**SUPPLEMENTAL DIGITAL MATERIAL**

**Detailed abstraction table of economic studies.**

| **Author (year)**  **Funding**  **Country**  **QHES** | **Population**  **Interventions** | **Design**  **Perspective**  **Time Horizon**  **Model** | **Assumptions** | **Model Specifications** | **Currency**  **Cost Sources**  **Discounting** | **Clinical Data Source (e.g. utility, other)** | **Primary Findings**  **Sensitivity analysis range of ICERs** | **Limitations, Risk of Bias** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Cost-effectiveness of ACDF versus CDR for cervical myelopathy or radiculopathy* | | | | | | | | |
| Menzin (2010)  Funding provided by Medtronic Sofamor Danek, Inc  Country: US  QHES: 58 | RCT  N = 541  F/U %: 77.8 (421/541)  F/U: 24 months  *ACDF*  Mean age: 43.9 ± 8.8 years  Male: 46.0% (122/265)  F/U %: 74.7 (198/265)  Mean F/U: 20 months  *CDR*  Mean age: 43.3 ± 7.6 years  Male: 46.4% (128/276)  F/U %: 80.8 (223/276)  Mean F/U: 21 months  **Diagnosis:**  Single-level cervical degenerative disc disease and radiculopathy or myelopathy  **Interventions:**   * ACDF with allograft and Atlantis anterior cervical plate (n = 265) * CDR with Prestige (n = 276) | **Design:** Cost benefit  **Perspective:** Societal (direct medical costs and indirect work productivity costs)  **Time horizon:** 2 year  **Model:** Simple decision analytic model | * All patients who had surgical treatment received one cervical flexion/extension radiograph and one MRI test before surgery. * Same occupation and level of employment after surgery as before surgery * For patients who did not work before surgery but did so after, assumed that they worked part-time after returning to work | NR | **Currency:** 2007 US$  **Direct cost sources**   * *Surgeon & radiographic costs:* Medicare 2007 costs with CPT codes for each specific procedure derived from CODEMANAGER software & American Hospital Dictionary * *Device costs:* IMS Hospital Supply Index & Orthofix * *Initial procedure facility costs:* Hospital billing data, adjusted to costs using hospital-specific cost-to-charge ratios. If hospital charges were not available, facility costs were imputed using cost-prediction equation and length of stay * *Secondary procedure facility costs:* Average value of facility costs for initial procedures   **Indirect cost sources**   * *Work productivity:* US Bureau of Labor Statistics national average wage data to estimate postoperative wages based on preoperative occupations and work schedules * *Return to work date:* Reported data of return to work after primary surgery from clinical trial data   **Direct costs used**   * Initial surgical procedure (facility & surgeon fees) * Additional surgical interventions (facility & surgeon fees) * Medical implants used * Radiographic procedures   **Indirect costs used**   * Postoperative wages * Postoperative average daily days of work after initial surgery   **Cost discounting:** NR | **Effectiveness outcomes**   * *Value of work productivity:* Calculated as preoperative average daily wage multiplied by days of work after initial surgery   **Utility measure**  Difference between incremental medical costs and gains in work productivity | **Direct medical costs**  *Initial procedure*  CDR: $11,147  ACDF: $11,036  ∆ Cost: $111 (CDR > ACDF)  *Secondary procedure (total number of procedures)*  CDF: $325 (11)  ACDF: $867 (26)  ∆ Cost: $542 (CDR < ACDF)  *Total medical costs*  CDR: $11,472  ACDF: $11,903  ∆ Cost: $431 (CDR < ACDF)  **Indirect costs**  *Value of work productivity (working days)*  CDR: $56,998 (523 days)  ACDF: $50,452 (485 days)  ∆ VWP: $6547 (CDR > ACDF)  **Net economic benefit**  CDR: $43,974  ACDF: $37,175   * ∆ economic benefit: $6978 (CDR < ACDF)   **Subgroup analysis** Performed on patients followed for 24 months   * *Total medical costs*   ∆ Cost: $542 (CDR < ACDF)   * *Net economic benefit* $6378 (CDR < ACDF) 9% less than result for entire study population | * No description of modeling used or model specifications * No description of software used * Only 2 year F/U * No cost discounting * Clinical trial was designed and powered around clinical endpoints rather than economic outcomes * 2-year F/U attained for about 80% of CDR group and 75% of ACDF group * No sensitivity analysis * Analysis limited to economic elements that were prospectively captured in the clinical trial (did not examine costs of other services, such as medication and physical therapy) * Hospital bills for initial stay were available for only 12.6% of patients; no hospital bills available for secondary procedures |
