

What is 'global surgery'? Defining the multidisciplinary interface between surgery, anaesthesia and public health

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ABSTRACT

'Global surgery' is the term adopted to describe a rapidly developing multidisciplinary field aiming to provide improved and equitable surgical care across international health systems. Sitting at the interface between numerous clinical and non-clinical specialisms, it encompasses multiple aspects that surround the treatment of surgical disease and its equitable provision across health systems globally. From defining the role of, and need for, optimal surgical care through to identifying barriers and implementing improvement, global surgery has an expansive remit. Advocacy, education, research and clinical components can all involve surgeons, anaesthetists, nurses and allied healthcare professionals working together with non-clinicians, including policy makers, epidemiologists and economists. Long neglected as a topic within the global and public health arenas, an increasing awareness of the extreme disparities internationally has driven greater engagement. Not necessarily restricted to specific diseases, populations or geographical regions, these disparities have led to a particular focus on surgical care in low-income and middle-income countries with the greatest burden and needs. This review considers the major factors defining the interface between surgery, anaesthesia and public health in these settings.

INTRODUCTION

Surgery has famously been described as the 'neglected stepchild of global health' and one of the 'Cinderellas of the global health agenda'.^{1,2} Anaesthesia has fared even worse, described as the 'invisible friend' of the neglected stepchild.³ As far back as 1980, the then WHO Director-General, Dr Halfdan Mahler, highlighted that 'the vast majority of the world's population has no access whatsoever to skilled surgical care and little is being done to find a solution'.⁴ Surgical care is typically considered as too complex, too expensive or having too limited a role to play in treating the global burden of disease.⁵

However, growing data now highlight the underappreciated volume of global surgical disease, profound variations in the delivery of surgery globally and cost effectiveness of

Summary box

- ▶ There is a large unmet need for surgical care worldwide, with surgical conditions and treatments being poorly recognised and resourced as public health priorities.
- ▶ Global surgery is the term now adopted to describe a rapidly developing multidisciplinary field, aiming to provide equitable and improved surgical care across international health systems.
- ▶ The emerging global surgery literature is centred on metrics, data and definitions; however, the underlying issues of workforce, training, equipment, infrastructure and funding also need to be addressed. These may all be synthesised around the three interdependent pillars of need, access and quality.
- ▶ Global surgery must engage a multidisciplinary range of individuals, including academics, clinicians, politicians, economists, and patients, at local, national and international levels.

surgical treatments. Taken together, these have resulted in increasing recognition of the need for affordable access to timely, safe and high quality surgery and anaesthesia services as essential components of a functional health system.⁶ New priorities within healthcare policy are now recognising this, challenging these assumptions regarding the relevance and affordability of surgery and anaesthesia in under-resourced health systems.⁷

The evolving interface between surgery, anaesthesia, public health and global health has been the result of numerous academic and policy stimuli, most notably the Lancet Commission on Global Surgery,⁸ as well as the increasing global burden of non-communicable diseases, many of which necessitate surgical management.⁹ Increased awareness of the major global disparities surrounding the disease burden amenable to surgery and the provision of safe surgical care has led to a particular focus on low-income and middle-income countries (LMICs), areas



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Figure 1 The multiple facets of global surgery.

with the greatest burden of surgical disease, yet often with the least capacity to manage it.

‘Global surgery’ is the term commonly adopted to describe this rapidly developing multidisciplinary field, concerning the improved and equitable surgical care across international health systems, often with an explicit focus on LMICs. However, this is an emerging terminology with variable definitions, unsurprising, given that the broader concept of ‘global health’ has been variously described as ‘a metaphor, a conceptual framing, a set of legal norms, and as a distinct field of practice’.¹⁰

We define global surgery and anaesthesia as the enterprise of providing improved and equitable surgical care to the world’s population, with its core tenets as the issues of need, access and quality (figure 1). This definition intentionally frames surgery and anaesthesia as a composite entity, in recognition of the interdependence of these two specialities, but without excluding other aspects of perioperative care and wider specialisms supporting this. Despite a clear recognition of the multidisciplinary nature of global surgery in its early definitions, the single-specialty global surgery moniker fails to represent the breadth of the professional community engaged in this work. We also see value in framing the issues around need, access and quality, rather than the means (study, research, practice and advocacy) by which they are often addressed.

This review updates and quantifies the current evidence underlying the core principles supporting this definition of global surgery, demonstrating that the emerging body of work is distinguished by a breadth of approaches with a commonality of core issues. Furthermore, we aim to show that global surgery and anaesthesia are not

led by any given clinical specialty, but instead have the patient requiring surgery as their focus. It is as much the responsibility of the policy maker and the public health researcher, as it is of the operating clinician.

