

Cost-effectiveness of Groin Hernia Surgery in the Western Region of Ghana

Samuel D. Shillcutt, MSc; Michael G. Clarke, MD, MRCS(Eng); Andrew N. Kingsnorth, MS, FRCS

Objective: To calculate the cost-effectiveness of tension-free inguinal hernia repair with mosquito net mesh in the Western Region of Ghana.

Design: Prospective study.

Setting: Four district hospitals in the Western Region of Ghana.

Patients: A total of 113 referred or presenting patients from rural areas with inguinal hernias of various sizes.

Intervention: Lichtenstein method of tension-free repair using mosquito net mesh by European and African surgeons.

Main Outcome Measure: Disability-adjusted life-years (DALYs) averted with counterfactual definitions based on precedent and expert opinion.

Results: All operations were performed as day cases, with 81 of the patients (71.7%) under local anesthesia and few complications. An average of 9.3 (95% confidence interval [CI], 8.0-10.7) DALYs were averted per person, with a total of 1052 averted in the study. Average cost per patient was \$120.02 (95% CI, \$117.66-\$122.39) from a provider perspective and \$102.88 (\$88.47-\$117.29) from a patient perspective. Cost-effectiveness was \$12.88 per DALY averted (95% CI, \$10.98-\$14.78), which is well below the Ghanaian per capita gross national income (\$590). Results were robust to sensitivity analysis and may be refined as further work is done on the burden of disease due to hernias in Africa.

Conclusions: Inguinal hernia repair was cost-effective in the Western Region of Ghana through international collaboration. Research in other settings should test the generalizability of results.

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BOTH DISABILITY-ADJUSTED life-years (DALYs) and quality-adjusted life-years measure health outcomes according to preference for health states and timing of death to inform public health decisions.^{1,2} Quality-adjusted life-years measure increases in life expectancy and improvements in health states; DALYs measure the reductions in premature death and disability and are most commonly used in low- and middle-income country (LMIC) settings.

See Invited Critique at end of article

Initial estimates indicate that surgery can address 7% of DALYs that occur in Africa,³ and this burden is probably increasing rapidly.⁴ The economic impact of these conditions is significant because they often disable or kill people in the prime of their life; however, surgery in LMICs has been a neglected public health need, with the perception of costs, training, and resource requirements exceeding what is feasible in resource-poor environments.⁵⁻⁷ In reality,

only basic skills and equipment are needed to sustain essential surgical services, making them feasible at first-referral-level health facilities. Surgery is therefore gaining recognition in international health agendas.⁴

Inguinal hernia repair is one of the most commonly performed operations in Africa. It is estimated that 175 people per 100 000 need hernia repair each year,⁸ with prevalence estimates as high as 1400 per 100 000 in Carpenter, Northern Region of Ghana (A.N.K., unpublished data, 2008). However, only a small percentage are actually repaired,⁸ often resulting in long-standing inguinoscrotal hernias (**Figure 1**). Waiting is associated with a higher incidence of morbidity and mortality, requiring expensive emergency care for many patients.⁹ Although significant progress has been made to increase uptake of surgery in Accra,¹⁰ strangulated inguinal hernia is still a common problem in rural areas because simple surgical services are unavailable or unaffordable.¹¹ There is an urgent need to make hernia repair more available and accessible to the geographic and social groups that need it.

The only evidence on the cost-effectiveness of inguinal hernia repair in

Author Affiliations:

Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland (Mr Shillcutt); and Department of Upper Gastrointestinal Surgery, Derriford Hospital (Drs Clarke and Kingsnorth), and Department of Surgery, Peninsula Medical School and Derriford Hospital (Dr Kingsnorth), Plymouth, England.

LMICs is based on expert opinion,¹² although it is listed as an essential service provided by district hospitals in *Disease Control Priorities in Developing Countries*, second edition.³ Our study meets the calls for cost-effectiveness evidence on surgical interventions in LMICs^{3,4} by assessing outpatient inguinal hernia repair by the Lichtenstein method using mosquito net mesh¹³ relative to no treatment at 4 rural hospitals in western Ghana.

