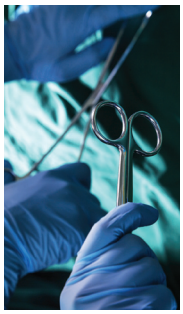

Chapter 1

Essential Surgery: Key Messages of This Volume

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VOLUME SUMMARY

Essential Surgery reflects an increased emphasis on health systems relative to previous editions of *Disease Control Priorities*. This volume identifies 44 surgical procedures as essential on the basis that they address substantial needs, are cost-effective, and can feasibly be implemented. This chapter summarizes and critically assesses the volume's key findings:

- Provision of essential surgical procedures would avert an estimated 1.5 million deaths a year, or 6 percent to 7 percent of all avertable deaths in low- and middle-income countries (LMICs).
- Essential surgical procedures rank among the most cost-effective of all health interventions. The surgical platform of first-level hospitals delivers 28 of the 44 essential procedures, making investment in this platform also highly cost-effective.
- Measures to expand access to surgery, such as task-sharing, have been shown to be safe and effective while countries make long-term investments in building surgical and anesthesia workforces. Because emergency procedures constitute 23 of the 28 procedures provided at first-level hospitals, such facilities must be widely geographically available.
- Substantial disparities remain in the safety of surgical care, driven by high perioperative mortality rates and anesthesia-related deaths in LMICs. Feasible measures, such as the World Health Organization's (WHO's) Surgical Safety Checklist (WHO 2008a), have led to improvements in safety and quality.
- The large burden of surgical conditions, the cost-effectiveness of essential surgery, and the strong public demand for surgical services suggest that universal coverage of essential surgery (UCES) should be financed early on the path to universal health coverage. We point to estimates that full coverage of the component of UCES applicable to first-level hospitals would require slightly more than $3 billion annually of additional spending and yield a benefit:cost ratio of better than 10:1. It would efficiently and equitably provide health benefits and financial protection, and it would contribute to stronger health systems.

INTRODUCTION

Conditions that are treated primarily or frequently by surgery constitute a significant portion of the global burden of disease. In 2011, injuries killed nearly 5 million people; 270,000 women died from complications of pregnancy (WHO 2014). Many of these injury- and obstetric-related deaths, as well as deaths from other causes such as abdominal emergencies and congenital anomalies, could be prevented by improved access to surgical care.

Despite this substantial burden, surgical services are not being delivered to many of those who need them most. An estimated 2 billion people lack access to even the most basic surgical care (Funk and others 2010). This need has not been widely acknowledged, and priorities for investing in health systems' surgical capacities have only recently been investigated. Indeed, until the 1990s, health policy in resource-constrained settings focused sharply on infectious diseases and undernutrition, especially in children. Surgical capacity was developing in urban areas but was often viewed as a secondary priority that principally served those who were better off.

In the 1990s, a number of studies began to question the perception that surgery was costly and low in effectiveness. Economic evaluations of cataract surgery found the procedure to be cost-effective, even under resource-constrained circumstances; Javitt pioneered cost-effectiveness analysis (CEA) for surgery, including his chapter on cataract in *Disease Control Priorities*, first edition (*DCP1*) in 1993 (Javitt 1993). In 2003, McCord and Chowdhury enriched the approach to economic evaluation in surgery in a paper looking at the overall cost-effectiveness of a surgical platform in Bangladesh (McCord and Chowdhury 2003). By design, *DCP2*, published in 2006, placed much more emphasis on surgery than had previous health policy documents. *DCP2* included a dedicated chapter on surgery that amplified the approach of McCord and Chowdhury and provided an initial estimate of the amount of disease burden that could be addressed by surgical intervention in LMICs (Debas and others 2006). *DCP3* places still greater emphasis on surgery by dedicating this entire volume (out of a total of nine volumes) to the topic. There is also a growing academic literature on surgery's importance in health system development; for example, Paul Farmer and Jim Kim's paper observes that "surgery may be thought of as the neglected stepchild of global public health" (Farmer and Kim 2008, 533). The WHO is paying increasing attention to surgical care through such vehicles as its Global Initiative for Emergency and Essential Surgical Care. Finally, the creation of *The Lancet* Commission on Global Surgery, now well into its work, points to a major change in the perceived importance of surgery.

The chapter seeks to do the following:

- Better define the health burden of conditions requiring surgery
- Identify those surgical procedures that are the most cost-effective and cost-beneficial
- Describe the health care policies and platforms that can universally deliver these procedures at high quality. In particular, *Essential Surgery* seeks to define and study a package of essential surgical procedures that would lead to significant improvements in health if they were universally delivered. This chapter and the volume focus on the situation of low-income countries (LICs) and lower-middle-income countries.

Box 1.1 describes the history, objectives, and contents of DCP3 (Jamison 2015).

DEFINITIONS

Health conditions cannot be neatly split between conditions that require surgery and those that do not. Different diagnoses range widely in the proportion of patients requiring some type of surgical procedure. At the upper end are admissions for musculoskeletal conditions; 84 percent of these patients underwent some type of surgical procedure in an operating room in the United States in 2010. At the lower end are admissions for mental health conditions (0.4 percent) (Rose and others 2014).

The surgical capabilities required are not only those related to performing operations. Surgical care also involves preoperative assessment, including the decision to operate; provision of safe anesthesia; and postoperative care. Even when patients do not need surgical procedures, surgical providers often provide care, such as management of severe head injuries and resuscitation for airway compromise and shock in patients with trauma. Such care occurs in contexts in which clinicians must be prepared to intervene operatively as complications arise or conditions deteriorate.

Within the limitations inherent in defining surgical conditions, *DCP3* has outlined, by consensus, a group of essential surgical conditions and the procedures and other surgical care needed to treat them. Essential surgical conditions can be defined as those that meet the following criteria:

- Are primarily or extensively treated by surgical procedures and other surgical care
- Have a large health burden
- Can be successfully treated by a surgical procedure and other surgical care that is cost-effective and feasible to promote globally (Bellagio Essential Surgery Group 2014; Luboga and others 2009; Mock and others 2010).

In most situations, procedures to treat these conditions, for example, cesarean section, can be done at first-level hospital—those that have 50–200 beds, serve 50,000–200,000 people, and have basic surgical capabilities.

Box 1.1

From the Series Editors of *Disease Control Priorities*, Third Edition

Budgets constrain choices. Policy analysis helps decision makers achieve the greatest value from limited available resources. In 1993, the World Bank published *Disease Control Priorities in Developing Countries* (*DCP1*), an attempt to systematically assess the cost-effectiveness (value for money) of interventions that would address the major sources of disease burden in low- and middle-income countries (Jamison and others 1993). The World Bank's 1993 *World Development Report* on health drew heavily on *DCP1*'s findings to conclude that specific interventions against noncommunicable diseases were cost-effective, even in environments in which substantial burdens of infection and undernutrition persisted.

