Chapter 21. Benefit-Cost Analysis of a Cleft Lip and Palate Surgical Subspecialty Hospital in India

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Outline

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Introduction

Since surgery was first included in the second edition of *Disease Control Priorities (DCP2)*, research examining the cost-effectiveness of surgical interventions in low-and-middle-income countries (LMICs) has expanded substantially (see chapter 18). A growing body of evidence suggests that surgical platforms can be cost-effective in these countries according to the criteria established by the World Health Organization (WHO) (Grimes and others 2013).

In parallel with the growing body of evidence that surgical platforms can be cost-effective in LMICs, a nascent field of study within global health economics has attempted to expand the use of benefit-cost analysis (BCA) to global health interventions in LMICs. In contrast with cost-effectiveness analysis (CEA), BCA attempts to estimate the economic benefit of an intervention in monetary terms. The nature of BCA allows researchers to investigate the potential economic return of an investment in global health; it also allows Ministries of Health and Finance to make meaningful comparisons of health care projects to investments in other governmental sectors, such as education and transportation, which are routinely valued with BCA. The use of BCA in global health has recently become more visible; for example, Dean Jamison and others prominently featured BCA in their challenge papers for the 2008 and 2012 Copenhagen Consensus (Jamison, Jha, and Bloom 2008; Jamison and others 2012).

Within the surgical cost-effectiveness literature, cleft lip and palate (CLP) has been the subject of at least three cost-effectiveness studies in LMICs; all suggest that CLP can be repaired in LMICs in a cost-effective manner (Corlew 2010; Magee, Vander Burg, and Hatcher 2010; Poenaru 2013). A more thorough review of CLP can be found in chapter 8 of this volume. This chapter presents an approach for performing BCA using CLP repair as a model surgical intervention in a subspecialty hospital dedicated to CLP in India.

Benefit-Cost Analysis and Global Health

The use of BCA to assess global health interventions builds on an economic concept of *full income*, which reframes how a country's economic performance is measured (Becker and others 2003) This approach assumes that gross domestic product (GDP) per capita does not completely capture a country's economic welfare. In addition to the value of goods and services provided over a year, the full income of a country accounts for changes in life expectancy by valuing additional years of life in monetary terms (Becker and others 2003). Changes in life expectancy are valued using the value of a statistical life (VSL) concept, which attempts to measure individuals' *willingness to pay* (WTP) for small risk reductions in mortality, and then from that it extrapolates what society would be willing to pay to prevent one statistical death; this latter number is termed the *value of a statistical life* (Hammitt 2007). As an example, we can assume that one would be willing to pay US$7 to decrease the risk of mortality by one in a million; this individual's VSL can be understood to be US$7,000,000.

Broadly, economists rely on two different methods to measure VSL: revealed preference studies and stated preference studies. Revealed preference studies use behavioral data, such as wage differentials of professions with different mortality risk profiles to estimate what additional income workers are willing to accept for increased mortality risk; stated preference studies use surveys to ask what one is willing to pay for small mortality or morbidity risk reductions. It is striking that among the various approaches to estimating VSL, studies in the United States—where the majority of VSL estimates in the literature have taken place—consistently find VSLs within the same order of magnitude (Viscusi and Aldy 2003). Nomenclature has unfortunately plagued VSL studies, as critics tend to argue that, especially when used in LMICs, the notion of differing *values* of life is unethical and morally suspect. The key to resolving this

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dilemma is to emphasize that VSL does not claim that the value of one's life is equivalent to his or her VSL. VSL studies do, however, suggest that individuals may value *reductions in mortality risk* differently based on age, income, and other demographic variables (Aldy and Viscusi 2008).