METHODS

Operation Hernia is a UK-based nongovernmental organization that links Takoradi Regional Hospital in Ghana with Deriford Hospital in Plymouth, England, and other international surgical teams.^{14,15} It has been in operation since 2005, adding a hernia treatment center in Takoradi, where European surgeons operate up to 10 weeks per year, repairing about 50 hernia cases per week. In November 2007, a team from the United Kingdom/Netherlands worked with a local team to repair hernias at 4 regional hospitals for 5 days, recruiting patients through advertisements and referrals. Medical details about the mission and intervention are described in another article.¹⁶

Data relating to patient demographics, clinical presentation, and patient-perspective costs were obtained before surgery. Each hernia was assessed by the operating surgeon, and inguinal hernias were classified preoperatively by Kingsnorth's method based on the size of the hernia (H1-H4) and obesity of the patient (F1-F4) (**Table 1**).¹⁷ Lichtenstein tension-free mesh repair was performed for all cases of inguinal hernia, using sterilized 100% polyester mosquito net mesh (Scotmas Group, Kelso, Scotland) and nylon sutures. All procedures were performed with the patient under local anesthesia except in young children or where the hernia was large and irreducible. Patients were discharged on the same day, and follow-up for wound checks was organized with the local hospital.

Health outcomes were calculated according to World Health Organization burden of disease equations.¹⁹ A framework for approximating utility weights, probabilities of survival without treatment, and incremental calculations based on McCord and Chowdhury was used,²⁰ informed by the opinions of one of us (A.N.K.) (Table 1). The spreadsheet to calculate DALYs is available from the authors.

The DALYs were calculated according to a discount rate of 3% with no age weighting, to be consistent with analyses in *Disease Control Priorities in Developing Countries*.²¹ Average life span data for each age were taken from sex-specific World Health Organization Model Life Tables for Ghana.²² If a patient had more than 1 hernia, the life expectancies and disability weights associated with the more severe-grade hernia were used in the reference case. Underlying DALY assumptions were tested in sensitivity analysis, along with scenarios that considered the effect on health according to total inguinal hernias repaired and the effect if treatment were provided within 1 year of onset.

Costs were calculated from a provider perspective, consisting of variable costs (associated with utilization and volume driven) and fixed costs (independent of patient volume). A sensitivity analysis from the patient perspective was performed, replacing variable costs to the provider with patient out-of-pocket costs. Inclusion of the "shadow price" of European surgeon salaries²³ and exclusion of patients with costs 1.96 SDs from average were also tested in 2 separate sensitivity analyses. Cost components from previous years were converted to US dollars by means of year-average exchange rates²⁴ and inflated to 2008 by using the US gross domestic product deflator.²⁵



Figure 1. Large inguinal hernia. These hernias can be several centimeters in diameter and debilitating, affecting a person's ability to maintain a livelihood and function normally in everyday life.

Resource use for variable costs was recorded prospectively. Unit costs were drawn from the International Drug Price Indicator Guide,²⁶ Ghana Pharmaceutical Pricing Study,²⁷ the World Health Organization Choosing Interventions That Are Cost-effective (WHO-CHOICE) project,²⁸ an unpublished US Agency for International Development report,²⁹ and catalog prices from local and international medical suppliers. Out-of-pocket costs were collected in a patient survey after treatment, which included both direct and indirect costs of treatment seeking.

Fixed costs were annualized according to factors corresponding with the life span of the component,²³ based on values from WHO-CHOICE,²⁸ and prorated to a 5-day time frame. Building improvements included the construction of the hernia treatment center at Takoradi and refurbishments to the remaining 3 hospitals. Furniture and equipment costs were based on standard requirements for a facility found in the region by the Operation Hernia team. Utilities consisted of water and electricity, accounting for a backup diesel generator. Figures from Gosselin and colleagues³⁰ were used to represent costs for land purchase, hospital construction, and building and equipment maintenance. A media campaign of 120 radio minutes was included.

