Articles

Catastrophic expenditure to pay for surgery worldwide: a modelling study

Mark G Shrime, Anna J Dare, Blake C Alkire, Kathleen O'Neill, John G Meara

Department of Global Health
and Population, Harvard
School of Public Health,
Boston, MA, USA
(M G Shrime MD); King's Centre
for Global Health, King's Health
Partners, King's College
London, London, UK
(A J Dare MBChB); Department
of Otology and Laryngology,
Harvard Medical School,
Boston, MA, USA (M G Shrime,
B C Alkire MD); Office of Global
Surgery, Massachusetts Eye
and Ear Infirmary, Boston, MA,
USA (M G Shrime, B C Alkire);
University of Pennsylvania
Medical School, Philadelphia,
PA, USA (K O'Neill BS); Program
in Global Surgery and Social
Change, Department of Global
Health and Social Medicine,
Harvard Medical School,
Boston, MA, USA (M G Shrime,
B C Alkire, J G Meara MD); and
Department of Plastic and Oral
Surgery, Boston Children's
Hospital, Boston, MA, USA
(J G Meara)

Correspondence to:
Dr Mark G Shrime, Massachusetts
Eye and Ear Infirmary,
243 Charles Street, Boston,
MA 02114,USA
shrime@mail.harvard.edu

Summary

Background Approximately 150 million individuals worldwide face catastrophic expenditure each year from medical costs alone, and the non-medical costs of accessing care increase that number. The proportion of this expenditure related to surgery is unknown. Because the World Bank has proposed elimination of medical impoverishment by 2030, the effect of surgical conditions on financial catastrophe should be quantified so that any financial risk protection mechanisms can appropriately incorporate surgery.

Methods To estimate the global incidence of catastrophic expenditure due to surgery, we built a stochastic model. The income distribution of each country, the probability of requiring surgery, and the medical and non-medical costs faced for surgery were incorporated. Sensitivity analyses were run to test the robustness of the model.

Findings 3·7 billion people (posterior credible interval 3·2–4·2 billion) risk catastrophic expenditure if they need surgery. Each year, 81·3 million people (80·8–81·7 million) worldwide are driven to financial catastrophe—32·8 million (32·4–33·1 million) from the costs of surgery alone and 48·5 million (47·7–49·3) from associated non-medical costs. The burden of catastrophic expenditure is highest in countries of low and middle income; within any country, it falls on the poor. Estimates were sensitive to the definition of catastrophic expenditure and the costs of care. The inequitable burden distribution was robust to model assumptions.

Interpretation Half the global population is at risk of financial catastrophe from surgery. Each year, surgical conditions cause 81 million individuals to face catastrophic expenditure, of which less than half is attributable to medical costs. These findings highlight the need for financial risk protection for surgery in health-system design.

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Introduction

Access to health care is not always free, and its use commonly carries a risk of impoverishment. In many parts of the world, out-of-pocket payments for health care remain the predominant form of health financing.[1] About 150 million cases of catastrophic expenditure—defined as an expenditure of more than 40% of non-food household expenditure[2] or 10% of overall household expenditure[3]—occur each year as a result of accessing care.[2] Little is known, however, about the magnitude of catastrophic expenditure attributable to various parts of the health system—both worldwide and in countries at differing stages of development. In particular, the contribution of surgical care to catastrophic health expenditure has not previously been estimated.

Access to surgery is increasingly recognised as a crucial component of a functioning health system for countries at all stages of development.[4] About 30% of the global burden of disease is surgical,[5] and the delivery of basic, life-saving surgical care is highly cost-effective in both high-income countries and those of low and middle income.[6] However, cost-effectiveness at the population level does not necessarily translate into affordability for an individual patient. In the absence of financial risk protection measures, accessing surgery can be catastrophically expensive for patients. Because common effectiveness measures (such as quality-adjusted or disability-adjusted life years) do not explicitly capture the potentially impoverishing effects of care, these financial effects on individuals have tended to be overlooked. The need for surgical care can be time-critical, unpredictable, and resource-intensive, so surgery is difficult to plan or save for. In addition, treatment seeking is more impoverishing for surgical conditions than for other conditions.[7]

As well as the financial burden of paying for surgical services, individuals face the costs of getting to care. These non-medical costs of transportation, food, and lodging[8] are substantial and can themselves drive patients into poverty.[9] The high costs associated with accessing surgical care not only increase the chance of catastrophic health expenditure, but can also act to prevent health-seeking behaviour, especially among the poor.[10]

Protection of households against catastrophic health expenditure has emerged as a leading policy goal for global health. The WHO,[11] the World Bank,[12] and the UN[13] have lately renewed calls for the introduction of universal health coverage and the assurance of financial risk protection against the costs of illness. The World Bank stated that, "By 2030, no one should fall into poverty because of out-of-pocket health care expenses."[14]

A greater understanding of the financial catastrophe attributable to various health interventions, including surgical care, has therefore become necessary to inform policy. Our aim was to estimate the number of patients worldwide who experience catastrophic expenditure each year from accessing surgery. We also investigated how rates of catastrophic expenditure from surgery change according to national development status and individual wealth quintile. We postulated that a large portion of worldwide financial catastrophe caused by medical care would be attributable to surgery, and that this burden would fall most heavily on the poor.