NEED, ACCESS AND QUALITY

Need

Surgical management forms a component of the care of a broad range of treatable illnesses that represent around 30% of the global burden of disease. These span every disease subcategory yet remain out of reach for the majority of the world’s population.^{8–11} While there are an estimated 266 million operations performed globally every year,¹² they are largely restricted to high-income countries (HICs), with the poorest third of the world’s population only receiving 3.5% of these.¹³

The need for surgical provision has been shown to vary between regions, with areas such as western sub-Saharan Africa having around 5625 unmet surgical cases per 100 000, compared with Australasia or Western Europe having no such unmet need.¹⁴ Many surgical subspecialties have now begun to also demonstrate the substantial variation of unmet surgical need within their field in LMICs, including neurosurgery,^{15–16} paediatric surgery^{17–18} and anaesthesia.¹⁹

From an obstetric perspective, the caesarean section is now the most commonly performed surgical procedure globally. Despite this, the greatest burden of maternal mortality falls on LMICs,²⁰ where limited access to safe and timely surgery hinders treatment of major complications.²¹ Even where this is available, maternal deaths following caesarean sections in LMICs remain 100 times higher than those in HICs, and around one-third of babies born in these settings will also die.²² Timely access to caesarean section is required for safe childbirth when needed, with models suggesting a 60% reduction in maternal mortality rates when LMICs increase their caesarean section rates to the WHO-recommended levels.²³

Frustratingly, despite these high-level estimations, there remains a relative paucity of data relating to access, capacity and quality in many resource-limited countries.^{12–24} Such concerns are beginning to be addressed, with prospective multinational studies such as the GlobalSurg Collaboration^{25–26} and the African Surgical Outcome Study (ASOS)²⁷ providing insights into these. In addition, the rapid spread of internet-enabled mobile devices has facilitated data collection and allowed for the expansion of clinical registries, providing clinicians with data to drive local quality improvement and researchers with aggregated data to inform policy. Future work needs to concentrate on ensuring consistent definitions and data fields to limit redundancy and to maximise collaboration.^{28–29}

The developing literature on unmet surgical need presents an increasingly nuanced picture. As an example, rises in road traffic use with economic development is driving

an increase in trauma globally, concentrated in LMICs with substantial deficiencies in trauma capacity.^{30 31} This creates a need for primary prevention strategies, prehospital and emergency care, surgical and anaesthetic intervention, critical care and rehabilitation.³² Defining this as a 'surgical need' is clearly inadequate; instead, a functional trauma system is required, of which surgery forms a core component. It has been shown that increasing the surgical workforce only correlates with decreased road traffic deaths in countries that have formal emergency medical services.³³ Hence, it is less helpful to characterise variations in surgical need, provision and access across different subspecialties, rather than deficiencies in the overall perioperative system.

Access

The financing, organising and delivery of healthcare in LMICs face significant challenges.³⁴ Considering access to surgical care, previous reviews highlight the complex and multifactorial barriers within these settings.^{35 36} Broadly, individuals who fail to access surgical care are most often limited by cost or economic factors,^{35 37} geographical location,^{37 38} services lacking sufficient capacity^{35 36} or sociocultural factors prohibiting access.³⁵

Rational geospatial distribution of hospitals and emergency care is rare in many settings, with tertiary centres clustered in political or academic centres. This is particularly problematic in countries with large distributed populations, a high proportion of rural poor and fragmented transport networks. Access is severely limited in many such regions, with the average patient in Tanzania needing to travel 119 km to reach surgical care³⁹ and 74 km for those in Ghana.⁴⁰ To compound this, international efforts at improving surgical care are often concentrated in larger urban centres.

Capacity

Approximately 70% of deaths following emergency general surgery occur within LMICs, with such regions reporting fewer than one operating theatre per 100 000 inhabitants (compared with >14 per 100 000 in some HICs).⁴¹ Basic infrastructure for surgery is frequently in short supply, limiting the consistency with which healthcare facilities can provide basic surgical care⁴²; as an example, running water was only available in 50% of Gambian health facilities,⁴³ and oxygen supplies with masks and tubing were available in only 26% of Rwandan health facilities.⁴⁴ High rates of delayed or cancelled procedures in LMICs have been shown to arise through both poor infrastructure^{45 46} and equipment shortages.⁴⁶

Workforce

The healthcare workforce gap remains substantial; a recent estimate put the number of surgeons, obstetricians and anaesthetists in the world at just over 2 million,¹² with an estimated 1.27 million more required by 2030 to achieve the minimal surgical workforce densities.⁴⁷ LMICs represent 48% of the global population but house only

19% of surgeons and 15% of anaesthesiologists worldwide,⁴⁸ alongside substantial variation in their national distributions.⁴⁹ With such sparsity in national-level data on healthcare providers,⁵⁰ more work is required to identify areas with the greatest need to focus improvement efforts.

