

# Surgery as a Global Health Need

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Clin Colon Rectal Surg 2022;35:362–370.

## Abstract

Surgical care is now recognized as a fundamental component of universal health coverage. Unfortunately, most of the world is still without access to safe and timely surgical care, including 9 out of 10 people living in low- and middle-income countries (LMICs). Additionally, even in LMICs with sustainable surgical programs, surgical outcomes continue to lag behind those in high-income countries. In this article, we will provide a brief history and introduction to global surgery, an overview of the existing literature on global surgical outcomes, and a discussion surrounding the challenges to building surgical capacity and improving surgical outcomes in LMICs. In addition, we will discuss the existing frameworks for building surgical care into national universal healthcare plans and initiatives striving improve surgical outcomes in LMICs.

## Keywords

- ▶ global health
- ▶ surgery
- ▶ colorectal surgery
- ▶ surgical outcomes
- ▶ disparities

## Part A. Disparities in Surgical Care and Outcomes

### Introduction to Global Surgery

Global disparities in access to surgical care are extreme.<sup>1</sup> For decades, international organizations and funding agencies have focused on communicable diseases (for example diarrheal diseases, HIV/AIDS, malaria and tuberculosis) and maternal and child health, without considering surgical care as a realistic or cost-effective global health solution. The World Bank Disease Control Priorities Second Edition (DCP2), published in 2006, reported that 11% of total global disability-adjusted life years, or DALYs, are the result of surgical disease.<sup>2</sup> Despite growing awareness of the need for improved surgical services around the world, minimal progress was made. In 2008, Drs. Paul Farmer and Jim Yong Kim famously labeled surgery as “the neglected stepchild of global public health.”<sup>3</sup>

In 2015, the Global Surgery movement gained significant momentum. The Lancet Commission on Global Surgery (LCoGS) coordinated the publication of several landmark papers, which identified substantial inequities in access to safe surgical care. One of LCoGS major contributions to the literature was the Global Surgery 2030 report, which provided international stakeholders with the data and rational

to advocate for increased global health attention in surgical care. Updating DCP2’s estimate, the Global Surgery 2030 report established that up to 30% of the global disease burden may require surgery.<sup>1</sup> In fact, it was estimated that 16.9 million lives—nearly one-third of all deaths worldwide—may be lost annually from conditions requiring surgical care, and an additional > 320 million surgical procedures are needed to address this burden of surgical disease.<sup>4</sup> Furthermore, five billion people worldwide are without access to safe surgical care, including 9 out of 10 people living in low- and middle-income countries (LMICs). Of the 313 million surgical cases occurring each year, only 6.5% of them occur in the poorest third of the world. To address these inequities, the LCoGS proposed six indicators to promote organized research and advancement in global surgical services by 2030 1) access to timely essential surgery, 2) specialist surgical workforce density, 3) surgical volume, 4) perioperative mortality rate, 5) protection against impoverishing expenditure, and 5) protection against catastrophic expenditure (▶ **Table 1**).<sup>1</sup>

In the same year, as a result of several well-coordinated advocacy movements, the 68th World Health Assembly (WHA) adopted resolution WHA68.15, “Strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage.”<sup>5</sup> WHA68.15 was

**Table 1** Lancet commission on global surgery indicators

Indicator	Definition	Goal
Access to timely essential surgery	Proportion of the population who can access, within 2 hours, a facility that can provide cesarean delivery, laparotomy, and treatment of open fracture (Bellwether procedures)	A minimum of 80% coverage of essential surgical and anesthesia services per country by 2030
Specialist surgical workforce density	Number of specialist surgical, anesthetic, and obstetric physicians who are working per 100,000 population	100% of countries with at least 20 surgical, anesthesia, and obstetric physicians per 100,000 population by 2030
Surgical volume	Procedures done in an operating room, per 100,000 population per year	100% of countries by 2030 tracking volume; a minimum of 5,000 procedures per 100,000 population by 2030
Perioperative mortality	All-cause death rate before discharge	100% of countries by 2030 tracking postoperative mortality; in 2020, evaluate global data and set national targets for 2030
Protection against impoverishing expenditures for surgical care	Proportion of households protected against impoverishment from direct out-of-pocket payments for surgical and anesthesia care	100% protection against impoverishment from out-of-pocket payments for surgical and anesthesia care by 2030
Protection against catastrophic expenditures for surgical care	Proportion of households protected against catastrophic expenditure from direct out-of-pocket payments for surgical and anesthesia care	100% protection against catastrophic expenditure from out-of-pocket payments for surgical and anesthesia care by 2030