DCP2, published in 2006, updated and extended *DCP1* in several respects, including explicit consideration of the implications for health systems of expanded intervention coverage (Jamison and others 2006). One way that health systems expand intervention coverage is through selected platforms that deliver interventions that require similar logistics but address heterogeneous health problems. Platforms often provide a more natural unit for investment than do individual interventions, and conventional health economics has offered little understanding of how to make choices across platforms. Analysis of the costs of packages and platforms—and of the health improvements they can generate in given epidemiological environments—can help guide health system investments and development.

The third edition of *DCP* is being completed. *DCP3* differs substantively from *DCP1* and *DCP2* by extending and consolidating the concepts of platforms and packages and by offering explicit consideration of the financial risk protection objective of health systems. In populations lacking access to health insurance or prepaid care, medical expenses that are high relative to income can be impoverishing. Where incomes are low, seemingly inexpensive medical procedures can have catastrophic financial effects. *DCP3* offers an approach that explicitly includes financial protection as well as the distribution across income groups of financial and health outcomes resulting from policies (for example, public finance) to increase intervention uptake (Verguet, Laxminarayan, and Jamison 2015). The task in all the volumes has been to combine the available science about interventions implemented in very specific locales and under very specific conditions with informed judgment to reach reasonable conclusions about the impact of intervention mixes in diverse environments. *DCP3*'s broad aim is to delineate essential intervention packages—such as the essential surgery package in this volume—and their related delivery platforms. This information will assist decision makers in allocating often tightly constrained budgets so that health system objectives are maximally achieved.

DCP3's nine volumes are being published in 2015 and 2016 in an environment in which serious discussion continues about quantifying the sustainable development goal (SDG) for health (United Nations 2015). *DCP3*'s analyses are well-placed to assist in choosing the means to attain the health SDG and assessing the related costs. Only when these volumes, and the analytic efforts on which they are based, are completed will we be able to explore SDG-related and other broad policy conclusions and generalizations. The final *DCP3* volume will report those conclusions. Each individual volume will provide valuable specific policy analyses on the full range of interventions, packages, and policies relevant to its health topic.

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However, treatments for some conditions, for example, cataract extraction, are primarily provided at higher level or specialized facilities. Table 1.1 lists the procedures that we define to be essential; this chapter addresses those conditions listed. We acknowledge that the list is not exhaustive, and other procedures might be considered as essential. For many countries, though, table 1.1 will provide a reasonable starting point for an essential surgical package, although there will be country-specific variations. Safe anesthesia and perioperative care are necessary components of all of these procedures.

KEY MESSAGES

This chapter synthesizes the main results of the individual chapters of *Essential Surgery* to provide broad directions for policy. The key messages deriving from our analysis are summarized and explained in the following sections and concern five categories of results: the surgically avertable disease burden, cost-effectiveness and economics, improving access, improving quality, and essential surgery in the context of universal health coverage (UHC).

Table 1.1 The Essential Surgery Package: Procedures and Platforms[a,b]

	Platform for delivery of procedure[c]		
Type of procedure	**Community facility and primary health center**	**First-level hospital**	**Second- and third-level hospitals**
Dental procedures	1. Extraction 2. Drainage of dental abscess 3. Treatment for caries[d]		
Obstetric, gynecologic, and family planning	4. Normal delivery	1. Cesarean birth 2. Vacuum extraction/forceps delivery 3. Ectopic pregnancy 4. Manual vacuum aspiration and dilation and curettage 5. Tubal ligation 6. Vasectomy 7. Hysterectomy for uterine rupture or intractable postpartum hemorrhage 8. Visual inspection with acetic acid and cryotherapy for precancerous cervical lesions	1. Repair obstetric fistula
General surgical	5. Drainage of superficial abscess 6. Male circumcision	9. Repair of perforations: for example, perforated peptic ulcer, typhoid ileal perforation 10. Appendectomy 11. Bowel obstruction 12. Colostomy 13. Gallbladder disease, including emergency surgery 14. Hernia, including incarceration 15. Hydrocelectomy 16. Relief of urinary obstruction: catheterization or suprapubic cystostomy	

table continues next page

Table 1.1 The Essential Surgery Package: Procedures and Platforms[a,b] (continued)

Type of procedure	Platform for delivery of procedure[c]		
	Community facility and primary health center	First-level hospital	Second- and third-level hospitals
Injury[e]	7. Resuscitation with basic life support measures	17. Resuscitation with advanced life support measures, including surgical airway	
	8. Suturing laceration	18. Tube thoracostomy (chest drain)	
	9. Management of non-displaced fractures	19. Trauma laparotomy[f]	
		20. Fracture reduction	
		21. Irrigation and debridement of open fractures	
		22. Placement of external fixator; use of traction	
		23. Escharotomy/fasciotomy (cutting of constricting tissue to relieve pressure from swelling)	
		24. Trauma-related amputations	
		25. Skin grafting	
		26. Burr hole	
Congenital			2. Repair of cleft lip and palate
			3. Repair of club foot
			4. Shunt for hydrocephalus
			5. Repair of anorectal malformations and Hirschsprung's Disease
Visual impairment			6. Cataract extraction and insertion of intraocular lens
			7. Eyelid surgery for trachoma
Nontrauma orthopedic		27. Drainage of septic arthritis	
		28. Debridement of osteomyelitis	

Sources: This list of essential surgical procedures is based on the authors' judgment in light of the burden, implementation feasibility, and cost-effectiveness information contained in *DCP3* volume 1, *Essential Surgery*. Earlier assessments of essential surgical interventions also provide useful information (WHO 2015b; Luboga and others 2009; Mock and others 2004, 2010).

a. Red type implies emergency procedure or condition.

b. All procedures listed in this table are discussed in *DCP3*, volume 1, *Essential Surgery*, with three exceptions, which will be covered in other *DCP3* volumes: male circumcision, visual inspection and treatment of precancerous cervical lesions, and eyelid surgery for ocular trachoma.

c. All of the procedures listed under community health and primary health centers are also frequently provided at first-level and second-level hospitals. All of the procedures under first-level hospitals are also frequently provided at second-level hospitals. The column in which a procedure is listed is the lowest level of the health system in which it would usually be provided. Not included in the table are prehospital interventions, such as first aid, basic life support procedures, or advanced life support procedures done in the prehospital setting. Health systems in different countries are structured differently, and what might be suitable at the various levels of facilities will differ. In this table, *community facility* implies primarily outpatient capabilities (as would be used to provide the elective procedures such as dental care), whereas *primary health center* implies a facility with overnight beds and 24-hour staff (as would be needed for procedures such as normal delivery). *First-level hospitals* imply fairly well-developed surgical capabilities with doctors with surgical expertise; otherwise, many of the procedures would need to be carried out at higher-level facilities. *Referral and specialized hospitals* (which could also be considered as second- and third-level hospitals) imply facilities that have advanced or subspecialized expertise for treatment of one or more surgical conditions, not usually found at lower-level facilities.

