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Best Buy in Public Health or Luxury Expense?:

The Cost-effectiveness of a Pediatric Operating Room in Uganda From the Societal Perspective

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Abstract

Objective: To determine the cost-effectiveness of building and maintaining a dedicated pediatric operating room (OR) in Uganda from the societal perspective.

Background: Despite the heavy burden of pediatric surgical disease in low-income countries, definitive treatment is limited as surgical infrastructure is inadequate to meet the need, leading to preventable morbidity and mortality in children.

Methods: In this economic model, we used a decision tree template to compare the intervention of a dedicated pediatric OR in Uganda for a year versus the absence of a pediatric OR. Costs were included from the government, charity, and patient perspectives. OR and ward case-log informed epidemiological and patient outcomes data, and measured cost per disability adjusted life year averted and cost per life saved. The incremental cost-effectiveness ratio (ICER) was calculated between the intervention and counterfactual scenario. Costs are reported in 2015 US$ and inflated by 5.5%.

Findings: In Uganda, the implementation of a dedicated pediatric OR has an ICER of $37.25 per disability adjusted life year averted or $3321 per life saved, compared with no existing operating room. The ICER is well below multiple cost-effectiveness thresholds including one times the

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A.Y., R.Y., D.O., and M.C. were involved in study conception and design. A.Y., M.C., A.M., N.K., P.K., and D.C. collected the cost information, outcomes data. G.Y., R.Y., and D.O. guided the economic evaluation. A.Y. carried out the main analysis and interpretation of the data. M.C., D.O., and R.Y. oversaw the analysis. A.Y. drafted the initial manuscript. M.C., D.O., and R.Y. provided critical revisions and all authors reviewed and approved of the final manuscript.

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country's gross domestic product per capita ($694). The ICER remained robust under 1-way and probabilistic sensitivity analyses.

Conclusion: Our model ICER suggests that the construction and maintenance of a dedicated pediatric operating room in sub-Saharan Africa is very-cost effective if hospital space and personnel pre-exist to staff the facility. This supports infrastructure implementation for surgery in sub-Saharan Africa as a worthwhile investment.

Keywords

charity; cost; cost-effectiveness analysis; DALY; disability-adjusted life year; expenditure; infrastructure; installation; operating room; outcomes; out-of pocket; pediatric surgery; Uganda; wages

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The Sustainable Development Goals emphasize global access to surgical services as an indivisible part of essential healthcare delivery.[1,2] However, insufficient infrastructure hinders treatment coverage for surgical disease in low-income settings.[3,4] An estimated two-thirds of the world lacks access to surgical and anesthesia services, and low-middle income countries (LMICs) shoulder a disproportionate burden of surgical disease.[5] Cost-effectiveness analysis (CEA) is one such method to compare disparate surgical and nonsurgical interventions to guide limited resource allocation.[6,7]

Using CEA, essential surgeries were shown to be very cost-effective, with incremental cost-effectiveness ratios (ICERs) similar to that of vaccinations or malaria bed nets.[8] For example, the median ICER for cleft lip or palate repair at $47.74 per disability adjusted life year (DALY) was comparable to that of the Bacillus Calmette-Guérin vaccine ICER ($51.86–220.39 per DALY).[8] Surgical facilities in LMICs are also cost-effective, with ICERs at US$10 to 220 per DALY averted.[9–11] Local surgical capacity expansion provides an reasonable return to the community's economic productivity, with $10 gained for every $1 spent.[12]

Assessing infrastructure improvement in global pediatric surgery is an uniquely unexplored area, as landmark disease burden and CEA studies focus on adult surgical disease.[13] The unmet need is profound in low-income countries such as Uganda, where 48% of the population is under the age of 15, and only 4 qualified pediatric surgeons serve over 20 million children.[14] Corrective procedures for congenital abnormalities at Mulago National Referral Hospital, 1 of 2 centers able to surgically treat neonates in the country, averted 5072 DALYs, but could meet a potentially avertable 140,154 DALYs with adequate surgical capacity.[15] Though surgery for common congenital anomalies is considered part of the essential healthcare package,[16] no dedicated pediatric operating facilities existed in the country until very recently.

In 2015, the construction of the first dedicated pediatric operating room (OR) in Uganda was funded by a charity that worked with Ugandan healthcare system to donate surgical and anesthetic equipment to Naguru hospital in Kampala, Uganda.[17] Our previous research demonstrated that this OR was cost-effective when fixed costs of donated long-term surgical and anesthetic equipment were accounted for,[18] but a limitation of the prior study was that it did not incorporate the full cost of a functioning OR. This study provides a comprehensive CEA from the societal perspective to evaluate economic return of building and maintaining a pediatric OR in a low-income country.

