

Variability in mortality following caesarean delivery, appendectomy, and groin hernia repair in low-income and middle-income countries: a systematic review and analysis of published data

Tarsicio Uribe-Leitz, Joshua Jaramillo, Lydia Maurer, Rui Fu, Micaela M Esquivel, Atul A Gawande, Alex B Haynes, Thomas G Weiser



Summary

Background Surgical interventions occur at lower rates in resource-poor settings, and complication and death rates following surgery are probably substantial but have not been well quantified. A deeper understanding of outcomes is a crucial step to ensure that high quality accompanies increased global access to surgical care. We aimed to assess surgical mortality following three common surgical procedures—caesarean delivery, appendectomy, and groin (inguinal and femoral) hernia repair—to quantify the potential risks of expanding access without simultaneously addressing issues of quality and safety.

Methods We collected demographic, health, and economic data for 113 countries classified as low income or lower-middle income by the World Bank in 2005. We did a systematic review of Ovid, MEDLINE, PubMed, and Scopus from Jan 1, 2000, to Jan 15, 2015, to identify studies in these countries reporting all-cause mortality following the three commonly undertaken operations. Reports from governmental and other agencies were also identified and included. We modelled surgical mortality rates for countries without reported data using a two-step multiple imputation method. We first used a fully conditional specification (FCS) multiple imputation method to establish complete datasets for all missing variables that we considered potentially predictive of surgical mortality. We then used regression-based predictive mean matching imputation methods, specified within the multiple imputation FCS method, for selected predictors for each operation using the completed dataset to predict mortality rates along with confidence intervals for countries without reported mortality data. To account for variability in data availability, we aggregated results by subregion and estimated surgical mortality rates.

Findings From an initial 1302 articles and reports identified, 247 full-text articles met our inclusion criteria, and 124 provided data for surgical mortality for at least one of the three selected operations. We identified 42 countries with mortality data for at least one of the three procedures. Median reported mortality was 7·9 per 1000 operations for caesarean delivery (IQR 2·8–19·9), 2·2 per 1000 operations for appendectomy (0·0–17·2), and 4·9 per 1000 operations for groin hernia (0·0–11·7). Perioperative mortality estimates by subregion ranged from 2·8 (South Asia) to 50·2 (East Asia) per 1000 caesarean deliveries, 2·4 (South Asia) to 54·0 (Central sub-Saharan Africa) per 1000 appendectomies, and 0·3 (Andean Latin America) to 25·5 (Southern sub-Saharan Africa) per 1000 hernia repairs.

Interpretation All-cause postoperative mortality rates are exceedingly variable within resource-constrained environments. Efforts to expand surgical access and provision of services must include a strong commitment to improve the safety and quality of care.

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Introduction

Surgery is an essential component of a functioning, comprehensive health system, but also a high-risk intervention. Recent work has estimated that 312·9 million operations occur annually, with most taking place in upper-middle-income and high-income countries.¹ Countries with more than 35% of the world's population account for only 6·3% of the total operations, probably indicating a vast unmet need for surgical care in these settings. Additionally, the safety of such care is known to be extremely variable with a presumably high proportion of preventable deaths.²

Many health interventions in low-income and middle-income countries have focused on infectious diseases and maternal and child health. Substantial improvements have been made through programmes developed within growing health systems (eg, developing cadres of skilled birth attendants) or in parallel to poorly functioning ones (eg, vaccination campaigns and directly observed therapy for tuberculosis and HIV).^{3–8} However, populations traditionally affected by infectious diseases and malnutrition are now also faced with the health problems of industrialisation and ageing.⁹ Yet the

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See [Comment](#) page e138

Department of Surgery (T Uribe-Leitz MD, M M Esquivel MD, T G Weiser MD) and Stanford University School of Medicine, Stanford, CA, USA (J Jaramillo BA, L Maurer BA); Management Science and Engineering, Stanford University, Stanford, CA, USA (R Fu BE); Ariadne Labs: a Joint Center for Health System Innovation, Boston, MA, USA (Prof A A Gawande MD, A B Haynes MD); Department of Health Policy and Management, Harvard School of Public Health, Boston, MA, USA (Prof A A Gawande, A B Haynes); Department of Surgery, Brigham and Women's Hospital, Boston, MA, USA (Prof A A Gawande); and Department of Surgery, Massachusetts General Hospital, Boston, MA, USA (A B Haynes)