d. Treatment for caries can include one or more of the following, depending on local capabilities: silver diamine fluoride application, atraumatic restoration, or fillings.

e. Trauma care includes a wide variety of procedures. Not included in the list of essential procedures would be procedures that are more applicable at higher-level facilities: repair of vascular injury, open reduction and internal fixation, drainage of intracranial hematoma other than through burr hole, or exploration of neck or chest.

f. Trauma laparotomy applicable at first-level hospitals: exploratory laparotomy for hemoperitoneum, pneumoperitoneum, or bowel injury; specific procedures include splenectomy, splenic repair, packing of hepatic injury, and repair of bowel perforation.

Disease Burden Avertable by Essential Surgery

The conditions treated at least in part by the procedures in table 1.1 account for 4·7 million deaths (nearly 10 percent of all deaths) in LMICs (table 1.2). This figure is likely to be an underestimate; the burden of several common surgical conditions listed in table 1.1, for example, bowel obstruction or gallbladder disease, are not estimated as distinct entities in the WHO Global Health Estimates and hence not included in table 1.2. With UCES in LMICs, 1.5 million deaths per year could be averted (table 1.3), representing 6.5 percent of all avertable deaths in LMICs.

In comparison, *DCP2* estimated that 11 percent of the total global burden of death and disability was from conditions that were very likely to require surgery (Debas and others 2006; Laxminarayan and others 2006). The current estimates are based on a more rigorous estimation method and a more narrowly defined subset of essential surgical conditions (figure 1.1) that excludes other highly prevalent conditions often treated by surgery, such as cancer and vascular disease.

Obtaining more accurate estimates of the avertable burden from surgically treatable conditions will require broad agreement on a definition of the concept of avertable burden and the methods for its measurement. The steps taken in *Essential Surgery* should be regarded as preliminary. Better estimates of the avertable burden will require more systematic data gathering from hospitals and population-based surveys on the significant proportion of the world's people who lack access to surgical care. Such a survey recently conducted in Sierra Leone indicated that 25 percent of deaths might have been prevented with timely surgical care (Groen and others 2012). Similar studies need to be repeated more widely. In addition to individual research studies, the international community could contribute to developing and promoting metrics for ongoing monitoring of the burden of essential surgical conditions, as is currently done for maternal mortality.

Table 1.2 Total Burden of Conditions Addressed by Essential Surgery, Low- and-Middle-Income Countries, 2011

Category	Deaths (thousands)	DALYS (thousands)
Category 1. Communicable, maternal, perinatal, and nutritional		
Maternal conditions	280	19,000
Birth asphyxia and birth trauma	780	78,000
Category 2. Noncommunicable diseases		
Cataracts	< 1	7,000
Peptic ulcer disease	230	7,000
Appendicitis	38	2,000
Skin diseases[a]	90	16,000
Cleft lip and palate	5	< 1,000
Oral conditions[b]	< 1	13,000
Category 3. Injuries[c]		
Road traffic crash	1,160	72,000
Other unintentional injuries	1,550	96,000
Intentional injuries	540	34,000
Burden from these conditions	**4,700**	**340,000**
Total burden from all causes	**45,000**	**2,400,000**
Share of burden due to conditions addressable by essential surgery (percent)	10.4	14.2

Source: Data are from WHO 2014.
Note: DALYs = disability-adjusted life years.
a. Skin diseases include abscess and cellulitis.
b. Oral conditions include caries, periodontal disease, and edentulism.
c. Other unintentional injury includes falls, fires (and heat and hot substances), and exposure to forces of nature; it excludes drowning and poisoning. Intentional injury includes violence and collective violence or legal intervention; it excludes self-harm.

Table 1.3 Disease Burden Avertable by Essential Surgery, Low- and Middle-Income Countries, 2011

	Deaths (thousands)	DALYs (thousands)
1. Total burden[a]	45,000	2,400,000
2. Total avertable burden[b]	23,000	1,300,000
3. Burden from conditions addressable by essential surgery[c]	4,700	340,000
4. Burden avertable by essential surgery[d]	1,500	87,000
5. Burden avertable by essential surgery as a % of total burden [(4) ÷ (1)]	3.3%	3.6%
6. Burden avertable by essential surgery as a % of avertable burden [(4) ÷ (2)]	6.5%	6.6%

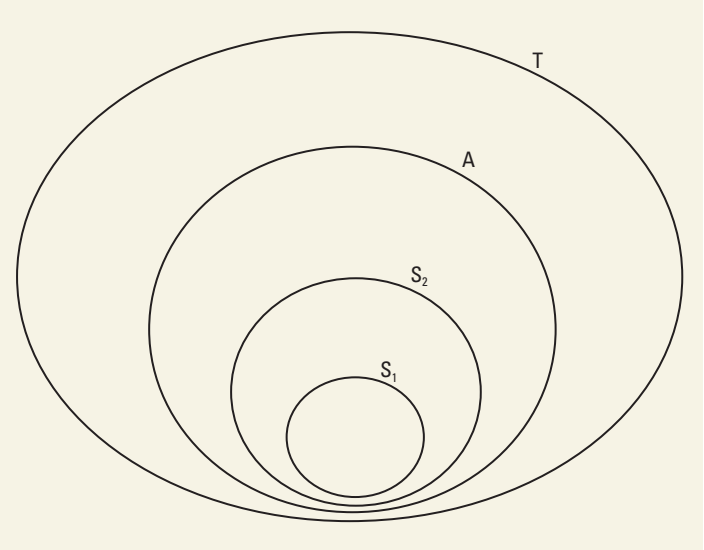
Note: DALYs = disability-adjusted life years.
a. Total disease burden from all causes in low- and middle-income countries (WHO 2014).
b. Total avertable burden: number of deaths and DALYs that would be averted if all-cause, age-adjusted rates of death and disability in high-income countries pertained in low- and middle-income countries (WHO 2014).
c. From table 1.2.
d. From Bickler and others 2015. The burden avertable from essential conditions reported in this table is adjusted downward from what is estimated in the chapter; this chapter does not categorize as essential the surgery to address congenital cardiac disease or neural tube defects, while the burden from those conditions is included in the chapter estimates. Furthermore, the total and avertable burden estimates in rows 1 and 2 of this table are slightly higher than those underlying the data in the chapter. This leads to the percentages reported in rows 5 and 6 being very slight underestimates.