Incremental cost-effectiveness ratios were calculated by comparing hernia repair with a hypothetical no-treatment scenario. The impact of variation in patient-level costs and health outcomes was represented by using probabilistic sensitivity analysis according to standard Monte Carlo simulation (10 000 iterations).²³ Cost-effectiveness acceptability curves were generated to show the robustness of policy recommendations according to variations in valuation of healthy life-years. Several sensitivity analyses were conducted, evaluating variations in DALY assumptions, the patient perspective, excluding cost out-

Table 1. Metrics Used to Value Health Outcomes

Inguinal Hernia Grade ^a	Probability of Death if Left Untreated, %	Disability Weight	Years Lived if Left Untreated	No. (%) of Hernias ^b	Definition
H1	<5	0	10	31 (25.0)	Groin only, reduces spontaneously when lying down
H2	5-19	0.1	10	18 (14.5)	Groin only, reduces completely with gentle manual pressure
H3a	20-49	0.5	4	21 (16.9)	Inguinoscrotal, reducible with manual manipulation
H3b	Same as H3a	Same as H3a	Same as H3a	28 (22.6)	
H3c	50-74	0.5	4	9 (7.3)	
H4a	75-94	0.8	2	3 (2.4)	Irreducible
H4b	≥95	1.0	2	5 (4.0)	
H4c	Same as H4b	Same as H4b	Same as H4b	9 (7.3)	

^aClassification based on Kingsnorth¹⁷ and Sanders et al.¹⁸ Subgrades are defined as follows: a, less than 10 cm; b, 10 to 20 cm; and c, greater than 20 cm. Patients were also graded according to obesity, defined in terms of subscapular skin fold thickness: F1, less than 15 mm (39 patients); F2, 15 to 25 mm (68 patients); F3, 26 to 35 mm (6 patients); and F4, greater than 35 mm (0 patients).

^bThere were 124 hernias in 113 patients.

Table 2. Descriptive Statistics

Characteristic	No. (%) (n=113)
Male sex	107 (94.7)
Occupation	
Professional ^a	7 (6.5)
Tradesman ^b	18 (16.8)
Merchant ^c	12 (11.2)
Laborer ^d	17 (15.9)
Student	12 (11.2)
Farmer	21 (19.6)
Fisherman	7 (6.5)
Retired	11 (10.3)
Unemployed/disabled	2 (1.9)
Mean (range)	
Age	40 (3 mo to 80 y)
Family size, No.	6 (1-20)
Hours worked per day	7 (0-13)

^aAccounts officer, missionary, nurse, operations clerk, teacher, or wood company supervisor.

^bBuilder, carpenter, electrician, mechanic, operations clerk, plumber, stonemason, vulcanizer, or welder.

^cBookseller, barber, caterer, clothing salesman, fishmonger, launderer, salesman, seamstress/tailor, telecommunications worker, or trader.

^dCleaner, concierge, driver, laborer, security guard, seafood processor, or stonemason.

liers (>2 SDs from the mean), including the oldest 25% of patients, and including the oldest 25% with H1 or H2 hernias only.

RESULTS

Descriptive statistics and occupational status are shown in **Table 2** for the 113 patients who underwent inguinal hernia repair. The average age (range) of patients was 40 years (3 months to 80 years), compared with an average life span in Ghana of 60 years.²⁵ Of these patients, 107 (94.7%) were male, of whom 60 (56.1%) were fathers, with an average family size of 6 (1-20).