\*Adapted from Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development.<sup>1</sup>

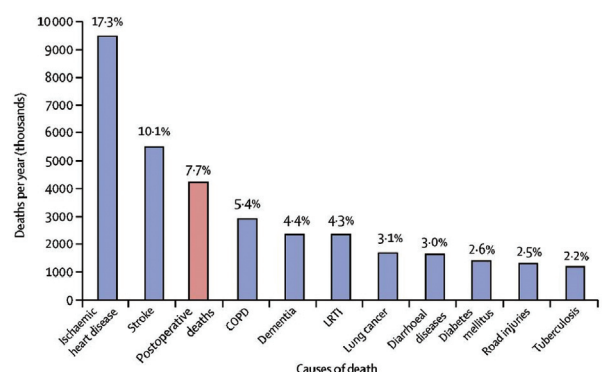
monumental as it was the first time the WHO and its member states recognized surgery and anesthesia as fundamental components of health systems strengthening. Finally, the World Bank's Disease Control Priorities 3 (DCP3) report, also published in 2015, asserted the necessity of bolstering global surgical systems and highlighted the cost-effectiveness of surgery in LMICs.<sup>6</sup>

The LCoGS, WHA68.15, and DCP3 were pivotal in acknowledging the importance of surgical care to promote health, well-being, and economic development. The ensuing years have been marked by rapid growth in academic global surgery activity, which has focused on understanding the burden of surgical disease, disparities in access to care, and best practices for bi-directional partnerships to augment surgical capacity in LMICs. Stemming from the LCoGS's work, the United Nations Institute for Training and Research (UNITAR), Harvard's Program in Global Surgery and Social Change (PGSSC) and the Global Surgery Foundation have proposed National Surgical Anesthesia Obstetric Plans (NSOAPs) as a method to guide national governments and ministries in creating locally relevant solutions to their unique surgical, obstetric and anesthesia (SOA) care delivery challenges.<sup>7</sup> Since establishing disparities in access to safe, timely surgical care, recent academic momentum is shifting to better understand disparities in global surgical outcomes.

### Surgical Outcomes: Introduction and Significance

Improving the safety of surgical care, measured by postoperative mortality and morbidity, must happen in tandem with increases in surgical capacity. Postoperative complica-

tions are associated with increased risk of postoperative mortality (within 30 days of surgery), higher treatment costs, shorter life expectancy and reduced quality of life.<sup>8</sup> Over 4 million deaths occur within 30 days of surgery every year. This staggering statistic places postoperative mortality third on the list of most common causes of death worldwide, after ischemic heart disease and stroke (►Fig. 1). In fact, postoperative deaths exceed those related to HIV, malaria and tuberculosis combined (2.97 million deaths). And as one might expect, these deaths are not equally distributed around the world. Although performing only a fraction of surgical cases, half of all postoperative deaths occur in LMICs.



**Fig. 1** Top ten global causes of death in 2016. Percentages are the proportion of total global deaths attributable to each cause. Data, except those on postoperative deaths, are from the Global Burden of Disease Study 2016.<sup>4</sup> COPD, chronic obstructive pulmonary disease. LRTI, lower respiratory tract infections.

Poor-quality, unsafe surgical care may now be a greater contributor to global mortality than lack of access to surgical care.