METHODS

Institutional review board approval was granted by both Yale University and Mulago Hospital.

Model Design

Following Shrime's template, a decision tree model created in Treeplan 2.03 charted possible life trajectories with and without definitive surgical treatment for 58 unique pediatric surgical conditions.[7] (Supplemental Figure 1, http://links.lww.com/SLA/B605) Model parameters were informed by the local pediatric OR case-log, the inpatient pediatric surgical ward database, payer price sheets, inpatient surveys with patients' families regarding out-of-pocket (OOP) costs, and previous literature.

Because of the variety of surgical diseases that were present in our case-log, we grouped diseases into categories and derived variations off a template model. The disease categories were sorted by the proportion of years of life lost (YLL) and years lived in disability (YLD) accumulated; some diseases were inevitably fatal shortly after presentation if untreated (accruing years of life lost only, eg, intestinal atresia), while others contributed to only patient morbidity, but no life-years are lost (YLD only, eg, inguinal hernia, see Supplementary Table 6, http://links.lww.com/SLA/B605).

Cohort Characteristics, Study Setting, and Time Horizon

The pediatric OR in Naguru Hospital, Kampala was the only surgical facility dedicated to children in Uganda at the time of data collection, and therefore represented country's capacity to treat pediatric surgical disease. Its case-log and corresponding ward database recorded patient outcomes, which informed our model's averted disease burden. Three hundred twenty-six cases met inclusion criteria of patients admitted for surgical procedures in the pediatric surgical ward (See Supp. Table 1, http://links.lww.com/SLA/B605, patient population characteristics described elsewhere).[18] Study duration spanned 1 year of cases from April 2015 to April 2016 performed in the Naguru OR, which treated the pediatric surgical patients at Mulago National Referral Hospital, the country's largest tertiary center. One year was an appropriate timespan as the theater had been in service for this duration. Wages and fixed costs such as anesthetic machines were best calculated annually.

Counterfactual

In this model, a comparison was made with and without the pediatric OR intervention. The comparative scenario was the natural disease course of the pediatric surgical condition, as patients had no access to a pediatric surgical facility that could provide definitive treatment prior to OR installation. Pediatric surgical disease did not usually allow for nonsurgical treatment alternatives, as the disease commonly involved an anatomical defect that requires surgical repair, so we assumed that the natural course of disease was likely in the setting of no surgery.

Cost Perspectives and Sources

Our model adopted the Ugandan societal perspective by including 3 major payer perspectives: the charity that paid for the fixed installation costs, the government funded worker's wages and other variable costs, and the patients' OOP costs (Table 1). All prices were converted from to USD using purchasing power parity and adjusted by an average inflation rate of 5.5% in Uganda in 2015.

Fixed costs (charity perspective): Market and subsidized prices of donated large-scale surgical and anesthetic equipment were obtained from budget sheets of participating charities. Equipment replacement costs were annualized by either its lifetime warranty or by an average of 9 years, as reported by the Government Office of Management and Budget.[19]

Variable costs (government perspective): OR staff wages were determined by the Ugandan government salary scale for the fiscal year of 2015 to 2016, as designated by the Ministry of Public Service.[20] Costs of perioperative medications and disposable equipment were obtained from order sheets and invoices compiled by the Naguru Hospital central pharmacy that were sent to the National Medical Store, a centralized medical supply pool for the country.

OOP costs (patient perspective): A prospective survey administered to the patients' families determined OOP expenditure for a hospital stay requiring surgery. Survey respondents were selected from a convenience sample of family members taking care of patients admitted to the pediatric surgical inpatient ward for surgical procedures.[21]

Outcomes Data Sources

Patient outcomes were extracted from the Naguru OR case-log and ward database, and 326 cases met inclusion criteria for our model (Supplementary Table 1, http://links.lww.com/SLA/B605). The DALY was used to quantify the disease burden each possible patient outcome in the decision tree. The DALY was calculated using methods proposed by the World Health Organization (WHO) and Drummond et al.[22,23] Disease-specific disability weights (DWs) were extracted from previous literature including the 2013 Global Burden of Disease study and Poenaru et al's work.[24–26] The majority of disease disability weights were extracted as singular disease states, under the premise that children did not harbor many comorbidities as they are generally not old enough to acquire chronic illness. Disability weights for comorbid conditions were computed following 2015 WHO guidelines on YLD calculations (eg, colostomy secondary to anorectal malformation is coded as "stoma" and "abdominopelvic problem level 2" based on disability weights reported by the Global Burden of Disease Study 2013). Postsurgical DWs and those with no previously published DW were obtained using validated severity score scales developed by McCord and Chowdhury.[11] 2015 sex-specific average life expectancies in Uganda were used (60 yrs for males and 64 yrs for females).[27] Disease-specific mean age of presentation and remaining life-expectancy were parametrized by the OR case-log. Probability of successful treatment (PST) and probability of postoperative death were extracted from the ward database and previously published literature. Any disease with a greater than 95% cure rate had a PST of one.[11] Estimated DWs and probabilities were agreed upon by a consensus of local and US pediatric surgeons.