Given the shortage of trained surgeons and anaesthetists, surgical tasks are frequently performed by non-specialist physicians and non-physician clinicians in low-resource settings, and training 'midlevel practitioners' is being increasingly supported. These healthcare workers have a variable level of training and often facilitate 'task shifting' to compensate for a lack of trained doctors. Task shifting can be controversial and is not as widely accepted in surgery compared with other healthcare areas, although this may change.⁵¹⁻⁵⁴

Previous work investigating surgical, obstetric and anaesthetic task shifting documented surgical task shifting in 19 of 52 countries and anaesthetic task shifting in 119 of 147 countries studied.⁵⁵ Augmenting the global surgical, obstetric and anaesthetic workforce in this way across geographical regions and income groups highlights the potential these workers have in upscaling the workforce.⁵⁵ However, clearly defining the limits of task shifting, ensuring adequate training and supervision, providing adequate recognition and remuneration, developing appropriate tools and guidelines, and ensuring engagement with regulatory bodies will be important.⁵⁴

Cost and economics

Surgical care is often thought of as complex and expensive, potentially limiting its application within global health efforts, and the risk of financial hardship for the individual patient following surgery remains high worldwide.⁵⁶ However, a number of economic evaluations of surgical treatment have shown surgery to be cost-effective,⁵⁷ including those performed at a regional hospital level.⁵⁸ Surgical treatments have cost effectiveness comparable to other standard public health interventions, such as oral rehydration treatments or antiretroviral therapy.^{59 60} Work from the Global Burden of Disease 2010 Study showed that over a fifth of the LMIC injury burden could be avoided through basic surgical care⁶¹ and that these interventions save lives, rather than just ameliorating potential disability.⁶¹

This economic quantification makes a powerful argument for improving provision of surgery and supporting services as part of global health improvement programmes. Decision-makers do not necessarily allocate funds proportional to avertable mortality and morbidity but demand effective interventions with credible metrics to measure success.⁶² Consequently, improvements in defining the burden of surgical disease, the cost effectiveness of interventions and key performance indicators can all help bolster the political prioritisation of global surgery. Given the favourable economic research on cost effectiveness and the wider impact on alleviating impoverishment and promoting development, national health

financing will likely become supplemented by combinations of external sources (eg, grants from international funding agencies), the private sector (eg, private insurance) and the public sector (eg, revenues from taxation or social security contributions).⁶³

The over-riding lesson from the emerging literature on surgical access is the importance of the interface between politics, economics and healthcare. While need can be explored by research partnerships and local clinicians, access remains largely in the control of governments. The degree by which a population and its government will accept a given model of healthcare is not always predictable and will need to develop alongside political will and expediency. Strategic planning for perioperative services should involve a consortium of researchers, clinicians, politicians, economists, patients and the public. These decisions need to be informed by primary data but remain fundamentally political and economic.

Quality

An estimated 4.2 million people die worldwide each year within 30 days of surgery, more than from HIV, tuberculosis and malaria combined, with half of these deaths occurring in LMICs.⁶⁴ Yet little is known about the quality of surgery globally at a national level, as robust postoperative mortality rates are limited. Populations that need surgical care will clearly only benefit from it if they have appropriate access, with the capacity to meet their needs, and if the care delivered is of a sufficient quality. Inadequate access to high-quality healthcare not only results in significant mortality but also imposes significant economic burden, impacting those in LMICs the most.⁵⁷

Recent work suggests that the quality of, rather than access to, care is the dominant driver in overall outcomes.⁶⁵ The ASOS and GlobalSurg Collaborative cohort studies have confirmed that perioperative mortality and morbidity are up to seven times higher in resource-poor settings than in high-income ones.^{25–27 66} As such, perioperative mortality rates have been recommended as an indicator of access to safe surgery and anaesthesia,⁶⁷ alongside newer tools that measure the quality of surgical care provided in LMICs.⁶⁸

Anaesthesia is fundamental to modern surgical practice; however, the specialty is often poorly developed in many LMICs. Anaesthesia machines and the capacity for performing general anaesthesia are only available in 43% and 56% of LMICs, respectively,⁶⁹ despite a high need for surgery. Reported perioperative mortality rates far exceed those in HICs,⁷⁰ and a lack of safe anaesthesia constitutes a major barrier to safe surgery in many low-resource settings.