The number and frequency of each hernia grade are shown in Table 1. Of these, 120 (94.5%) were primary hernias, and 7 (5.5%) were recurrent. From data collected on 124 hernias, 106 (85.5%) were reducible, 17 (13.7%) were irreducible, and 1 (0.8%) was obstructed. Sixteen of the 113 patients (14.2%) reported vomiting,

Table 3. Sensitivity Analysis of DALY Calculations

	DALYs Averted	% of Baseline
Reference Case Calculation		
DALY (3, 0) ^a	1052	Baseline
DALY (0, 0)	1726	164
DALY (6, 0)	714	68
DALY (3, 1)	1157	110
Considering Each Hernia Individually		
DALY (3, 0)	1096	Baseline
DALY (0, 0)	1793	164
DALY (6, 0)	744	68
DALY (3, 1)	1213	111

Abbreviation: DALY, disability-adjusted life-year.

^aNumbers in parentheses are the discount rate (*r*) and the age-weighting modulating factor (*K*), respectively.³¹

with 85 (75.2%) reporting pain. The median time that patients had lived with their hernia was 3 years, with the longest duration being 42 years. Seventy-one of 112 patients (63.4%) reported limitations in activities such as recreation, occupation, or procreation, and 39 (34.8%) reported limitations in 2 or more areas. Ten of the total 113 patients (8.8%) reported having a limitation in daily living such as bathing, cooking, walking, or housework.

Mosquito net mesh was used to repair 107 inguinal hernias (86.3%), including 22 bilateral inguinal hernias (17.7%), with the rest being corrected by herniotomy (15 cases [12.1%]), by reinforcement of previous mesh (1 case [0.8%]), or without mesh (1 case [0.8%]). Local anesthesia was used for 81 of the 113 patients (71.7%), specifically lidocaine hydrochloride, 1%, or bupivacaine hydrochloride, 0.5% or 0.25%, and epinephrine, with general anesthesia being used in the remaining 32 (28.3%). The average duration of each operation was 50 minutes (shortest, 20 minutes; longest, 2 hours). Seventy-one patients (62.8%) received intraoperative medication, most commonly meperidine hydrochloride or a combination of other analgesics and nonsteroidal anti-inflammatory drugs.

We calculated DALYs with a discount rate (*r*) of 3 and an age-weighting modulating factor (*K*) of 0 in the reference case, with an average of 9.3 (95% confidence interval [CI], 8.0-10.7) DALYs averted per person and 1052 (902-1204) total DALYs averted in the study (**Table 3**).

Table 4. Treatment-Seeking Factors and Patient-Perspective Costs

	No. (%) ^a
Mean (range)	
Distance traveled, km	6 (0.2-97)
Time since medical consultation, mo	2 (0-180)
Treatment-seeking factors	
Radio	64 (50.8)
Medical recommendation	31 (24.6)
Personal recommendation	30 (23.8)
Pain	54 (42.9)
Interference with daily activities	34 (27.0)
Other (television, friend, boss)	9 (7.1)
Patient believed treatment was affordable	80 (71.4)
Management of costs	
Self	84 (74.3)
Family	23 (20.4)
Loan	5 (4.4)
Savings	7 (6.2)
Sold possessions	5 (4.4)
Friends	1 (0.9)
Services forgone owing to cost	24 (21.8)
Costs per patient, \$	
Indirect costs (% of total costs)	3.17 (4.2)
Transportation (% of indirect costs)	3.15 (99.4)
Food (% of indirect costs)	0.02 (0.6)
Direct costs (% of total costs)	72.01 (95.8)
Total Costs	75.18 (100.0)

^aSeveral patients indicated more than 1 treatment-seeking factor as influencing their decision to receive surgery. Several patients used more than 1 source to finance their surgery.

Of these, 39% were attributable to years of life lived with disability and 61% due to years of life lost. Varying discounting to 0% and 6% had a significant effect on results, ranging from 714 to 1726 DALYs averted. Introducing age weighting increased the DALYs averted by 10%.

Years of life lived with disability incurred before surgery were not included in calculations, leading to a conservative estimate of the impact of an established program. A program that addresses hernias during the same year of onset would avert 25 (2.4%) more DALYs because of fewer years lived with disability. In addition, DALYs were calculated only for the most severe hernia in the reference case. If DALYs are calculated for each inguinal hernia that was repaired (both hernias when bilateral), 43 (4.1%) more are averted relative to the baseline.