Cost-effectiveness Analysis

The primary metric was the ICER, defined as $(\text{Cost}_{\text{OR Intervention}} - \text{Cost}_{\text{natural disease course}}) / (\text{DALYs}_{\text{OR Intervention}} - \text{DALYs}_{\text{natural disease course}})$ in units of US dollars per DALYaverted. According to the WHO guidelines, a cost-effective intervention should be under the threshold of 3 times the country's gross domestic product (GDP) per capita. In Uganda, this cut-off was $2026 per DALYaverted in 2015. The World Bank cost-effectiveness threshold is more conservative at $240 per DALY averted.

Scenario Sensitivity Analysis

One-way deterministic sensitivity analysis of possible scenarios captured parameters ranges that were subject to the most variation. Scenarios included adjustments of cost from different payer perspectives, inflation rates, market value of equipment, and number of patients treated without the OR intervention.

Probabilistic Sensitivity Analysis

A Monte Carlo simulation characterized the uncertainty of the model parameters and tested the robustness of our ICER. Randomization of outcome parameters included life expectancy, age of presentation, DWs, PSTs, and probability of death (Table 2). For diseases and surgeries with þ10 patients in the Naguru OR case log, age of presentation and life expectancy was fitted with continuous probability distributions (log-normal, Weibull, or gamma) using Java Math Package statistical software. For diseases with less than 10 patients, uniform and triangle distributions were used. DWs and probabilities were fitted with a beta distribution using previously reported confidence intervals, and when published data was unavailable, a confidence interval range of ±0.2 constrained between 0 and 1 was used, as proposed by previous cost-effectiveness studies.[28]

Wages, fixed costs, and OOP costs were randomized by gamma distribution (with range of ±20%; income brackets served as distribution ranges for wages). Medications costs were randomized by probability of utilization in Naguru OR anesthetic reports. The amount of disposable equipment used was similar for each operation regardless of type of disease treated and was calculated as a constant incremental price per procedure.

To emulate a facility-based study, simulated patients were batched in uniformly randomized cohorts of 250 to 500 patients. Presenting disease frequency was empirically randomized to follow the case distribution of the Naguru OR case-log (Supplementary Table 6, http://links.lww.com/SLA/B605). Cumulative DALYs averted were divided over the cumulative annual costs of running the OR to obtain the simulation ICER. Two hundred simulations were run on Visual Basic Application script, and 100 bootstrap uncertainty intervals were calculated for the ICER. Results of the Monte Carlo simulation were presented in a cost-effectiveness plane.

RESULTS

The predicted health benefit after utilizing the dedicated pediatric OR for 1 year was 6551 DALYs averted with an average of 374 patients treated, or 17.5 DALYs averted per patient. The total annual cost of the pediatric OR operation was $244,001 after a 5.5% inflation rate. The incremental cost-effectiveness ratio of a pediatric OR intervention in Uganda was $37.25 per DALY averted when compared with no existing OR. The cost per life saved was $2321 based on average life expectancy in Uganda in 2015 (62.3 yrs). The ICER is lower than the WHO cost-effectiveness threshold of 1 and 3 times Uganda's GDP per capita per DALYaverted. The ICER is also lower than the more stringent World Bank threshold of $240 per DALY averted. This suggests that the construction and maintenance of a dedicated pediatric OR in Uganda is very cost-effective.

One-way deterministic sensitivity analysis was performed for plausible alternative scenarios by adjusting a single input parameter at a time. With all 1-way scenario analyses, the ICER remained cost-effective (Fig. 1). The ICER was most sensitive to changes on annual wages when salaries were substituted with American wages, as the total annual workers' compensation for the OR was 103 times costlier, increasing from $9572 to $986,360. The ICER was relatively sensitive to increasing disease burden averted in the counterfactual of up to 50% averted, a hypothetical amount of potential surgical intervention in the absence of the pediatric OR, but still stayed well below the cost-effectiveness threshold. The ICER was relatively insensitive to changes in cost of OOP purchases, large-scale equipment prices and inflation. The number of patients treated in the OR per year also did not change the ICER significantly.

