

Original article

The cost effectiveness of reconstructive surgery in Cambodia

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Background: Surgical care is often regarded as too expensive and complex for people in poor countries and so has long been neglected.

Objective: We demonstrated that the cost per disability-adjusted life year (DALY) saved of reconstructive surgery in Cambodia is competitive with many basic public health interventions.

Methods: The Children's Surgical Centre (CSC) in Phnom Penh provides orthopedic, plastic, ophthalmological, and general reconstructive surgical services free to disabled people in Cambodia. Following standard guidelines for calculating operation costs and assigning disability weights we calculated the cost effectiveness of surgical treatment for 343 patients treated at CSC in January and March, 2012.

Results: Our data for these two months yielded 1785 DALYs averted and operating costs totaling \$164,543; resulting in \$99 per DALY averted.

Conclusion: Reconstructive surgery is cost effective compared to other basic public health interventions and should not be neglected when designing integrated health care services in a developing country.

Keywords: Disability-adjusted life year (DALY), Cambodia, reconstructive surgery

Surgery has finally begun to gain recognition for being a cost-effective health intervention, comparing favorably to, for example, vaccines and provision of antiretroviral drugs, and should be an essential aspect of primary health care services in all developing countries [19, 23].

Cost effectiveness analyses from around the world, for a range of different types of surgery, are beginning to appear in the literature [7, 9, 11-15, 23], but it is recognized that more are needed, in particular, because the situation in every country is unique. The discussion has moved on to implementation of different models of how to provide surgical services, training and delivery effectively in the developing country setting [21].

The Children's Surgical Centre (CSC), Phnom Penh, is a donor funded non-governmental organization (NGO) hospital and offers free assessment and treatment to all patients. CSC provides rehabilitation surgery for disabled poor people, including orthopedics, plastics, eye surgery, clubfoot, cleft palate, acid burns, and obstetric fistulae. With a catchment area covering

the entire country the vast majority of patients come from rural parts of Cambodia, traveling an average of three hours with some traveling overnight and as far as 400 km.

Established and run by a British, American trained orthopedic surgeon, CSC's Cambodian team (ten surgeons including rotating Cambodian interns, eight anesthesiologists, and thirty nurses) performs approximately 12,000 consultations and 3,500 to 4,000 surgeries each year in a fifty bed hospital [24]. Teams of health professionals visit regularly from Europe, Asia, Australia, and the North America enabling complex procedures to be carried out and facilitating the sharing of subspecialty knowledge and skills with Cambodian colleagues. Referrals to CSC come from every province in the country from NGOs, hospitals, and through word of mouth, and media promotion via radio advertising and newspaper articles.

In this article we evaluated the cost effectiveness of the type of surgeries carried out at CSC. We put forward our surgical service as a model for surgical training and delivery that enables high quality care and follow up of patients. We postulate that the CSC delivery model of surgical services and training is a cost effective, sustainable, and scalable option in resource-limited healthcare systems. This model of

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delivery enables high quality benchmarks and continuity of care with results that transform and prolong life.

Methods

Patient information

We analyzed patient records from operations conducted in January and March of 2012 at the CSC, Phnom Penh. Nonconsecutive months were chosen to account for local holidays and patient fluctuations attributable to weather and agriculture. We believe this represents an accurate sample that can be extrapolated to approximate the annual patient population. Patients, diagnosis, age of disability onset, age at time of treatment, and surgical intervention were recorded. The CSC's computerized database enabled us to see follow up of some patients and assess efficacy of treatment more accurately. Before surgeries, the risks and benefits of the procedures were explained to patients with adequate measures to protect the subjects. All patients agreed to undertake the surgeries.

Disability adjusted life year calculation

Disability adjusted life years (DALYs) were first introduced by Jamison et al. at the World Bank in 1993 [4] and later adapted by Murray and Lopez in

the Global Burden of Disease report series [5, 6]. DALYs allow information about patient disease and treatment to be summarized into quantifiable data for cost effective analysis (CEA), aiding in proper allocation of scarce health resources. Because DALYs convert complex information into a single numerical value they have been the subject of much debate over their use in policy making [8]. Issues have been raised about the subjectivity of assigning disability and treatment efficacy values in different resource settings as well as undervaluing the lives of the very young, very old, and the disabled [22]. These are important considerations for policymakers to consider; however, DALYs are a widely used method to compare treatment models. We chose DALYs to evaluate and compare our program with other programs in similar resource poor surgical settings such as Haiti [11, 12], Sub-Saharan Africa [13, 14], and Southeast Asia [15], while adding to the DALY methodology.

Briefly, a DALY is the sum of years of life lost (YLL) from premature death because of disability plus the years of life lived with disability (YLD). The goal of treatment is to decrease both premature death and suffering from disability. In effect, averting DALYs is the goal of medicine (**Figure 1**). In this paper we used the DALY calculation guidelines from Rushby and Hanson [8].