Economic Evaluation of Essential Surgery

Surgical Procedures. At the time of *DCP2*, a small number of cost-effectiveness analyses had found specific surgical procedures to be very cost-effective. Since then, the literature has expanded and consistently documented that many of the essential surgical services identified in this chapter rank among health care's most cost-effective interventions (figure 1.2). A few examples, all context-specific, include cleft lip repair (US$10–US$110 per disability adjusted life year [DALY] averted), inguinal hernia repair (US$10–US$100 per DALY averted), cataract surgery (US$50 per DALY averted), and emergency cesarean section (US$15–US$380 per DALY averted). Many of the widely disseminated public health measures are of similar cost-effectiveness or are not as cost-effective: of vitamin A supplementation (US$10 per DALY averted), oral rehydration solution (more than US$1,000 per DALY averted), and antiretroviral therapy for HIV/AIDS (US$900 per DALY averted) (Chao and others 2014; Grimes and others 2014).

Benefit-cost analyses have shown similar findings. An analysis of the benefits from cleft lip repair looked at the costs needed to run a specialized cleft clinic in India and the resulting health benefits, to which a monetary benefit was ascribed. Cleft surgery had a cost of approximately US$300 per DALY averted and a benefit-cost ratio (BCR) of 12 (Alkire, Vincent, and Meara 2015). These findings put cleft repair within the BCR range for the key investment priorities for disease control established by the Copenhagen Consensus, an organization that asks experts to rank global health and development interventions (Jamison, Jha, and others 2013). The BCR for cleft surgery is also very high in the range of BCRs across different development sectors. Box 1.2 provides an overview of approaches to economic evaluation of surgical procedures and an overview of findings.

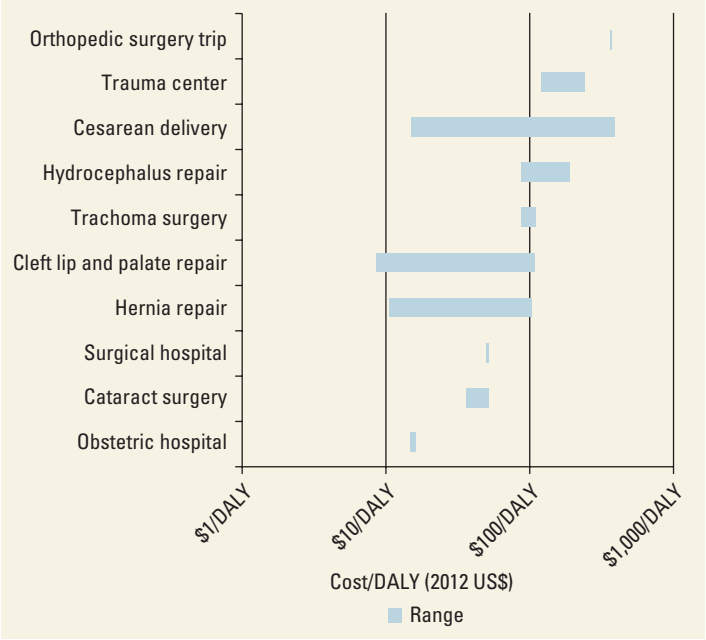
Figure 1.1 Deaths, Avertable Deaths, and Surgically Avertable Deaths in Low- and Middle-Income Countries, 2011



Note: T= total deaths (45 million); A = avertable deaths (23 million); S_2 = surgically avertable deaths (estimate not available); S_1 = deaths avertable by essential surgery (1.5 million).

Definitions
1. S_1 = 2011 deaths in low- and middle-income countries (LMICs) that would have been averted by the universal coverage of essential surgery (UCES).
2. (S_1 / T) × 100 = percentage of total deaths in 2011 in LMICs that would have been averted by UCES.
3. (S_1 / A) × 100 = percentage of avertable deaths in 2011 in LMICs that would have been averted by UCES.

Figure 1.2 Cost-Effectiveness of Surgical Interventions



Source: Data from Prinja and others 2015.
Note: DALY = disability-adjusted life year. This figure summarizes the cost-effectiveness of surgical interventions in low- and middle-income countries according to available literature.

Surgical Platforms. The cost-effectiveness of certain platforms or facility types for providing surgical care also needs to be considered. *Essential Surgery* includes a chapter on CEA (Prinja and others 2015). Basic essential procedures are likely to be cost-effective when delivered at any level of the health care system. However, the first-level hospital has been found to be especially cost-effective as a surgical delivery platform, with costs of US$10–US$220 per DALY averted for all surgical care delivered, across a wide range of LMICs (Gosselin and Heitto 2008; Gosselin, Maldonado, and Elder 2010; Gosselin, Thind, and Bellardinelli 2006; McCord and Chowdhury 2003). Most surgery in first-level hospitals is emergency surgery. Therefore, health systems need to disperse surgical facilities widely in the population, and surgical teams working in first-level hospital should have a broad array of basic emergency skills rather than a narrow range of specialized skills.

Our analysis also considered a range of other surgical platforms. Short-term surgical missions by outside surgeons appear beneficial only if no other option is available; otherwise, suboptimal outcomes, unfavorable cost-effectiveness, and lack of sustainability limit their usefulness. Self-contained mobile platforms, such as hospital ships, appear to offer good outcomes for people who can reach them, but there are no data on their cost-effectiveness and obvious limitations for scale-up and national ownership. Specialized hospitals, including those providing surgery for cataract and obstetric fistula, appear to be among the most cost-effective of the competing options for specialized platforms (Shrime, Sleemi, and Ravilla 2015). Such specialized hospitals would be most sustainable if they develop strong links with local practitioners living and working in that country to promote training and to ensure appropriate postsurgical care, and if they eventually evolve to be led by these local professionals. Since most essential procedures undertaken in specialized hospitals are elective rather than urgent, patients can be scheduled to achieve high volumes, contain costs, and improve technical quality.

Many people with surgical conditions, especially trauma, die in prehospital settings. For example, one study found that 81 percent of trauma deaths were in prehospital settings in Kumasi, Ghana (Mock and others 1998). Most prehospital deaths occur in areas of LMICs where formal emergency medical services are rudimentary or absent. Improving the first aid skills of lay first responders can cost less than US$10 per year of life gained, making it one of the most cost-effective of all health interventions. Similarly, basic ambulance services can cost less than US$300 per year of life gained, which is still highly cost-effective (Thind and others 2015).

Cost of Universal Access. Jamison and colleagues estimate that it would cost approximately US$3 billion annually to scale up delivery of the component of the essential surgery package shown in table 1.1 that is applicable to first-level hospitals, so that this package would be available universally (Jamison, Jha, and others 2013). This expenditure would have a BCR of 10:1, which is broadly consistent with the BCR of other surgical procedures as described by Alkire, Vincent, and Meara (2015).