Treatment-seeking factors and out-of-pocket costs are presented in **Table 4**. Institutional financing most commonly came from insurance (40 of 113 patients [35.4%]). Of 112 patients who responded, 41 (36.6%) had to resort to coping mechanisms, and 24 of 110 patients (21.8%) reported that services were forgone because of cost. Sixty-one patients spent an average of \$5.83 on transportation (\$3.15 sample average), and 3 patients spent an average of \$0.81 on food (\$0.02 sample average). No patient with an inguinal hernia stayed in the hospital overnight. Patients reported direct out-of-pocket costs to be \$72.01 on average.

The average variable cost from the provider perspective was \$111.02 per patient (**Table 5**). These costs were almost exclusively intraoperative and personnel because only small amounts of painkillers and antibiotics were re-

Table 5. Provider-Perspective Variable Costs

Cost Component	Value, \$	% of Total Costs
Intraoperative costs	89.95	81.0
Laboratory tests ^a	8.83	9.8 ^b
Nondisposable ^c	19.09	21.2 ^b
Disposable ^d	60.98	67.8 ^b
Medications ^e	1.05	1.2 ^b
Postoperative costs	2.28	2.1
Personnel	18.79	16.9
Total Costs	111.02	100.0

^aSickle cell test and complete blood cell count.

^bPercentage of intraoperative costs.

^cScalpel, forceps, scissors, retractor, needle holder, dish, and sharps bin.

^dGloves, syringes, cetrimide and chlorhexidine gluconate antiseptic cream + alcohol, blades, diathermy, drapes, gauze, dressings, sutures, masks, hats, needles, gowns, mesh, cannulas, endotracheal tubes, and giving sets (fluid-administration apparatuses).

^eLidocaine hydrochloride, bupivacaine hydrochloride, meperidine hydrochloride, ibuprofen, acetaminophen, ketamine hydrochloride, midazolam hydrochloride, sodium thiopental, succinylcholine chloride, tramadol hydrochloride, lanoxin, halothane, nitrous oxide-oxygen, meloxicam, diclofenac, and diazepam.

Table 6. Fixed Costs

Cost Component ^a	Value, \$	% of Total ^b
Building improvements	215.05	21.1
Furniture and equipment	209.73	20.6
Utilities	260.75	25.6
Facility construction and maintenance ^c	312.02	30.7
Radio campaign	19.57	1.9
Total	1017.12	100.0

^aAnnuitization factors included hospital addition and refurbishment (annuitization factor, 10), utilities equipment (10), beds (10), doors (9.3), air conditioning (7.5), windows (7), chairs (6.5), and lighting (5).

^bBecause of rounding, percentages do not sum to 100.

^cFacility costs extrapolated from Gosselein et al³⁰ and based on a 90-bed hospital.

quired after surgery. Disposable items accounted for the bulk of intraoperative costs. Fixed costs amounted to \$1017.12 (\$9.00 per patient) (**Table 6**). These costs were relatively evenly distributed across categories.

Cost-effectiveness was calculated from provider and patient perspectives (**Table 7**). From a patient perspective, each patient cost an average of \$102.88 (95% CI, \$88.47-\$117.29) and averted an average of 9.32 (8.0-10.7) DALYs. From a provider perspective, each patient cost an average of \$120.02 (95% CI, \$117.66-\$122.39), leading to an incremental cost-effectiveness ratio of \$12.88 per DALY averted (\$10.98-\$14.78), which compares favorably with a ceiling ratio of \$590, the per-capita gross national income of Ghana.²⁵ The acceptability curve shows that this result is robust to fluctuations in the ceiling ratio, with cost-effectiveness being 95% certain above a valuation of life of \$14.66 per DALY averted (**Figure 2**). Results remain cost-effective even when only 2% of DALYs are averted at baseline parameterizations, or only one-fifth of a DALY is averted per patient. Results were robust to all sensitivity analyses except for the cohort of 7 patients older than 58 years with H1 hernias (Table 7).