| Qureshi (2013)  Funding: NR  Country: US  QHES: 70 | **Diagnosis:**  Single-level cervical degenerative disc disease with radiculopathy  **Interventions:**   * ACDF * CDR   Model assumed target population of patients aged 45 years | **Design:** Cost effectiveness (utility) analysis  **Perspective:** Health care payer  **Time horizon:** 20 year  **Model:** Simple decision analytic model | * Target population of patients aged 45 years * CDR prosthesis survival 20 years * CDR 1-year success rate 99% * CDR utility value 0.9, ACDF utility value 0.8 * ACDF 5%/year pseudarthrosis, hardware failure (short-term complication) rate * ACDF 3%/year ASD (long-term complication) rate * CDR 1.5%/year hardware failure rate * $50,000/QALY gained willingness-to-pay (WTP) threshold | * Decision tree analysis modeling using TreeAge Pro 2011 software package * One-way sensitivity analyses | **Currency:** 2010 US$  **Cost source:**  Gross-cost estimates were generated using NIS to determine the disease-related group costs, and Medicare 2010 costs with CPT codes specific for each procedure were used to determine surgeons fees.  **Cost and utility discounting:** 3% per year | **Outcome measures (from literature):**   * Short-term complications * Long-term complications * Revision   **Effectiveness outcomes:**   * SF-36 scores * NDI scores * Neurologic status * Range of motion * Overall success   **Utility measure:**   * QALYs (from literature) | **Total lifetime cost**  CDR: $11,987  ACDF: $16,823  ∆ Cost: $4836 (CDR vs ACDF)  **Effectiveness of surgical procedure**  CDR: 3.94 QALYs  ACDF: 1.92 QALYs  ∆ QALY: 2.02 (CDR vs ACDF)  **Cost effectiveness ratio**  CDR: $3042 per QALY  ACDF: $8760 per  CDR is dominant (less costly and more effective) compared to ACDF  **Sensitivity analysis** *Prosthesis survival*   * CDR threshold value: 9.75 years, below which ACDF is more cost-effective * CDR is cost-effective as prosthesis survival time approaches 11 years * CDR 1-year failure rate would have to be >29% for ACDF to be more cost-effective   *Costs of CDR*   * CDA cost would have to increase > $16,319 before ACDF would be more cost-effective   *Utility of CDR*   * CDR threshold utility value: 0.796, below which ACDF is more cost effective * Using $50,000 WTP threshold, CDR is more cost-effective if utility factor ≥ 0.81 * ACDF is more cost-effective if its utility is > 0.908   *Long-term CDR failure*   * CDR long-term threshold failure rate: 30.8% per year, above which ACDF is more cost effective   *Revision*   * For the reference case, a patient who demonstrates primary hardware failure is as likely to have revision CDR as revision ACDF. * No threshold value determined | * Only one-way sensitivity analyses * No complex modeling (e.g. Markov) * Differential utility values for CDR, ACDF * Differential hardware failure rates for CDR, ACDF |
| *Cost-effectiveness of anterior versus posterior procedures for cervical myelopathy* | | | | | | | | |
| Ghogawala (2011)  Funding: Funding provided by Jean and David Wallace Foundation with additional support from the Clinical and Translational Science Award grant UL1 RR024146 from the National Center for Research Resources, National Institutes of Health  Country: US  QHES: 34 | Prospective cohort  N = 50  F/U %: 82% (41/50)  F/U: 12 months  **Diagnosis:** Patients  40-85 years with CSM (defined as ≥ 2 of the following symptoms/signs: clumsy hands, gait disturbance, hyperreflexia, Babinski reflexes, bladder dysfunction) and cervical spinal cord compression at ≥ 2 levels due to degenerative spondylosis, presenting from November 2006-January 2009.  **Interventions:**  After preoperative radiographs, surgeon-reviewers confirmed equipoise: eligibility for a anterior or posterior surgical approach   * Anterior multilevel discectomy with fusion and plating (n = 28) * Posterior midline cervical laminectomy with lateral mass screws and rods for rigid fixation (n = 22)   **Exclusion:** C2-C7 kyphosis>5°, segmental kyphotic deformity, OPLL, developmental narrow canal, previous cervical spine surgery, significant active health-related comorbidity | **Design:** Cost effectiveness (utility) analysis  **Perspective:** Hospital-based  **Time horizon:** 1 year  **Model:** Simple decision analytic model | NR | NR | **Currency:** NR  **Direct cost sources**   * *Total hospital charges:* Hospital charges for each patient were adjusted to costs using hospital-specific cost-to-charge ratios derived from Medicare data. * CSM-related ICD-9-CM diagnosis and procedure codes, diagnosis-related group codes, and CPT codes   **Direct costs used**   * Total hospital charges   **Cost and utility discounting:** NR | **Clinical data source:** Clinical records  **Clinical data used**   * Modified Japanese Orthopedic Association scale * Oswestry Neck Disability Index * Length of hospital stay * Complications   **Effectiveness outcomes**   * SF-36 Physical Component Summary * EQ-5D   **Utility measure**  None | **Unadjusted hospital costs**  Anterior: $19,245  Posterior: $29,465  ∆ Cost: $10,220 (Anterior < Posterior)  **Effectiveness of surgical procedure**  Anterior: 0.16 (EQ-5D)  Posterior: 0.13 (EQ-5D)  ∆ EQ-5D: 0.03 (Anterior > Posterior)  **Cost effectiveness ratio**  ICER was not calculated because anterior surgery was followed by larger improvements in mean HR-QOL and lower mean costs and thus dominated the posterior approach.  **Sensitivity analysis**  NR | * No description of modeling used or model specifications * No description of software used * Only 1 year F/U * No cost discounting * No sensitivity analysis * Economic analysis conducted on a subset of patients for whom both baseline and 1-year EQ-5D were available (N=41) * Economic analysis did not include postoperative care, productivity loss, or costs associated with subsequent hospitalizations |
| Whitmore (2011)  Funding: Funding provided by Jean and David Wallace Foundation  Country: US  QHES: 38 | Prospective cohort  N = 72  F/U %: 85% (72/85)  F/U: 12 months  **Diagnosis:** Patients  40-85 years with CSM, defined as ≥ 2 of the following symptoms/signs: clumsy hands, gait disturbance, hyperreflexia, Babinski reflexes, bladder dysfunction.  **Interventions:**   * Anterior multilevel discectomy with fusion and plating (n = 41) * Posterior midline cervical laminectomy with lateral mass screws and rods for rigid fixation (n = 31)   **Exclusion:** C2-C7 kyphosis>5°, segmental kyphotic deformity, OPLL, developmental narrow canal, previous cervical spine surgery, significant active health-related comorbidity | **Design:** Cost effectiveness (utility) analysis  **Perspective:** Hospital-based and society-based  **Time horizon:** 1 year  **Cost and utility discounting:** NR  **Model:** Simple decision analytic model | NR | NR | **Currency:** 2010 US$  **Direct cost sources**   * *Total hospital charges:* Hospital charges adjusted to costs using hospital-specific cost-to-charge ratios derived from Medicare aggregate data for each year of patient accrual. * *Alternate hospital charges:* Medicare rates of reimbursement for all CSM-related ICD-9-CM diagnosis and procedure codes, disease-related group codes, and CPT codes were recorded for each patient from the index hospitalization. * *Outpatient expenses:* Estimated from total CPT code Medicare reimbursement (2008 rates) plus out-of-pocket expenses. Retrospective cost diary utilized on a subset of 20 patients. Expenses were recorded for diagnostic testing, medications, physical therapy, durable medical equipment, and in-home assistance.   **Direct costs used**   * Total hospital charges (*CCR method*; hospital-based perspective) * Total Medicare reimbursement plus sum of disease-related group code and all CPT codes (*Medicare reimbursement method*; society-based perspective) * Outpatient costs | **Clinical data source:** Clinical records  **Clinical data used**   * Modified Japanese Orthopedic Association scale * Oswestry Neck Disability Index * Estimated blood loss * Length of stay * Operating room time   **Effectiveness outcomes**   * SF-36 Physical Component Summary * EQ-5D   **Utility measure**   * QALYs (calculated from EQ-5D US population-based index score) | **Total medical costs**  *CCR method*  Anterior: $21,563  Posterior: $27,942  ∆ Cost: $6379 (Anterior < Posterior)  *Medicare reimbursement method*  Anterior: $17,538  Posterior: $16,579  ∆ Cost: $959 (Anterior > Posterior)  *Outpatient costs*  Anterior: $1998  Posterior: $4733  ∆ Cost: $2735 (Anterior < Posterior)  **Effectiveness of surgical procedure**  Anterior: 0.16 QALYs  Posterior: 0.13 QALYs  ∆ QALY: 0.03 (Anterior > Posterior)  **Cost effectiveness ratio**  ICER (CCR method): Anterior approach is less costly and more effective than posterior  ICER (Medicare reimbursement method): $34,533 per QALY (Anterior < Posterior)  **Sensitivity analysis:** NR | * No description of modeling used or model specifications * No description of software used * Only 1 year F/U * No cost discounting * No sensitivity analysis * Did not account for costs associated with complications of index procedure * Outpatient costs were not included in ICER calculations * Direct costs were derived from the index hospitalization only |
| *Cost-effectiveness of anterior versus posterior procedures for cervical radiculopathy* | | | | | | | | |
| Tumialan (2010)  Funding: No financial support was received  Country: US  QHES: 40 | Retrospective cohort  N = 38  F/U %: NR  F/U: 5-34 months  *ACDF*  Age: 39.3 (range 24-52) years  Male: 100% (19/19)  Mean F/U: 18.1 (range 6-34) months  *PCF*  Age: 41.4 (range 27-56) years  Male: 89.5% (17/19)  F/U %: 80.8 (223/276)  Mean F/U: 11.2 (range 5-24) months  **Diagnosis:**  Unilateral cervical radiculopathy without myelopathy in active-duty military patients, presenting between July 2007 and August 2009  **Interventions:**   * ACDF with or without discectomy (n = 19) * PCF with or without discectomy   (n = 19)  Procedures performed in the military; 19 patients who underwent PCF were matched by age, treatment level and surgeon with 19 patients who underwent ACDF  **Exclusion:** Previous cervical surgery, myelopathy, spinal infection or tumor, psychiatric illness | **Design:** Cost benefit  **Perspective:** Societal  **Time horizon:** NR  **Model:** Simple decision analytic model | * Salaries were a surrogate marker for lost productivity * 4-tier rank system was underestimated to a low end value to indirect cost | NR | **Currency:** 2009 US$  **Direct cost sources**   * *Hospital & instrumentation costs:* TRICARE military health plan reimbursement figures   **Indirect cost sources**   * Monthly salary based on 2009 fiscal year figures for ranks of junior enlisted service member (E4), senior enlisted member (E7), junior officer (O1), senior officer (O4)   **Direct costs used**   * Hospitalization * Surgical instrumentation   **Indirect costs used**   * Monthly salary * Time required for return to unrestricted active-duty military service within service member’s presurgical military occupational specialty   **Cost discounting:** NR | **Clinical data sources**   * Hospital and clinical records   **Clinical data used**   * Operating room times * Estimated blood loss * Length of hospital stay * Postoperative narcotic medication refills   **Effectiveness outcome**   * *Cost of time away from active duty:* Calculated by multiplying service member’s monthly salary by difference in time away from active duty   **Utility measure**   * Difference between incremental medical costs and gains in work productivity | **Direct medical costs**  PCF: $3570  ACDF: $10,078  ∆ Cost: $6508 (PCF < ACDF)  **Time to return to duty**  PCF: 4.8 weeks  ACDF: 19.6 weeks  ∆ Time: 14.8 weeks (PCF < ACDF)  **Indirect costs**  *Difference in time to return to work multiplied by salary*  ∆ indirect costs (PCF < ACDF)  E4: $13,586  E7: $17,797  O1: $17,475  O4: $24,045  **Net economic benefit**  *Direct plus indirect costs*  ∆ economic benefit (PCF < ACDF)  E4: $20,094  E7: $24,305  O1: $23,983  O4: $30,553  **Sensitivity analysis**: NR | * No description of modeling used or model specifications * No description of software used * F/U ranged from 5-24 months * No cost discounting * No sensitivity analysis * Bonus pay was not included in the cost estimation |