Improving Access

Challenges. The significant avertable burden from surgical conditions is directly related to the low capacity for surgical care in many LMICs, as reflected in the numbers of surgical procedures performed globally (map 1.1). Most operations (60 percent) take place in wealthier countries where 15 percent of the world's people live. Only 3.5 percent of operations take place in the poorer countries where 35 percent of the world's people live (Weiser and others 2008).

Across 23 LMICs, the ratio of general surgeons per population ranges from 0.13 to 1.57 per 100,000; the ratio of anesthesiologists per population ranges from 0 to 4.9 per 100,000 (Hoyler and others 2014). In contrast, the United States has 9 general surgeons and 11.4 anesthesiologists

Box 1.2

Economic Evaluation of Investments in Surgery

Economic evaluations aim to inform decision making by quantifying the tradeoffs between resource inputs required for alternative investments and resulting outcomes. Four approaches to economic evaluation in health are particularly salient:

- ***Assessing how much of a specific health outcome,*** for example, HIV infections averted, can be attained for a given level of resource input.
- ***Assessing how much of an aggregate measure of health***—such as deaths or disability or quality adjusted life years (DALYs or QALYs)—can be attained from a given level of resource inputs applied to alternative interventions. This cost-effectiveness analysis (CEA) approach enables the attractiveness of interventions addressing many different health outcomes to be compared, for example, tuberculosis treatment versus cesarean section.
- ***Assessing how much health and financial risk protection*** can be attained for a given level of public sector finance of a given intervention. This approach, extended cost-effectiveness analysis (ECEA), enables the assessment not only of efficiency in improving the health of a population but also of efficiency in achieving the other major goal of a health system, that is, protecting the population from financial risk.
- ***Assessing the economic benefits***, measured in monetary terms, from investment in a health intervention, and weighing that benefit against its cost (benefit-cost analysis or BCA). BCA enables health investments to be compared with investments in other sectors.

CEAs predominate among economic evaluations in surgery and for health interventions more generally. Three recent overviews of CEA findings for surgery (one in chapter 18 of this volume) underpin this chapter's conclusion that many essential surgical procedures are highly cost-effective even in resource-constrained environments (Grimes and others 2014; Chao and others 2014; Prinja and others 2015). This volume's chapter 18 looks as well at the cost-effectiveness of the first-level hospital surgical platform.

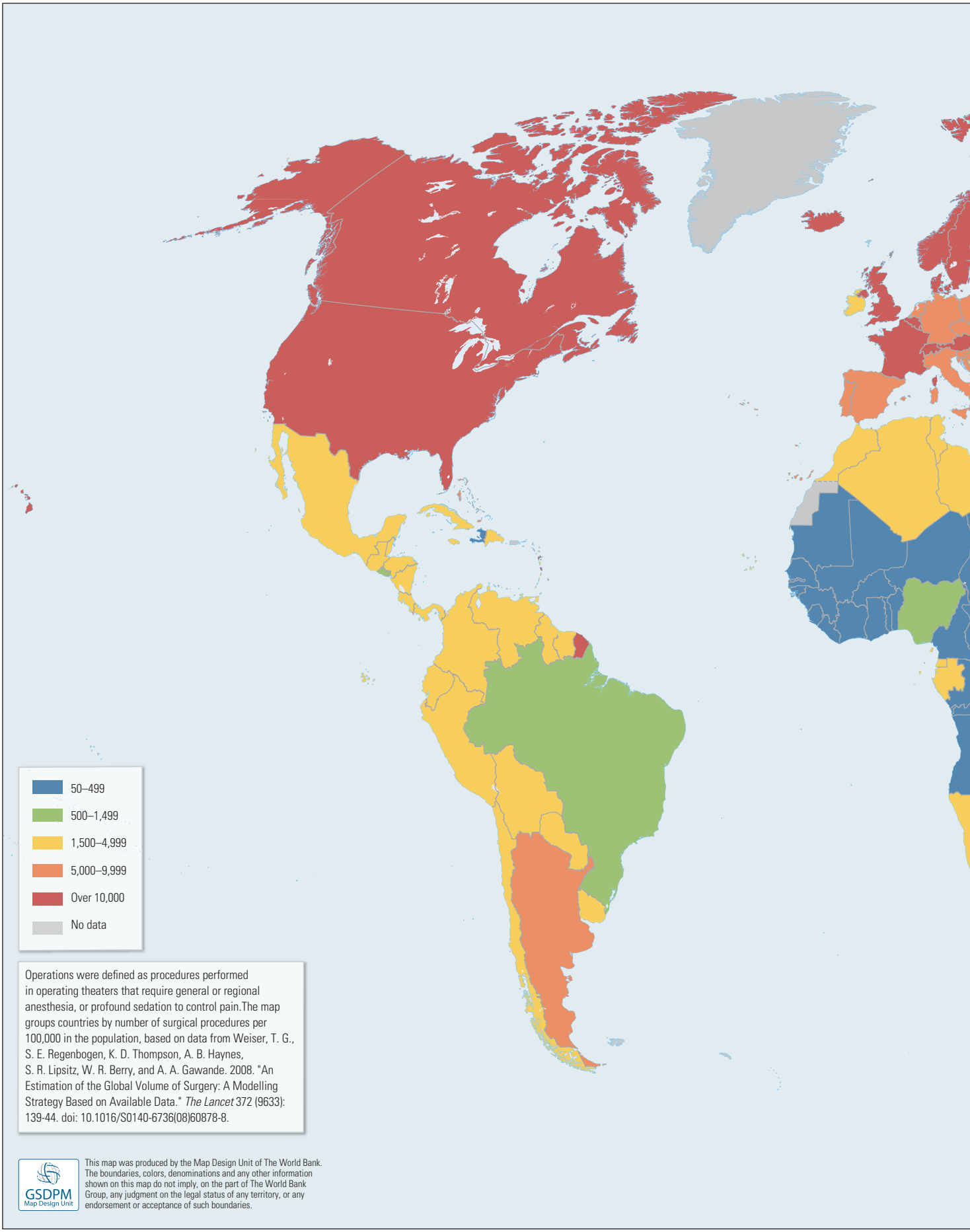
The Lancet Commission on Investing in Health applied BCA to broad investments in health and found B:C ratios often in excess of 10 (Jamison, Summers, and others 2013). This volume contains BCA evaluations of selected surgical procedures reporting similarly high BCAs (Alkire, Vincent, and Meara 2015). Earlier, the Copenhagen Consensus for 2012 used BCA to rank "strengthening surgical capacity" as number 8 in a list of 30 attractive priorities for investment in development across all sectors (Jamison, Jha, and others 2013; Kydland and others 2013).

