The Spine Journal 14 (2014) 2748–2762

THE SPINE JOURNAL

Review Article

Cost-effective studies in spine surgeries: a narrative review

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Received 2 April 2013; revised 19 March 2014; accepted 18 April 2014

Abstract

BACKGROUND CONTEXT: Although the pathologic processes that affect the spine remain largely unchanged, our techniques to correct them continue to evolve with the development of novel medical and surgical interventions. Although the primary purpose of new technologies is to improve patients' quality of life, the economic impact of such therapies must be considered.

PURPOSE: To review the available peer-reviewed literature on spine surgery that addresses the cost-effectiveness of various treatments and technologies.

STUDY DESIGN: A narrative literature review.

METHODS: Articles published between January 1, 2000 and December 31, 2012 were selected from two Pubmed searches using keywords cost-effectiveness AND spine (216 articles) and cost analysis AND spine (358 articles). Relevant articles on cost analyses and cost-effectiveness were selected by the authors and reviewed.

RESULTS: Cervical and lumbar surgeries (anterior cervical discectomy and fusion, standard open lumbar discectomy, and standard posterior lumbar laminectomy) are reasonably cost effective at 2 years after the procedure (<100,000 US dollars per quality-adjusted life years gained) and become more cost effective with time because of sustained clinical improvements with relatively low additional incurred costs. The usage of transfusion avoidance technology is not cost effective because of the low risk of complications associated with allogenic transfusions. Although intraoperative neuromonitoring and imaging modalities are both cost saving and cost-effective, their cost-effectiveness is largely dependent on the baseline rate of neurologic complications and implant misplacement, respectively. More rigorous studies are needed to evaluate the cost-effectiveness of recombinant bone morphogenetic protein.

CONCLUSIONS: An ideal new technology should be able to achieve maximal improvement in patient health at a cost that society is willing to pay. The cost-effectiveness of technologies and treatments in spine care is dependent on their durability and the rate and severity of the baseline clinical problem that the treatment was designed to address.

Keywords: Costs; Economics; Cost-effectiveness; Spine surgery; Narrative review; Treatments and technologies

Introduction

In recent years, numerous novel technologies have been developed for the treatment of spinal pathologies. Although the ultimate purpose of these technologies is the improvement of patient health, the cost-effectiveness of any treatment strategy must be taken into consideration. A cost-effectiveness analysis estimates the economic cost of a given technology to provide a unit of improvement in patient health. Studies evaluating or comparing the cost-effectiveness of different treatment options are instrumental in determining and optimizing treatment guidelines for generating improvements to patients' quality of life while minimizing unnecessary usage of health-care resources and dollars [1–3].

Methods of expressing cost-effectiveness

To express cost-effectiveness of an intervention, both the costs and the clinical benefits of that treatment strategy must be estimated [4]. The cost of a treatment is the sum of direct costs (the costs of the procedure, technology, or drugs),

FDA device/drug status: Approved (X-STOP Interspinous Decompression Device).

Author disclosures: ***YL:*** Grants: Orthopaedic Research and Education Foundation (C, Paid directly to institution). ***SAQ:*** Royalties: Zimmer (Paid directly to institution); Consulting: Zimmer (C), Stryker (C), Orthofix (C), Medtronic (C); Grants: OREF (C, Paid directly to institution), CSRS (C, Paid directly to institution).

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1529-9430/$ - see front matter
http://dx.doi.org/10.1016/j.spinee.2014.04.026

indirect costs (production losses of the patient secondary to morbidity after the procedure), and miscellaneous costs (patient discomfort or pain after a procedure). Direct costs are typically measured through determining the patients' utilization of medical resources and estimating the unit costs for each resource. Indirect costs are typically the costs associated with any loss of work productivity. Because miscellaneous costs are difficult to quantify, they are usually not included as part of the total costs (Table 1) [4,5].