Returning to the concept of full income, Jamison and others argue that when economic performance is measured in full income terms, a more complete assessment of economic welfare is obtained. Looking to the AIDS epidemic in Sub-Saharan Africa in the 1990s, the Commission on Macroeconomics and Health noted that while GPD per capita remained relatively constant during this period, full income fell and is likely to more closely approximate the economic performance of these countries during this devastating era (WHO 2001). A more complete discussion of full income revealing a different economic picture than GDP per capita can be found in the Copenhagen Consensus (CC) challenge paper and the Lancet Commission on Investment in Health (Jamison and others 2012; Jamison and others 2013).

If full income can provide a more complete picture of economic performance, then valuing changes in morbidity and mortality in terms of economic welfare is a valuable exercise in itself. The analysis becomes more powerful, however, if we pair potential economic benefits to economic cost. BCA has long been used by the World Bank to assess development projects (World Bank 2010) and is commonplace in governmental assessments of transportation or environmental projects (Robinson 2007). Applying BCA specifically to global health interventions can allow analysts to demonstrate potential economic return on investment to governments, nongovernmental organizations (NGOs), or donors; it can also allow stakeholders to compare healthcare projects to projects in other sectors, such as transportation or education. With these concepts in mind, Jamison and others performed a BCA for scaling up a number of interventions in LMICs and found benefit-cost (BC) ratios that ranged from 10:1 for essential surgical services to 35:1 for treatment of malaria (Jamison and others 2012).

The BCA in this chapter builds on the CC analysis, but it differs in a number of important ways. As in the CC, we also value disability-adjusted life years (DALYs) averted using the value of a statistical life methodology. This process involves converting the VSL into its annualized equivalent, the value of a statistical-life year (VSLY). The economic benefit of an intervention, then, is as follows:

$$\text{Economic Benefit} = \text{DALYs Averted} \cdot \text{VSLY}$$

An important distinction between our analysis and the CC is that we are performing ex post analysis of interventions, whereas the goal of the CC was to project benefit-cost ratios for interventions ex ante in a broad range of LMICs. The end result is that, for equity purposes, the CC chose to value the VSLY equally across LMICs (at US$1,000 to US$5,000). The approach used in this chapter is necessarily different as we are evaluating an intervention that has already occurred; although formal VSL studies have not been performed in most LMICs, the seminal review on VSL concludes that it strongly correlates with income (Viscusi and Aldy 2003). To be useful to the governments and NGOs in which these interventions have occurred, our estimates of VSLY are specific to the country assessed, in this case, India. We adjust the VSLY for age, as economic data suggests that it peaks at roughly two-thirds of life expectancy (Aldy and Viscusi 2008). To maintain consistency, our procedure for adjusting VSLY for age uses age weights from the DALY literature.

Cleft Lip and Palate Overview

The incidence of CLP varies by ethnicity and geography; current estimates range from one in every 300 live births to one in every 1,500 live births, placing CLP among the most common congenital anomalies (Canfield and others 2006; Poenaru 2013; Vanderas 1987)

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Although the pathogenesis of CLP is complex and the subject of ongoing study, current data suggest a complex interplay of environment and genetics (Flint and Cummings 2010). Untreated CLP results in a number of potentially life-altering sequelae, including feeding difficulties, social stigmatization, and speech and hearing developmental delays (Corlew 2010). The primary treatment modality is surgery within a broader multidisciplinary approach that includes speech therapy, dental care, possible revision surgery, orthodontics, and nutrition counseling. Given that surgery can avoid the majority of the burden of disability, CLP has lent itself well to concentrated efforts such as mission trips and surgical specialty hospitals and is the focus of multiple prominent NGOs (Hughes and others 2012).

CLP has been included in estimates of the global burden of disease (GBD) since its inception. While earlier GBD studies only considered CLP's contribution to morbidity, the most current iteration assumes a mortality risk associated with GBD, with an estimated 3,700 deaths in 2010. The most current GBD data for CLP, including total DALYs and deaths by GBD super-region, are shown in table 21.1. It is important to note that the GBD of CLP is heavily skewed to LMICs. For example, although South Asia and Sub-Saharan Africa make up roughly 35 percent of the global population in 2010, 50 percent of total CLP DALYs and close to 60 percent of CLP mortality occurred in these two regions (Institute for Health Metrics and Evaluation 2013; World Bank 2013). Of particular relevance to LMICs is the surgical backlog of CLP cases, defined as the total number of patients eligible for CLP repair but who have not received it. Poenaru places the global estimate of the CLP surgical backlog between 420,000 and 2,100,000 cases, with the majority of the backlog in Southeast Asia and Sub-Saharan Africa (Poenaru 2013). Clearly, the developing world continues to have a substantial unmet need for CLP repair.