ECEAs remain a relatively new evaluation approach. This volume's chapter 19 applies ECEA to surgical intervention in Ethiopia and finds substantial financial protection benefits (Shrime and others 2015).

per 100,000 (Stewart and others 2014). Striking differences also exist in the ratio of operating theaters per population across countries at different economic levels: 25 per 100,000 in Eastern Europe, 14–15 in North America and Western Europe, 4–14 in Latin America and the Caribbean, 4.7 in East Asia, but only 1.3 in South Asia, and 1–1.2 in Sub-Saharan Africa (Funk and others 2010).

Two related WHO efforts have defined optimal infrastructure needs for first-level hospitals for surgical care in general (the Programme for Emergency and Essential Surgical Care [WHO 2015a]), and for trauma care at all levels of the health care system (the Essential Trauma Care Project [WHO 2015b]). Surveys conducted using these WHO guidelines and tools have shown the consistent absence of many low-cost pieces of equipment and supplies, such as chest tubes, oxygen, and equipment for airway management and anesthesia, in many locations, but especially in LICs and at first-level hospitals. In some cases, items are physically present but nonfunctional, such as equipment awaiting repairs. Often, equipment is functional, but it is only available to those who can pay, sometimes in advance; many of those who need the services are unable to access them (Belle and others 2010; Kushner and others 2010; Mock and others 2004, 2006; Ologunde and others 2014; Vo and others 2012; WHO 2003; WHO 2015a; WHO 2015b).

Map 1.1 Number of Surgical Procedures per 100,000 Population, 2004



Operations were defined as procedures performed in operating theaters that require general or regional anesthesia, or profound sedation to control pain.The map groups countries by number of surgical procedures per 100,000 in the population, based on data from Weiser, T. G., S. E. Regenbogen, K. D. Thompson, A. B. Haynes, S. R. Lipsitz, W. R. Berry, and A. A. Gawande. 2008. "An Estimation of the Global Volume of Surgery: A Modelling Strategy Based on Available Data." *The Lancet* 372 (9633): 139-44. doi: 10.1016/S0140-6736(08)60878-8.

GSDPM Map Design Unit

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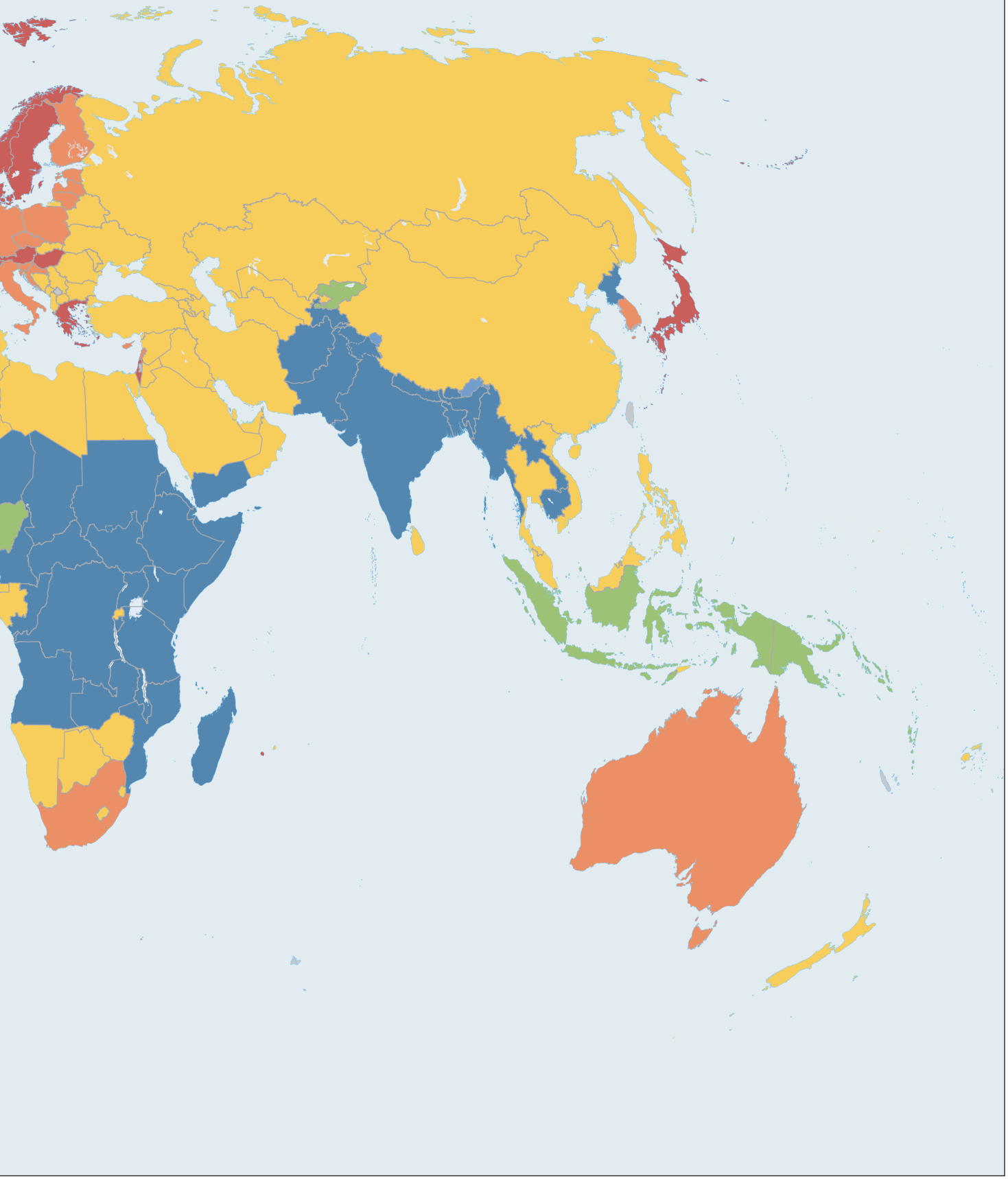


Approaches to Improve Access. Some institutions and health systems have successfully overcome these barriers. For example, the Hanoi Health Department steadily improved its physical resources for trauma care in its network of clinics and hospitals. Such improvements have been stimulated in part by research defining substantial gaps in availability of low-cost items recommended in the WHO's *Guidelines for Essential Trauma Care* and by advocacy to remedy those gaps (Nguyen and Mock 2006). There have also been improvements in the availability of human resources for surgical care. For example, the establishment of the Ghana College of Physicians and Surgeons in 2003 created the first in-country credentialing process for surgeons and led to an expansion of the workforce of fully trained general surgeons and obstetricians. As of June 2014, 284 specialist surgeons and obstetrician-gynecologists had graduated from the college and been posted to first- and second-level hospitals throughout the country to serve as both providers and trainers.

