In Brief

Cost-effectiveness Analyses in Orthopaedics

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Background

Cost-effectiveness has become increasingly important for physicians [2, 28]. However, cost-effectiveness analyses can vary considerably in quality owing to wide differences in available data on which to base the analyses. Many physicians do not have sufficient knowledge of economic analysis and access to relevant databases to appraise and interpret economic analyses, whereas economists and policymakers lack the clinical insight physicians have acquired during the years.

Question

What are the common methods of economic analyses in orthopaedics?

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Discussion

Two facts dictate economic reality: scarcity, or the fact that there is only so much money, time, etc; and opportunity cost, the cost of choosing to do one thing instead of something else. Therefore, it seems prudent and ethical to put all (extra) money where it does the most good. Current estimates suggest approximately 1/3 of the money spent on health care in the US is spent because of misuse, overuse, or underuse [6]. Properly conducted economic analyses should improve this situation. These are defined as “the comparative analysis of alternative courses of action in terms of both their costs and consequences”, ie, they place treatment costs into relation to treatment outcomes [2, 11]. The three common methods are (1) cost-effectiveness analyses (using any clinical outcome), (2) cost-utility analyses (using quality-adjusted-life-years), and (3) cost-benefit analyses (using value of outcomes) (Table 1). Before describing the three methods, an introduction to cost analysis—the common baseline for all these methods—is provided. Cost-minimization analysis, a widely outdated method, is described because it is an historical link between cost-analyses and cost-effectiveness analyses. The results of such studies, preferably more than one, are introduced in decision-analysis models that help one to arrive at a clinically effective and cost-effective decision. A full description of such models is not possible here, but they have been described by others [2, 15, 16, 26].

Cost Analysis

The first, and most important but probably most complicated, task in economic analysis is to measure costs. Briefly, one should include all costs from a patient's

Table 1. Methods of economic analysis—input and output parameters

Method of analysis	Input	Outcome measure	Outcome measure obtained through
Cost-minimization analysis (CMA)	Monetary units (\$)	Assumed equal (thus canceled out)	–
Cost-effectiveness analysis (CEA)	Monetary units (\$)	Natural outcome measure (life-years saved, infections prevented, etc)	High-quality trials
Cost-utility analysis (CUA)	Monetary units (\$)	Generic outcomes measures (typically QALYs, DALYs)	Standard gambles, time trade-off, validated scores (Short Form-36, EuroQol-5D, etc)
Cost-benefit analysis (CBA)	Monetary units (\$)	Generic monetary outcome (\$)	Willingness to pay, human capital, revealed preferences

QALYs = quality-adjusted life years, DALYs = disability-adjusted life years.

perspective including (1) direct costs of treatment (eg, the hip implant), (2) direct cost to the patient (transportation, childcare), (3) costs to the patient owing to loss of income, and (4) indirect costs of treatment (building and maintaining the hospital and OR, etc) [27]. However, most studies use hospital charges as a measure of cost instead, which is problematic because hospital charges do not reflect the true cost to society and often are distorted (by cross-subsidies in hospitals, monopolies, etc) [7, 21]. Further, all costs are discounted with time (usually between 3% and 5% per year) [14, 15, 20], to account for the loss of value of money with time and put future cost on an equal base with current values [10, 22]. In interpreting cost-benefit analyses one must consider two effects of time: (1) Instead of spending money on health care, it could be invested in an interest-earning instrument and its value would increase with time; this opportunity is forgone. (2) There is an intrinsic preference in choosing when to spend money and accrue benefits, ie, we prefer to have it now, rather than later. Graves et al. [13] and Halliday and Darba [14] offer detailed reviews of the methods used and problems to be encountered in the current literature on cost analysis. The costs are the common baseline for all the current methods, and studies with inadequate cost analysis will be of limited validity.

Cost-minimization Analysis (CMA)

The essence of a CMA is that if two treatment options have largely equivalent outcomes (effectiveness), the less expensive treatment is the preferred treatment. Although the elegant simplicity of such an approach is appealing, there are considerable problems in practical application, mainly because neither costs nor effectiveness can be determined with sufficient certainty [5]. This lack of certainty (eg, whether outcomes will be equivalent) also a priori eliminates the choice of CMA as a study design [5, 8, 14].

Cost-effectiveness Analysis (CEA)

A CEA is used in a situation where a decision-maker operating with a fixed budget is choosing from a limited range of treatment options in a given field [9, 11]. Incremental costs are put in relation to incremental outcomes, such as death rates or infection rates, but any other measure of treatment effectiveness can be used. The obvious problem is that the validity of the data strongly affects the outcome of such analyses. Some publications suggest only 3% to 6% of orthopaedic studies are randomized, controlled trials [1, 19, 25]. That typically leaves us with studies having a greater potential for inherent biases and which introduce a considerable level of uncertainty concerning the plausibility of their outcomes; this uncertainty, in turn, will affect the economic analyses for which these outcomes are used. However, the advantages of CEA should not be underestimated. First, any form of output can be used for analyses, which is especially helpful when such outcomes cannot be translated readily into benefits (US dollars) or utility (quality-adjusted life years [QALYs] [11, 22]). Second, CEA is a useful tool for preliminary analyses and to establish a baseline before proceeding to more complicated methods.