Isolated ICER from each payer's perspective showed that the largest proportion of funding to maintain the OR came from the government in a combination of perioperative medications, disposable equipment, and employee salaries. Government spending totaled to $119,626 (49%), while donated long-term equipment costed $66,285 (27%), and patient families spent $57,964 (23%) on their children's healthcare (Fig. 1).

A Monte Carlo simulation of 200 annual, facility-based iterations included all the above variables to produce total operational cost and DALYs averted after 1 year of functioning OR (Fig. 2). Accounting for annual inflation rate of 5.5% in 2015, mean cost of the OR was $240,526 (95% uncertainty interval or UI 236,264–244,789). The distribution of simulation costs from the government, patient, and charity perspective is depicted in Figure 3, where perioperative medications paid by the government were most costly, whereas reusable equipment and wages were least expensive. Mean simulation DALYs accumulated were 10,572 (95% UI 10,301–10,843) for the counterfactual with no accessible OR, and 4022 (95% UI 3916–4127) with the pediatric OR intervention, averting a mean of 6,551 DALYs (95% UI 6376–6725).

According to the probabilistic sensitivity analysis, the ICER was $37.25 per DALY averted (95% uncertainty interval 36.80–37.81), or $2321 per life saved (95% UI 2293–2355). The simulation ICER range was still less than 5% and therefore well below the cost-effectiveness threshold of both 1 and 3 times Uganda's GDP per capita in 2015. In absolute terms, this meant that the intervention was likely cost-effective in the perspective of the Ugandan healthcare system.

DISCUSSION

Based on our model, a pediatric OR in Uganda had an ICER of $37.25 per DALY averted, or a cost of $2321 per life saved over 1 year of operation, compared with no existing OR for treating pediatric surgical disease. This study demonstrates that a dedicated pediatric surgical facility in Uganda is very cost effective from the societal perspective and lies under both the WHO and the World Bank cost-effectiveness thresholds. Following the current WHO guidelines, the OR appears to be well below the cost-effective threshold of 3 times the country's GDP per capita, or $2026.[29] As a more comprehensive analysis that includes several payer perspectives, this study substantially adds to our previous work which portrays only the donor perspective.

The decision tree model served as a malleable skeleton with manifold input parameters emulating the characteristics of various disease and intervention scenarios. Multiple cost perspectives from the patient, government, and charity provided a comprehensive estimate of the financial investment, while the incorporation of the OR case log with over 300 cases informed the patient outcomes to reflect realistic disease burden averted. The yearlong timespan allowed for an extended period of observation to account for the background noise that may distort results over a shorter study duration.

In our 1-way sensitivity analysis, the largest change in ICER resulted from a wage adjustment to American salaries, increasing the total pediatric OR cost several-fold. This finding is notable as overseas surgeons and staff take part in the care during surgical mission trips, and it is important to capture the added cost of staffing an international healthcare worker versus a local one. The ICER does not change significantly when OOP costs or fixed costs of surgical infrastructure were toggled, meaning that that these payers would not add a substantial cost burden.

In the simulated cost of wages, all the staff in the OR had a wage that was higher than that of the national average using the median monthly wage in Uganda in 2013 (110,000 UGX, or $115.82 in 2016 USD after adjusting for inflation[30]) as frame of reference. However, absolute values of the incomes were consistently low across the entire salary scale, and only the fellow and attending physician earned marginally more than US minimum wage ($1256.67 per month in 2016). This differential is made apparent with the adjustment of wages to US salaries in the 1-way sensitivity analysis, marking up the total cost of the OR 6-fold. The disparity of wages between private and public sectors and across nations continues to spur a brain-drain toward more lucrative practices and higher-income countries.[31,32] Local government hospitals could be left with a dearth of competent providers, especially in fields that require a large training investment.[33] Simulated medication cost was moderately sensitive to randomization and exhibited values over a range of $51,418–$117,870, as medications were a function of patient number and presentation age. However, the variation was not sensitive enough to affect the pediatric OR ICER in the Monte Carlo simulation, which remained cost-effective.

