had similar numbers of patients on disability at 2 yrs (46 vs 45%); however, the overall reduction was greater for fusion (p &lt; 0.0001) compared w/ exercise (p = 0.23). The satisfaction survey showed good responses to be significantly higher in the op group (p &lt; 0.01).</td>
<td>RTE appears to be an indicator of improvement. A satisfaction survey was not reliably studied but did appear to be a responsive indicator for outcome &amp; satisfaction had improved more after fusion.</td>
</tr>
</tbody>
</table>
Continued

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Class</th>
<th>Description</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slosar, et al., 2000</td>
<td>III</td>
<td>141 patients underwent circumferential lumbar instrumented fusion, either primary (31%) or secondary (69%). FU averaged 37 mos &amp; was done by a basic satisfaction survey; 1) op met expectations; 2) op improved my condition; 3) op improved but would not redo; 4) op worsened condition.</td>
<td>133 FU patients (10.5% = 1, 51.1% = 2, 19.5% = 3, &amp; 18.8% = 4). RTE occurred in 38% of patients; it was more likely in those not involved w/ Workers' Compensation (57 vs 22%; p &lt; 0.001). There was a 20% complication rate included transient weakness, infection, &amp; graft extrusion. Satisfaction appears to be a responsive outcome measure at 37 mos; however, its reproducibility was not tested. RTE is a responsive measure &amp; improves in the noncompensation patients. A complication rate of 20% was seen, suggesting a negative economic impact.</td>
<td></td>
</tr>
<tr>
<td>Fritzell, et al., 2001</td>
<td>II</td>
<td>294 patients w/ L4–S1 disc degeneration &amp; LBP who underwent op (222) or expectant (72) management over a 6-yr period. Evaluation was completed at 6, 12, &amp; 24 mos using the ODI, Million, &amp; general function score along with patient assessment. RTE was also monitored.</td>
<td>RTE was similar in both groups but improved from 24% to 36% (no statistics used to analyze) w/ no difference in subgroups. RTE did not appear to work as a responsive indicator of improvement, &amp; RTE seemed to correlate w/ an improvement in DPQ score. The net RTE rate of 20% was seen, suggesting a negative economic impact.</td>
<td></td>
</tr>
<tr>
<td>Christensen, et al., 2002</td>
<td>III</td>
<td>148 patients underwent lumbar fusion w/ 73 in PLF group and 75 in ALIF/PLF group. Three patients were lost to FU. RTE was also followed at 2 years. FU performed at 0, 1, &amp; 2 yrs.</td>
<td>The instrumented group had a 28% reop rate compared w/ 14% for the noninstrumented group (p &lt; 0.03). Op time 212 vs 127 min (p &lt; 0.0001) w/ greater periop blood loss (p &lt; 0.01).</td>
<td></td>
</tr>
<tr>
<td>Christensen, et al., 2002</td>
<td>II</td>
<td>129 patients w/ chronic LBP &amp; isthmic spondylolisthesis, primary degeneration, or secondary degeneration who underwent instrumented or noninstrumented fusion. Outcome at 5 yrs was done using functional questionnaires along with rates of RTE &amp; reop.</td>
<td>Medical outcome by reop &amp; op time may be a responsive indicator w/ in 5 yrs of lumbar fusions w/ instrumentation. The medical evidence cited in this report is statistical in nature. The study &amp; selection bias by the operating surgeons as to which patients were treated with internal fixation.</td>
<td></td>
</tr>
</tbody>
</table>

* ALIF = anterior lumbar interbody fusion; DPQ = Dallas Pain Questionnaire; FU = follow up; HCCFA = Health Care Financing Administration; LBP = low-back pain; ODI = Oswestry Disability Index; PLF = posterolateral fusion; QALY = quality-adjusted life year; QOL = quality of life; RTE = return to employment; SF-36 = Short Form–36.

Return to Employment
Economic Outcome

come questionnaires and return-to-work status. In an overall assessment, 63% in the surgical group indicated they were better or much better following treatment compared with 29% in the nonsurgical group (p < 0.0001). The net return-to-work rate was 39% in the surgical group and only 23% in the nonsurgical group (p < 0.05). These two studies suggest that the resumption of employment is a responsive economic outcome measure for patients with low-back pain who may be considered surgical candidates.