Several reviews highlight the need for investment to develop the requisite infrastructure and workforce for safe anaesthesia, as well as the need to improve existing service quality.^{71 72} However, the standing of anaesthesia lags behind that of surgery in many countries, where it is seen as a non-physician or technician role, with poor

governance and a lack of advocacy at ministerial level limiting efforts to improve provision.

Fortunately, this picture is improving, with an increasing recognition of the role of anaesthesia in delivering surgical care by both governmental and non-governmental organisations. International initiatives such as the Global Oximetry Project⁷³ and the WHO Surgical Safety Checklist⁷⁴ are working to provide a global framework for evidence-based anaesthesia quality improvement⁷⁵; the use of the WHO checklist remains lower in LMICs, but its impact in reducing 30-day mortality post emergency laparotomy is greater than that in HICs.⁷⁶

A number of models have been proposed for improving the recruitment, training and retention of anaesthesia providers.^{77 78} There remains a critical lack of funding to support the development of safe anaesthesia in many settings, and this needs to be addressed at regional, national and international levels. Despite the Lancet Commission recommending the tracking and reporting of core surgical indicators,⁶ current availability of these metrics is poor, with a sizeable proportion of countries having virtually no data available.¹² Postoperative complications are known to increase treatment costs and to reduce both life expectancy and quality of life worldwide,⁷⁹ yet if global perioperative care standards, anaesthesia included, are to meaningfully improve, more primary data are required to drive policy makers and health ministers to provide the financial and political support required.

ROLE OF NATIONAL AND INTERNATIONAL BODIES

The principal responsibility for populations suffering from surgically treatable diseases lies with their respective governments. The World Health Assembly in 2015 unanimously passed resolution 68.15, calling for its members to recognise this care as a critical and integral component of universal health coverage.⁸⁰ Subsequent work towards developing and implementing new National Surgical Obstetric and Anaesthetic Plans (NSOAPs) demonstrates the response to this call.⁸¹ These support surgical system strengthening through a three-step process, consisting of a national baseline assessment, facility assessments and national planning, which is fully integrated into a country's national health strategy.⁸² Zambia was the first country to complete this,⁸³ and a total of five countries have now launched their NSOAPs, with over 20 countries having committed to initiating similar processes.^{84 85}

International professional bodies, such as the College of Surgeons of East, Central and Southern Africa and the College of Anaesthesiologists for East Central and Southern Africa, are also working to champion increased standards, enhanced training and improved professional regulation of specialist medical practitioners. This is supported by a constellation of political, academic and charitable organisations operating at the policy level, including the WHO Global Initiative for Emergency and Essential Surgical Care.

Central to these national and international approaches is the recognition that surgical care represents an 'indivisible, indispensable part of health care and of progress towards universal health coverage'.⁸⁶ The care of the patient with a surgically treatable condition requires more than an isolated surgeon in an operating room; the surgical system reaches from prehospital care through to rehabilitation and, even within the hospital environment, relies on the emergency department, anaesthesia, critical care, radiology and pathology services. This multifaceted relationship both underpins the value of surgery in healthcare system strengthening and explains the complexity in driving improvement.

However this concept, clearly articulated in the Lancet Commission, may not survive contact with reality. Although system strengthening is commonly name-checked, the use of established systems methodologies and approaches are largely lacking in the global surgery and anaesthesia literature. This may help explain why advocacy for surgical care is often so difficult. Rather than the clean narrative of pathology-specific vertical interventions with easily measurable end points, improving surgical care necessitates a more nuanced understanding of horizontal system strengthening and an appreciation that focussing on overall mortality and morbidity might mask genuine improvements in specific areas that are still insufficient to affect the overall clinical trajectory at a population level. National and international bodies will need to embrace new ways of thinking if they are to grasp the nettle of improving surgical care on a population basis.

VOLUNTEERING AND CHARITABLE SUPPORT

A wide array of charities and non-governmental organisations are involved in the global effort to improve surgical services. These vary in their approach, including those providing practice guidelines and standards, such as the World Federation of Societies of Anaesthesiologists (www.wfsahq.org), groups providing training and essential equipment, such as the Lifebox Foundation (www.lifebox.org),⁸⁷ and volunteer clinical staff organisations, such as VSO (www.vsointernational.org).

