

Addressing the Millennium Development Goals From a Surgical Perspective

Essential Surgery and Anesthesia in 8 Low- and Middle-Income Countries

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Hypothesis: Surgical and anesthetic care is increasingly recognized as a neglected but cost-effective component of primary health care in low- and middle-income countries (LMICs). Strengthening delivery can help achieve Millennium Development Goals 4, 5, and 6. Large gaps in access to essential surgical care in LMICs result in considerable morbidity and mortality. The goal of this study was to provide a baseline overview of essential surgical and anesthetic capacity at district-level health facilities in multiple LMICs.

Design: Survey.

Setting: District-level health facilities in multiple LMICs

Main Outcome Measures: A standardized World Health Organization tool was used at selected district-level hospitals to assess infrastructure, supplies, and procedures relating to essential surgical and anesthetic capacity. The analysis included facilities from countries that assessed more than 5 health facilities. All data were aggregated and blinded to avoid intercountry comparisons.

Results: Data from 132 facilities were analyzed from 8 countries: Democratic Socialist Republic of Sri Lanka ($n=32$), Mongolia ($n=31$), United Republic of Tanzania ($n=25$), Islamic State of Afghanistan ($n=13$), Republic of Sierra Leone ($n=11$), Republic of Liberia ($n=9$), Republic of The Gambia ($n=6$), and Democratic Republic of São Tomé and Príncipe ($n=5$). Universally, facilities demonstrated shortfalls in basic infrastructure (water, electricity, oxygen) and functioning anesthesia machines. Although 73% of facilities reported performing incision and drainage of abscesses, only 48% were capable of undertaking an appendectomy. In line with Millennium Development Goals 4, 5, and 6, only 32% of facilities performed congenital hernia repairs, 44% of facilities performed cesarean sections, and few facilities always had goggles and aprons to protect surgical health care workers from human immunodeficiency virus.

Conclusion: Enormous shortfalls in infrastructure, supplies, and procedures undertaken are common at district-level health facilities in LMICs.

Arch Surg. 2010;145(2):154-160

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DESPITE GROWING EVIDENCE suggesting that surgical care represents a cost-effective component of primary health care,¹⁻⁴ anyone who has ever worked in a low- and middle-income country (LMIC) health system knows that surgery and anesthesia have frequently been neglected.⁵⁻¹⁰ While much attention has focused on attaining the Millennium Development Goals (MDGs), there has been little mention of how strengthening basic surgical care might help to achieve the targets, especially for MDGs 4 (reduction of child mortality), 5 (improvement of maternal health), and 6 (the combat of human immunodeficiency virus [HIV/AIDS]). Recently, however, the editors of *PLoS Medicine* characterized how surgery could play a crucial role in obtaining these goals.¹¹

In September 2007, at the second meeting of the World Health Organization (WHO) Global Initiative for Emergency and Essential Surgical Care (GIEESC), participants discussed strategies by which the delivery of essential surgical and anesthetic services could be strengthened in LMICs. Research priorities included defining the epidemiology

See Invited Critique at end of article

of surgical diseases, identifying gaps in access to care, and characterizing deficiencies in the capacity to deliver safe surgery and anesthesia, including infrastructure, personnel, and resources, and need to evaluate the quality of interventions.¹²

Previously, mostly single-institution or single-country reports on surgical needs in LMICs have been published,^{7-10,13-20} with Mock et al²¹ documenting an overview of 4 countries including 49 small and large hospitals. However, recently, Kingham et al²² documented the surgical capacity of Sierra Leone using the WHO survey tool. The goal of the current study was merely to provide a baseline snapshot of infrastructure, supplies, and procedures relating to essential surgical and anesthetic capacity at multiple resource-limited health (district-level) facilities in various LMICs; more in-depth studies, such as the Kingham et al article, are currently being prepared.

METHODS

DEVELOPMENT OF THE TOOL TO ASSESS EMERGENCY AND ESSENTIAL SURGICAL CARE

The standardized WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care was developed by the GIEESC research group. Questions were initially solicited from various Ministries of Health (MOHs), WHO departments, country and regional WHO offices, and health providers from the field representing all 6 WHO regions: Africa, Americas, Eastern Mediterranean, Europe, South East Asia, and Western Pacific. A draft survey was pilot tested in 8 facilities in Gambia and Tanzania. Based on the results, additional questions on various procedures, including basic suturing, hydrocele repair, male circumcision, and tubal ligation, were included. Additionally, type of facility was noted in addition to catchment area and number of beds. In November 2007, the GIEESC research group assembled in Geneva, Switzerland, and agreed on a final assessment tool to document infrastructure, personnel, procedures undertaken or referred, supplies, and equipment. The final survey tool includes 256 data points for each facility. Answers to survey questions on infrastructure are recorded as 1, always available; 2, sometimes available; or 3, not available. Procedures are recorded as either undertaken at the facility or referred. The equipment and supply list is based on the WHO Integrated Management for Emergency and Essential Surgical Care (IMEESC) toolkit generic Essential Emergency Equipment List.²³