### Disparities in Global Surgical Outcomes

In 2007, the WHO's World Alliance for Patient Safety launched an initiative called Safe Surgery Saves Lives, which sought to foster improved surgical safety and reduce surgical deaths and complications through emphasis on 4 key areas: surgical site infection prevention, safe anesthesia, safe surgical teams and measurement of surgical services.<sup>9</sup> The initiative culminated in creation of the WHO Guidelines for Safe Surgery and WHO Surgical Safety Checklist, which is designed to "ensure that surgical teams consistently follow critical safety steps and thereby minimize the commonest avoidable risks that endanger the lives and wellbeing of surgical patients."<sup>9</sup>

While Safe Surgery Saves Lives and similar programs have worked to improve the safety of surgical care, data on surgical outcomes remain sparse in LMICs, as many facilities lack the research infrastructure to collect, analyze and report their outcomes. Studies of individual locations and disease processes have hinted at the disparate surgical outcomes worldwide. For example, maternal mortality following cesarean section in sub-Saharan Africa is up to 50 times higher than in high-income countries.<sup>10</sup> Surgical site infections (SSIs) are more than twice as common (OR: 2.57, 95% CI: 1.33–4.99) for patients undergoing appendectomy in low-income countries, compared with HICs.<sup>11</sup> Post-esophagectomy patients in LMICs face an almost 3-fold increase in 90-day mortality, compared with HIC (9.4% vs. 3.7%,  $p < 0.001$ ).<sup>12</sup> Likewise, burn patients face a significantly higher mortality in LMICs compared with HICs (17% vs. 9%;  $p < 0.001$ ), despite similar injury patterns and total body surface area involved.<sup>13</sup> Such studies offer a glimpse into global surgical outcomes, but fail to capture the magnitude of the disparity. A recent Delphi survey of surgical leadership in LMICs identified three priority research areas: (1) access to surgery, (2) outcomes of cancer surgery, and (3) perioperative care.<sup>14</sup>

In an attempt to better understand the global landscape for surgical outcomes, multiple international consortia have collected outcomes data through "snapshot" cohort studies in which patient-level data are collected for a short period of time. While these study designs have certain limitations (e.g., data quality control), they provide a necessary starting point to identify benchmarks, set priorities and goals, and measure progress toward them. ► **Table 2** summarizes the methods and results of these studies.<sup>15–22</sup> Collectively these studies highlight a few important points. First, data collection on surgical outcomes in LMICs is possible. Barriers and lessons learned from these studies can be expanded to establish longitudinal data collection programs aimed at improving the quality and safety of surgical care. Post discharge data are difficult to obtain and we still need sustainable solutions to understand how patients fare after they leave the hospital. Second, these studies demonstrate disparities in mortality and morbidity across the globe within and between countries and institutions at different resource levels highlighting

the need for local research and local solutions. With respect to morbidity, surgical infections bear a heavy burden in most LMICs. Lastly, a common theme in many of these studies is that of failure-to-rescue. Mortality after suffering a complication is high in many LMIC settings and is an area of research and improvement that has a potentially high impact. ► **Fig. 2**, highlights some of these key concepts from the GlobalSurg3 study.

### Capacity and Resource Constraints

Across the spectrum of healthcare services (not only surgical), Global Burden of Disease (GBD) data suggests that unsafe medical care ranks between the 14–20th leading cause of DALY loss worldwide, placing unsafe medical care in a comparable realm to tuberculosis and malaria.<sup>23</sup> For surgical diseases, poor-quality care may be a greater contributor to mortality than lack of access to care. The following sections will address several of the specific capacity and resource constraints to providing accessible, high quality surgical care in LMICs.

### Workforce

Workforce limitations have important repercussions for healthcare delivery. According to The World Health Report 2006: "Working Together for Health," the Americas and Europe have total health workforce densities ~6–10-fold higher than Africa, the Eastern Mediterranean and Southeast Asia.<sup>24</sup> The report estimated that 57 countries had critical shortages of doctors, nurses, and midwives at the time, defined as less than 2.5 providers per 1000 population or less than 80% of the required workforce.<sup>24</sup> In Africa, it was estimated that an additional 800,000 providers (140% expansion) were required to reach 80% of the required workforce. The Western Pacific and Southeast Asian nations likewise required significant expansion in medical workforce, requiring 32, 560 providers (119% expansion) and 1.1 million providers (50% expansion), respectively.<sup>24</sup> For surgery in particular, there is a drastic shortage of trained professionals in LMICs, where general surgeon density is reported to be between 0.13 to 1.57 per 100,000 population.<sup>25</sup> In contrast, the United States has 5.2 general surgeons per 100,000 population (plus many other trained surgical specialists). Although the global surgical workforce is growing, the rate of growth is not sufficient. If we continue at the current rate by 2035 4.9 billion people – or 70% of the world's population – will still be without access to safe surgical care.<sup>26</sup>

