

DISEASE CONTROL PRIORITIES • THIRD EDITION

1

Essential Surgery



EDITORS

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Charles N. Mock

WITH A FOREWORD BY
Paul Farmer

VOLUME **1**

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Series Editors

Dean T. Jamison
Rachel Nugent
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DISEASE CONTROL PRIORITIES

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. 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 aspects, including explicit consideration of the implications for health systems of expanded intervention coverage. One way that health systems expand intervention coverage is through selected platforms that deliver interventions that require similar logistics but deliver interventions from different packages of conceptually related interventions, for example, against cardiovascular disease. Platforms often provide a more natural unit for investment than do individual interventions. Analysis of the costs of packages and platforms—and of the health improvements they can generate in given epidemiological environments—can help to guide health system investments and development.

The third edition of *DCP* is being completed. *DCP3* differs importantly 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 to explicitly include 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. The task in all of the *DCP* 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 and their related delivery platforms to 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. *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.

More than 500 individuals and multiple institutions have contributed to *DCP3*. We convey our acknowledgments elsewhere in this volume. Here we express our particular

gratitude to the Bill & Melinda Gates Foundation for its sustained financial support, to the InterAcademy Medical Panel (and its U.S. affiliate, the Institute of Medicine of the National Academy of Sciences), and to the External and Corporate Relations Publishing and Knowledge division of the World Bank. Each played a critical role in this effort.

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Cover photo: The 16 Makara hospital in Cambodia's remote Preah Vihear province is equipped with modern equipment. The maintenance of 16 Makara is supported by the World Bank and other international donors through the Health Sector Support Program and the Cambodia Second Health Sector Support Program. Photo: © Chhor Sokunthea/World Bank. Further permission required for reuse.

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Foreword

The past few decades have seen enormous changes in the global burden of disease. Although many people, especially those living in (or near) poverty and other privations, are familiar with heavy burdens and much disease, the term “global burden of disease” emerged in public health and in health economics only in recent decades. It was coined to describe what ails people, when, and where, and just as reliable quantification is difficult, so too is agreeing on units of analysis. Does this term truly describe the burden of disease of the globe? Of a nation? A city?

We have also learned a thing or two about how to assess this global burden, and how to reveal its sharp local variation and transformation with changing conditions ranging from urbanization to a global rise in obesity (Murray, Lopez, and Jamison 1994; Murray and Lopez 1997; Lopez and others 2006; Mathers, Fat, and Boerma 2008; Jamison and others 2013; Lozano and others 2013). Measuring illness has never been easy, nor has attributing a death—whether premature or at the end of fourscore years—to a specific cause (Yarushalmy and Palmer 1959; Rothman 1976; Byass 2010; Byass and others 2013). Even countries with sound vital registries generate data of varying quality, given that cause of death is rarely confirmed by autopsy (Mathers and others 2005; Mahapatra and others 2007). When nonlethal or slowly debilitating illness is added to considerations of burden of disease, the challenge of both measurement and etiologic claims can appear overwhelming (Kleinman 1995; Arnesen and Nord 1999; Salomon and others 2012; Voigt and King 2014).

The challenges of measuring the burden of disease only get more complex when attempting to use the category of surgical disease. For starters, even experts do not agree on definitions of ostensibly simple terms such as “surgical disease” (Debas and others 2006; Duba and Hill 2007;

Ozgediz and others 2009; Bickler and others 2010). Some illnesses rarely considered to be surgical problems pose threats to health if neglected long enough. Some trends are clear, however. Take the examples offered by Haiti and Rwanda, where different types of trauma (intentional or the result of crush injuries) account for a majority of young-adult deaths. How many of these deaths are classified as attributable to surgical disease? If someone dies of acute abdomen—and if his or her death is recorded at all—was it attributed to appendicitis or to enteric fever? Are these infectious complications of surgical disease or surgical complications of infectious disease? If a child with untreated epilepsy falls into a fire and succumbs from burns, how is this death reported, if it is registered at all? Clinicians who work in settings far from any pathology laboratory have seen infected tumors (misdiagnosed as primary infection) as often as they have discovered that a suspected breast cancer was a long-untreated canalicular abscess. Brain tumors are revealed to be tuberculomas and vice versa.