ADMINISTRATION OF THE TOOL TO ASSESS EMERGENCY AND ESSENTIAL SURGICAL CARE

The survey tool was introduced in 30 countries to key health providers and policy makers through joint WHO-MOH workshops and country and regional meetings on emergency and essential surgical care in collaboration with GIEESC members (**Table 1**). Instructions on the tool provided assistance with identification of district-level health facilities, which were defined as locations where emergency, surgical, and anesthesia interventions are or should be performed. Preference was suggested for a district hospital outside of major population centers; however, identification of health facilities for distribution of the survey was left to the discretion of the representatives of the MOH, WHO country offices, and/or GIEESC focal persons in the individual countries. As such, no formal sampling methods were used.

Table 1. Countries Where World Health Organization Integrated Management for Emergency and Essential Surgical Care Toolkit Has Been Introduced

Country
Afghanistan
Barbados
China
Côte d'Ivoire
Democratic Republic of Korea
Dominica
Ethiopia
Gambia
Ghana
Grenada
Guyana
India
Kenya
Kyrgyzstan
Malawi
Maldives
Mongolia
Mozambique
Nepal
Oman
Pakistan
Philippines
Sierra Leone
Sri Lanka
Tajikistan
Uganda
United Republic of Tanzania
Vietnam
Zambia
Liberia

Administering the survey tool entailed site visits either by WHO or MOH staff or GIEESC focal persons to each district-level facility and included on-site inspections of the operating room, admission or emergency departments/wards, and supply rooms and interviews lasting from 1 to 3 hours with key clinical and administrative personnel. Some of the data were collected in individual countries by distributing the survey tool to local hospital staff. All data were collected between February and October 2008. The data were then entered into the WHO DataCol database for analysis by the GIEESC research group.

ANALYSIS

Countries that met inclusion criteria for this study provided data on more than 5 facilities and included district, rural, community, provincial, or general hospitals or major health centers with a minor or major operating room and 5 or more beds.

The survey tool was administered individually by representatives in each country and the results were shared with the MOH. All data contained in this article have been reviewed and acknowledged by the WHO country offices and the local MOH. For comparative purposes and to prevent intercountry comparisons, the results were grouped for aggregate analysis.

Major infrastructure items, such as oxygen, water, electricity, and functioning anesthesia machines, were recorded as always available, sometimes available, or not available. Surgical procedures undertaken and supplies were grouped according to the health-related targets for MDGs 4 (children), 5 (maternal health), and 6 (combating HIV/AIDS).

Table 2. Characteristics of 8 Countries Included in Analysis and the United States^a

Country	2007 Population, Millions	2007 GNI, \$	2005 Per Capita Health Expenditures, \$	2000 Maternal Mortality Rate Per 100 000 Live Births	2000 Mortality Rate in Children Younger Than 5 Years Per 1000 Live Births	No. of Facilities Analyzed
Sri Lanka	19.2	1540	51	92	20	32
Mongolia	2.6	1290	15	110	46	31
Tanzania	39.5	400	17	1500	69	23
Afghanistan	26.1	Estimated <935	20	1900	96	13
Sierra Leone	5.7	260	8	2000	90	11
Liberia	3.6	150	10	760	104	9
Gambia	1.7	320	15	540	79	6
São Tomé and Príncipe	0.15	870	49	61	NA	5
United States	302	44 070	6714	17	7	

Abbreviations: GNI, gross nation income; NA, not available.

^aAll values in US dollars at average exchange rates. Health expenditures are total, including private and public. Sources: www.who.int/countries/en/ and www.worldbank.org/data/databytopic/GNIPC.pdf.**Table 3. Overview of Major Infrastructure Availability for 132 Facilities**

	No. (%)		
	Always Available	Sometimes Available	Never Available
Oxygen	28 (21)	44 (33)	60 (46)
Water	67 (50)	35 (27)	30 (23)
Electricity	48 (36)	69 (53)	15 (11)
Anesthesia machine	42 (32)	31 (23)	59 (45)