Agencies often have discrete objectives or a particular area of focus, and some work exclusively in particular countries or even single hospitals. Those that have developed long-term partnerships between institutions are typically the most sustainable in their impact, although these require a high level of support to remain effective. International programmes are able to work through these partnerships to provide specific and targeted training and equipment.⁸⁸

The funding support for surgical care in LMICs is poorly understood.⁸⁹ Between 2008 and 2013, around \$27 billion was provided by charitable organisations towards global health, of which around 12% was towards surgery.⁹⁰ Most of these charitable contributions are often focused towards elective procedures and are not fully

aligned with global surgical care requirements.^{89 90} Moreover, while temporary missions are the most common platform by which charitable surgical care is delivered,⁹¹ the benefit is often limited and is seen as an imperfect solution to countries' unmet surgical needs.^{91 92} Quantification of financial support and the development of long-standing bidirectional partnerships should be the mainstay of every charitable support mission.⁹³

The provision of surgical services is significantly hindered by the lack of essential surgical supplies and equipment in low-resource settings. The WHO estimates that 95% of medical equipment in LMICs is imported and that 80% of it is funded by international donors or foreign governments.⁹⁴ In the longer term, appropriate funding and supply chains for medical equipment need to be established. However, many charitable organisations have been set up to alleviate short-term needs by providing discarded clean and unused medical supplies from HIC hospitals.^{95–98} If run appropriately, such cost-effective needs-based donation could reduce waste and provide substantial benefits to recipient communities.⁹⁹ However, while up to 70% of medical equipment in sub-Saharan Africa is donated,¹⁰⁰ current estimates suggest that only 10%–30% of this becomes operational.^{101 102} While best-practice guidelines for donations of medical equipment and supplies exist, there is a need for greater adherence to these and in developing longer-term partnerships to work in closer collaboration with recipients.¹⁰³

The role of volunteers in improving surgical care is complex, given the need for immediate surgical care but also for a sustainable contribution to improving local surgical provision. Criticism can be made of both approaches, with immediate care absolving local health providers from providing care for their populace, while long-term projects can fail to deliver the much-needed surgical intervention for current patients. In practice, a dual approach is required, although the scant funding available often means that charities are forced to operate in competition with each other.

Interest among HIC trainees wanting increased exposure to global surgery is high^{104–107}; however, several barriers limit the development of any formalised training pathway, such as logistical and time constraints or limited funding opportunities.^{104 107} Such formalised training could, however, prove feasible within current training models¹⁰⁸ and may even benefit home health organisations.¹⁰⁹ Ensuring that institutional partnerships are developed is essential to allow for bidirectional international exchanges⁹³; however, sustainability and high ethical standards must be ensured. With growing momentum behind the global surgery movement, a more formalised career pathway in global surgery and anaesthesia could come to fruition.

FUTURE HEALTH POLICY AND RESEARCH IN GLOBAL SURGERY

The recognition of both surgery and anaesthesia as key areas in the global health debate is comparatively recent, and surgical conditions and treatments remain poorly

recognised as a public health priority.¹¹⁰ Public health and infectious diseases have developed an evidence base to underpin future work, and while this remains in relative infancy for both surgery and anaesthesia, research studies in the field are now driving development of future interventional projects.^{25 26}

In order to manage surgical health systems and to monitor their development, it is first necessary to establish meaningful and comparable baseline data on need, access and quality. Six standardised metrics for capturing health system dimensions of capacity, service delivery and outcomes were put forward by the Lancet Commission on Global Surgery: (1) 2-hour access to the three Bellwether procedures (caesarean delivery, emergency laparotomy and management of an open fracture); (2) surgeon, anaesthetist and obstetrician workforce >20 per 100 000; (3) surgical volume of 5000 procedures per 100 000; (4) reporting of perioperative mortality rates; (5) risk rates of catastrophic expenditure and (6) impoverishment when requiring surgery.⁸

Some of these have now been included among the WHO 100 Core Global Health Indicators, and four have since been published in the World Bank's World Development Indicators. Unfortunately, none are yet collected routinely and reported to the WHO, with data collection frequently driven by professional associations and researchers rather than governments. A recent evaluation of these six global surgery metrics revealed that only one (workforce) had data from more than half of the WHO member states, and two (protection against catastrophic and impoverishing expenditure) had virtually no data collected.¹²

