# Cost-Effectiveness Research in Neurosurgery

Corinna C. Zygourakis, MD[a,*], James G. Kahn, MD, MPH[b]

**KEYWORDS**

• Cost-effectiveness • Cost-utility • QALY • Neurosurgery • Spine surgery

**KEY POINTS**

- A cost-effectiveness analysis (CEA) reports the added cost per added quality-adjusted life year (QALY) by moving from less to more expensive interventions; the focus is on differences in cost and effectiveness among options, so the result is called the incremental cost-effectiveness ratio (ICER).
- With the exception of spine surgery, there is a relative paucity of cost-effectiveness studies in the field of neurosurgery; and many of these use inconsistent cost metrics, variable outcome measures, and data sets that are poorly matched to the analysis.
- It is of utmost important for this field to establish and adhere to guidelines for cost and CEA methodology and reporting so that results can be appropriately compared among neurosurgery cost-effectiveness studies and with interventions in other medical fields.

## INTRODUCTION

Cost and value (defined as the quality or outcomes of care compared with cost) are increasingly important components of health care. Despite a wealth of CEAs in many areas of medicine, there has been little research addressing the cost of neurosurgical procedures until recently. This is particularly problematic because this specialty represents one of the most expensive areas in medicine. According to the Centers for Disease Control and Prevention, there were approximately 1.2 million neurosurgical procedures performed in the United States in 2010.[1] The cost of lumbar laminectomies alone exceeded $2 billion, and spinal fusions cost $12.8 billion nationwide in 2011.[2]

This article first discusses the general principles of CEAs, then reviews the cost-related research that has been done to date in the neurosurgical subspecialties, primarily spine and also trauma, functional, vascular, pediatric, and tumor neurosurgery. Finally, the need for standardization of cost and cost-effectiveness metrics within neurosurgery is highlighted and an easy-to-use set of metrics to guide future research in neurosurgical cost-effectiveness is defined.

## PRINCIPLES OF COST-EFFECTIVENESS ANALYSES

A CEA is a type of economic analysis that compares the costs and health outcomes of 2 or more courses of action.[3] CEAs are often expressed in terms of a ratio of cost per health gain. The most commonly used health outcomes measure in the United States and Europe is QALYs. A QALY reflects both the quantity and quality of the years gained by a medical intervention, and is equal to time (years) × quality (ie, utility). Health utility is on a scale from 0 to 1, with 0 indicating death and 1 representing perfect health. Direct methods to estimate health state utility include time tradeoff, standard gamble, and visual analog scale. Indirect methods include the Health Utility Index,[4]

[a] Department of Neurological Surgery, University of California, San Francisco, 505 Parnassus Avenue, Room 779M, San Francisco, CA 94143, USA; [b] Philip R. Lee Institute for Health Policy Studies, Global Health Economics Consortium, University of California, San Francisco, 3333 California St., Suite 265, Box 0936, San Francisco, CA 94118, USA
* Corresponding author.
*E-mail address:* zygourakisc@neurosurg.ucsf.edu

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EuroQoL–5 Dimension (EQ-5D),[5] and Short Form–6 Dimension (SF-6D).[6] A single year spent in perfect health yields 1 QALY, and effective medical interventions increase QALYs. To compare 2 interventions (eg, treatments A and B), an ICER, which equals (cost of B – cost of A)/(QALYS with B – QALYs with A), is calculated. The use of ICERs enables the cost of achieving a certain benefit to be compared with similar ratios calculated for other health interventions, providing a broader context in which to make judgments about the value for money of a particular health intervention.[3] In the United States, ICERs less than $150,000 are typically considered cost effective, because this represents 2 times the gross domestic product per capita.[7]

A cost-utility analysis is a specific type of CEA that uses health utilities expressed as QALYs (described previously). CEAs can also include other health outcomes, such as cost per death averted or added year of life. A cost-benefit analysis, distinct from a CEA, assigns a monetary value to health outcomes, usually based on a population's "willingness to pay" for those outcomes. Thus, it calculates the net monetary cost or savings of an intervention. It is used less frequently than CEAs in medicine.[3]

A rigorous CEA must specify its cost methods. Costs include both direct costs (eg, resources consumed by the surgical procedure, such as surgical implants and hospital stay, and the costs of future medical care) and time costs (eg, due to loss of productivity from the morbidity of a surgical procedure). In the literature, hospital-allowed charges (ie, what the hospital is paid by the insurance company) are often used as a proxy for direct cost. Importantly, crude (billed) hospital charges can bear little resemblance to economic cost[8]; and use of hospital charges as a proxy for cost may lead researchers to draw unwarranted conclusions.[9] The best measure of cost is actual resource utilization,[9] which can be difficult to calculate but is available via some hospital cost-accounting systems. Many articles in the literature are forced to use insurance payments, specifically the Centers for Medicare and Medicaid Services reimbursement values for specific diagnosis-related group and current procedural terminology codes, as estimates for cost.[10]

Several additional aspects of CEA methods should also be reported in each study. These include the analytical time period and perspective (eg, that of society or health care payers), the discount rate, the type of sensitivity or uncertainty analysis performed, and the selected cost-effectiveness threshold (if used). All these criteria are reported in the Cost-Effectiveness Analysis Registry,[11] which is a comprehensive database of 4007 cost-utility analyses that have been assessed by reviewers with training in cost-effectiveness and decision analysis. The CEA model structure and input values must be transparent and thoroughly documented and justified, typically with some detail in online supplemental documents.

## COST-EFFECTIVENESS ANALYSES IN NEUROSURGERY

A comprehensive PubMed search for "cost-effectiveness" and "neurosurgery" had 691 hits, although only a small subset of these results were true CEAs. A more refined search ("cost-effectiveness" [ti] "cost utility" [ti] neurosurgery) helped narrow the list to 140 articles. A search of the Cost-Effectiveness Analysis Registry (search terms, "neurosurgery" and "spine") revealed fewer than 50 verified cost-utility analyses in the field of neurosurgery up to early 2013, a majority of which are in the subspecialty of spine.[12–25] Admittedly, there has been an increased interest in this area recently, with a significant rise in the number of neurosurgery cost-effectiveness studies published over the past 2 years. A majority of purported cost-effectiveness neurosurgery studies, however, do not adhere to the CEA methodology described previously. Many of these are actually cost comparison (ie, descriptive comparisons of cost differences) rather than cost-effectiveness studies. They also have several limitations, including inconsistent use of cost methods (direct vs indirect costs, charges vs payments), variable outcome measures, and potentially noncomparable data sets (ranging from large national databases, such as the Nationwide Inpatient Sample database, to small, single-institution series).

## SPINE: THE LEADER IN NEUROSURGERY COST-EFFECTIVENESS

Driven largely by the high costs of their procedures and insurance companies' demands for justification of their interventions, spine surgeons were among the first neurosurgeons to enter the cost-effectiveness field. One of the earliest studies, published in 2008, showed the cost-effectiveness of lumbar laminectomy, compared with nonoperative treatment, for lumbar disc herniation at 2 years (ICER $69,403).[26] Using the same Spine Patient Outcomes Research Trial data, this research group also found that lumbar laminectomy was a cost-effective treatment option compared with nonoperative treatment for spinal stenosis with and without degenerative spondylolisthesis at 2 years (ICER <$150,000).[27] These findings were