Correspondence to: Dr Thomas G Weiser, Department of Surgery, Section of Trauma, 300 Pasteur Drive, S067 Stanford, CA 94305, USA tweiser@stanford.edu

Research in context

Evidence before this study

Wide variability in postoperative mortality has been described in countries with substantial health and financial resources; however, little research has been done on the variability in postoperative mortality in low-income and middle-income countries. We searched OVID, PubMed, MEDLINE, and Scopus to identify articles published in 2000 or later that provided mortality information following caesarean delivery, appendectomy, and groin hernia repair in countries classified as either low income or lower-middle income (LMICs) by the World Bank in 2005, and included articles published in English, Spanish, or French that reported mortality following one of these interventions regardless of preoperative status, urgency of intervention, indication for procedure, or cause of death. We originally undertook this study as a result of our observations of excessively high death rates reported following surgery in LMICs, and recognised the need for a deeper understanding

of the range of mortality rates following surgery. Almost nothing has been written about this on a global scale.

Added value of this study

This study provides evidence of tremendous variability in mortality following three common operations, and signals a potential area for focused efforts to improve safety and quality of care. Compared with the Netherlands who have some of the lowest reported mortality in the world, we noted a relative risk of death following surgery as high as 22.2 for caesarean delivery, 2.4 for appendectomy, and 1.8 for groin hernia repair.

Implications of all the available evidence

Although several factors prevent direct comparisons of outcomes between rich and poor countries, the fact that the range in death rates amongst LMICs is so variable indicates that improvements are possible even with the resource constraints faced by many health systems.

sophisticated and coordinated care required to confront these health issues will require considerable health system development in the next few decades.^{10,11} Surgical care is particularly complex, and its performance requires organisation and management of several clinical and administrative departments within a facility. Because of this, access to surgical care is frequently absent, and typically low on the list of priorities for public health intervention. Additionally, services that are provided are of variable quality and might in fact contribute to health burden.¹²

Several barriers to improving surgical capacity exist. Surgery requires infrastructure and consumable and durable resources with an effective supply chain, advanced skills, and a robust training programme for providers, along with management practices that allow the coordination of complex care. Many health systems in resource-poor settings do not have capacity in at least one of these domains.^{13–15} As health systems improve surgical capacity, concerns regarding quality and safety will be ongoing. Previous studies in high-income nations have already shown significant differences in outcomes of surgical care, both between countries and within countries.^{16,17} Yet little focus has been paid to the outcomes of surgical care in low-income and middle-income countries. We aimed to assess surgical mortality following three common surgical procedures—caesarean delivery, appendectomy, and groin (inguinal and femoral) hernia repair—to quantify the potential risks of expanding access without simultaneously addressing issues of quality and safety.

Methods

Population and health data

We collected population, health, demographic, and economic information from the WHO for all 113 countries

classified as low or lower-middle income (LMICs) by the World Bank in 2005. We obtained total population size, life expectancy, maternal mortality ratios, under-5 mortality, physician and nursing density, number of hospital beds, gross domestic product, per capita expenditure on health, literacy rates, urban versus rural population size, and proportion of the population younger than 15 years. We also collected geographic information, including country size and road infrastructure, from the Central Intelligence Agency *World Factbook*.¹⁸ We further collected information about corruption from Transparency International, and financial inequality using the Gini coefficient, a measure of the inequality of income distribution, from the World Bank. We also categorised countries by the six WHO regions and by the 21 Global Burden of Disease (GBD) regions.

We expected surgical deaths would be increased in LMICs for one of five reasons: (1) prehospital delays that included geographic location, distance, transportation challenges, financing, cultural factors, and other care-seeking behaviours; (2) delays during hospital admission that included absence of financing, failure of appropriate triage, and cultural factors, stereotyping, and barriers inhibiting care for vulnerable populations; (3) infrastructure and resource limitations including absence of skilled providers, of durable and consumable goods, material, or medications, and of sterility and equipment; (4) absence of management and organisational structure including inability to organise services appropriately or provide guidance and direction for goal-oriented and outcomes-driven care and services; and (5) other unknown elements and components of care that affect health-seeking behaviour and service delivery.^{15,18–22} We chose country-level variables a priori to represent these issues as follows:

For the World Bank Open Data see <http://data.worldbank.org/>

For the Transparency International country corruption data see <http://www.transparency.org/country>

For the Global Burden of Disease data see <http://www.globalburden.org>

For the WHO Global Health Observatory data repository see <http://apps.who.int/gho/data/node.home>

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