At present, the future model of surgical provision is not yet clear; whether funding should go into a few very high-quality centres with better transport links or through multiple centres to integrate surgery into a more familiar tiered model of expanded district hospitals remains undetermined.^{111 112} The role of new technologies to improve global health also remains uncertain but offers considerable potential, provided it is affordable, acceptable and adoptable.¹¹³

Traditionally, clinical academics have been slow to engage with and support the global surgery cause, although the importance of this field is now being recognised.¹¹⁴ In the UK, the National Institute for Health Research funds a number of research groups with an explicit focus on global surgery.^{115 116} As part of this, a recent international Delphi process has engaged LMIC clinicians, patients and expert methodologists to prioritise future research into areas of unmet clinical need for surgical patients in LMICs; this has led to the identification of three priority topics: access to surgery, outcomes of cancer surgery and perioperative care.¹¹⁷ The recent publication of a dedicated global surgery issue by the *British Journal of Surgery* reflects the growing academic recognition of this field,⁶² allowing for a revolutionary dynamic between HIC and LMIC researchers.

Global surgical collaboratives may be one effective means to facilitate and train local health workers to engage with such research and quality improvement endeavours,^{118 119} as at present, research from LMICs represents only about 4% of surgical literature.¹²⁰ However, a genuine sense of collaboration can be achieved by encouraging locally driven and locally accessible research and quality improvement.¹²¹ This includes engaging local clinicians to lead on topics that may be rare or less relevant to high-income clinicians but are important in low-resource settings.¹²² Moreover, in addition to surgical disease-specific research, there is also a need to ensure global outcome comparisons by means of certain patient groups, such as children,⁶¹ surgical approach, such as laparoscopy,¹²³ or operative intervention, such as anastomosis formation.¹²⁴

Future directions for developing and implementing global surgery health policy is a topic of ongoing debate. The Lancet Commission on Global Surgery suggested that a broad array of ongoing research themes are required, including policy, quality and safety, training and education, partnership, information management and care delivery innovation and burden.⁶ For this to be delivered, there is a need for clinicians, the public health policy community and other stakeholders to agree on the specific surgical conditions and treatments warranting investment,¹²⁵ ensuring an effective public positioning to attract suitable political support.¹²⁶ Individuals and organisations from across the globe should work collectively and interprofessionally with HIC and LMIC partners working in equal contributions to build the surgical systems of the future.¹²⁷

CONCLUSION

Global surgery and anaesthesia can be defined as the multidisciplinary enterprise of seeking to provide improved and equitable surgical care to the world's population, based around the central pillars of need, access and quality (figure 1). This deliberately broad definition includes disadvantaged areas of otherwise wealthy countries as much as it does LMICs, and covers the spectrum of activities from primary research, through public health interventions and policy making, to direct improvements in clinical care. It does not focus on the events that occur in the operating theatre alone, or attribute ownership of either patients or their pathologies to a single clinical provider, but instead frames surgical care as an integrated pathway within a wider health system that requires multiple elements working in concert to deliver safe, timely and affordable care.

There remains a need to redefine global surgery and anaesthesia not by its tools or constituent specialisms but by its aims. Delineating need, access and quality into discrete entities is a useful device to structure discussion. In practice, however, they are heavily interdependent, and efforts at understanding and improving existing care will necessarily involve an element of each. Importantly,

it must be a field that explicitly links all those engaged, from the upper echelons of the WHO to local rural providers delivering their clinical care.