Comparing the pediatric OR intervention with nonsurgical healthcare services, our pediatric OR ICER was comparable to offering the Bacillus Calmette–Guérin vaccine in low-income countries ($51.86–220.39 per DALY averted).[8] Despite the general perception that surgical intervention would be unacceptably costly, the pediatric OR was approximately 10 times more cost-effective than antiretroviral therapy treatment for HIV in Sub-Saharan Africa (ICER $350–1494 per DALY averted), and this finding was consistent with prior studies.[8]

Only a few studies have utilized CEA for children's surgical conditions. The Ugandan pediatric OR ICER was comparable to that of a Kenyan refugee camp, where the ICER for operating on congenital anomalies ranged from $40 to 88 per DALY averted.[34] Comparing to specific pediatric surgical conditions, our ICER was higher than pediatric inguinal hernia repair in Uganda, which was very cost-effective at $12.41 per DALYaverted.[35] This finding could be explained by our OR model's increased cost by treating more complex pediatric surgical conditions and the inclusion of an inpatient stay, both which an elective hernia repair would not require. Meanwhile, our ICER was lower than that of a cleft lip repair in the same region, a procedure with a mean averted 3.7 DALYs per patient, at a ICER of $81 per DALYaverted.[36] This burden and CEA data can help attract attention of policy makers to improve pediatric surgical interventions. However, CEA of children's surgical care in LMICs are still scarce due to sparse data collection, overworked hospital personnel (who are usually spread thin from case overload), and inconsistent methodology.

The cost-effective ICER can be explained by the young patient population, large disease burden averted per procedure, and the relative low cost of living in Uganda. Treating a child at a young age averts a large burden of disease per patient. Moreover, many of the surgeries are life-saving, and DALYs are saved in whole years in addition to partial YLD. This distinction sets the pediatric OR apart from disease-specific CEA on pediatric surgeries that avert mainly disability, such as cleft lip repair. Finally, the low cost of living in Uganda allows for purchases of relatively inexpensive capital and services, even when purchasing power parity is accounted for.

Another strength of our study is the utilization of empiric data on patient outcomes to inform model's health benefit including discharge or death postoperatively and real-time patient prognosis. This adds an authenticity to our patient outcomes that is not usually present in other cost-effectiveness analyses that derive data mainly out of case logs that have little or no outcomes data and must rely more heavily on theoretical parameters.

Notable limitations in calculating health utility saved were 2- fold. First, the lack of data to support the counterfactual led to the assumption that no disease was averted in the absence of a pediatric OR. Second, disability weights that either were predetermined for an adult population (in the case of the Global Burden of Disease study) or did not exist previously and were estimated based on preference scales, predispose these values to misjudge the true burden of disease. These limitations were accounted for in the sensitivity and scenario analyses, where the ICER remained robust.

Medication simulation cost calculation was limited by small disease-specific sample sizes, especially with relatively rare conditions such as choledochal cysts or teratomas, appearing in the OR case-log infrequently. These limitations did not significantly hinder or deviate the calculation of medication costs, since the rare procedures did not contribute heavily to the total medication cost as the number of cases was small. The postoperative inpatient medication costs supplied by the government (and therefore not out of pocket) were also omitted, since there was not a consistent record of the complete list of medications that was administered postoperatively to each patient in the operative reports or patient charts. However, a sizable proportion of these costs were captured in the OOP spending from families, as they frequently paid for postoperative medications when hospital supplies were running low.

Costs of maintenance personnel conducting check-ups were not included, although calculation of equipment costs based on the lifetime of the equipment accounts for gradual degradation over time, so upkeep costs were not necessary. Our model also used cost values derived from the charity's perspective, which were lower from the market value, though we included the market values of equipment in our 1-way scenario sensitivity analysis.

As we did not have full records regarding the comorbidities of the patients included in the study, these were not included in the analysis. For example, some of the common congenital conditions such as anorectal malformations and esophageal atresia are part of the VACTERL association which can be associated with cardiac defects. The most severe of the associated defects may have caused morbidity or mortality prior to surgical repair, while others may have compromised outcome. Other diseases may have had outcomes complicated by common underlying medical conditions such as malaria, diarrhea, or respiratory infections, leading to a slight overestimate in the health benefits of surgery.