Cost-utility Analysis (CUA)

A CUA can be seen as an extension of a cost-effectiveness analysis (in its early days it was referred to as generalized CEA) [24]. The main difference, and advantage of a CUA, is the use of composite summary outcomes, usually QALYs. Thus a CUA is used when a decision-maker operating with a fixed budget is choosing from a limited range of treatment options from different fields and/or with numerous outcomes. Utility traditionally is determined in standardized gambles where patients are offered two options at varying likelihoods of arrival until they do not have a preference. At this point the utility is the chance of

the options, thus within the range of 0 to 1 (or 0% to 100%). Another method specifically developed for health care is time trade-off, which is basically a gamble between time t spent in disease state x versus time $z < t$ spent in health [23, 24]. Alternatively, quality of life can be measured using validated scores. Either measure is multiplied by life years to obtain QALYs. An alternative measure is disability-adjusted-life-years (DALY), which put stronger weights on age groups in the middle, whereas with QALYs, value is reduced with age.

Cost-benefit Analysis (CBA)

A CBA compares monetary costs (eg, dollars) with monetary benefits (eg, dollars or other monetary unit) to create a net social benefit (NSB) [12]. As it provides a money-for-money result, it can be used to assess treatments without an external standard or reference treatment, by asking whether its benefits exceed its costs (positive NSB). This is the major difference from CEA and CUA, which compare current treatments with competing new ones. The problem with a CBA is how to assign monetary values to health outcomes [30]. This is done by willingness to pay, revealed preference, or human capital. Human capital involves estimation of a patient's future earnings, with the obvious problems of predictability, income inequalities, and value of health not expressed in wages. Willingness to pay is simply a person's willingness to pay for a given reduction in risk. O'Brien and Gafni provided an overview of willingness to pay studies in the literature [18]. Among the most promising and fast growing study types to estimate health outcome value are contingent valuation studies that estimate value by posing a set of contingencies [20]. However, their main problem is that such valuation depends on the nature and presentation of these contingencies [29]. Despite the inherent problems of trying to attach economic value to health, CBA is a very powerful tool.

Current Status of Economic Analyses of Orthopaedic Treatments

Searching for the three different kinds of economic analyses and orthopaedics as key words in PubMed as of June 2010 produced 1498 studies, with $\frac{2}{3}$ published during the last 10 years. Brauer et al. summarized the trends in orthopaedic CEAs, which showed shortcomings in study selection, methodologic approaches, and lack of transparency, leading to considerable variation in the calculated cost-effectiveness ratios [4]. Another study reported similar findings, with the majority of studies lacking a clear description of its perspective, 40% not clearly describing

what was compared and 24% not fully disclosing their source of utilities [3]. Interestingly, in orthopaedic CUAs, industry-sponsored studies were not more likely to produce positive results, in contrast to other fields of medicine. Also, 73% of orthopaedic studies disclosed funding, as opposed to 64% in general medicine [3, 4, 17].

Myths and Misconceptions

A common misconception regarding economic analysis is that it is a cold, mechanical accounting exercise that cares more for the least expensive treatment than the patient's benefit. The fact is that economic analyses always compare different treatment options and suggest the use of the one that produces the most good per additional expense. The principles of scarcity and opportunity cost show that money spent on one patient will not be available for the treatment of the next one. Another common misconception is that costs and treatment outcomes must be estimated with certainty. This rarely is possible but not problematic as uncertainty can be accounted for by sensitivity analyses, where initial estimates of costs or outcomes are made from the best available data, then one or more variables are changed at a time and the resulting variation in the outcome is observed [27]. Beyond testing robustness, sensitivity analyses also can be performed to determine which of numerous variables are more or most influential. Sensitivity analyses also can be used to identify break-even points, ie, the point where the cost-benefit of two different treatments is equivalent.

Conclusions

Economic evaluations aim to put all extra expense where it does the most good. Various methods exist, based on what outcome measure is available and what question needs to be answered, but most doctors do not know how to use the methods and most do not know how to interpret them. Economic analyses are only one of many tools that should be used in decision making. Others include clinical impact assessment, need and equity assessment and regulatory constraints that have to be united using clinical pathways, and resource planning, process planning, and control in hospitals and clinics. In the future, systematic collection of cost information for the clinical pathway of a patient could provide powerful information allowing better assessment of true cost and subsequently lead to more equitable and effective allocation of resources. A stronger collaboration between physicians, hospitals, and industries will lead to identification of more cost-effective solutions for patient treatment.

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