It will likely be impossible to expand access to essential surgical services in rural areas of LMICs in the foreseeable future by depending only on fully certified surgeons and anesthesiologists. Innovative solutions to the surgical workforce crisis are imperative. Evidence shows that mid-level operators can safely perform a number of essential surgical procedures, provided they are properly trained and supervised and perform the operations frequently (McCord and others 2009; Pereira and others 2011). In some locations, these operators are general practitioners. In other cases, they are nonphysician clinicians (NPCs), such as *técnicos de cirurgia* (TCs) in Mozambique or assistant medical officers (AMOs) in Tanzania.

Outcomes such as maternal and neonatal mortality rates after cesarean section and other emergency obstetric procedures were similar for AMOs, compared with doctors in Tanzania (McCord and others 2009; Pereira and others 2011). Although cost studies are few, preliminary evidence shows the cost-effectiveness of task-sharing. For example, in Mozambique, it was three times more cost-effective to train and deploy TCs than to train and deploy physicians to provide obstetric surgery; the 30-year cost per major operation was US$40 for TCs and US$140 for physicians (Kruk and others 2007). Similarly, emergency obstetric care provided by general practitioners was found to be more cost-effective than that provided by fully trained obstetricians in Burkina Faso (Hounton and others 2009).

NPCs are more likely than physicians to stay in underserved rural areas, and they are less likely to emigrate, so their deployment significantly increases the availability of surgical services in underserved rural areas. In Mozambique and Tanzania, NPCs perform about 90 percent of major emergency obstetric surgery in rural areas where most of the population live (Bergström and others 2015). Challenges continue for many countries, including physicians' acceptance of NPCs, as well as of standardizing their training, supervision, regulatory mechanisms, continuing skills improvement, and remuneration and nonfinancial incentives. The long-range goal is expanding the number of fully trained surgeons. However, general practitioners and NPCs, with appropriate support from surgeons, can be an important intermediate solution to the problem of access to basic surgery.

Many essential physical resources, such as equipment and supplies, are low cost and could be better supplied through improved planning and logistics. The availability of some of the more expensive items, such as x-ray machines and ventilators, would be improved by research on product development. Such research should address improved durability, lower cost of both purchasing and operating, and increased ease of operation. Similarly, the availability of many items could be improved by increased capabilities for local manufacture (WHO 2012). However, international assistance for provision of basic essential equipment and supplies will be needed for the immediate future for the poorest countries. An often overlooked ingredient is the need to ensure local capacity to maintain and repair equipment.

Population, policy, and implementation research (PPIR) could contribute by identifying more efficient and lower-cost delivery methods. The WHO has made significant contributions by establishing norms for human and physical resources for surgical and trauma care and by documenting success stories of individual countries (Mock and others 2004; WHO 2010; WHO 2015b); this is a role for the WHO and other stakeholders that should be expanded.

Surgical training has traditionally emphasized decision making and operative technique for individual patient care; this is appropriate, given the clinical role that most surgeons play. However, those surgeons who wish to address the systems-level barriers to achieving UCES will need additional skills in management and supervision of health care systems, quality improvement (QI), and public health.

A considerable additional barrier to access to surgical care is financial, especially in situations in which user fees are high or where out-of-pocket payments are required. The cost of surgical care is also a significant contributor to medical impoverishment (Schecter and Adhikari 2015). Including UCES within universal public finance would remove financial barriers to access to

essential surgical care and would offer financial risk protection, as discussed in the conclusions of this chapter.

Improving the Safety and Quality of Anesthesia and Surgery

Surgical care in all settings is fraught with hazards, including risks from the diseases themselves, the operation, and the anesthesia. These hazards translate into dramatically different risks of death and other complications in different settings. For example, compared with Sweden's rate of 0.04 deaths per 1,000 cesarean sections, mortality is at least 2–4 times higher in Latin America and the Caribbean, 6–10 times higher in South Asia, and 100 times higher in Sub-Saharan Africa (Hogberg 1989; Weiser and Gawande 2015).

A large component of the differences in postoperative mortality is due to differences in anesthesia-related mortality. Major advances have occurred in anesthesia safety in high-income countries (HICs), primarily due to improved monitoring and increased standardization and professionalization. In wealthier countries (those with higher scores on the human development index), mortality per million anesthetics has decreased from 357 deaths per million anesthetics before 1970 to 25 deaths per million anesthetics in the 1990s–2000s, but high rates of anesthetic deaths remain prevalent in most LMICs. Deaths solely attributable to anesthesia are estimated to occur at a rate of 141 deaths per million anesthetics in poorer countries, that is, those with lower score on the human development index, in comparison with the noted 25 deaths per million anesthetics in wealthier countries (Bainbridge and others 2012).

Many of the deaths and complications from surgery in LMICs are potentially preventable with three specific affordable and sustainable improvements:

- Use of a surgical safety checklist
- Improved monitoring and related safety practices during anesthesia
- Improved systems-wide monitoring and evaluation of surgical care overall.

The use of the simple, 19-item WHO Surgical Safety Checklist across eight countries was found to double adherence to basic perioperative safety standards (Haynes and others 2009; WHO 2008a), such as confirmation of the procedure and operative site, objective airway assessment, and completion of instrument and sponge counts at the end of the procedure. Use of the checklist reduced deaths by 47 percent (the postoperative death rate fell from 1.5 percent before introduction of the checklist to 0.8 percent afterward) and inpatient complications by 35 percent, from 11 percent to 7 percent. The checklist improved outcomes in HICs and upper-middle-income countries (UMICs), LMICs, LICs, and in elective and emergency cases.

The safety of anesthesia in HICs has been achieved by adopting standards of care, such as the continuous presence of a trained anesthesia provider and uninterrupted monitoring of oxygenation, ventilation, and perfusion (Eichhorn and others 1986). Anesthesia delivery systems have been better standardized, with safety features engineered into the machines. One critical technology is pulse oximetry, an essential standard in HICs, which allows ongoing monitoring of oxygenation status so that problems can be corrected early, before they lead to serious or lethal consequences. In one study in Moldova, the introduction of a surgical safety checklist and pulse oximetry led to a significant drop in the number of hypoxic episodes and in the complication rate (Kwok and others 2013). A barrier to pulse oximetry availability has been its cost, although a concerted global effort is underway to lower these costs and increase its availability in LMICs. With lower-cost options now available, the cost-effectiveness of introducing pulse oximetry appears very favorable (Burn and others 2014).