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REFERENCES

- Farmer PE, Kim JY. Surgery and global health: a view from beyond the OR. *World J Surg* 2008;32:533–6.
- Lavy C, Sauven K, Mkandawire N, et al. State of surgery in tropical Africa: a review. *World J Surg* 2011;35:262–71.
- Citron I, Meara JG. A global surgery, obstetrics and anaesthesia metamorphosis. *Update in Anaesthesia* 2019;33.
- Surgery and Health For All. Address by DR H. Mahler director-general of the world Health organization. *XXII Biennial World Congress of the International College of Surgeons*, 1980.
- Bae JY, Groen RS, Kushner AL. Surgery as a public health intervention: common misconceptions versus the truth. *Bull World Health Organ* 2011;89:394.
- Meara JG, Leather AJM, Hagander L, et al. Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet* 2015;386:569–624.
- Mukhopadhyay S, Lin Y, Mwaba P, et al. Implementing World Health Assembly Resolution 68.15: National surgical, obstetric, and anaesthesia strategic plan development—the Zambian experience. *Bull Am Coll Surg* 2017;102:28–35.
- Meara JG, Hagander L, Leather AJM. Surgery and global health: a Lancet Commission. *Lancet* 2014;383:12–13.
- Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the global burden of disease study 2010. *Lancet* 2012;380:2224–60.
- Taylor S. 'Global health': meaning what? *BMJ Glob Health* 2018;3:e000843.
- Funk LM, Weiser TG, Berry WR, et al. Global operating theatre distribution and pulse oximetry supply: an estimation from reported data. *Lancet* 2010;376:1055–61.
- Holmer H, Bekele A, Hagander L, et al. Evaluating the collection, comparability and findings of six global surgery indicators. *Br J Surg* 2019;106:e138–50.
- Weiser TG, Regenbogen SE, Thompson KD, et al. An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet* 2008;372:139–44.
- Rose J, Weiser TG, Hider P, et al. Estimated need for surgery worldwide based on prevalence of diseases: a modelling strategy for the who global health estimate. *Lancet Glob Health* 2015;3 Suppl 2:S13–20.
- Park KB, Johnson WD, Dempsey RJ. Global neurosurgery: the unmet need. *World Neurosurg* 2016;88:32–5.
- Dewan MC, Rattani A, Fieggen G, et al. Global neurosurgery: the current capacity and deficit in the provision of essential neurosurgical care. executive summary of the global neurosurgery initiative at the program in global surgery and social change. *J Neurosurg* 2018;1:1–10.
- Ozgediz D, Langer M, Kisa P, et al. Pediatric surgery as an essential component of global child health. *Semin Pediatr Surg* 2016;25:3–9.
- Sitkin NA, Farmer DL. Congenital anomalies in the context of global surgery. *Semin Pediatr Surg* 2016;25:15–18.
- Epiu I, Tindimwebwa JVB, Mijumbi C, et al. Challenges of anesthesia in low- and middle-income countries: a cross-sectional survey of access to safe obstetric anesthesia in East Africa. *Anesth Analg* 2017;124:290–9.
- Harrison MS, Goldenberg RL. Cesarean section in sub-Saharan Africa. *Matern Health Neonatol Perinatol* 2016;2.
- Ologunde R, Vogel JP, Cherian MN, et al. Assessment of cesarean delivery availability in 26 low- and middle-income countries: a cross-sectional study. *Am J Obstet Gynecol* 2014;211:504.e1–2.
- Sobhy S, Arroyo-Manzano D, Murugesu N, et al. Maternal and perinatal mortality and complications associated with caesarean section in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet* 2019;393:1973–82.
- Thomas S, Meadows J, McQueen KAK. Access to cesarean section will reduce maternal mortality in low-income countries: a mathematical model. *World J Surg* 2016;40:1537–41.
- Ozgediz D, Jamison D, Cherian M, et al. The burden of surgical conditions and access to surgical care in low- and middle-income countries. *Bull World Health Organ* 2008;86:646–7.
- GlobalSurg Collaborative. Mortality of emergency abdominal surgery in high-, middle- and low-income countries. *Br J Surg* 2016;103:971–88.
- GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. *Lancet Infect Dis* 2018;18:516–25.
- Biccard BM, Madiba TE, Kluyts H-L, et al. Perioperative patient outcomes in the African surgical outcomes study: a 7-day prospective observational cohort study. *Lancet* 2018;391:1589–98.
- Beane A, De Silva AP, Athapattu PL, et al. Addressing the information deficit in global health: lessons from a digital acute care platform in Sri Lanka. *BMJ Glob Health* 2019;4:e001134.
- Raza A, Raza I, Drake TM, et al. The efficiency, accuracy and acceptability of smartphone-delivered data collection in a low-resource setting - A prospective study. *Int J Surg* 2017;44:252–4.
- World Health Organization. *Global status report on road safety 2015*. World Health Organization, 2015.
- Wong EG, Gupta S, Deckelbaum DL, et al. Prioritizing injury care: a review of trauma capacity in low and middle-income countries. *J Surg Res* 2015;193:217–22.
- Reynolds TA, Stewart B, Drewett I, et al. The impact of trauma care systems in low- and middle-income countries. *Annu Rev Public Health* 2017;38:507–32.
- Hung Y-C, Bababekov YJ, Stapleton SM, et al. Reducing road traffic deaths: where should we focus global health initiatives? *J Surg Res* 2018;229:337–44.
- Mills A. Health care systems in low- and middle-income countries. *N Engl J Med* 2014;370:552–7.
- Grimes CE, Bowman KG, Dodgion CM, et al. Systematic review of barriers to surgical care in low-income and middle-income countries. *World J Surg* 2011;35:941–50.
- Ologunde R, Maruthappu M, Shanmugarajah K, et al. Surgical care in low and middle-income countries: burden and barriers. *Int J Surg* 2014;12:858–63.
- Tansley G, Stewart BT, Gyedu A, et al. The correlation between poverty and access to essential surgical care in Ghana: a Geospatial analysis. *World J Surg* 2017;41:639–43.
- Juran S, Broer PN, Klug SJ, et al. Geospatial mapping of access to timely essential surgery in sub-Saharan Africa. *BMJ Glob Health* 2018;3:e000875.
- Penoyar T, Cohen H, Kibatala P, et al. Emergency and surgery services of primary hospitals in the United Republic of Tanzania. *BMJ Open* 2012;2:e000369.