RESULTS

Since December 2005, the IMEESC toolkit has been introduced into 30 countries (Table 1); of these, 18 (60%) responded to a January 2008 request to complete the assessment tool for their health facilities. Data from 160 facilities were forwarded to WHO, Geneva, for entry in the WHO DataCol database. Twenty-one facilities from 10 countries were excluded because countries failed to submit data on more than 5 facilities. Eight countries met inclusion criteria by providing data on 5 or more facilities. These countries included the Democratic Socialist Republic of Sri Lanka ($n=37$), Mongolia ($n=31$), United Republic of Tanzania ($n=27$), the Islamic State of Afghanistan ($n=13$), Republic of Sierra Leone ($n=11$), Republic of Liberia ($n=9$), Republic of The Gambia ($n=6$), and Democratic Republic of São Tomé and Príncipe ($n=5$). Of these 139 facilities, 7 (5 from Sri Lanka and 2 from Tanzania) were subsequently excluded from analysis because they assessed facilities with no reported beds. Final analysis was conducted on 132 facilities (Table 2).

The majority of health facilities included in this study had between 50 and 100 beds and 1 or 2 functioning operating rooms. On average, they served a population of 100 000, except for Mongolia, where the population density is very low and health facilities are separated by great distances. In Sri Lanka, assessed

facilities were limited to the regions involved in the ongoing conflict and included the North-Central, North, and East provinces. Sierra Leone included 10 government facilities and 1 nongovernmental organization hospital and covered 80% of the population. Tanzania's assessed facilities from 14 regions included district hospitals in the eastern and central areas of the country, and in Afghanistan, the mix was of government facilities from throughout the country. The Gambia included all health facilities outside of the capital, Banjul. São Tomé and Príncipe included all major health facilities, and Liberia included 50% of its government facilities.

The total population of the 8 countries in this study is 98.5 million (Table 2). Based on the most recent criteria determined by the World Bank,²⁴ these are 6 low-income countries with annual per capita gross national incomes of less than \$935 (Afghanistan, Gambia, Liberia, São Tomé and Príncipe, Sierra Leone, and Tanzania) and 2 low- to middle-income countries (Mongolia and Sri Lanka). Per capita annual total health expenditures for these countries are well below \$100 (Table 2).

OVERALL

Data are shown for infrastructure that is always available, sometimes available, or never available in Table 3. Table 4 consists of surgical conditions, injuries, maternal health, and HIV preventive procedures and equipment and the percentages reflect the aggregate total for all facilities where services or items were "always available."

INFRASTRUCTURE

No country had 100% of facilities reporting continuous supply of uninterrupted water, electricity, and oxygen, and most reported less than 50% availability or supply; the overall averages were 50%, 36%, and 21%, respectively. In 2 countries, none of the facilities surveyed had an uninterrupted supply of oxygen. For 3 countries, a

functional anesthesia machine was present in only 3%, 11%, and 19% of facilities, respectively, with an overall rate of 33% (Table 3).

SURGICAL CONDITIONS AND INJURIES

For basic surgical conditions, most facilities (73%) reported undertaking simple incision and drainage of abscesses and suturing of wounds (80%); however, for procedures of modest complexity, such as appendectomies, hernia repairs, and laparotomies, individual-country reports ranged from 6% to 92%.

Except for the management of acute burns (73%), all facilities reported rates of less than 50% for life-saving and disability-preventive emergency surgical procedures, such as cricothyroidotomy, chest tube insertion, management of open fractures, and amputations.

CHILDREN, MATERNAL HEALTH, AND HIV

Only 32% of facilities reported being able to perform congenital hernia repairs on a regular basis; however, 1 country reported that this was available at 76% of facilities. Clubfoot repair was reportedly undertaken at only 13% of facilities.

For MDG 5 (maternal health), only 44% of facilities were able to offer cesarean sections and other emergency (dilatation and curettage) and elective (tubal ligation) procedures were available only 48% and 39% of the time, respectively.

For MDG 6 (preventing the spread of HIV/AIDS), while male circumcision is reportedly performed in 100% of the surveyed facilities in 3 countries, the overall rate was only 48%. Two countries reported that none of the facilities had any eye protection for operating room staff, with an overall rate of 18%. The provision of sterile gloves was only "always available" in 1 country and available less than 50% of the time in 2 other countries. The overall average was 52%.