CONCLUSION

The pediatric OR is cost-effective from the societal perspective. This study is the first to demonstrate the cost-effectiveness of furnishing and maintaining a pediatric OR in low-income setting from the perspective of the Ugandan healthcare system. The pediatric OR's low ICER at $37.25 per DALYaverted supports OR installation and maintenance at an existing hospital as a viable intervention, provided that suitable healthcare personnel and infrastructure are present. This study strengthens the claim of our previous study that included only the installation cost of the OR by analyzing the OR intervention through the societal perspective. This data supports surgery as a cost-effective way of treating life-threatening pediatric surgical conditions in the low-income setting and the model remains robust over multimodal sensitivity analyses. This implies that an OR intervention can be a very attractive option for healthcare capacity building in Uganda, and possibly other developing nations. Furthermore, this study demonstrates that economic analysis of surgical intervention in a LIC can inform sensible resource allocation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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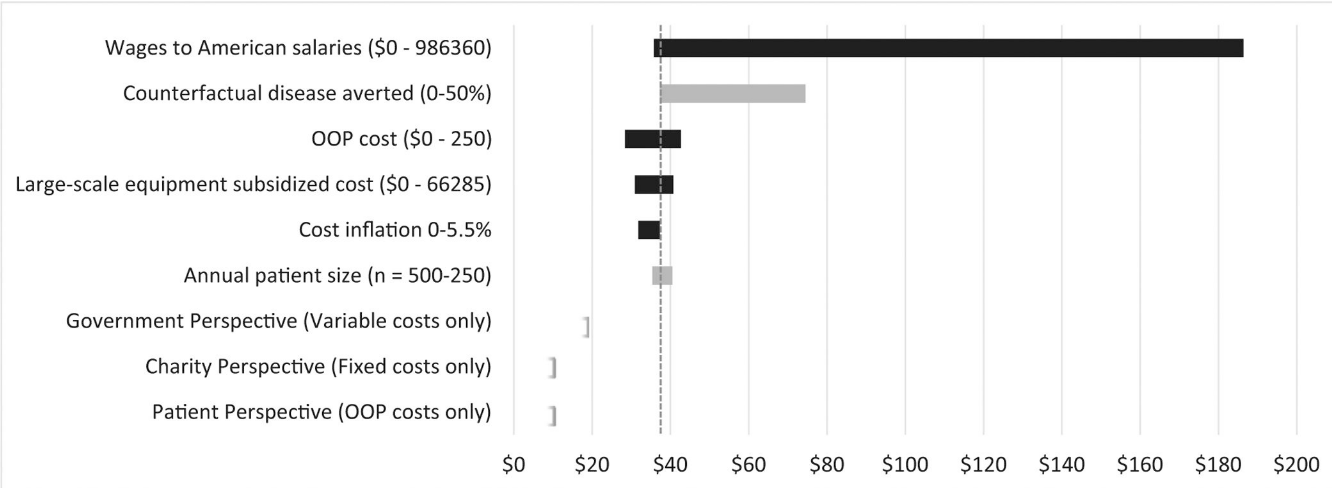

FIGURE 1.

Tornado diagram of 1-way sensitivity analyses showing plausible scenarios that affect the ICER by adjusting a single parameter. Scenarios are categorized by value adjustment in costs (black bars) and disease burden averted (gray bars). The bottom 3 rows show the ICER from isolated cost perspectives. The dotted vertical line marks the base case value.