The clinical benefit of a treatment option may be measured in several methods. Any quantitative clinical outcome such as the visual analog scale for pain or "number of hospitalization days" can be used to describe improvements after an intervention. However, the common method to express patient health is the use of "quality-adjusted life years" (QALYs), which express both the quantity and quality of life. The QALY is the product of the number of years of life and the quality of life. The QALY for a given year may vary from 0 to 1 in which a year of perfect health is considered "1," whereas death will be considered "0." In some instances, the patients' quality of life may be poor enough to warrant negative values [5–7].

A widely used tool to estimate QALY is the EuroQol-5D (EQ-5D) questionnaire, which determines a patients' quality of life based on disease severity. Scores from EQ-5D are generated based on the five dimensions of health, mobility, pain/discomfort, self-care, anxiety/depression, and usual activities, and are then used to estimate the quality of life [5,6,8].

Using both the costs of the intervention and change in the QALY after the intervention, the cost-effectiveness of the intervention can be expressed by the cost per QALY gained or the economic cost that is needed to achieve a unit of QALY gained. Although the cost-effectiveness of the intervention should be evaluated on a case-by-case basis, an intervention is generally considered to be economically acceptable in the United States if the cost per QALY gained ranges from 50,000 to 100,000 and possibly 200,000 US dollars (USD) [9]. Because of regional variations in the economy, it is important to note that the acceptable cost per QALY gained varies in different countries. In the United Kingdom, the National Institute for Health and Clinical Excellence proposed the preferred cost per QALY gained within the UK health-care system [10]. Although National Institute for Health and Clinical Excellence suggested that the cost-effectiveness of each treatment strategy should be evaluated on a case-by-case basis, their guidelines suggest that treatment options with cost per QALY gained that exceeded 20,000 to 30,000 euros (~30,000 to 45,000 USD) are generally not considered cost effective [10].

The cost-effectiveness of two different interventions can also be compared using the incremental cost-effectiveness ratio (ICER), which is the difference in the costs of the two intervention types divided by their difference in QALYs. Incremental cost-effectiveness ratio expresses the economic price associated with the additional clinical benefits of one intervention over another. In cases where one intervention is less expensive and generates a greater increase in QALYs, the difference is considered "dominant" [6,11,12].

Another method of expressing cost-effectiveness is by comparing the cost per QALY gained with payer or societal willingness to pay. The willingness to pay is an estimation of what society or the patient deems as a reasonable economic price to accrue a unit of health benefit or the economically acceptable cost per QALY gained. Therefore, cost-effective interventions are those whose costs per QALY gained are less than or equal to the societal or patient willingness to pay. Furthermore, the ICER can be combined with the willingness to pay to express net benefit. The net benefit of an intervention is equal to the health-care improvement minus the ratio of the total cost to willingness to pay (net benefit=health improvement in QALYs–total costs/willingness to pay). A positive net benefit suggests cost-effectiveness of the treatment option [5,6,11].

It is important to note that there are variabilities regarding the costs and effectiveness of new technologies or treatment options [13]. In turn, statistical models are used to incorporate the variances and uncertainties of the different factors that can influence the estimation of cost-effectiveness. Probability sensitivity analysis (PSA) expresses the costs per QALY gained as a scatter plot in which the y-axis represents the incremental costs of the

Table 1
Cost-effectiveness studies on treatments relating to the cervical spine

Study	Study type	Study design (study population)	Methods to estimate costs	Utility measure	Follow-up period (mo)	Significant findings
Whitemore et al. (United States)	Prospective study (nonrandomized)	Ventral vs. dorsal decompressions. (cervical myelopathy)	CCR Medicare reimbursement	EQ-5D	12	Ventral approach is dominant over dorsal approach
Carreon et al. (United States)	Control group of an RCT	Cost-effectiveness of ACDF	Medicare fee schedule	SF-6D	60	ACDF is modestly cost effective at 1 y
Fehlings et al. (Canada)	Prospective study	Cost-effectiveness of surgery for cervical myelopathy	Hospital expense database and reimbursement data	SF-6D	24	Surgery for cervical myelopathy conferred stable clinical improvements over 2 y

ACDF, anterior cervical discectomy and fusion; CCR, cost-to-charge ratio; EQ-5D, EuroQol-5D; RCT, randomized controlled trial; SF-6D, Short-Form 6D.