QHES = quality of health economic studies; RCT = randomized controlled trial; ACDF = anterior cervical discectomy and fusion; CDR = cervical disc replacement; NR = no report; CPT = current procedural terminology; VWP = value of work productivity; ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year; SF-36 = short-form 36; NDI = Neck Disability Index; QALY = quality-adjusted life year; CSM = cervical spondylotic myelopathy; ICD-9-CM = International Classification of Diseases, 9th revision, clinical modification; EQ-5D = EuroQol-5D; OPLL = ossification of posterior longitudinal ligament; PCF = posterior cervical foraminotomy

**Web Appendix**

*1. Search Strategy*

Human studies published in the English language and containing abstracts were considered for inclusion, with no other limits placed on the search. Reference lists of key articles were also systematically checked to identify additional eligible articles. The search strategy included the use of controlled vocabulary (MeSH terms) as well as keywords. Terms specific to the cervical spine, degenerative disease and surgery, as well as those related to cost-benefit and cost-effectiveness were used. We sought to identify economic studies comparing ACDF to CDR (question one), anterior to posterior surgical procedures (questions two and three), and surgical intervention to nonsurgical management (question four). Table 1 of the manuscript provides additional information on inclusion/exclusion criteria. Information about data abstraction and critical appraisal of included articles is detailed below. Only economic studies that evaluated and synthesized the costs and consequences of surgical treatments for cervical degenerative disease were considered for inclusion. Meeting abstracts/proceedings, white papers, editorials, narrative reviews, case reports, non-clinical and animal studies, cost-only studies, and studies with less than ten subjects were excluded. Articles were also excluded if the patients were pediatric or were treated for tumor, trauma, infection, deformity correction, ankylosing spondylitis, previous adjacent segment pathology, or less than 80% of the subjects in the study had a diagnosis of cervical degenerative disease.

*2*. *Data Extraction*

Each retrieved citation was reviewed by two independently working reviewers. Most articles were excluded on the basis of information provided by the title or abstract. Citations that appeared to be appropriate or those that could not be excluded unequivocally from the title and abstract were identified, and the corresponding full text reports were reviewed by the two reviewers. Any disagreement between them was resolved by reviewer consensus. From the included articles, the following data were extracted: study design, patient demographics, intervention and comparator, perspective, time horizon, cost and utility discounting, currency, cost sources, costs used, clinical data sources, clinical data used, effectiveness outcome, utility measure, modeling and software used, model assumptions and specifications, primary results, and results of sensitivity analysis/evaluation of variability.

*3.* *Critical Appraisal*

The Quality of Health Economic Studies (QHES) instrument developed by Ofman, et al. was used to provide an initial basis for critical appraisal of included economic studies.[1](#_ENREF_1) QHES is a sixteen 'yes' or 'no' question instrument that assesses multiple aspects of economic study design, modeling and reporting to determine internal validity. QHES was assessed prospectively[1](#_ENREF_1),[2](#_ENREF_2) for content and construct validity by the developers and has been evaluated externally as well.[3](#_ENREF_3) Components are weighted by importance (as concluded by expert health economists) to yield a score from 0 (lowest quality) to 100 (highest quality). Items that are considered most important (based on their weighting) include: Use of data from best available sources (e.g. RCT), statistical analysis to address random events and use of sensitivity analysis to explore model, use of appropriate sources and methodologies for measuring and estimating costs, use of valid and reliable outcomes measures, transparent description of economic modeling used including delineation and justification of main assumptions and limitations of the model, and extent to which conclusions and recommendations were justified and based on study results.

Some have suggested that a score of 75-100 points indicates a high quality economic study.[4](#_ENREF_4) The QHES does not provide insight into study external validity (generalizability) nor does it directly assess the validity of clinical assumptions and inputs. A study may receive a high score based on factors assessed in QHES, but ultimately may not be applicable to a broader range of clinical populations. Thus, in addition to assessment of criteria in the QHES, other factors are important in critical appraisal of studies from an epidemiologic perspective to assist in evaluation of generalizability and consideration of potential sources of bias related to clinical inputs into the economic model.

Two reviewers independently applied the QHES to included studies. Discrepancies in ratings were discussed so that consensus could be reached and a final score obtained.