### Expenditure and Infrastructure

High-income countries spend on average \$2,937 USD per person on healthcare compared with \$41 USD per person in LMICs.<sup>27</sup> And in low-income countries, public spending on health is actually decreasing (from 7.9% to 6.8% in 2016). Although this decline in public healthcare spending may be attributed to an increase in foreign aid, it emboldens the concept that "prioritization [on health] is largely a collective choice made by societies, generally expressed by politicians empowered by their citizens." On a global scale, total

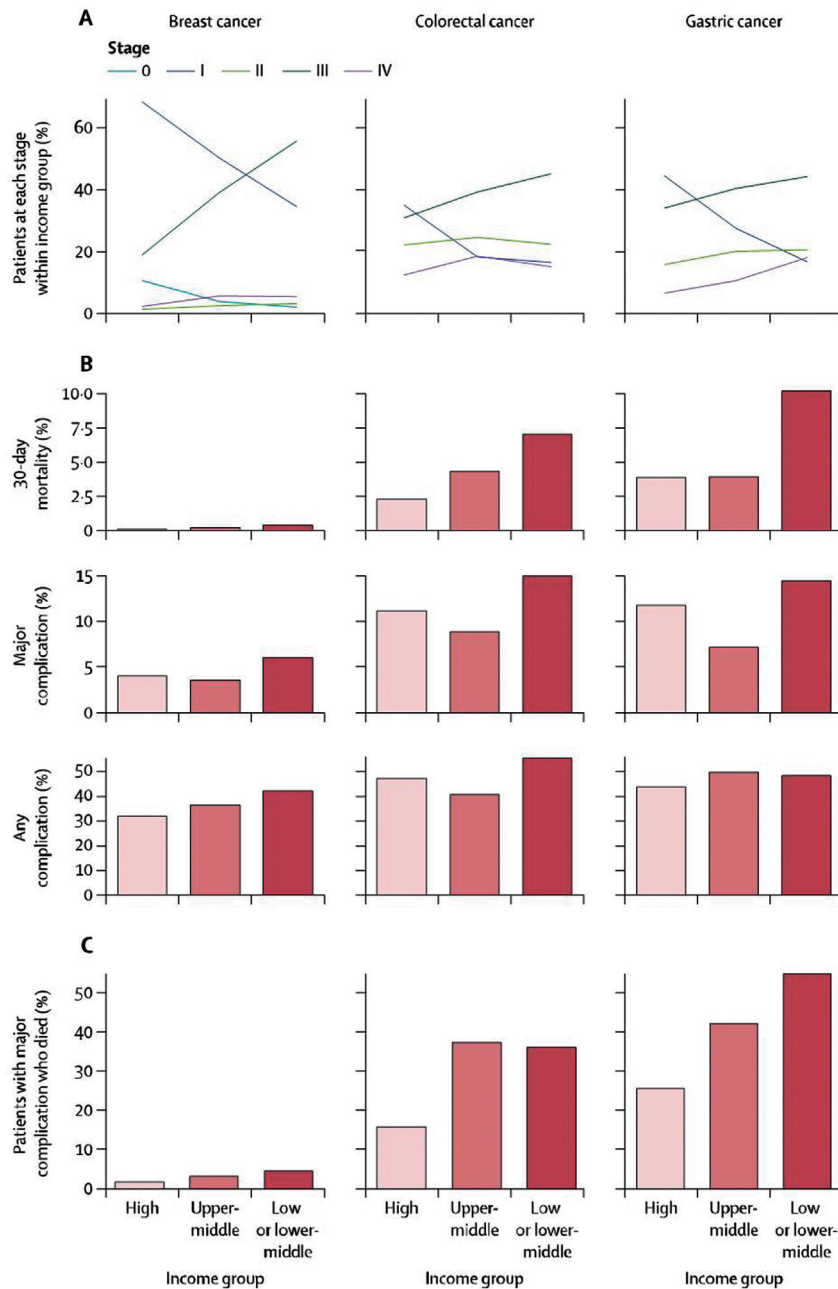
**Table 2** Summary of global surgery outcomes cohort studies

