

Cost-Effectiveness of a District Trauma Hospital in Battambang, Cambodia

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Abstract

Background The Emergency Hospital in Battambang, Cambodia, is essentially a surgical center for victims of injuries.

Methods Using methods previously described, operating costs were calculated, and effectiveness of treatment was estimated for 957 patients undergoing 895 surgical procedures over a 3 month period (October–December 2006).

Results Results of the cost effectiveness analysis are compared to the few existing ones in the literature.

Conclusion At \$77.4 per DALY averted, surgery for trauma in such a context is deemed very cost-effective and compares favorably to other non-surgical public health interventions.

Introduction

Although there seems to be an increasing interest in the cost-effectiveness of surgical activities in developing countries, there is still a dearth of published data. This probably reflects how recent the perception is that surgery can be an effective component of the public health armamentarium in developing countries [1, 2]. It is now well-documented that the burden of injuries, particularly from road traffic crashes, is steadily increasing in developing

countries, and represents a major public health issue [3–8]. Debas et al. [1] have estimated that injuries account for approximately 38% of the world's surgical disability-adjusted life years (DALYs), with malignancies a distant second at 19%. A significant proportion of injuries are best treated surgically, but the necessary human and material resources often are severely deficient in poor countries [9]. Cost-effectiveness analysis (CEA) is a widely used tool to inform those responsible for allocating scarce resources, and the World Health Organization has published guidelines for its use in 2003 [10]. It has proven its usefulness in developing countries settings [10–14], and countries such as Uganda have been receptive to incorporate this information in their health care sector planning [15]. Unfortunately data about both the costing and the effectiveness is usually not as easily obtainable in developing countries as it may be in developed ones, which have computerized databanks and more reliable mid- and long-term patient follow-up [16, 17]. The few existing reports focused on surgical activity have found it to be surprisingly cost-effective [18–21].

Cambodia is a small country in Southeast Asia of approximately 15 million people. The scars left at the end of the bloody Khmer Rouge regime are still fresh, and the health care system is struggling with insufficient and inadequate resources—human and material. Battambang, in the northwest, is the country's second largest city, and the capital of a province heavily infested with landmines. Emergency Hospital is an Italian nongovernmental organization that is dedicated to providing free surgical care for civilian victims of war and conflict. Inaugurated in 1998, the hospital has now a bed capacity of 106, with a near 100% average occupancy rate. In 2006, there were 3083 admissions, 96% of which were trauma-related—new and old. Non-trauma-related admissions were for ENT/Plastics

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surgical teams that come two or three times per year for a week or so of elective surgery. Although there are still fresh landmine injuries, the vast majority of trauma admissions are now related to road traffic crashes. The hospital usually has an expatriate staff of approximately 6 people and employs 182 nationals—94 care providers and 88 support and administrative staff—with priority given to those with handicaps and widows. All medical and other services are provided at no cost to patients or their families, a unique situation in the country.

Previously published CEAs in similar contexts have dealt with cataract surgery [18], obstetrics [4], or a more general case load of pediatrics, general surgery, and orthopedics [19]. Cost-effectiveness of approximately \$11 per DALY averted [4] and \$33 per DALY averted [19] compared favorably to more conventional public health interventions, such as some vaccination programs or other preventive interventions [2]. The purpose of this study was to add to this scarce body of knowledge, observations made during a 3-month period in this district hospital with an almost exclusive focus on the management of trauma and its sequelae.

Materials and methods

The study includes the 3-month period from October to December 2006. All admission logs and records from the wards, emergency room, intensive care unit (ICU), and operating theaters were reviewed, as were the institutional statistics from the previous months and years. The number of trauma-related admissions is fairly constant during the year, without evidence of seasonality. During that period, there were a total of 895 surgical procedures. The ENT/Plastics team performed 67 elective procedures, or 7.5% of total, leaving a trauma-related percentage of surgeries of approximately 90%, below the annual average of 96%. These cases were included in the calculations because we were not able to disaggregate the specific costs that they incurred. All charts were reviewed and data were collected for age, sex, diagnosis, and treatment.