A sound grasp of the burden of disease is essential to those seeking data-driven methods to design and evaluate policies aimed at decreasing premature death and suffering (Nordberg, Holmberg, and Kiugu 1995; Taira, McQueen, and Burkle 2009; Poenaru, Ozgediz, and Gosselin 2014). But surgical disease was not often on the agenda. The immensity and complexity of the task of quantifying the surgical burden of disease has led many to avoid that task, leading to an analytic vacuum with adverse consequences. For too long, the global health movement has failed to count surgery as an integral part of public health. Prevailing wisdom dictated that the surgical disease burden was too low, surgical expenses too high, and delivery of care too complicated. The predecessor to this volume, the second edition of *Disease Control Priorities in Developing Countries*

(*DCP2*; Jamison and others 2006), changed this paradigm. Published in 2006, it included, for the first time in a major global health platform, sustained attention to surgery. The editors sought to marshal the experience of its contributors to help quantify and classify the burden of surgical disease. Admittedly, this most widely cited estimate of surgical need—11 percent of the global burden of disease was surgical—was based on the best educated guesses of a convenience sample of 18 surgeons on an online survey. Nonetheless, this figure was later validated by the common experience of providers and patients alike from the poorest reaches of the world: the burden of surgical disease was never trivial.

DCP3 builds upon this foundation and substantially improves it. It enhances our understanding of *DCP2*'s pioneering work with more robust methodology. Over the years, researchers—led by the editors of and many of the contributors to this volume—have devoted attention to cancers, orthopedic injuries, disfigurements after burns, congenital defects such as cleft lip and palate, blindness from cataracts, and the many causes of death from acute surgical needs. This volume collates the knowledge gained through the increased attention to global surgery since 2006.

This new volume of *DCP* underlines the central importance of surgical care because, by these measures, surgical disease is thought to account for a significant portion of the global disease burden. The *Essential Surgery* volume of *DCP3* helps definitively dispel many of the myths about surgery's role in global health, in part by showing the very large health burden from conditions that are primarily or extensively treatable by surgery. It dispels the myth that surgery is too expensive by showing that many essential surgical services rank among the most cost-effective of all health interventions. This volume begins to dispel the myth that surgery is not feasible in settings of poverty by documenting many successful programs that have improved capacity, increased access, and enhanced quality of surgical care in countries across the globe.

As argued many times in the past—and worth repeating to clinical colleagues, students, trainees, and diverse interlocutors—global surgery is one of the most exciting frontiers in the quest for global health equity. Patients and providers, along with those who set and evaluate policies, will want (or need) to join this quest if we are to avert unnecessary suffering. We all have cause to be grateful for the many individuals whose time and energy have been invested in producing the wealth of knowledge presented in the *Essential Surgery* volume of *DCP3*.

Paul Farmer
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Preface

Conditions that are treated primarily or frequently by surgery constitute a significant portion of the global burden of disease. In 2012, injuries killed nearly 5 million people, and about 270,000 women died from complications of pregnancy. Many of these deaths, as well as deaths from abdominal emergencies, congenital anomalies, and other causes, could be prevented by improved access to quality surgical care. However, surgical care itself has barely been addressed within the field of global health. A growing number of people from diverse backgrounds are attempting to change this, and to increase access to appropriate, safe, surgical care in low- and middle-income countries. The *Essential Surgery* volume of *Disease Control Priorities*, third edition (DCP3), contributes to these efforts by (1) better defining the health burden from conditions requiring surgery, (2) identifying those surgical procedures that are the most cost-effective and cost-beneficial, and (3) describing the health care policies and platforms that can universally deliver these procedures safely and effectively.