Improved monitoring and evaluation of surgical care across institutions, such as through QI programs, help to better inform administration and management. QI programs range from very simple outcome assessments, such as morbidity and mortality conferences, to more complex monitoring, such as surveillance of complications and use of risk-adjusted mortality. Many hospitals in LMICs have some type of basic QI activities. The effectiveness of these activities could be increased by simple measures, such as more systematic recording of proceedings, more purposeful enactment of corrective action, and monitoring of the outcome of corrective action. A WHO review of QI programs for trauma care shows that most programs led to improvements in patient outcomes, including mortality, or process of care; many also reported cost savings (Juillard and others 2009). Although most of the programs were in HICs, two were in Thailand, an upper-middle-income country, where a model QI program led to sustained improvements in both process of care and mortality rates. Despite their effectiveness, simplicity, and affordability, QI programs are at a rudimentary level of development and implementation in most LMICs (Juillard and others 2009; Mock and others 2006).

An important role for the international community is to support PPIR that (1) addresses affordable and sustainable methods to improve quality of care and (2) documents and disseminates specific case studies of sustaining good practices. The WHO has already made

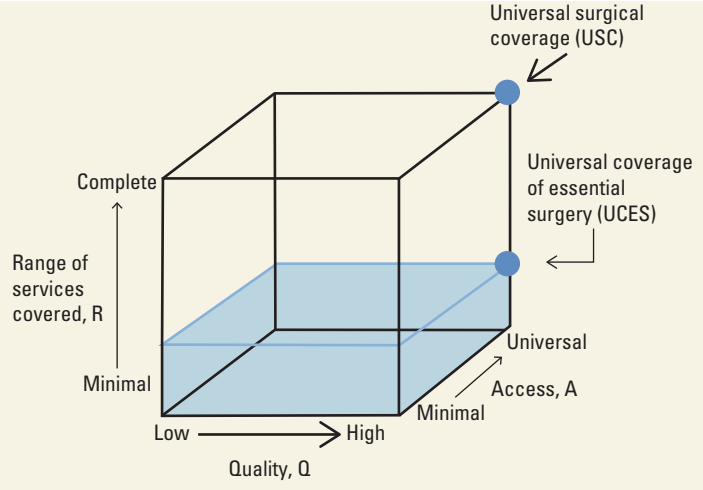
significant contributions by establishing norms, such as the Surgical Safety Checklist (WHO 2008a). This role of governments, the WHO, and other stakeholders needs to be expanded, by establishing and promoting standards for safer, lower-cost anesthesia machines, and norms for monitoring and evaluation procedures for surgical care. Definition and tracking of a variety of quality indicators, such as the perioperative mortality rate needs to be better globally (McQueen 2013; Weiser and others 2009).

Surgery: A Core Component of Universal Health Coverage

Our results point to the potential for essential surgery to cost-effectively address a large burden of disease. Moreover, there are several viable short- and longer-term options for improving access to and safety and quality of surgical care. Figure 1.3 illustrates alternative uses for incremental resources in light of these findings. A country's situation today could be portrayed as a point in the cube: its position on dimension Q depicts the current average quality of care. Its position on dimension A reflects the proportion of the population with access to care, and its position on dimension R reflects the range of services available. Investment choice requires assessment of whether to put incremental money into improving access, improving average quality, or increasing the range of services to be offered. *Our interpretation of the results presented is that it will generally prove both equitable and efficient to achieve full access to essential surgery at high quality before committing public resources to expanding the range of services for a smaller percentage of the population.* The shading in figure 1.3 depicts this situation, which we have termed UCES. UCES should appear early on the pathway to UHC (Jamison, Summers, and others 2013).

Other surgical conditions and procedures merit consideration, such as those for cancer; vascular disease; and conditions requiring more advanced treatments, such as transplantation. Improving access to these procedures will also provide benefits. With regard to sequencing and use of public funds, efforts to ensure greater access to the essential services should be undertaken first, relative to increased investment in those conditions that are more expensive to treat or that have smaller health impacts.

Figure 1.3 Dimensions of Universal Coverage of Essential Surgery



Note: Access is defined as the extent to which services are available to the population—geographically, socially, and financially, for example, with low or zero out-of-pocket payment at the point of service.

CONCLUSIONS

There is a high burden of avertable death and disability from conditions that can be successfully treated by surgery. Many of the surgical procedures and capabilities needed to treat these conditions are among the most cost-effective of all health interventions and most in demand from the population. These include procedures to treat injuries, obstetric complications, abdominal emergencies, cataracts, obstetric fistula, and congenital anomalies. Many of the most needed procedures are affordable and feasible to deliver, but improving their coverage and quality will require a focused effort to strengthen the health system, particularly at first-level hospitals.

With the exception of obstetric care, the global health community has largely failed to address the unmet need for surgery. The surgical community, in turn, has not tackled the broader requirements for incorporating surgery into resource-constrained health systems—with the important exceptions of exploring task-sharing and improving quality of care.

Ensuring access to essential surgical services for everyone who needs them, when they need them, is in part about improving training in safe surgical care and technique, and in part about improving the functioning of health systems, including better monitoring and evaluation, developing appropriate financing mechanisms, and promoting equity, social justice, and human rights. The global system can play an important role in these efforts through informed leadership and advocacy, support for PPIR, and financial transfers to LICs to assist in attaining UCES.

Improved access to essential surgery should be implemented early in the path to UHC as part of the overall essential benefit package advocated by the Commission on Investing in Health (Jamison, Summers, and others 2013). Implementation would include measures such as using public funds to ensure access to essential surgery and including essential surgery in the packages covered

by national health insurance schemes. Such measures would also offer financial risk protection against medical impoverishment from the costs of surgical care. Surgery should be considered an indispensable component of a properly functioning health system and can indeed be a means for strengthening the entire system, thereby increasing the return on investment (Jamison, Summers, and others 2013; WHO 2008b). Investments to provide and maintain equipment and to ensure a steady flow of supplies required for a functioning surgical service can strengthen the supply chain for an entire facility.

The nascent literature in this area also suggests positive spillovers between surgical investments and the functioning of and demand for health care. For example, upgrading facilities to provide surgery improved the confidence of providers in their facility and in their own clinical skills in Uganda (Kruk, Rabkin, and others 2014). Several studies show that availability of surgical services increased demand for health care in potentially high-risk conditions, such as labor and delivery or emergency care (Kruk, Hermosilla, and others 2014; Yaffee and others 2012).

Commitments by national governments and the international community to UCES would substantially reduce the mortality and suffering from treatable surgical conditions. Such commitments would also protect populations from financial risk and contribute to the development of the broader health system.

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NOTE

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  - lower-middle-income = US$1,046 to US$4,125
  - upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

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