The burden of each patient's surgical condition was estimated in DALYs, using disability weights from the Global Burden of Disease (GBD) study [20]. To estimate the burden avoided by surgery, we used the simplifications of the McCord approach [4], as previously reported [19]. Both severity of disease/condition and effectiveness in preventing death/disability were weighted (Table 1). DALYs are the sum of YLLs (years of life lost) and YLDs (years lived with disability). The GBD study calculated YLLs by discounting the highest life expectancy at the time (82.5 years for women and 80 years for men in Japan) at a rate of 3% a year, based on the principle that a year of

healthy life today is more valuable than in 20 years (same as the \$). This also is age-weighted, slightly in favor of children and young adults, and to the detriment of infants and the elderly, so that, for example, a male newborn dying at birth incurs 33.01 YLLs, whereas it would be 37.47 YLLs if he died at age 10 years and 17.12 YLLs if he died at age 50 years.

Thus, a 20-year-old male treated for a femur fracture would have the following calculation:

$35.24 \text{ (YLL)} \times 0.272 \text{ (long-term disability weight)} \times 0.7 \text{ (estimated risk of permanent disability between 50\% and 95\%)} \times 0.7 \text{ (estimated effectiveness of treatment to prevent disability between 50\% and 95\%)} = 4.7 \text{ DALYs averted.}$

The same calculation was performed for each patient, and the most conservative estimates were always used. The sum of all DALYs and all DALYs averted for each condition/procedure was rounded to the nearest unit.

Fixed costs were obtained by straight line depreciating the land and building costs over 30 years, and the initial equipment costs (medical, furniture, vehicles, etc.) over 7 years. Local operating costs included salaries and benefits to all staff, and all that was purchased locally to maintain the hospital running (food, drugs, fuel, utilities, etc.). Nonlocal operating costs were the sum of air cargo and the biannual container shipped from Italy, with medical supplies and equipment, prorated on a monthly basis. When needed conversion was performed with the prevailing rate at the time: 1 \$US = 0.75 Euro = 4000 Riels. This is summarized in Table 2.

Results

During the study period, there were 957 admissions and 895 surgical procedures. The ICU admitted 163 patients, 101 of which had surgery. Three of these surgical patients died during the perioperative period for an overall surgical

Table 1 Scoring system

	Weight
<i>Severity of disease</i>	
>95% fatal or disabling without treatment	1.0
<95% and >50%	0.7
<50% and >5%	0.3
<5%	0
<i>Effectiveness of treatment</i>	
>95% chance of survival or cure	1.0
<95% and >50%	0.7
<50% and >5%	0.3
<5%	0

Table 2 Monthly operating costs

		US \$
Fixed costs	Land and infrastructures	2,083
	Equipment	2,976
Operating costs (local)	Expat staff salaries/benefits	30,459
	Local staff salaries/benefits	23,585
	Equipment and consumables	15,584
	Drugs	5,774
Maintenance	Infrastructures and equipment	1,514
	Fuel and transportation	1,948
	Utilities	5,280
Operating costs (nonlocal)	Container from Italy	6,008
	Air cargo	5,522
Miscellaneous		4,123
Total		104,856

mortality rate of 0.3%, because there were no deaths on the regular wards. Of the 62 nonsurgical ICU patients, 5 died, all of head trauma, for an overall hospital mortality rate of 0.9%. Almost all of the surviving nonsurgical ICU patients suffered craniofacial injuries and were transferred to the regular surgical wards before discharge. These were the only nonsurgical patients admitted to the hospital, and we have estimated that their conservative treatment has avoided 279 DALYs.

Details of the conditions/procedures, relative burden, and DALYs averted are shown in Table 3. Of the 895 surgical procedure, 805 (90%) were performed for trauma-related conditions. More than 60% of those were for management of acute fractures or soft-tissue injuries. All

43 laparotomies were performed for acute abdomen, with an estimated mortality rate >95% if left untreated and an estimated treatment effectiveness >95%. Thus, the DALYs and DALYs averted are the same. There were eight times more fractures treated surgically, representing almost twice the burden, but only 4/5 of the burden averted. We have estimated the total surgical DALYs for that period at 6428, and the DALYs averted by surgery at 3786. Adding the ICU DALYs averted and dividing by 3 gives a monthly average of 1355 DALYs averted.

Salaries and benefits account for more than 50% of the operating costs, which is line with what was reported in the Sierra Leone series (Table 2) [8]. The major difference with that report concerns the fixed costs, particularly for equipment: \$2,976 for Cambodia on a 7-year depreciation schedule, and \$6,731 for Sierra Leone on a 10-year depreciation schedule. This can be explained by the fact that most of the initial equipment for Cambodia was available at low costs, either locally or regionally (Thailand, Pakistan), whereas almost all of the initial equipment for Sierra Leone was purchased and shipped from Europe.