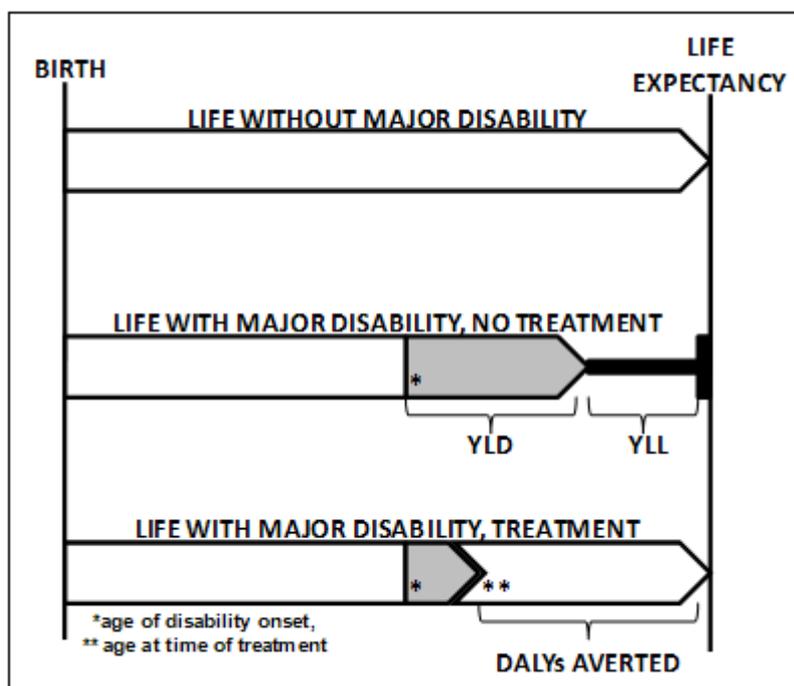


Figure 1. Disability adjust life year (DALY) is the sum of years of life lived with disability (YLD) plus years of list lost (YLL) because of disability. With treatment both suffering from disability and premature death can be ameliorated resulting in DALY's averted.

First, calculation of a patient DALY assumes that a year of life is not linearly valuable. One year of life lost during working age is more valuable than one year of life lost during retirement, so year value is discounted at a rate of 3% per year-effectively, a year of health ten years from now is worth 75% of the value of a year of health today. Second, not all disabilities and diseases are equally debilitating or life threatening. To assign disability weights to each diagnosis, three Cambodian and two British surgeons affiliated with CSC applied the guidelines [7] to the setting of Cambodia. Third, treatment efficacy varies between interventions. Again, using the guidelines, we gave each treatment an efficacy value-in essence, how much of a return to normal can a patient expect to gain following treatment. Efficacy is a composite of surgery success rate, complications, and postoperative expected functioning (**Table 1**). Using this calculation each patient received two DALY values: one without treatment and, using treatment efficacy scores, another with treatment. The differences between these values are DALYs averted, extra years of life lived or extra years of healthy life with absent or diminished disability.

For example, a 22-year-old Cambodian male has a foreign body lodged into his eye-potentially blinding him and leaving him permanently disabled. Our severity value for this disability is 0.4, while the highly effective treatment efficacy is 0.8 following surgery. Using the World Health Organization (WHO) [5, 6] and Rushby and Hanson [8] guidelines DALYs for this patient without treatment are 13.71, with treatment they drop to 2.67 with a savings of 11.04 DALYs averted.

It is important to mention that the standard life expectancy used in this calculation was set to 80 years for two reasons; (1) to make our calculations comparable to other models using the WHO standard of 80 years and (2) Cambodia is less than a generation away from a genocide that saw 25% of its population wiped out; actual life expectancy in Cambodia is in a state of flux and difficult to calculate broadly for all age groups.

Cost calculation

We assumed hospital costs to be uniform throughout the year and have therefore used the annualized budget to calculate costs over two-months.

Table 1. Disability weights and efficacy of treatment

Disability weights	Severity of disability
0.9	Needs assistance with activities of daily living such as eating, personal hygiene, or toilet use
0.8	Needs assistance with instrumental activities of daily living: meal preparation, shopping, or housework
0.6	Limited ability to perform most activities in all of the following: recreation, education, procreation, or occupation
0.4	Limited ability to perform activities in two or more of the following: recreation, education, procreation, or occupation
0.2	Limited ability to perform most activities in one of the following: recreation, education, procreation, or occupation
0.1	Limited ability to perform at least one activity in one of the following: recreation, education, procreation, or occupation
Efficacy of treatment	
1.0	Above 95% chance of permanent cure of this problem
0.8	75–94% chance of permanent cure
0.5	25–74% chance of permanent cure
0.1	5–25% chance of permanent cure
0.0	<5% chance of permanent cure

Total direct and indirect costs of care include NGO administrative costs, hospital staff salaries, medical consumables, building costs (depreciated over 30 years) [15], meals provided for patients and caretakers, and travel costs. We also included large donations of medical devices. Donated consumable medical supplies at CSC are inconsistently procured and not always used when donated. For this reason CSC has never cataloged miscellaneous supplies-for this study their negligible value was omitted in our cost calculation.

Results

In January and March of 2012 Children's Surgical Center performed surgeries on 343 patients; 82 (23.9%) in orthopedics, 207 (60.3%) in ophthalmology, 54 (15.7%) in plastics and reconstructive surgery (**Table 2**). DALYs without treatment for all patients totaled 2,084, DALYs with treatment totaled 438 and DALYs averted through surgical treatment totaled 1,644.