*4. Summary of QHES*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Questions** | **Possible points** | **Ghogawala (2011)** | **Menzin (2010)** | **Qureshi (2013)** | **Tumialan (2010)** | **Whitmore (2011)** |
| 1. Was the **study** **objective** presented in a clear, specific, and measurable manner? | 7 | 7 | 7 | 7 | 7 | 7 |
| 2. Were the **perspective** of the analysis (societal, third-party payer, etc.) and reasons for its selection stated? | 4 | 0 | 4 | 0 | 0 | 4 |
| 3. Were **variable estimates** used in the analysis **from the best available source** (ie, randomized controlled trial - best, expert opinion - worst)? | 8 | 0 | 8 | 8 | 0 | 0 |
| 4. If estimates came from a **subgroup analysis**, were the groups prespecified at the beginning of the study? | 1 | 1 | 1 | 1 | 1 | 1 |
| 5. Was **uncertainty** handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions? | 9 | 0 | 0 | 0 | 0 | 0 |
| 6. Was **incremental analysis** performed between alternatives for resources and costs? | 6 | 0 | 6 | 6 | 0 | 0 |
| 7. Was the methodology for **data abstraction** (including the value of health states and other benefits) stated? | 5 | 0 | 0 | 5 | 0 | 0 |
| 8. Did the **analytic horizon allow time** for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3% to 5%) and justification given for the discount rate? | 7 | 0 | 0 | 7 | 0 | 0 |
| 9. Was the **measurement of costs** appropriate and the methodology for the estimation of quantities and unit costs clearly described? | 8 | 8 | 8 | 8 | 8 | 8 |
| 10. Were the primary **outcome measure(s**) for the economic evaluation clearly stated and did they include the major short-term, long-term and negative outcomes included? | 6 | 0 | 6 | 6 | 6 | 0 |
| 11. Were the health outcomes **measures/scales valid** and reliable? If previously tested valid and reliable measures were not available, was justification given for the measures/scales used? | 7 | 7 | 7 | 7 | 7 | 7 |
| 12. Were the **economic model** (including structure), study methods and analysis, and the components of the numerator and denominator displayed in a clear, transparent manner? | 8 | 0 | 0 | 0 | 0 | 0 |
| 13. Were the choice of economic model, main **assumptions, and limitations** of the study stated and justified? | 7 | 0 | 0 | 7 | 0 | 0 |
| 14. Did the author(s) explicitly discuss direction and magnitude of potential **biases?** | 6 | 0 | 0 | 0 | 0 | 0 |
| 15. Were the **conclusions/recommendations** of the study justified and based on the study results? | 8 | 8 | 8 | 8 | 8 | 8 |
| 16. Was there a statement disclosing the **source of funding** for the study? | 3 | 3 | 3 | 0 | 3 | 3 |
| **TOTAL POINTS** | 100 | **34** | **58** | **70** | **40** | **38** |