Methods

Model construction

Several thresholds have been proposed for catastrophic expenditure. Here, we chose to use a threshold of 10% of overall household expenditure,[15] which we explored in sensitivity analyses.

An individual faces catastrophic expenditure when the out-of-pocket costs faced to access care are greater than this threshold. That is:

$$OOP \times c \geq t\gamma$$

where c is the total cost of a service, OOP the out-of-pocket proportion of that cost, γ household expenditure before care was sought, and t the threshold, expressed as a proportion of household expenditure, at which catastrophic expenditure is said to have occurred. For example, an individual whose expenditure before health care was sought was $1000 would face catastrophic expenditure if he or she had to pay more than $100 for health care.

The methodology behind the application of the equation to the world population is given in detail in the appendix. Briefly, the income distribution of a country's population was modelled, and the proportion of the population undergoing surgery estimated, by wealth quintile, from published data (see data sources, below, and appendix p 2–6). For individuals who need surgical services, an out-of-pocket cost was assessed. If that amount was greater than 10% of their preceding income, they were counted as having experienced catastrophic expenditure. This calculation was repeated across all countries to obtain a global estimate. To estimate the number of individuals at risk of catastrophic expenditure, the same calculation was repeated, with the probability of getting surgery factored out.

Data sources

World Bank data were used for each of the necessary variables in 199 countries. Household expenditure was used where available.[16] If it was not available, gross domestic product (GDP) per person[17] was used as a proxy. WHO-CHOICE estimates for the unit cost of a caesarean section were taken to represent costs of surgery,[18] an assumption that was tested in sensitivity analyses. According to WHO, this cost includes "initiation of labour at referral level, diagnosis of obstructed labour and referral, devices and medicines associated with caesarean delivery, operative facility time, medical human resources time, management of shock including hysterectomy and blood transfusion (assumed for 1% of procedures), postoperative hospital stay for stabilisation, programme administration, training, and the corresponding office space, electricity, and other services, as well as various standard consumables and equipment".[18] In probabilistic sensitivity analysis, a multiplier was applied to this cost. The reported cost for one country (Iceland) was a significant outlier. Its cost was taken as the result of a linear regression on its GDP per head.

Out-of-pocket expenditure was calculated as a proportion of total health expenditure.[19] The model was run with and without the inclusion of non-medical costs faced by patients when accessing surgical services (eg, transportation, lodging, food). When these costs were included, we used a conservative estimate consistent with estimates from Ethiopia,[20] Bangladesh,[7,21–23] India,[24–29] and Vietnam;[30] specifically, the non-medical costs were constructed as a multiplier to direct medical costs on the basis of these data, with the introduction of error from the varied estimates. This approach was examined in detail in sensitivity analyses, below. All costs, expenditure, and income estimates were adjusted to 2007 international dollars, by use of UN purchasing power parity conversion factors and World Bank GDP deflators, as previously described.[31] 2007 was chosen because it was the year for which the most robust primary data were available.

The probability of accessing surgery was taken from previously published estimates.[32] For countries in which estimates of cases per population were not available, regional estimates for countries with similar overall health-care expenditure per head were used instead. Similarly, when Gini indices for individual countries were not available, regional indices were used.[33] The

See **Online** for appendix

	Cases of catastrophic expenditure (95% PCI)
Base case (without non-medical costs)	32 768 603 (32 447 074–33 090 131)
Base case (including non-medical costs)	81 262 319 (80 793 101–81 731 536)
Increasing non-medical costs	145 395 830 (144 777 380–146 014 280)
Lowered threshold for catastrophic expenditure (without non-medical costs)	63 268 868 (61 608 121–64 929 614)
Lowered threshold for catastrophic expenditure (including non-medical costs)	119 781 104 (117 504 932–122 057 276)
Average cost of surgery halved (without non-medical costs)	7 692 269 (7 255 498–8 129 041)
Average cost of surgery halved (with non-medical costs)	28 034 971 (27 127 473–28 942 470)
Average cost of surgery doubled (without non-medical costs)	79 232 250 (77 546 379–80 918 122)
Average cost of surgery doubled (with non-medical costs)	135 634 968 (133 213 154–138 056 782)

PCI=posterior credible interval.

Table: **Cases of catastrophic expenditure per year, by assumption**