Study	Year	Methods	Study population	Study participants	Outcome measures	Findings
European Surgical Outcomes Study (EuSOS)	2011	Prospective, cohort study 7 days data collection	Adult (>16 years), non-cardiac surgical patients	498 hospitals 28 European nations N = 46,539	<u>Primary:</u> In-hospital mortality <u>Secondary:</u> LOS, ICU admission, duration critical care stay	In-hospital mortality: 4% (range: 1.2% to 21.5%) ICU admission: 8% LOS of 1-2 days (IQR 0.9–3.6) 1,358 (73%) patients who died were not admitted to critical care at any stage after surgery. Crude mortality rates varied widely between countries
International Surgical Outcomes Study (ISOS)	2015	Prospective, cohort study 7 days data collection	Adults (≥18 years) elective surgical patients with planned overnight stay	498 hospitals 27 countries (19 high-, 7 middle- and 1 low-income) N = 44, 814	<u>Primary:</u> In-hospital complications <u>Secondary:</u> In-hospital death, death following complications (failure to rescue)	16.8% developed in-hospital complications, 0.5% patients died before hospital discharge 2.8% overall failure to rescue. Overall mortality similar across income levels (0.4% in LMICs versus 0.5% in HICs) Failure to rescue higher in LMICs versus HICs (3.3% versus 2.6%, respectively)
GlobalSurg <sup>1</sup>	2016	Prospective, cohort study 14 days data collection	Any patient undergoing emergency intraperitoneal surgery (no age restrictions)	357 hospitals 58 countries N = 10,745 High: 6,538 Middle: 2,889 Low: 1,318	<u>Primary:</u> 24h postoperative mortality rate <u>Secondary:</u> 30-day postoperative mortality rate, postop complications and reintervention rate	1.6% overall 24h mortality rate: High: 1.1% Middle: 1.9% Low: 3.4% 5.4% overall 30-day mortality rate High: 4.5% Middle: 6.0% Low: 8.6% Mortality is three times higher in low- compared with high-HDI countries even when adjusted for prognostic factors.
ASOS	2018	Prospective, cohort study 7 days data collection	Adults (>18 years) undergoing inpatient surgery (elective and urgent/emergent)	247 hospitals 25 African countries Middle: 11 Low: 14 N = 11,422	<u>Primary:</u> In-hospital postoperative complications <u>Secondary:</u> In-hospital mortality	18.2% with postoperative complications (95% CI 17.4–18.9) of 10885 patients. 2.1% of patients died in-hospital, of which 225 94.1% occurred after the day of surgery. Infection was the most common complication - 10.2% of patients, of whom 9.7% died in-hospital.
GlobalSurg <sup>2</sup>	2018	Prospective, cohort study 14 days data collection	Any patient undergoing elective or emergency surgery including gastrointestinal resection (no age restrictions)	343 hospitals 66 countries N = 12,539 High: 7,339 (193 hospitals in 30 countries) Middle: 3,918 (82 hospitals in 18 countries)	<u>Primary:</u> 30-day surgical site infection (SSI) rate <u>Secondary:</u> 30-day postoperative mortality rate, perioperative antibiotic administration, 30-	Overall 12.3% had SSIs within 30 days of surgery. High: 9.4% Middle: 14% Low: 23.2% Patients from low-HDI countries were at greatest risk of SSI (adjusted odds ratio 1.60, 95% credible interval 1.05–2.37; <i>p</i> = 0.030). Resistant infections were common:

(Continued)

Table 2 (Continued)