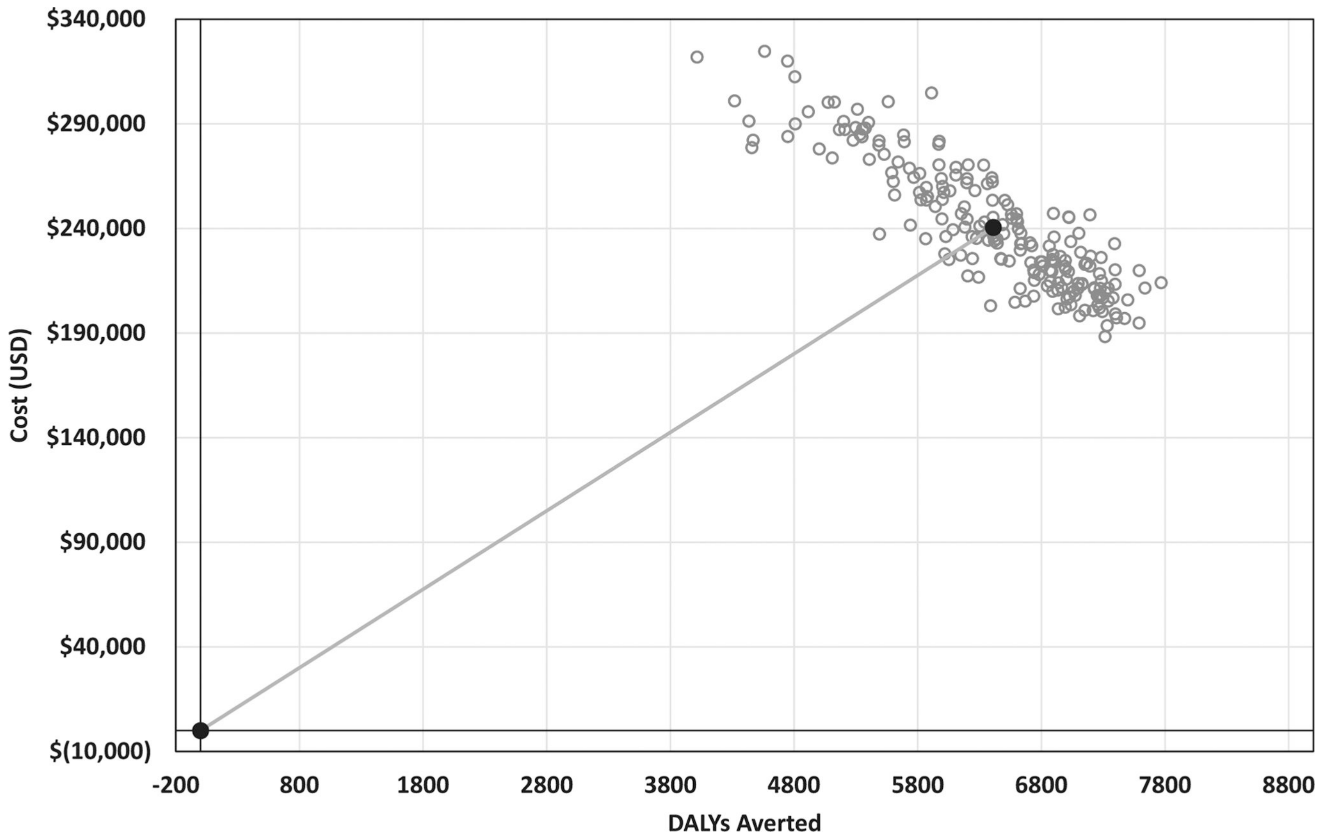

FIGURE 2.

Cost-utility analysis. Results of 200 Monte Carlo simulations of a functional pediatric OR in Uganda, with corresponding simulated ICER represented by the gray line. Gray dots represent the incremental cost and nondiscounted DALYs as compared with the counterfactual.