Table 7. Cost-effectiveness Outputs

	Cost per Patient, \$	DALYs Averted	ICER, \$	% of Baseline
Reference case: provider perspective	120.02	9.32	12.88	Baseline
Sensitivity analyses				
Patient perspective	102.88	9.32	11.04	85.7
DALY (0, 0) ^a	120.02	15.29	7.85	60.9
DALY (6, 0)	120.02	6.33	18.96	147.2
DALY (3, 1)	120.02	10.27	11.69	90.9
European surgeon costs	274.56	9.32	29.46	228.7
Excluding cost outliers (n=105)	120.12	9.63	12.47	96.8
All patients with hernia grade H1 (n=27)	115.07	0.30	383.57	2978.0
Older patients (>58 y) (n=24)	119.77	4.17	28.72	223.0
Older patients, H1 and H2 only (n=11)	118.07	0.39	303.74	2350.5
Older patients, H1 only (n=7)	115.56	0.10	1155.60	8972.0

Abbreviations: DALY, disability-adjusted life-year; ICER, incremental cost-effectiveness ratio.

^aNumbers in parentheses are the discount rate (*r*) and the age-weighting modulating factor (*K*), respectively.³¹

^bSee Table 1 for the hernia grade classification system.

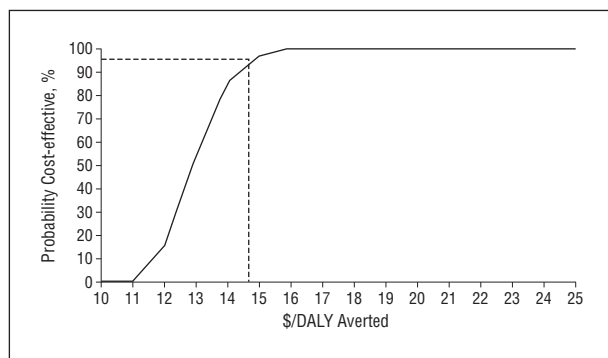


Figure 2. Cost-effectiveness acceptability curve. Inguinal hernia repair is cost-effective with 95% certainty when the value of a healthy year of life is greater than \$14.66 (vertical line). DALY indicates disability-adjusted life-year.

COMMENT

This study demonstrated that mosquito net–based tension-free repair of inguinal hernia was cost-effective relative to no treatment at a rural district hospital in Ghana. Results were robust to sensitivity analysis, remaining cost-effective even if 45.81 times fewer DALYs are averted relative to reference case conditions. Qualified surgeons performed operations at a high level of quality and efficiency. Local anesthetic was used, in keeping with evidence and recommendations,³²⁻³⁴ eliminating the need for hospital stays. Use of mosquito net mesh eliminated the higher cost of manufactured varieties.³⁵ The number of DALYs averted was substantial because 60% of hernias were H3 or H4, which increases the probability of bowel strangulation and death without treatment.³⁶ Patient demand was high because of effective advertising, high hernia prevalence, and low out-of-pocket costs, allowing capital costs to be widely distributed.

The benefits of this program extended beyond those included in this analysis. Economies of scale can be expected, such as the use of capacities to address other types of hernias and life-threatening conditions. Furthermore, 62 patients lost time from work because of their hernias (average, 98 days), and 4 caregivers lost an av-

erage of 2.25 days, totaling \$42 641.90 in lost wages not accounted for in our cost-effectiveness calculations. The program provided a unique training opportunity for both the European and African practitioners³⁷ and has stimulated participation among a growing number of surgical teams from other countries. Several articles document levels of interest and incentives surgeons and trainees recognize in international work through programs such as Operation Smile and medical school residency programs.³⁸⁻⁴²

Limitations of DALYs are described elsewhere,^{43,44} and empirical research to support the DALY weights in our calculations is an area for further research. Our estimates are based on methodologic precedent from other studies in the absence of evidence.^{20,30} However, a “watch and wait” approach to repairing large hernias is not recommended, and our results remain cost-effective within limits for health outcomes that extend beyond what is medically plausible.