Table 21.1 Disability-Adjusted Life Years and Death Secondary to Cleft Lip and Palate in 2010, by Global Burden Of Disease Region

Global Burden of Disease Region	DALYs	Deaths
Central Europe, Eastern Europe, and Central Asia	23,507	115
High-income countries	17,060	29
Latin America and the Caribbean	34,716	170
North Africa and Middle East	37,097	114
South Asia	192,950	1,470
Southeast Asia, East Asia, and Oceania	174,705	1,061
Sub-Saharan Africa	91,073	724
Total	**571,108**	**3,683**

(Institute for Health Metrics and Evaluation 2013)

A number of studies have examined the cost-effectiveness of CLP repair in LMICs. Magee estimated the cost per DALY for nine one-week mission trips to LMICs, which included Kenya and Vietnam, to range from US$7 to US$96 per non-discounted, non-age-weighted DALY averted (Magee, Vander Burg, and Hatcher 2010). Poenaru examined the cost-effectiveness of the extensive Smile Train network; using the organization's reimbursement to hospitals as a proxy for cost, he estimated a cost per DALY (3,1) averted of US$134 (Poenaru 2013). Finally, Corlew found a cost per discounted, age-weighted DALY of US$70 at a Nepalese hospital staffed primarily by local physicians and (Corlew 2010). Although each study used a different methodology to estimate cost and DALYs were not calculated under uniform assumptions (namely, discounting and age-weighting), these estimates fall well within the WHO guidelines for what can be considered a cost-effective intervention (WHO 2002).

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Finally, CLP has been the subject of at least two studies that have attempted to capture the potential economic benefit of surgical repair. Both Corlew and Alkire and others valued DALYs averted with a VSLY approach (Alkire and others 2011; Corlew 2010). Each study also valued DALYs using the *human capital* approach, which assumes that people are analogous to machines and that lost years of life are equivalent to lost years of productivity. With this method, gross national income (GNI) per capita is used as a proxy for productivity, and DALYs are valued at a country's GNI per capita. Corlew valued the DALYs averted in treated patients in Nepal and found that with a human capital approach, cleft lip and cleft palate repair resulted in an economic benefit per patient of US$2,500 and US$7,000, respectively. Using a VSLY approach, the value of cleft lip and cleft palate repair was US$57,000 and US$150,000, respectively (Corlew 2010). Alkire and others asked what the potential economic benefit to Sub-Saharan Africa would be if all new cases of CLP in one year were surgically repaired. With the human capital approach, the potential ranged from US$252 million to US$441 million; with VSL, the potential economic benefit of the same CLP repair ranged from US$5.4 billion to US$9.7 billion (Alkire and others 2011). While these figures are significant, it is difficult to draw meaningful conclusions without the context of cost.

Benefit-Cost Analysis of Cleft Repair

The basic approach for modeling the economic impact of an intervention is discussed in depth by Corlew, and the model for valuing DALYs used in this chapter is discussed in more detail in the appendix by Alkire and others, available free of charge on the Public Library of Science Website (Alkire and others 2012; Corlew 2013). As BCA attempts to measure economic costs and benefits, it is necessary to make adjustments to the financial cost of caring for patients that was provided by Operation Smile. This final cost includes accounting for the opportunity cost to patient families. To derive economic benefit, we did not use a human capital approach; VSL is the approach favored by economists because it is more firmly rooted in actual human behavior and more accurately approximates the value associated with health risk reduction (Belli and others 2001)