*5. Excluded articles.*

|  |  |  |
| --- | --- | --- |
| **Author** | **Year** | **Reason for exclusion** |
| Angevine, P. D., J. G. Zivin, et al. (2005). "Cost-effectiveness of single-level anterior cervical discectomy and fusion for cervical spondylosis." Spine (Phila Pa 1976) 30(17): 1989-97. | 2005 | Does not assess comparators of interest |
| Arts, M. P., R. Brand, et al. (2010). "The NEtherlands Cervical Kinematics (NECK) trial. Cost-effectiveness of anterior cervical discectomy with or without interbody fusion and arthroplasty in the treatment of cervical disc herniation; a double-blind randomised multicenter study." BMC Musculoskelet Disord 11: 122. | 2010 | Article discusses trial design; no results are presented. |
| Bhadra, A. K., A. S. Raman, et al. (2009). "Single-level cervical radiculopathy: clinical outcome and cost-effectiveness of four techniques of anterior cervical discectomy and fusion and disc arthroplasty." Eur Spine J 18(2): 232-7. | 2009 | Does not report synthesized cost with effectiveness or utility outcome measure |
| Carreon, L. Y., P. A. Anderson, et al. (2013). "Cost-effectiveness of single-level anterior cervical discectomy and fusion five years after surgery." Spine (Phila Pa 1976) 38(6): 471-5. | 2013 | Does not assess comparators of interest |
| Fehlings, M. G., N. K. Jha, et al. (2012). "Is surgery for cervical spondylotic myelopathy cost-effective? A cost-utility analysis based on data from the AOSpine North America prospective CSM study." J Neurosurg Spine 17(1 Suppl): 89-93. | 2012 | Does not assess comparators of interest |
| Feng, Y. T., S. L. Hwang, et al. (2012). "Safety and resource utilization of anterior cervical discectomy and fusion." Kaohsiung J Med Sci 28(9): 495-9 | 2012 | Does not report synthesized cost with effectiveness or utility outcome measure |
| Fernandez-Fairen, M., A. Murcia, et al. (2012). "Is anterior cervical fusion with a porous tantalum implant a cost-effective method to treat cervical disc disease with radiculopathy?" Spine (Phila Pa 1976) 37(20): 1734-41. | 2012 | Does not assess comparators of interest |
| Kepler, C. K., S. M. Wilkinson, et al. (2012). "Cost-utility analysis in spine care: a systematic review." Spine J 12(8): 676-90. | 2012 | Systematic review; does not report outcomes of interest |
| Liu, B., W. Ma, et al. (2012). "Comparison between anterior and posterior decompression for cervical spondylotic myelopathy: subjective evaluation and cost analysis." Orthop Surg 4(1): 47-54. | 2012 | Does not report synthesized cost with effectiveness or utility outcome measure |
| McLaughlin, M. R., V. Purighalla, et al. (1997). "Cost advantages of two-level anterior cervical fusion with rigid internal fixation for radiculopathy and degenerative disease." Surg Neurol 48(6): 560-5. | 1997 | Does not assess comparators of interest |
| O'Neill, K. R., R. J. Wilson, et al. (2013). "Anterior Cervical Discectomy and Fusion for Adjacent-Segment Disease: Clinical Outcomes and Cost-Utility of Surgical Intervention." J Spinal Disord Tech. | 2013 | Does not assess comparators of interest |
| Patil, P. G., D. A. Turner, et al. (2005). "National trends in surgical procedures for degenerative cervical spine disease: 1990-2000." Neurosurgery 57(4): 753-8; discussion 753-8. | 2005 | Does not report synthesized cost with effectiveness or utility outcome measure |
| Qureshi, S. A., S. M. Koehler, et al. (2013). "Utilization trends of cervical artificial disc replacement during the FDA investigational device exemption clinical trials compared to anterior cervical fusion." Journal of Clinical Neuroscience 20(12): 1723-1726. | 2013 | Does not report synthesized cost with effectiveness or utility outcome measure |
| Rasanen, P., J. Ohman, et al. (2006). "Cost-utility analysis of routine neurosurgical spinal surgery." J Neurosurg Spine 5(3): 204-9. | 2006 | Does not assess comparators of interest |
| Shamji, M. F., C. Cook, et al. (2009). "Impact of surgical approach on complications and resource utilization of cervical spine fusion: a nationwide perspective to the surgical treatment of diffuse cervical spondylosis." Spine J 9(1): 31-8. | 2009 | Does not report synthesized cost with effectiveness or utility outcome measure |
| Warren, D. T., P. A. Ricart-Hoffiz, et al. (2013). "Retrospective cost analysis of cervical laminectomy and fusion versus cervical laminoplasty in the treatment of cervical spondylotic myelopathy." International Journal of Spine Surgery 7(1): e72-e80 | 2013 | Does not report synthesized cost with effectiveness or utility outcome measure |
| Zechmeister, I., R. Winkler, et al. (2011). "Artificial total disc replacement versus fusion for the cervical spine: a systematic review." Eur Spine J 20(2): 177-84. | 2011 | Systematic review; does not report outcomes of interest |

*6. References*

1. Ofman JJ, Sullivan SD, Neumann PJ, et al. Examining the value and quality of health economic analyses: implications of utilizing the QHES. *Journal of managed care pharmacy : JMCP* 2003;9:53-61.

2. Chiou CF, Hay JW, Wallace JF, et al. Development and validation of a grading system for the quality of cost-effectiveness studies. *Medical care* 2003;41:32-44.

3. Gerkens S, Crott R, Cleemput I, et al. Comparison of three instruments assessing the quality of economic evaluations: a practical exercise on economic evaluations of the surgical treatment of obesity. *International journal of technology assessment in health care* 2008;24:318-25.

4. Spiegel BM, Targownik LE, Kanwal F, et al. The quality of published health economic analyses in digestive diseases: a systematic review and quantitative appraisal. *Gastroenterology* 2004;127:403-11.