Study	Year	Methods	Study population	Study participants	Outcome measures	Findings
GlobalSurg3	2021	Prospective, cohort study 28 days data collection	Adults (>18 years) undergoing surgery for primary breast, colorectal, or gastric cancer	Low: 1,282 (68 hospitals in 18 countries).  428 hospitals 82 countries N = 15,958 High: 9,106 Upper-middle: 2,721 Low- or lower- middle: 4,131	day postoperative reintervention rate, prevalence of antimicrobial resistance for SSI, in-hospital SSI incidence, 30-day SSI incidence  Primary: 30-day post-operative mortality and 30-day major complication Secondary: 30-day any complication (Clavien–Dindo grade I–V); 30-day unplanned reintervention, unplanned readmission to a health-care facility, cancer-specific complications, cancer treatment pathways, hospital-level care processes	High: 16.6% Middle: 19.8% Low: 35.9%  Breast cancer: Overall 0.2% and 5.9% 30-day mortality and major complication High: 0.1% and 5.2% Upper-middle: 0.2% and 4.7% Lower-middle and low: 0.4% and 7.6% Colorectal cancer Overall 3.3% and 14.4% 30-day mortality and major complication High: 2.3% and 14.2% Upper-middle: 4.3% and 11.3% Lower-middle and low: 7.0% and 19.1% Gastric cancer Overall 5.4% and 14.5% 30-day mortality and major complication High: 3.8% and 14.8% Upper-middle: 3.9% and 9.2% Lower-middle and low: 10.1% and 18.6%



**Fig. 2** Stage of presentation (A), 30-day mortality (B), and 30-day complications (C) by cancer and country income group. (A) Proportion of patients enrolled by cancer stage by country income group. (B) Proportion of patients dying or sustaining a major complication or any complication by day 30 after surgery stratified by country income group. (C) Proportion of patients sustaining a major complication who died within 30 days.

healthcare cost grows 3.9% per year, outpacing total GDP growth of 3.0% annually. Fortunately, global health public spending continues to grow steadily at ~4.3% per year (averaged from 2000 to 2017), which has actually allowed out-of-pocket spending to decrease. Low-income countries have seen out-of-pocket spending decrease from 50% to 41%. This still exceeds high-income and upper middle-income countries, where out-of-pocket spending is 22% and 31%, respectively. The lifeline for low-income countries is donor

funding, which while accounting for only 0.2% of total health spending globally, makes up 27% of health spending in low-income countries.

Increasing surgical and anesthesia workforce alone is not sufficient, as a host of allied professionals, diagnostic tools, surgical instruments, and operating theaters are also necessary to provide safe surgical care. Low-income countries have on average less than 2 operating theaters per 100,000 population, compared with the global average of 14.3 per



100,000 in North America and 25.1 theaters per 100,000 in eastern Europe. And a staggering number of operating theaters – 51% to 70% in sub-Saharan Africa – do not have access to basic equipment to provide safe surgical care, such as pulse oximetry.<sup>28</sup>

### Quality Improvement Programs

Expanding access to surgeons, operating theaters and surgical equipment is not sufficient to augment access to *safe*, surgical care in LMICs. Surgical safety is best measured by postoperative morbidity and mortality. Several HICs have successfully implemented surgical quality improvement programs that rely on systematically collecting risk-adjusted outcome data (mortality and morbidity). They use patient-specific data to benchmark postoperative outcomes, identify areas for improvement and implement targeted quality improvement initiatives. As an example, the American College of Surgeons' NSQIP program has led to decreases in postoperative morbidity and mortality by 45% and 27%, respectively, in less than three decades. Another impressive example is the Dutch Surgical Colorectal Audit (DSCA), which was initiated by the Association of Surgeons of the Netherlands (ASN) in 2009 to monitor and improve colorectal cancer care. In less than 10 years, postoperative mortality following colon and rectal cancer resections almost halved in the Netherlands (3.4 to 1.8% and 2.3% to 1.0% for colon and rectal cancers, respectively). In addition, after implementation of the DSCA, the proportion of low rectal cancer patients receiving a non-diverted primary anastomosis (rather than diverting stoma or end colostomy) was significantly increased, from 5.4% in 2011 to 14.4% in 2016.<sup>29</sup> These impressive figures demonstrate the value of collecting longitudinal, locally relevant data for quality improvement efforts.