Operation Smile is a not-for-profit NGO that focuses on CLP in LMICs; from its inception in 1982 through 2010, it has cared for over 120,000 children (Magee, Vander Burg, and Hatcher 2010). Although the delivery platform of Operation Smile has historically been short-term international missions, recent efforts have focused on establishing subspecialty hospitals within LMICs. The Operation Smile Guwahati Comprehensive Cleft Care Center (GCCCC) was founded in 2011 with the goal of providing sustainable, high-quality subspecialized surgical care to the Indian state of Assam. The organization is funded by a combination of government, private business, and NGO resources. In addition to providing primary surgical CLP repair by a full-time staff that is made up of greater than 90 percent local medical professionals, additional services such as dentistry, otolaryngology, speech pathology, and nutrition are offered to patients (Campbell 2013). These services are typically offered at cleft centers in high-income countries, but are often missing from cleft care delivered in LMICs, especially when the mission model is employed.

Using cost and patient data supplied by Operation Smile and a model that converts DALYs averted to economic benefit, we estimate the cost and benefit of delivering cleft care in a surgical specialty hospital in Guwahati, India, for one year.

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Methods

The cost data for surgical care at GCCCC for fiscal year 2012 (April 2012 to May 2013) submitted by Operation Smile included the following:

- Operating overhead
- Depreciation of hospital building and equipment
- Training
- Staff expenses: salary, travel, and food
- Patient food and travel
- Medicine
- Laboratory testing.

To maintain consistency and facilitate comparison with economic benefits, we converted cost to U.S. dollar estimates using the purchasing power parity (PPP) conversion factor for India in 2012 (World Bank 2013). The PPP method compares the relative price levels of a fixed basket of goods between countries to establish a currency conversion rate such that the price of the basket of goods is the same in both countries when stated in the reference currency. Market driven exchange rates are dependent upon the supply and demand of a currency and reflect the price of money. The PPP approach results in a better, and typically more stable, cross-country comparator of the cost of goods. It is worth noting that this approach results in cost estimates that are roughly twice those if market exchange rates were used. In addition to the cost of the center, we attempted to account for opportunity cost to the families of patients, using GNI per capita to value days lost secondary to preoperative, perioperative, and postoperative care. Finally, a cost per patient was obtained by dividing the total cost by the total surgical cases for FY2012; to obtain the cost of primary CLP repair, this cost per patient was multiplied by total primary CLP repairs.

Calculating DALYs

A number of disability weights are available for accounting for CLP morbidity. The original global burden of disease study provides disability weights for treated and untreated CLP (Murray and Lopez 1996), which implies residual morbidity and is most consistent with the reality of CLP; surgery can address a substantial portion of morbidity, but ongoing challenges remain with middle ear disease, speech, and other morbidities. As there are no disability weights for combined CLP, for patients who underwent repair of both we assigned a disability weight for repaired cleft palate only. DALYs averted for a surgical intervention rely on estimates of (a) the likelihood of disability or mortality without surgery (0.0-1.0) and (b) the likelihood of disability mortality to be averted by surgery (0.0-1.0) (Gosselin, Maldonado, and Elder 2010).

For the purposes of this analysis, we assume that CLP both carry a value of 1.0 for likelihood of disability without surgery, and that cleft lip has a value of 0.9 for disability to be averted by surgery. For cleft palate, we assumed the likelihood of disability to be averted by surgery to be 0.7. This is consistent with the approach taken by Poenaru (Poenaru 2013). Our study attempts to estimate the number of DALYs averted secondary to surgical intervention for primary cleft lip and palate. Although the newest iteration of the GBD does consider mortality secondary to CLP (Vos and others 2012), we chose not to consider reduction in mortality. Further, we did not include DALYs averted from revision cleft surgery.