Hospital costs during this two-month period calculated from the annual budget totaled \$163,159 including 55% in medical and administrative staff salaries, 14% in medical consumables, 10% in facility operating costs, 4.2% in medical equipment.

These data gave us a result of \$99 per DALY averted-comparable to a range of \$70 to \$230 per DALY averted from surgical intervention in a typical low to middle income country hospital [10].

Discussion

We believe that our cost per DALY averted estimate is conservative because of constrictions in budget calculations. The CSC incurs additional, though negligible, nonsurgical costs including physiotherapy, speech therapy, and occupational therapy for all patients following surgery. The overall cost of running the facility includes a wide variety of costs not directly related to the operations provided, including an extensive and costly eye-screening program (in 2010 approximately 8,000 patients were given free eye exams), which could not be separated from the budget.

An extremely important factor in the CSC's success, and a point often overlooked in this and other CEA publications, is donated time and training by visiting medical professionals. Donated time can be given a financial value by applying a wage comparable to the local hourly rate (Cambodian physicians earn roughly USD\$ 8.50/hour); but this does not consider lost wages, airfare, hotel, and food costs.

Our assignment of disability weights and efficacy is admittedly subjective in nature. The World Health Organization's disability weight standards [16] were used as a guide. However, the McCord and Chowdhury [7] guidelines used by Gosselin et al. in an earlier Cambodian study [15] allowed us to individualize disabilities based on the unique environment in Cambodia.

Table 2. Common operations at CSC

	N	Disability weight	Treatment efficacy	DALYs averted
Orthopedic				
Fracture reduction	19	0.4	0.8	177.5
Arthroscopy	6	0.1	0.8	5.8
Arthroplasty	5	0.6	0.5	28.6
Club foot	4	0.2	0.8	25.1
Ophthalmology				
Cataract, uni-/bilateral	78	0.6/0.9	0.9	507.2
Pterygium	33	0.1	0.9	98.1
Foreign body removal	20	0.4	0.8	211.3
Corneal wound repair	19	0.1	0.8	26.4
Plastic and Reconstructive Surgery				
Cleft lip/palate repair	17	0.2/0.3	0.9	105.3
Burn contracture release	5	0.4	0.5	35.1
Skin graft	4	0.4	0.5	20.0
Other Surgeries	127	variable	variable	330.8

Additionally, the format of our annual budget and sharing of medical supplies between operating theatres does not allow us to dissect our cost structure by specialty or on a per procedure basis. Other studies have shown notable variation in calculated cost per DALY averted depending on surgical specialty and region. In a 2008 report by Gosselin and Heitto of a hospital in Battambang, Cambodia, that provides almost exclusively surgical trauma services, totaled \$77.40 per DALY averted [15]. More recently Gosselin et al. have shown a cost range from delivery of surgical trauma services at \$172 per DALY averted [11] to \$362 for elective orthopedic services [12], each case in Haiti. Studies conducted in Sub-Saharan Africa tended towards lower costs per DALY averted with Warf et al. showing hydrocephalus treatment costs ranging from \$37 to \$80 in Uganda [13] and \$32.78 per DALY averted for basic surgical services in Sierra Leone [14].

Conclusions

The model evaluated here is cost-effective, and we suggest, sustainable, scalable, and reproducible. First, staffing is almost exclusively by local healthcare professionals. This allows for long-term follow-up and a more comprehensive understanding of the socioeconomic challenges facing patients. The CSC maintains staff salaries at a competitive level to keep retention high. Second, there exist strong relationships with Western hospitals and health professionals to provide continuous and updated training to local staff. This allows staff to expand their ability to provide more complex, challenging and unique medical services to Cambodia. Third, physicians at the CSC have joint appointments at public run hospitals, while some move from the CSC to other professional appointments allowing them to disseminate their skills beyond CSC and affect change nationally. Additionally, the CSC is coupled with a private, for-profit clinic in Phnom Penh. This enables staff career progression outside of the charity realm and enables staff surgeons to supplement

their income so they can continue to work at CSC.

So, in spite of the obvious benefits to expanding surgical services and infrastructure in developing nations, why is surgery still considered “the neglected stepchild of global health” by policy makers and large donors, with support overshadowed by HIV/AIDS, tuberculosis, malaria, and other communicable diseases? [18]. One theory put forth in by Gosselin et

al. in 2011 is that efforts to expand surgical services by sending foreign doctors to local hospitals for brief medical missions, training foreign graduates in Western facilities or sending floating surgical centers to poor countries have been tried and failed [21]. However, these failures do not refute the growing evidence that expanding surgical services should be a priority in healthcare planning. Governments, Ministries of Health, and global health actors should look seriously at expanding capacity in developing countries by partnerships linking or twinning with developed clinics to train and equip local surgeons at local hospitals. Policy planners and international donors should invest in surgical infrastructure and services in sustainable ways that encourage in-country training of local staff, by promoting these partnerships and providing financial or other resources to encourage shared expertise.

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