Systematic Review of Cost-effectiveness analyses in US spine surgery

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Introduction

• In 2018, the US spent 18% of annual GDP ($3.5 billion) on healthcare.
• An estimated $90 million was spent on the diagnosis and management of low-back pain alone.

• The objective of this study is
  • To systematically review all cost-effectiveness analyses (CEA) ever published on spine surgery through March 2019
  • To highlight strengths and weaknesses of CEAs
  • To proscribe a quality standard to ensure transparence and utility of future spine CEAs
PRISMA-style systematic review of all studies from Pubmed, Embase, Tufts CEA Registry through March 2019.

<table>
<thead>
<tr>
<th>Exclusion Reason</th>
<th>Details</th>
<th>No. of Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>wrong intervention</td>
<td>does not include ≥1 surgical interventions</td>
<td>3</td>
</tr>
<tr>
<td>wrong setting</td>
<td>does not use US cost/efficacy data</td>
<td>25</td>
</tr>
</tbody>
</table>
| wrong study design | (1) does not compare clinical and/or surgical interventions to treat spine disorders  
(2) does not include information on collection of health and/or cost data                                                                 | 21             |
| not full text   | commentary, conference abstract, etc.                                                                                                                                                         | 6              |
| Publication date | 1/1/1976 - 4/1/2019                                                                                                                                                                                |                |
| TOTAL            |                                                                                                                                                                                                  | 55             |
Each dot indicates an incremental cost-effectiveness ratio (ICER), or the cost of gaining a quality-adjusted life year (QALY) using cervical disc arthroplasty (CDA) instead of anterior cervical discectomy and fusion (ACDF). All six studies on 1-level CDA vs. ACDF indicate CDA to be a very cost-effective alternative, < $50,000/QALY, while the four studies on 2-level CDA vs. ACDF range from very cost-effective to only cost-effective, $50,000-$100,000/QALY.

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>1-level</th>
<th>2-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>US$2019/QALY gained</td>
<td>$47,080</td>
<td>$67,433</td>
</tr>
<tr>
<td></td>
<td>$10,527</td>
<td>$9,214</td>
</tr>
<tr>
<td></td>
<td>$120,037</td>
<td>$120,037</td>
</tr>
<tr>
<td></td>
<td>$96,300</td>
<td>$96,300</td>
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<tr>
<td></td>
<td>$738</td>
<td>$738</td>
</tr>
</tbody>
</table>

Cost-Effectiveness of One and Two-level CDA vs. ACDF
Cost-Effectiveness of Lumbar Surgical vs. Non-Operative Intervention

Comparing ICERs for lumbar surgical intervention versus non-operative management for three lumbar surgical indications (intervertebral disc herniation (IDH), lumbar stenosis, and lumbar spondylolisthesis). Each dot indicates the cost per QALY gained of using the specified surgical intervention instead of medical management. For IDH and lumbar stenosis, all studies found that surgery is effective or very cost effective. For lumbar spondylolisthesis, one of three studies found surgery to not be cost-effective compared with medical management.
To assess the impact of study design--randomized control trial (RC), retrospective cohort (RC), prospective cohort (PC), and literature--on ICER results, the percentage of ICER results that were VCE, CE, or NCE are represented as a percentage of all studies in each design. For example, for studies using an RCT design, < ~60% reported VCE, ~25% CE, and 15% NCE ICERs. Using health outcome data from literature lead to the most favorable ICERs, perhaps because of the ability to select more favorable health outcomes prior to cost analysis.

RCT: randomized control trial, RC: retrospective cohort, PC: prospective cohort, VCE: very cost effective (<$50,000), CE: cost effective ($50,000-150,000/QALY), NCE: not cost effective (> $150,000/QALY)
Of the six studies comparing 1-level cervical disc arthroplasty (CDA) and anterior cervical discectomy and fusion (ACDF), studies using insurance reimbursement found CDA more expensive than ACDF, while ACDF is more expensive when using cost-charge ratios (CCR) or cost accounting system (CAS). The same was true for other studies comparing the same interventions—allowed charges lead to higher costs and incremental cost-effectiveness ratio (ICER) inconsistent with CCR or CAS costing methods.
Discussion

• Superiority efficacy of interventions—particularly of fusion procedures—do not manifest until several years after surgery revealing the *importance of long-term follow-up*.

• As not all studies include indirect costs, only direct costs were included in this review which may negate the benefit of minimally-invasive procedures which initially cost more but allow for quicker recovery and return to work (i.e. less productivity loss)

• *Cost-calculation methods were poorly standardized and serve as the most important barrier to study generalizability across clinical contexts.* Allowed charges, meaning charges paid by insurance and patients, though easier to track lead to inflated costs and higher ICERs inconsistent with cost-charge ratios (CCR) and cost accounting systems (CAS), more accurate measures of actual spending.

• About *50% of studies were industry financed and industry-financed studies published disproportionately favorable results.*
Conclusion:
4 Recommended Quality Standards

To improve generalizability and accuracy of spine surgery CEAs.

1. Only utilize efficacy studies reporting statistical & power analyses
2. Minimum 2-yrs follow-up
3. Include sensitivity analyses for all cost inputs
4. Standardize costing methodology to cost-charge ratio or cost accounting system