There is little evidence to predict the outcomes of untreated hernias, which often follow the pattern of irreducibility, incarceration, and strangulation. The literature on strangulation risks focuses on newly diagnosed hernias, usually classified as H1 or H2,⁴⁵⁻⁴⁸ although it is recognized that risks may increase in patients with long histories.³⁶ One study found that 30% of hernias became irreducible at 10 years,⁴⁹ and another found that hernias lasting less than 60 months had a 8.6% chance of becoming irreducible.⁴⁵ Historical accounts of larger hernias among soldiers serving in the British Army before surgical techniques existed describe them as “by far the greatest wastage in the army.”⁵⁰ Whether this wastage was due to death is not mentioned, but these men had access to trusses to reduce and control the hernia, a device unavailable to most African patients. Unsupported hernias are not reduced during daily activities and heavy work, leaving them at great risk of severe outcomes.

Few complications arose after the mission, and all were treated conservatively by a registered nurse without hospitalization. At 6 weeks after surgery, 4.4% of patients returned with hematomas and 1.7% with wound infections, which were managed successfully with antibiotics. These findings were comparable to published evi-

dence. In Scotland, 7% of patients developed wound hematomas within 3 months after surgery,⁵¹ and 5% to 8% developed wound infections despite antibiotic prophylaxis.^{51,52} The cost of managing complications is not included in this analysis but is expected to be negligible because of their infrequency and the fraction of nurse time required. No cases of recurrence or mesh rejection were reported in our study after 6 months.

Evidence showing the return on alternative investments is considered important for clinical and health policy decisions, both in the World Health Organization and at the country level in Africa.^{12,28} Ghanaian health policy makers specifically consider cost-effectiveness a top criterion for choosing between health care programs.⁵³ Previous evidence in resource-constrained settings has shown favorable cost-effectiveness for district hospitals,^{20,30} with surgical interventions accounting for as many as 60% of the DALYs averted.²⁰ The only evidence that currently exists on the cost-effectiveness of hernia repair is \$108 per year of life saved, on the basis of expert opinion.¹² Although current health system development in Ghana is focused on the Millennium Development Goals,⁵⁴ cost-effective interventions without supporting evidence at the time recommendations were made, such as hernia repair, should not be overlooked by the health system.

Improving accessibility of hernia repair should be a priority in international public health, both at the structural level and at the point of care, with particular attention paid to financing strategies. Out-of-pocket costs are the most significant barrier to elective surgery uptake in rural Ghana.⁵⁵ National health insurance was introduced in 2001 to protect people in both the formal and informal sectors, and all residents are required to subscribe or use an alternative source.⁵⁴ Hernia repair is an excellent candidate for this scheme, meeting the criteria defined by Musgrove⁵⁶ for public financing: a public good with constraints to patient demand, a cost-effective intervention with preferential benefit to the poor, and a form of protection against catastrophic costs where private insurance systems are inadequate. More detail on the case for prioritizing hernia repair in African health systems is presented in an accompanying article.⁵⁷

Strategies to improve accessibility are particularly needed in rural areas. In response, Ghana has earmarked \$5 million for incentives for health workers who choose to work in underserved areas of the country.⁵⁴ Several countries in Africa have created alternative cadres of health workers to increase the availability of surgery,⁵⁸ and evidence exists that quality of care outcomes can compare with those of physicians in some circumstances.⁵⁹ Given its lower cost, this strategy has been argued to be cost-effective,⁶⁰ although proper safeguards are needed to ensure quality standards,⁶¹ and nonphysicians should be used only for less complicated procedures.⁶²

Projections of future trends in the cost-effectiveness of hernia repair in Ghana are mixed. Cost-effectiveness of the program can be expected to improve as efficiencies are developed through program expansion. However, cost-effectiveness would be expected to worsen with the spread of human immunodeficiency virus