COMMENT

Recognizing that the world's burden of surgical disease is considerable and largely neglected, in 2004 WHO established the Emergency and Essential Surgical Care Project (Department of Essential Health Technologies) and developed an IMEESC toolkit.²⁵ The project was designed to integrate life-saving and disability-preventing emergency, surgery, and anesthesia services as a component of primary health care toward achieving MDGs. The WHO launched the GIEESC in 2005, a partnership of international organizations, institutions, civil and professional societies, nongovernmental organizations, and individuals representing various disciplines, including surgery, orthopedics, anesthesia, emergency medicine, and obstetrics; directors of nursing; paramedics and technicians in training; and individuals in medical education and health economics.^{26,27}

The goal of this study was to provide a baseline snapshot of infrastructure, supplies, and procedures

Table 4. Overview of MDG-Related Procedures Always Performed and Supplies Always Available for 132 Facilities

	No. (%)
Surgical conditions	
Incision and drainage of abscess	96 (73)
Suturing	105 (80)
Biopsy	53 (40)
Management of osteomyelitis	57 (43)
Appendectomy	63 (48)
Hernia repair	62 (47)
Laparotomy	54 (41)
Injuries	
Cricothyroidotomy	48 (36)
Chest tube insertion	55 (42)
Management of open fracture	44 (33)
Amputation	51 (39)
Management of burns	96 (73)
Child health	
Congenital hernia repair	42 (32)
Clubfoot repair	17 (13)
Maternal health	
Cesarean section	58 (44)
Dilatation and curettage	63 (48)
Tubal ligation	51 (39)
HIV preventive procedures and equipment	
Male circumcision	63 (48)
Gloves	68 (52)
Eye protection	24 (18)
Apron	44 (33)
Sharps container	63 (48)
Sterilizer	62 (47)

Abbreviations: HIV, human immunodeficiency virus; MDG, Millennium Development Goal.

relating to emergency and essential surgical and anesthetic services at numerous resource-limited health facilities in multiple LMICs. For this article, we assessed 132 facilities in 8 countries, which may be the most comprehensive global assessment of surgical capacity ever undertaken for health facilities in LMICs. The results clearly demonstrate massive shortfalls in the infrastructure and physical resources required to provide the most basic surgical care to save lives and prevent long-term disability. The data were purposefully combined to avoid any intercountry comparisons. Individual-country publications are planned, such as the recent article by Kingham et al²² on Sierra Leone, and will address different data and also recognize the extensive work of local investigators at the individual-country level. This article solely provides an overview of some of the gaps in access to emergency, surgical, and anesthesia interventions. Our goal was to highlight the vast deficiencies in resources overall and not address the needs of individual countries or locations. In the future, more in-depth results will be reported.

Weiser et al⁶ recently estimated that only 3.5% of the estimated 234 million surgical procedures performed worldwide each year are undertaken in countries with a per capita health expenditure lower than \$100; this suggests enormous gaps in access to surgical care. Bickler and Spiegel²⁸ recently called for more

detailed research into baseline deficiencies in order to improve surgical care. Before we can create appropriate interventions, we must better understand regional patterns in the burden of surgical diseases, characterize the unmet needs for surgical care in these environments, and set priorities. Identifying such gaps, however, is just one component of improving surgical care. We also need to characterize deficiencies in the capacity to deliver essential surgery and anesthesia and address the issue of the quality of selected interventions.

The survey tool developed by WHO together with GIEESC members was used to assess the surgical capacity for this study and was applied with the support of various representatives of MOHs and WHO country offices. Rather than being exhaustive and challenging to administer, the survey tool focused on key elements or standards that should be in place to deliver essential services. In line with the recent editorial in *PLoS Medicine*,¹¹ we chose to group procedures and interventions as they relate to the MDGs. More specific indicators might be useful at the country level. Even with this constraint, our study highlights the enormous gaps that must be addressed if we are to see a reduction in maternal mortality from a lack of cesarean sections or reductions in morbidity and mortality from road traffic injuries due to basic life-saving techniques, such as chest tube insertion or management of open fractures.²¹ While growing, though controversial, evidence suggests that the spread of HIV can be reduced by male circumcision,²⁹⁻³¹ resources must also be in place to prevent HIV transmission to health care workers and patients by providing eye protection, aprons, and sterile gloves.³²⁻³⁴

The limited number of facilities in the analysis raises the question of how representative the data are, particularly since sampling methods were not used. Including all of the countries' district health facilities and using unrestricted sampling approaches would have required high-level policy decisions and more resources and were not deemed feasible for this study. The facilities were selected at the discretion of the local health personnel, MOH, and WHO country office representatives and GIEESC members. While we have been assured that the facilities selected are representative of district-level facilities in each participating country, we cannot prove this. Varying-sized facilities were assessed, some more urban, some more rural; however, facilities studied for this analysis included at least 5 beds and an operating room. The decision to limit the analysis to 5 beds was arbitrary, but given that most of the surgical procedures at these facilities are considered essential to prevent mortality and long-term disability, we feel that all procedures potentially could be undertaken with appropriate training in skills and availability of equipment at even these smaller health care facilities.³⁵

The study was designed to analyze the state of surgical care at a single point. For major infrastructure, such as oxygen, water, electricity, and anesthesia machines, data were characterized as sometimes, always, or not available. Procedures were documented as either under-

taken or referred. Because the availability of supplies and equipment frequently changes, we aimed to reduce the effects of these confounders by only recording items as either always available or not available. Even so, our findings also only reflect the capacity to deliver services, rather than the quality of those services. Assuming that facilities can be adequately staffed with health professionals, the quality of services will need to be assessed and monitored in future studies.