DALYs averted (CLP repair) = YLD averted (Primary CLP repair)

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Discounting and Age-Weighting

The inclusion of discounting and age-weighting results in a complex DALY formula (Murray and Acharya 1997):

$$\text{DALYs} = \int_a^L \{[K * DW * Cxe^{-\beta x} e^{-r(x-a)}] + [DW * (1-K)e^{-r(x-a)}]\}dx \qquad (1)$$

where a = age of onset of disease, L = country-specific life-expectancy if calculating YLLs or the age at onset of a disease plus the duration of disease if calculating YLDs, K = age-weighting modulation constant (0 = no age weights, 1 = full age weights), DW = disability weight (1 for death), C = age-weighting correction constant, x = age integrated over the duration of disease (YLDs) or years of life lost (YLLs), r = discount rate (3 percent in this study), and β = age-weighting constant (Lopez and others 2006). To specify which flavor of DALYs are being considered, we rely on the notation DALYs[r, K, β]. To facilitate comparison with prior studies with regard to cost-utility analysis, we estimated DALYs averted with no age-weighting or discounting (DALYs [0,0,0]) and DALYs averted with standard GBD age-weighting and discounting (DALYs [3, 1, 0.04]).

For the special case of calculating DALYs, to be valued using a VSLY approach, the formula is as follows:

$$\text{DALYs}[3,1,\tilde{\beta}] = \int_a^L \{[DW * \tilde{C}xe^{-\tilde{\beta}x} e^{-r(x-a)}]\}dx \qquad (2)$$

Compared to equation (1), the integral includes just one term because K =1 (age-weighting is turned on, because VSLY varies with age (Aldy and Viscusi 2008), which causes the second term to equal zero. The other key differences are the presence of $\tilde{\beta}$ and $\tilde{C}$, where the tilde indicates that country-specific age-weighting parameters and correction constants were used. Evidence indicates that VSLY peaks at about two-thirds of life expectancy (Aldy and Viscusi 2008), so we modified the age-weighting factor in the DALY formula such that it peaks at two-thirds the life expectancy (LE). Therefore, DALYs [3,1, $\tilde{\beta}$] are discounted at 3 percent and are age-weighted such that the maximum weight occurs at two-thirds of LE. Since (1/β) = age at which the age-weighting factor peaks, to calculate a country-specific β, we used the following expression to determine $\tilde{\beta}$:

$$\tilde{\beta} = 1 / [(2/3) \cdot LE]$$

The value of C is also country-specific, as it varies with β according to table 5.2 in the GBD (Lopez and others 2006). We fit a cubic polynomial to the values in that table and used it to predict $\tilde{C}$ for a given value of $\tilde{\beta}$.

Converting DALYs Averted to Economic Benefit

To value DALYs using the VSLY approach, we first estimated the VSL using the following formula (Viscusi and Aldy 2003):

$$\text{VSL (Unknown)} = \text{VSL (U.S.)} \cdot \left[\frac{\text{GNI p.c. (Unknown)}}{\text{GNI p.c. (U.S.)}}\right]^{\text{IE-VSL}}$$

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where VSL (Unknown) = value of a statistical life in a country where VSL studies have not been performed, VSL (USA) = value of a statistical life in the United States (US$7.4 million in 2006 dollars, updated to reference year) (Environmental Protection Agency 2013), GNI p.c. (Unknown) = GNI per capita in the desired study year, GNI p.c. (U.S.) = GNI per capita in United States in the desired study year, and IE-VSL = the income elasticity of VSL. The key variable in this transfer method is the "income elasticity of VSL" (IE-VSL), which determines the degree to which VSL estimates rely on the proportion of relative income of the two considered countries. As IE-VSL increases, the estimated VSL in the lower-income country decreases. Although values of 0.55-1.0 are most often used in transferring estimates of VSL, recent evidence suggests that higher values are more appropriate for transfers to low-income countries (Hammitt and Robinson 2011).