Essential Surgery identifies and studies a group of “essential” surgical conditions and the procedures needed to treat them. These surgical conditions can be defined as those that (1) are primarily or extensively treated by surgery, (2) have a large health burden, and (3) can be successfully treated by surgical procedures that are cost-effective and feasible to promote globally. To address these conditions, the authors derive a set of 44 essential surgical procedures. These include procedures to treat injuries, obstetric complications, abdominal emergencies, cataracts, and congenital anomalies, among others. We estimate that universal access to this package of essential procedures would prevent about 1.5 million deaths per year or 6 to 7 percent of all preventable deaths in low- and middle-income countries. These procedures rank among the most

cost-effective of all health interventions. They are eminently feasible to promote globally, and many could be delivered at first-level hospitals.

The large burden of surgical conditions, cost-effectiveness of essential surgical procedures, and strong public demand for those procedures suggest that universal coverage of essential surgery should be implemented early on the path to universal health coverage. Implementation would include measures such as using public funds to ensure access to essential procedures and including them in the packages covered by national health insurance programs. 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 be a means for strengthening the entire system, thus increasing the return on investment.

Not covered in this volume are procedures to treat other surgical conditions, such as transplantation, or surgery for cancer and vascular disease. Improving access to these procedures will also have benefits. But for prioritization of the sequencing and use of public funds, efforts to ensure greater access to the essential surgical services should be undertaken first, relative to increased investment in those conditions that are more expensive to treat or that have smaller health impacts.

The editors and authors of *Essential Surgery* hope that this volume will increase efforts to improve access to and quality of essential surgical care in low- and middle-income countries. We especially hope to stimulate increased attention to addressing essential surgery on the part of two very different communities: the global health community and the surgical community. 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 broader requirements for incorporating surgery into resource-constrained health systems (with the important exceptions of exploring task-sharing and improving safety of care). We hope that this volume invigorates the global health community to advocate for inclusion of essential surgery as part of universal health coverage and as an integral part of a well-functioning health system. Likewise, we hope that this volume motivates the surgical community to advocate for increased investment in surgical capabilities in first-level hospitals and for greater access to the basic essential procedures. Ensuring that essential surgical services are available to everyone who needs them when they need them is in part about improving training in safe surgical care and techniques, and in part about improving the functioning of health systems, including better monitoring and evaluation and developing appropriate financing mechanisms. It is also about promoting equity, social justice, and human rights.

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Abbreviations

ADLA	adenolymphangitis
AIDS	acquired immune deficiency syndrome
ALS	advanced life support
AMO	assistant medical officer
ANAC	African Network of Associate Clinicians
ARM	anorectal malformation
ASA	American Society of Anesthesiologists
BC	benefit-cost
BCA	benefit-cost analysis
BCVA	best-corrected visual acuity
BCR	benefit-cost ratio
BLD	banana leaf dressing
BLS	basic life support
bpm	beats per minute
BPOC	Basic Package of Oral Care
CC	Copenhagen Consensus
CEA	cost-effectiveness analysis
CFR	case fatality rate
CLP	cleft lip and palate
CYP	couple-year of protection
DALY	disability-adjusted life year
DCP	Disease Control Priorities
<i>DCP2</i>	<i>Disease Control Priorities in Developing Countries</i> , second edition
<i>DCP3</i>	<i>Disease Control Priorities</i> , third edition
D&C	dilation and curettage
ECCE	extracapsular cataract extraction
ECG	electrocardiogram
EESC	Emergency and Essential Surgical Care
EHCP	Essential Health Care Program
EMLA	eutectic mixture of local anesthetics
EMRI	Emergency Management and Research Institute
EMS	emergency medical service
ETV	endoscopic third ventriculostomy
EVA	electric vacuum aspiration
FI	fascial interposition
FIGO	International Federation of Gynecology and Obstetrics