Our estimation is that the surgical activity of this district hospital averts on average 1,355 DALYs each month, at a cost of \$104,856, or at \$77.4 per DALY averted.

Discussion

Other than changing the depreciation schedule for fixed equipment costs from 10 to 7 years, the methodology used for this report is the same as previously published, with its known and unknown biases [19]. We were equally

Table 3 Estimated burden and burden averted by condition/procedure with distribution by sex and median age

	Males (median age)	Females (median age)	Total	DALYs	DALYs averted
Laparotomies ^a	31 (21)	12 (25)	43	1424	1424
Chest drainage	5 (41)	0	5	101	101
Fractures	285 (21)	67 (26)	352	2780	1175
Debridements ^b	240 (25)	59 (29)	299	969	475
Amputations ^c	34 (29)	6 (29)	40	341	208
Osteomyelitis	8 (21)	3 (12)	11	40	19
Soft-tissue releases ^d	35 (12)	16 (14)	51	567	277
ENT ^e	42 (9)	25 (8)	67	120	84
Other ^f	20 (16)	7 (19)	27	86	42
Total	700 (78%)	195 (22%)	895	6428	3786

^a For blunt or penetrating trauma (32), peritonitis (4), strangulated hernia (3), ruptured ulcer (3), ovarian torsion (1)

^b For acute, subacute or chronic soft tissue problems, without fractures, including trauma, infections, delayed wound closure and skin grafting

^c For primary amputations (22) or stump revision (18)

^d Elective surgery for congenital malformations (clubfeet), contractures secondary to burns or poliomyelitis, or tendon transfers for paralysis

^e Elective ear-nose-throat procedures, such as for chronic otitis/mastoiditis or cleft palate

^f Includes surgery for tumors, removal of hardware, joint stiffness

conservative in our DALY estimates, but there is definitely a significant component of subjectivity. Data were insufficient to allow us to calculate DALYs averted by the outpatient treatment of emergency room patients, which averaged 914 visits per month for that period, so none were added to the total. At almost \$78 per DALY averted, the Cambodia series is more than double the \$33 per DALY averted in the Sierra Leone series. One likely explanation is the difference in the case mix. The Sierra Leone hospital is a more general hospital with a heterogeneous population of pediatrics, general surgery, and orthopedic surgery, both emergent and elective. The hospital in Battambang deals almost exclusively with injuries and their sequelae and is purely surgical. Even if during the study period, approximately 10% of the procedures were for nontrauma conditions, we estimate that they represent only approximately 5% of the DALYs and 5% of the DALYs averted. Therefore, this study population is far more homogenous in terms of diagnosis and treatment. The median age of the trauma-related population is higher than the Sierra Leone one, which may have had a small impact on the DALY calculations. More importantly is the fact that DALYs averted in the emergency room and the pediatric outpatient department were calculated and included in the Sierra Leone data, accounting for 37.5% of total DALYs averted. Had they not been included, which is the case for this report, the cost per DALY averted would have been \$52 instead of \$33. Although there is no basis to do so, if we assumed the same proportion for this series as an exercise, the cost per DALY averted would decrease to \$53.

The difference with the \$11 per DALY averted reported by McCord et al. [4] is even more striking. As already argued elsewhere [19], it can be explained by their lower monthly operating costs, and more importantly, because of the difference between the two patient populations. A successful obstetrical intervention saves the lives of a baby and a young mother and averts many more DALYs than successful disability prevention in a single older patient.

Even if their methodologies are similar, the patient populations of these three series are different enough to make any comparisons tenuous at best. The Emergency Hospital in Battambang essentially focuses on one problem: injuries. Even at an overly conservative \$77.4 per DALY averted, it is still very cost-effective, particularly for a “surgical” hospital. It compares favorably to other highly lauded public interventions in similar contexts, such as antiretroviral therapy (\$350–500 per DALY averted) or pentavalent (diphtheria, pertussis, tetanus, hepatitis B, and hemophilus influenza type B) vaccination (\$42–250 per DALY averted) [10]. These results suggest that surgery, particularly for the growing problem of injuries, has a significant role to play as a cost-effective public health intervention.

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