While our results cannot be extrapolated to represent the global state of surgical care at the district hospital level, and recognizing the limitations stated earlier, the results are compelling in quantifying deficiencies in the capacity to deliver emergency and essential surgical care at these selected facilities. This highlights the lack of universal access to basic life-saving essential surgical care and a need for local capacity building through integration of these services within the primary health care reforms.

Our findings also suggest not only the need for a more comprehensive assessment of the capacity to deliver these services at the district level in LMICs, but also systems for monitoring capacity, which would simultaneously strengthen each country's health information system. This might be accomplished, for example, by expanding the WHO Service Availability Mapping framework to include the capacity to deliver surgery and anesthesia.³⁶

Finally, we urge global leaders, policy makers, and public health professionals to reassess their thoughts on surgical care. Too many people are dying or are left disabled from surgical conditions that are easily treatable and resources must be devoted to addressing this neglected epidemic. Strengthening the delivery of surgical and anesthetic services, as a component of the primary health care in LMICs, will undoubtedly reduce morbidity and mortality and contribute to achieving 3 of the health-related MDGs and, in addition, contribute to MDG 1 (eradicate poverty and hunger).

Accepted for Publication: March 12, 2009.

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Author Contributions: Drs Kushner and Cherian had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. **Study concept and design:** Kushner, Cherian, Noel, Spiegel, Groth, and Etienne. **Acquisition of data:** Cherian and Noel. **Analysis and interpretation of data:** Kushner and Spiegel. **Drafting of the manuscript:** Kushner, Cherian, Noel, and Spiegel. **Critical revision of the manuscript for important intellectual content:** Kushner, Cherian, Noel, Spiegel, Groth, and Etienne. **Statistical analysis:** Kushner. **Administrative, technical, and material support:** Kushner, Cherian, and Noel. **Study supervision:** Cherian, Noel, Groth, and Etienne.

Financial Disclosure: None reported.

Disclaimer: The authors include staff members of the WHO. They are responsible for the views expressed in this publication and they do not necessarily represent the decisions or the stated policy of WHO.

Additional Contributions: We thank T. Peter Kingham, MD, and Reinou S. Groen, MD, Surgeons Overseas (SOS); T. B. Kamara, MD, Connaught Hospital, Sierra Leone; Soccoh A. Kabbia, MD, and K. S. Daoh, MD, Ministry of Health and Sanitation, Sierra Leone; Wondimagegnehu Alemu, MD, WHO representative, Sierra Leone; Lynda Foray-Rahall, MD, WHO, Sierra Leone; Patience Kibatala, MD, St. Francis Designated District Hospital, Ifakara, United Republic of Tanzania; Amri Mohammed, MD, WHO, United Republic of Tanzania; Taqdeer Asadullah, MD, WHO, Afghanistan; Nestor Shivute, MD, WHO representative, Gambia; Agnes Kuye, WHO, Gambia; Yankuba Kassama, MD, and Ramou Cole-Ceesay, MOH, Gambia; Momadu Baro, Royal Victoria Teaching Hospital, Gambia; Salik Govind, MD, WHO, Mongolia; Orgoi Sereglen, MD, Mongolia; Lundeg Ganbold, MD, University Teaching Hospital, Mongolia; Harischandra Yakandawala, MD, WHO, Sri Lanka; Fernando Neves, MD, and Pierre Kahozi-Sangwa, MD, WHO, São Tomé and Príncipe; Pascoal Fonseca, MD, Hospital Central; Ayres Menezesf, MD, São Tomé and Príncipe; Peter Clement, MD, WHO, Liberia; Bernice Dahn, MD, and Walter Gwenigale, MD, MOH, Liberia; Lawrence Sherman, MD, Firestone Hospital, Liberia; Adam Idriss, Johns Hopkins University School of Medicine; Nabila Metwalli, MD, regional adviser, WHO/Regional Office for the Eastern Mediterranean; Jean Bosco Ndihokubwayo, MD, regional adviser, WHO/Regional Office for Africa; and Art Pesigan, MD, regional adviser, WHO/Regional Office for the Western Pacific.

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