GBD	Global Burden of Disease study
GCCCC	Guwahati Comprehensive Cleft Care Center
GCS	Glasgow Coma Score
GDP	gross domestic product
GHE	Global Health Estimates
GHS	Ghana Hernia Society
GIEESC	Global Initiative for Emergency and Essential Surgery Care
GNI	gross national income
GPELF	Global Programme to Eliminate Lymphatic Filariasis
HD	Hirschsprung's disease
HDI	Human Development Index
HIC	high-income country
HIV	human immunodeficiency virus
HPV	human papilloma virus
IA	inflammatory arthropathies
ICD-9	International Classification of Diseases, Ninth Revision
ICER	incremental cost-effectiveness ratio
IMEESC	Integrated Management of Emergency and Essential Surgical Care
ISO	International Organization for Standardization
ISOFS	International Society of Obstetric Fistula Surgeons
IOL	intraocular lens
IUD	intrauterine device
IVD	intra vas device
LBP	low back pain
LE	life expectancy
LF	lymphatic filariasis
LIC	low-income country
LMICs	low- and middle-income countries
LYS	life-year saved
M&M	Morbidity and Mortality Conference
MBBHS	
M&E Matrix	<i>Monitoring the Building Blocks of Health Systems</i> Monitoring and Evaluation Matrix
MDA	mass drug administration
MDG	Millennium Development Goals
MEBO	moist exposed burn ointment
MIC	middle-income country
MLP	midlevel provider
MMR	maternal mortality ratio
mm	millimeter
MSICS	manual small-incision cataract surgery
MSK	musculoskeletal system
MVA	manual vacuum aspiration
NGO	nongovernmental organization
NHANES	National Health and Nutrition Examination Survey (U.S.)
NHS	National Health Service (U.K.)
NIS	Nationwide Inpatient Sample
NPC	nonphysician clinician
NSAID	nonsteroidal anti-inflammatory drug
OA	osteoarthritis
PE	phacoemulsification
PCO	posterior capsule opacification
PCR	posterior capsular rupture
PMMA	polymethylmethacrylate

POMR	perioperative mortality rate
PPP	purchasing power parity
QALY	quality-adjusted life year
QI	quality improvement
QOL	quality of life
RA	rheumatoid arthritis
RTI	road traffic injury
RVF	recto-vaginal fistula
SIA	surgically induced astigmatism
TBA	traditional birth attendant
TBSA	total body surface area
TBI	traumatic brain injury
TC	<i>técnicos de cirurgia</i> (Mozambique)
TJR	total joint replacement
TTO	time tradeoff
UCVA	uncorrected visual acuity
UMIC	upper-middle-income country
UNFPA	United Nations Population Fund
VA	vacuum aspiration
VSL	value of a statistical life
VSLY	value of a statistical life year
VVF	vesico-vaginal fistula
WFSA	World Federation of Societies of Anaesthesiologists
WHA	World Health Assembly
WHO	World Health Organization
WTP	willingness to pay
YLD	years lived with disability
YLL	years of life lost
YLS	years of life saved

Income Classifications

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

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

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 (*DACP1*) 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, *DACP2*, published in 2006, placed much more emphasis on surgery than had previous health policy documents. *DACP2* 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). *DACP3* 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 *DACP3* (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, *DACP3* 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}

Type of procedure	Platform for delivery of procedure ^c		
	Community facility and primary health center	First-level hospital	Second- and third-level hospitals
Dental procedures	<ol style="list-style-type: none"> 1. Extraction 2. Drainage of dental abscess 3. Treatment for caries^d 		
Obstetric, gynecologic, and family planning	<ol style="list-style-type: none"> 4. Normal delivery 	<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 1. Repair obstetric fistula
General surgical	<ol style="list-style-type: none"> 5. Drainage of superficial abscess 6. Male circumcision 	<ol style="list-style-type: none"> 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	<p>7. Resuscitation with basic life support measures</p> <p>8. Suturing laceration</p> <p>9. Management of non-displaced fractures</p>	<p>17. Resuscitation with advanced life support measures, including surgical airway</p> <p>18. Tube thoracostomy (chest drain)</p> <p>19. Trauma laparotomy^f</p> <p>20. Fracture reduction</p> <p>21. Irrigation and debridement of open fractures</p> <p>22. Placement of external fixator; use of traction</p> <p>23. Escharotomy/fasciotomy (cutting of constricting tissue to relieve pressure from swelling)</p> <p>24. Trauma-related amputations</p> <p>25. Skin grafting</p> <p>26. Burr hole</p>	
Congenital			<p>2. Repair of cleft lip and palate</p> <p>3. Repair of club foot</p> <p>4. Shunt for hydrocephalus</p> <p>5. Repair of anorectal malformations and Hirschsprung's Disease</p>
Visual impairment			<p>6. Cataract extraction and insertion of intraocular lens</p> <p>7. Eyelid surgery for trachoma</p>
Nontrauma orthopedic		<p>27. Drainage of septic arthritis</p> <p>28. Debridement of osteomyelitis</p>	

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.