(HIV) if life spans decrease and the number of DALYs averted by each surgery is reduced. Prevalence of HIV in Ghana has increased from 2.4% to 3.6% between 1994 and 2003,⁶³ and evidence indicates that it is higher in patients undergoing surgery in Africa (11%-36%).⁶⁴ On the other hand, improving surgical capacity will be an important part of addressing HIV-related complications such as abscesses, fistulas, and Kaposi sarcoma as the epidemic spreads.⁷

In conclusion, Africa has the highest ratio of DALYs due to surgical conditions per 1000 people of any global region.³ Evidence from our study indicates that tension-free hernia repair can be cost-effective through international partnerships in a rural district hospital for all patients except those older than 58 years with H1 hernias. The health gains from this type of program can be significant, both in terms of disability and mortality averted, at costs that are affordable to patients and health systems. Larger-scale evaluation of the cost-effectiveness of inguinal hernia repair is warranted to inform recommendations that will scale up access to surgical services in Ghana and similar countries.

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Correspondence: Andrew N. Kingsnorth, MS, FRCS, Department of Surgery, Peninsula Medical School, Derriford Hospital, Plymouth PL6 8DH, England (andrew.kingsnorth@phnt.swest.nhs.uk).

Author Contributions: *Study concept and design:* Shillcutt, Clarke, and Kingsnorth. *Acquisition of data:* Clarke and Kingsnorth. *Analysis and interpretation of data:* Shillcutt, Clarke, and Kingsnorth. *Drafting of the manuscript:* Shillcutt and Kingsnorth. *Critical revision of the manuscript for important intellectual content:* Shillcutt, Clarke, and Kingsnorth. *Statistical analysis:* Shillcutt. *Obtained funding:* Clarke and Kingsnorth. *Administrative, technical, and material support:* Shillcutt, Clarke, and Kingsnorth. *Study supervision:* Kingsnorth.

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INVITED CRITIQUE

Surgeon, Do You Know Where Your DALYs Are?

(Can You Fix a Hernia With a Mosquito Net?)

This excellent article introduces surgeons to the concept of DALYs—a metric that, in simple terms, quantifies the gap between current health status and an ideal health situation in which the entire population lives to an advanced age, free of disease and disability. The DALYs measure the outcome of an intervention in terms of the amount of reduction of premature death or disability. While the bulk of the world's public health care resources have been appropriately focused on the devastating infectious disease burdens of AIDS, malaria, and tuberculosis, the burden and distribution of surgical disease remain largely unknown and neglected. The authors demonstrate the importance of assessing surgical disease in the language of our public health policy makers. Until we merge our languages, we will not be effective advocates of eradicating surgical disease from a public health perspective and will not influence the resource allocation decisions.

It has often been assumed, primarily by nonsurgeon evaluators, that the costs of providing surgical services are prohibitive. However, the authors indicate that, especially where labor is inexpensive, only basic skills and equipment are needed to sustain essential surgical services, such as cesarean section and hernia repair.

Inguinal hernia repair, for example, is a commonly performed operation. If death from strangulated hernia is prevented in a young person in the prime of his or her life, then a significant number of disability-free years are added to that person's life.

In this article, the authors not only assess the costs and outcomes of hernia repair in terms of DALYs averted but also describe a fabulously clever, inexpensive, and context-appropriate way to treat this specific surgical disease: using locally available mosquito netting and local/regional anesthesia. As we in the United States begin the conversation about the cost-effectiveness of interventions, DALY-type analyses will be necessary to inform our decision making.

Diana L. Farmer, MD

Author Affiliation: Division of Pediatric Surgery, University of California, San Francisco.

Correspondence: Dr Farmer, Division of Pediatric Surgery, Fetal Treatment Center, University of California, San Francisco, 513 Parnassus Ave, Room HSW1601, Campus Box 0570, San Francisco, CA 94143 (diana.farmer@ucsfmedctr.org).

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