We used GNI/capita estimates based on the purchasing power parity (PPP) method (Viscusi and Aldy 2003), and an IE-VSL of 0.5, 1.0, and 1.5. It is important to note that that formal estimates of VSL have been performed in India (Shanmugam 1996) with a minimum VSL estimate of $1.2 million in 2000 U.S. dollars (Viscusi and Aldy 2003), and other studies have found similar values (Madheswaran 2007). When this value is updated to 2012 using the GDP deflator index, the estimate is roughly equivalent to setting IE-VSL = 0.5. Therefore, our upper estimates of VSL are compatible with the available literature.

To calculate the potential economic benefit of an intervention that averts a given number of DALYs [3,1, $\tilde{\beta}$], we multiplied DALYs [3,1, $\tilde{\beta}$] by the value of a statistical life-year. $VSLY_x$, the value of a statistical life-year at age x, is given by the following:

$$VSLY_x = V \cdot \tilde{C} x e^{-\tilde{\beta} x}$$

where V= age-neutral (constant) value of a statistical life-year (literally, a parameter that converts a single DALY unweighted for age to a monetary value), and $\tilde{C} x e^{-\tilde{\beta} x}$ is the age-weighting factor found in the original DALY formula modified to peak at 2/3 of life expectancy. We discuss the calculation of V in the following section. Using the DALY age-weighting factor creates internal consistency with the age-weighting of DALYs and the VSLY.

The formula for estimating the economic benefit of an intervention to the individual receiving it can therefore be written as:

$$\text{Economic Benefit} = \int_a^L \{[DW \cdot VSLY_x \cdot e^{-r(x-a)}]\}dx$$

Substituting the equation for $VSLY_x$ into this results in the following:

$$\text{Economic Benefit} = \int_a^L \{[DW \cdot V \cdot \tilde{C} x e^{-\tilde{\beta} x} \cdot e^{-r(x-a)}]\}dx$$

If the constant V is moved out of the integral, the formula can be rewritten as follows:

$$\text{Economic Benefit} = V \int_a^L \{[DW \cdot \tilde{C} x e^{-\tilde{\beta} x} \cdot e^{-r(x-a)}]\}dx$$

which by equation (2) reduces to:

$$\text{Economic Benefit} = V \cdot DALYs(3,1,\tilde{\beta})$$

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The DALY formula already contains the age-weighting factor ($\tilde{C}\, xe^{-\tilde{\beta} x}$), and so we need only multiply DALYs (3,1, $\tilde{\beta}$) by V, not $VSLY_x$, which would result in double age-weighting. Assuming one has already calculated DALYs (3,1, $\tilde{\beta}$), the only variable left to define is V, the age-neutral value of a statistical life-year. To solve for V, set DW = 1 and a = 0, which indicates that the disability is equivalent to death at birth. By definition, the economic benefit in this case is the VSL, and L = life expectancy (LE). Therefore, V is defined by the following expression:

$$VSL = \int_0^{LE} V \cdot \tilde{C} x e^{-\tilde{\beta} x} e^{-r(x-a)} dx$$

We move the constants outside of the integral:

$$VSL = V \cdot \tilde{C} \int_0^{LE} x e^{-\tilde{\beta} x} e^{-r(x-a)} dx$$

We solve for V and integrate:

$$V = \frac{VSL}{\tilde{C}} \cdot \frac{\left(\tilde{\beta} + r\right)^2}{1 - e^{-\left(\tilde{\beta} + r\right)LE}\left[1 + LE\left(\tilde{\beta} + r\right)\right]}$$

As described, multiplying V by DALYs (3,1, $\tilde{\beta}$) yields the economic value of averting these DALYs.

Results

During FY2012, the GCCCC treated 1,498 patients with primary surgical repair for cleft lip, cleft palate, or cleft lip and palate, which resulted in an estimated 9600 DALYs [0,0,0] averted. The present value of the total economic benefit is sensitive to the assumed income-elasticity of demand; using the most conservative (lower bound of VSL) parameters, it was US$32 million (2012 US$). Assuming a total economic cost of US$2.7 million, this resulted in a cost per DALY [0,0,0] averted of US$285 and a benefit-cost ratio (BCR) of 12, using the most conservative estimates of economic benefit. Estimates using a range of DALY and IE-VSL assumptions are presented in table 21.2.