Unfortunately, many LMICs are without a system to collect surgical outcomes data for quality improvement projects (QIP). QIPs require a systematic method to collect, analyze, and report risk-adjusted outcome data. As opposed to one-time data collection exercises, such as those described above, QIPs are set up for ongoing assessments and interventions, which are critical for sustained improvement. The exact barriers to collecting risk adjusted outcome data (mortality and morbidity) after surgery in LMICs remain largely unknown. Some barriers cited in the literature include poor data quality, lack of a dedicated research team, lack of material resources (computers, internet connectivity), and administrative personnel. Additionally, gaps in research funding often lead to gaps in data collection; this problem even affects the Kampala Trauma Registry—an outstanding model of longitudinal data collection in a low-income setting. Nevertheless, it is important that we prioritize standardizing outcome data collection in LMICs, if not for any other reason than because LMIC surgeons have identified it as a top priority to establish current quality baselines and measure the impact of future QI initiatives.

### Political Instability and Safety

Certain regions of the world have such volatile political climates that starting a medical career may not be feasible.

During conflict, facilities can become abandoned or destroyed, providers may be killed or flee to safer regions propagating the disparity of workers. As put by WHO, “Management systems collapse, working environments deteriorate and professional values decline...[where] health workers...slide into practices such as taking under-the-table fees or embezzling drugs.”<sup>24</sup> Studies have identified several factors which contribute to political instability, including demographics (population size, “youth bulge,” growth rate and mortality rate), development (GDP and life expectancy), and government. According to Fragility State Index (FSI) scores, sub-Saharan African countries have a score which ranges from 0–120. For comparison, the US has a score of 44, New Zealand 18, and France 32.<sup>30</sup> Although FSI scores are over twice as high in some cases, sub-Saharan Africa, has continued to become more stable over the past decades. Notably, there have been fewer armed conflicts – from 20 between 1990–2000 to 6 between 2000–2010—and most African countries have improved since 1995. This provides hope that as historically conflict-ridden regions become more stable, they can grow and create a healthcare system that provides care for all citizens regardless of where they live.

### Colorectal Surgeons in the Global Healthcare Field

There is a paucity of data regarding the role of colorectal surgeons in the global healthcare field. Many low-income and lower-middle-income countries do not have colorectal surgery as a defined subspecialty. Furthermore, most training programs in low-income and lower-middle-income countries do not have colorectal surgery residencies or fellowships. This is not due to a lack of colorectal diseases. In fact, colorectal diseases form a significant proportion of surgical diseases. This is mainly because within the scope of the shortage of surgical manpower, the greatest need is for “generalists” who can treat a broad spectrum of surgical pathologies. It would not make sense to spend scarce resources to train subspecialists when there are not enough general surgeons. It is, therefore, important to ensure that general surgeons in low-income and lower-middle-income countries have adequate training in the management of colorectal diseases. This can be done through collaborative efforts of developed countries working with facilities and individual surgeons in these regions to increase exposure to various techniques in the management of colorectal diseases. Organizations such as the West African College of Surgeons (WACS) can incorporate colorectal disease into the training curricula of their general surgical trainees. At some point in their development, there will be a need to create the subspecialty of colorectal surgery. The global community can be of immense help in this regard. By creating international fellowships, surgeons from low-income and lower-middle-income countries can benefit from additional training in HICs to help them gain expertise in the management of colorectal diseases. These individuals can then become the seed faculty to train others in their respective countries to help develop the specialty of colorectal surgery.

## Conclusions

Access to safe and timely surgical care is now recognized as a fundamental component of universal health coverage. Most of the world, however, is still without access to surgical, obstetrical and anesthesia care. In regions where such care is available, outcomes vary significantly by country income level. In this chapter, we have described many of the logistical and financial challenges to improving access to surgical care and surgical outcomes in LMICs. The need for surgical providers in LMICs is increasing at a faster rate than the pace of surgical training. Fortunately, the field of global surgery is also continuing to grow - more and more surgical trainees are seeking careers in global health and opportunities to participate in longitudinal international partnerships. To achieve universal access to safe surgical care in the coming decades, we rely on clear benchmarks, realistic goals and well-coordinated surgical quality improvement programs on both the national and local levels.

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