In the study by Franklin and colleagues7 of Workers’ Compensation patients, the end of total disability was monitored in patients who underwent lumbar fusion between 1986 and 1987. The termination of total disability as an end point occurred in 16% of treated patients at 1 year, 32% at 2 years, and 49% at 3 years; however, compared with historical controls for Workers’ Compensation patients, the RR of ending total disability was less likely among patients treated with lumbar fusion (0.66 at 1 year; 0.88 at 2 years, and 0.93 at 3 years) compared with Workers’ Compensation patients as a whole. In contrast, Christensen, et al.,1 examined 148 patients who underwent lumbar fusion over a 3-year period: posterolateral fusion (73 cases) or a combination of posterolateral and anterior interbody fusion procedures (75 cases). Outcome was assessed over 2 years. Overall improvement was greatest in the circumferential treatment group, with a lower reoperation rate (22% compared with 7%, p < 0.009). The return-to-work rate improved in both groups from 24 to 36% with no difference between subgroups. No statistical analyses were used to assess the overall return-to-work rate. Slosar, et al.,14 reported on 133 patients who underwent circumferential fusion during a 2-year follow-up period. In this group, 50 patients (38%) returned to work; 16 (22%) of the 73 injured workers resumed work compared with 34 (57%) of the 60 patients who were not receiving Workers’ Compensation (chi-square test, p < 0.001). These studies indicated that return to work and/or termination of disability payments are responsive measures for economic outcome after lumbar fusion procedures. They further indicate that the presence of a compensable injury is associated with a lower rate of return to work.

Cost–Benefit Analysis

Kuntz and colleagues11 undertook a cost-effectiveness analysis of lumbar fusion by constructing a hypothetical model based on historical reports in prior clinical studies. They examined lumbar laminectomy, laminectomy with noninstrumented fusion, and laminectomy with instrumented fusion. Rates of clinical improvement and return to employment were culled from series reported in the literature as were costs, complication rates, fusion rates, reoperation rates, and the incidence of clinical worsening. Each negative and positive outcome was assigned a relative value pertaining to quality of life, which the authors adjusted according to hypothetical outcomes. The authors determined that laminectomy with noninstrumented fusion cost $56,500 per quality-adjusted year of life compared with laminectomy alone.11 The addition of instrumentation to lumbar fusion procedure cost $3,112,800 per quality-adjusted year of life. The authors concluded that laminectomy with noninstrumented fusion compared favorably with decompression alone; however, improvement in outcome associated with instrumentation was not well defined enough to accrue a benefit. The authors noted that a hypothetical rate of 90% symptom relief for patients treated with instrumented fusion compared with 80% for noninstrumented patients would reduce the quality-adjusted year of life cost to $82,400.

Tunturi and colleagues13 analyzed 133 consecutive patients who underwent lumbar fusion between 1968 and 1975. Results were reported for 116 patients in whom the mean follow-up period was 4.8 years. These authors calculated the mean expense of the hospital stay and postoperative visits in 1976 dollars. Economic benefits were calculated based on return-to-employment rates compared with the costs of continued disability. The rate of return to employment was approximately 31%. The mean cost in 1976 US dollars for a lumbosacral fusion was $5569. The mean economic benefit in 1976 US dollars for the same period was $16,075. The calculated cost/benefit ratio was therefore 1:2.9 for lumbosacral arthrodesis. The authors concluded that lumbosacral fusion had a positive cost–benefit ratio when return-to-employment status and the termination of disability payment were considered as indices of economic outcome.

Summary

Lumbar fusion may be associated with a high short-term cost, especially if instrumentation is placed; however, there appear to be long-term economic benefits associated with lumbar fusion including resumption of employment. To describe the economic impact of lumbar fusion for degenerative disease adequately, it is important to define the patient population treated with fusion and to compare efficacy as well as the costs of other treatment alternatives. Any such analysis should include both short- and long-term costs and benefits.

Key Issues for Future Investigation

The application of valid and reliable outcome measures in conjunction with a complete short- and long-term economic analysis will be necessary to assess fully the economic impact of lumbar fusion. To reach meaningful conclusions, it is imperative to compare the economic outcomes of patients treated with lumbar fusion with those in patients with similar disease treated without fusion and to include all relevant costs. This analysis should include subsequent operative and nonoperative medical care, ongoing disability costs, and the costs of loss of productivity. Measures such as return-to-work status and quality-adjusted life years must be included in to allow the development of meaningful data.

References


Manuscript received December 7, 2004. Accepted in final form March 22, 2005.

Address reprint requests to: Daniel K. Resnick, M.D., Department of Neurological Surgery, University of Wisconsin Medical School, K4/834 Clinical Science Center, 600 Highland Avenue, Madison, Wisconsin 53792. email: Resnick@neurosurg.wisc.edu.