Table 21.2 The Economic Cost, Benefit, and DALYs averted of the Guwahati Comprehensive Cleft Care Center for fiscal year 2012 (2012 US$)

Guwahati Comprehensive Cleft Care Center	Outcome
Total Cost[a]	$2, 745,000
DALYs Averted[b]	
DALYs [0,0,0]	9,600
DALYs [3,1,0.04]	5,400
Cost per DALY Averted	
DALYs [0,0,0]	$285
DALYs [3,1,0.04]	$508
Estimated Economic Benefit[c,d]	
IE-VSL = 1.5	$32,000,000

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IE-VSL = 1.0	$116,000,000
IE-VSL = 0.5	$422,000,000
Benefit-Cost Ratio[d]	
IE-VSL = 1.5	12
IE-VSL = 1.0	42
IE-VSL = 0.5	154
[Q: Source:?]	

a: Cost includes fixed and variable costs, along with opportunity cost to the families of patients. Includes only primary cleft lip and palate repair.
b: Non-age weighted, non-discounted DALYs are represented with the notation DALY [0,0,0], while discounted, age-weighted DALYS are represented with the notation DALYs [3,1,0.04]
c: IE-VSL = income elasticity of value of a statistical life; VSL estimates vary significantly with different assumptions re: IE-VSL
d: Estimates of economic benefit and consequently benefit-cost ratio rely on valuing DALYs in monetary terms. A special form of the DALY was devised to account for the fact that the VSL varies with age.

Discussion and Recommendations

This chapter derives a BCR for CLP repair in a subspecialty surgical hospital in Guwahati India and finds a BCR of 12 to 42, using the more conservative estimates of economic benefit. These findings suggest that investment in CLP repair is a good economic proposition with a net positive return on investment. Our cost per DALY averted depends on assumptions regarding age-weighting and discounting and ranges from US$285 to US$508. While these estimates fall well within the range of being considered "highly cost-effective" by WHO guidelines (WHO 2002),they are greater than prior estimates of CLP repair in the literature discussed. The initial investment in infrastructure and equipment required at GCCCC, the broad range of services offered to CLP patients when compared to short-term international missions, and inclusion of opportunity cost of lost productivity likely explain the observed difference in cost per DALY averted estimates.

A Model for Delivery of Surgical Care

The GCCCC demonstrates a number of important principles. As opposed to many short-term missions, GCCCC provides additional services to cleft patients, including otolaryngology, speech therapy, dentistry, and nutrition counseling. Further, the vast majority of medical care staff is made up of local providers; in addition to the ongoing training provided onsite, this fact underscores the sustainability of the center. The unique public-private partnership established among NGOs, private business, and the local government—the major funder of GCCCC—has been essential to developing and sustaining this model (Campbell 2013). In sum, GCCCC demonstrates that high-quality, sustainable, locally supported surgical care can be provided to an underserved population in an LMIC such as India. It further indicates that this care can be provided in a highly cost-effective and economically favorable fashion.

Advantages of BCA

An additional benefit of BCA is that it facilitates comparison with investment in other sectors of government or development projects. For the 2012 CC, BCRs were calculated for a number of development projects, including investments in global health, education, and agriculture. Our BCR of 12 to 42 is similar to the BCR of 10 for essential surgical services as estimated by Jamison (Jamison and others 2012). BCRs were also estimated for reducing the prevalence of stunting through a package of

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interventions aimed at malnutrition in India and ranged between 44 and 138.6 (Hoddinott, Rosegrant, and Torero 2012); the BCRs for retrofitting schools in India to better withstand earthquakes ranged from 0.04 – 5.6 (Kunreuther and Michel-Kerjan 2012). While it is admittedly difficult to directly compare a project that is aimed at one disease process, such as cleft repair, to projects that have broader goals, such as investing in nutrition, we present these data only as an example of how BCA can be used to compare investment across health sectors. A BCA for essential surgical services in LMICs, however, would lend itself well to these broader comparisons