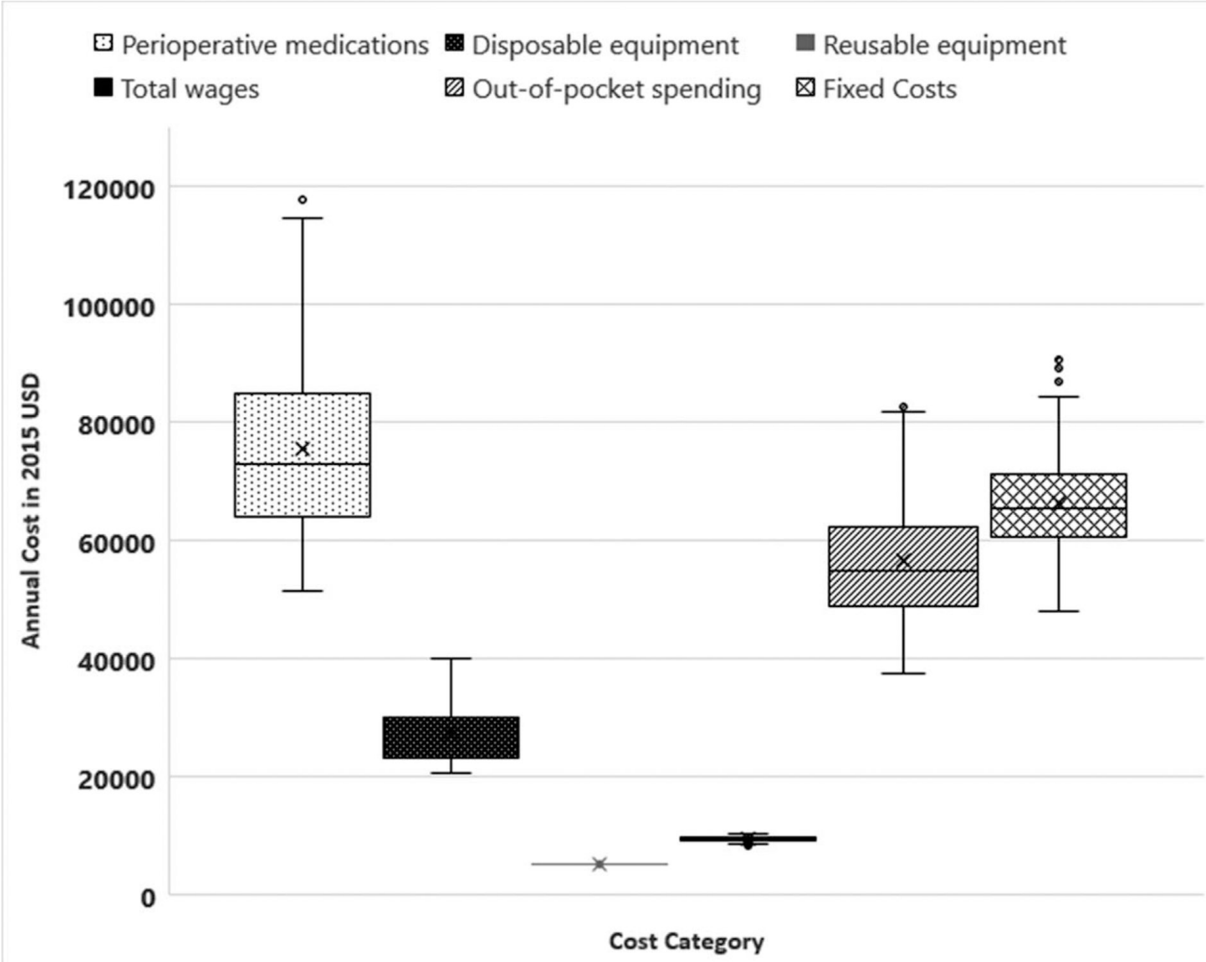

FIGURE 3.

Spread of simulated OR costs in the probabilistic model, including government funded medications, equipment, wages, out of pocket spending, and the fixed costs of large-scare equipment installation donated by the charity.

TABLE 1.

OR Components Funded by the Following Stakeholders: Charity, Government, and Patient

Cost Perspective	Categories Included With Representative Items
Charity perspective (fixed costs)	Annualized large-scale anesthetic equipment (Boyle's machine, vital sign monitors etc.)
	Annualized Large-scale surgical equipment (OR table and light, autoclave etc.)
	Shipping and installation costs
Government perspective (variable costs)	Annual wages of participating healthcare workers
	Perioperative medications and anesthetics
	Disposable equipment (syringes, gloves etc.)
	Reusable equipment (cloth sterile drapes, garbage cans etc.)
Patient perspective (out-of-pocket costs)	Postoperative medications
	Diagnostic tests
	Food and lodging expenses
	Transportation to and from hospital
	Indirect cost of productivity loss (in forfeited wages)

TABLE 2.

Input Variables That Contain Inherent Uncertainty, and Their Respective Probability Density Functions to Randomize and Account for Sources of Uncertainty in the Monte Carlo Probabilistic Simulation Model

		Costs		
Input	**Category**	**Given Value**	**Density Function**	**Distribution Source**
Total fixed costs of large-scale equipment	Charity	$101847.57	Gamma	±20%[18]
Attending physician annual wage	Government—Wages	$ 2413.74	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Fellow physician annual wage	Government—Wages	$ 1674.90	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Resident physician annual wage	Government—Wages	$ 1208.45	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Senior nurse annual wage	Government—Wages	$ 961.05	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Registered nurse annual wage	Government—Wages	$ 664.83	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Intern physician annual wage	Government—Wages	$ 710.06	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
OR attendant annual wage	Government—Wages	$ 493.58	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Ward attendant annual wage	Government—Wages	$ 391.50	Gamma	Supp. Table 2, http://links.lww.com/SLA/B605
Perioperative medications	Government—Meds	Supp. Table 3, http://links.lww.com/SLA/B605	Single probabilities	Operative reports *
Disposable equipment	Government—Equip	Supp. Table 4, http://links.lww.com/SLA/B605	Single probabilities	Operative reports *
Reusable equipment	Government—Equip	Supp. Table 5, http://links.lww.com/SLA/B605	Single probabilities	Operative reports *
Total out of pocket family costs	Patient family	$ 150·62	Gamma	OOP surveys †
		Outcomes		
Input	**Category**	**Given Value**	**Density Function**	**Distribution Source**
Disease disability weights	Patient outcomes	Supp. Table 6, http://links.lww.com/SLA/B605	Beta	Supp. Table 6, http://links.lww.com/SLA/B605
Presentation ages	Patient outcomes	Supp. Table 6, http://links.lww.com/SLA/B605	Gamma, Weibull, Log-Normal, Triangle, Uniform	Supp. Table 6, http://links.lww.com/SLA/B605
Number of operations in a year	Patient outcomes	326	Uniform	±20%
Probability of successful treatment	Patient outcomes	Case-based	Beta	±20%
Probability of death after treatment	Patient outcomes	Case-based	Beta	Pediatric surgical Ward database

*Probabilities of the utilization of each drug were derived from Naguru OR anesthetic reports (n = 114).

†OOP surveys calculated total cost per family distribution (n = 132) (Citation #21).