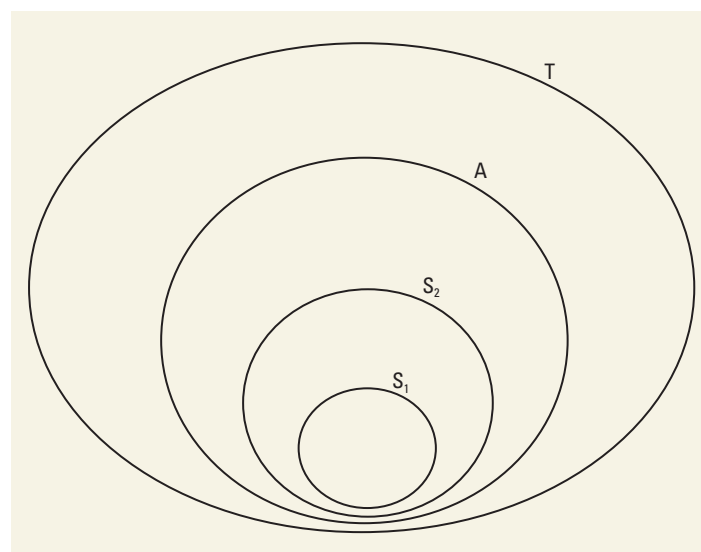
d. From Bickler and others 2015. The burden avertable from essential conditions reported in this table is adjusted downward from what is estimated in the chapter; this chapter does not categorize as essential the surgery to address congenital cardiac disease or neural tube defects, while the burden from 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

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



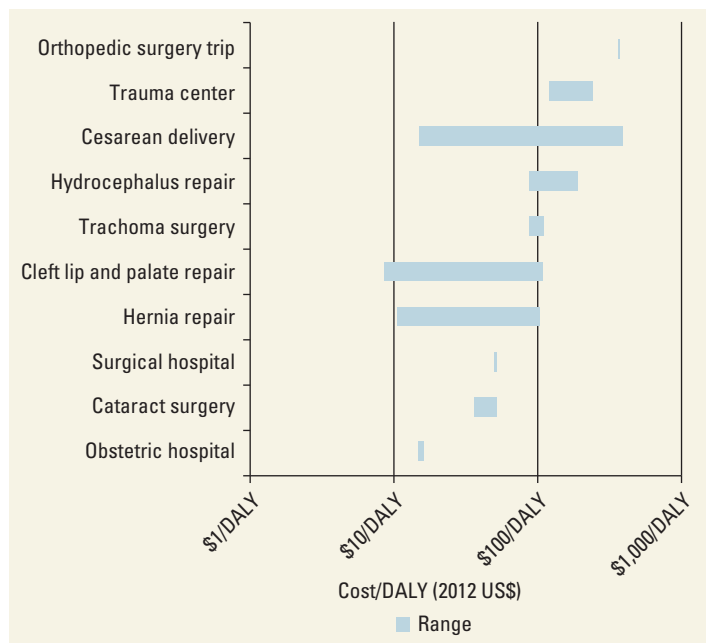
Note: T = total deaths (45 million); A = avertable deaths (23 million); S₂ = surgically avertable deaths (estimate not available); S₁ = deaths avertable by essential surgery (1.5 million).

Definitions

1. S₁ = 2011 deaths in low- and middle-income countries (LMICs) that would have been averted by the universal coverage of essential surgery (UCES).
2. (S₁ / T) × 100 = percentage of total deaths in 2011 in LMICs that would have been averted by UCES.
3. (S₁ / A) × 100 = percentage of avertable deaths in 2011 in LMICs that would have been averted by UCES.

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 1.2 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).