While the technical aspects of BCA are appealing, the economic valuations of benefits also allow for a more intuitive discussion with stakeholders that are less academically oriented. For example, the cost per DALY averted of an intervention carries meaning to global health academicians and is necessary for cost effectiveness analysis, but donors and other stakeholders are not always well-versed in the theory of DALYs. The ability to say that an intervention will return $X for every $1 dollar spent has meaning to all potential audiences, especially those that are making decisions about allocation of funds.

The Bellagio Essential Surgery Group, which is comprised of physicians, economists and policy-makers that wish to improve access to surgical care in SSA, made a number of recommendations regarding essential research questions, which included estimating the burden of surgical disease at the country level, assessing the ability access to surgical care in terms of surgical capacity and patient financial resources, and addressing the quality and effectiveness of surgery at the district hospital level (Luboga and others 2009). In addition to these necessary efforts, estimates of the economic cost and benefit of surgical intervention are essential to developing the evidence base. Kruk and others estimated current surgical expenditure at the district hospital level in three Sub-Saharan hospitals and found that only 7percent to 14 percent of the total operating cost was allocated to surgery; in addition, they found that the majority of surgical care was delivered by midlevel providers (Kruk and others 2010). Quantifying current levels of expenditure on surgical care allows policy makers to make crucial funding decisions; as the burden of surgical disease is further delineated, these types of data will prove essential as decisions are made about how to scale up surgical care delivery. By also exploring estimates of economic benefit in addition to cost, policy makers can better understand both current and potential returns on investment in global surgery.

Study Limitations

BCA as performed in this chapter has a number of limitations. We have also assumed that the counterfactual in our scenario is the absence of CLP services. This may be an oversimplification of the issue and would almost certainly drive our BC ratios downward if patients receiving CLP care at GCCCC could have received comprehensive cleft care elsewhere; however, with the estimated surgical backlog of CLP in India ranging from 233,000 to 544,000 cases (Poenaru 2013), it is not an unreasonable assumption to make.

The current analysis focuses on an admittedly narrow subspecialty of surgical care, and estimating the benefits and cost of increasing surgical capacity in LMICs would undoubtedly be a useful contribution to the global surgical evidence base. We recognize that there is uncertainty when deriving economic benefit with a VSL methodology, but we have in fact utilized the most conservative estimate of VSL. At the recommendation of Hammitt and Robinson, we use an IE-VSL of 1.5 to transfer estimates of VSL from the United States to LMICs such as India (Hammitt and Robinson 2011). If the more commonly used IE-VSL value of 1.0 were used, then our estimates of benefit would increase dramatically. As noted, the few formal VSL studies carried out in India are consistent with an IE-VSL of 0.5, which would result in even greater estimates of economic benefit as outlined in table 21.2.

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Finally, the DALY age-weighting formula, while adjusted in this study to be more consistent with the VSL literature, results in implied VSL curves that peak too early. Consequently, the VSL of children may be an overestimate in this study, depending on one's assumptions. The VSL of children is the subject of research; however the available evidence suggests that the VSL is at least that of an adult, if not higher (Hammitt and Haninger 2010; Roman and others 2012).

Conclusions

In summary, we find that investment in a surgical subspecialty center dedicated to CLP repair can be a good economic proposition, and that it is possible to deliver high-quality, sustainable surgical care to underserved populations in a LMIC. More broadly, we emphasize that BCA serves as a useful tool for evaluating the potential economic return on investments in global health, allows for the evaluation and discussion of projects both within and outside of global health academia, and facilitates comparisons of investment in health with projects in other governmental sectors. For these reasons, BCA should be applied more broadly in global health analysis, and this chapter demonstrates one manner in which this could be accomplished.

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