- 40 Choo S, Perry H, Hesse AAJ, *et al.* Assessment of capacity for surgery, obstetrics and anaesthesia in 17 Ghanaian hospitals using a who assessment tool. *Trop Med Int Health* 2010;15:1109–15.
- 41 Petroze RT. Global disease burden of conditions requiring emergency surgery (Br J Surg 2014; 101: e9–e22). *Br J Surg* 2014;101:e23.
- 42 Knowlton LM, Banguti P, Chackungal S, *et al.* A geospatial evaluation of timely access to surgical care in seven countries. *Bull World Health Organ* 2017;95:437–44.
- 43 Idriss A, Shivute N, Bickler S, *et al.* Emergency, anaesthetic and essential surgical capacity in the Gambia. *Bull World Health Organ* 2011;89:565–72.
- 44 Petroze RT, Nzayisenga A, Rusanganwa V, *et al.* Comprehensive national analysis of emergency and essential surgical capacity in Rwanda. *Br J Surg* 2012;99:436–43.
- 45 Forrester JA, Boyd NJ, Fitzgerald JEF, *et al.* Impact of surgical lighting on intraoperative safety in low-resource settings: a cross-sectional survey of surgical providers. *World J Surg* 2017;41:3055–65.
- 46 Prin M, Eaton J, Mtalimanja O, *et al.* High elective surgery cancellation rate in Malawi primarily due to infrastructural limitations. *World J Surg* 2018;42:1597–602.
- 47 Daniels KM, Riesel JN, Meara JG. The scale-up of the surgical workforce. *Lancet* 2015;385(Suppl 2):S41.
- 48 Holmer H, Lantz A, Kunjumen T, *et al.* Global distribution of surgeons, anaesthesiologists, and obstetricians. *Lancet Glob Health* 2015;3(Suppl 2):S9–11.
- 49 O'Flynn E, Andrew J, Hutch A, *et al.* The specialist surgeon workforce in East, central and southern Africa: a situation analysis. *World J Surg* 2016;40:2620–7.
- 50 Hoyler M, Finlayson SRG, McClain CD, *et al.* Shortage of doctors, shortage of data: a review of the global surgery, obstetrics, and anesthesia workforce literature. *World J Surg* 2014;38:269–80.
- 51 Kruk ME, Wladis A, Mbembati N, *et al.* Human resource and funding constraints for essential surgery in district hospitals in Africa: a retrospective cross-sectional survey. *PLoS Med* 2010;7:e1000242.
- 52 Beard JH, Oresanya LB, Akoko L, *et al.* Surgical task-shifting in a low-resource setting: outcomes after major surgery performed by nonphysician clinicians in Tanzania. *World J Surg* 2014;38:1398–404.
- 53 Galukande M, Kaggwa S, Sekimpi P, *et al.* Use of surgical task shifting to scale up essential surgical services: a feasibility analysis at facility level in Uganda. *BMC Health Serv Res* 2013;13:292.
- 54 Chu K, Rosseel P, Gielis P, *et al.* Surgical task shifting in sub-Saharan Africa. *PLoS Med* 2009;6:e1000078.
- 55 Federspiel F, Mukhopadhyay S, Milsom PJ, *et al.* Global surgical, obstetric, and anesthetic task shifting: a systematic literature review. *Surgery* 2018;164:553–8.
- 56 Shrimpe MG, Dare A, Alkire BC, *et al.* A global country-level comparison of the financial burden of surgery. *Br J Surg* 2016;103:1453–61.
- 57 Alkire BC, Shrimpe MG, Dare AJ, *et al.* Global economic consequences of selected surgical diseases: a modelling study. *Lancet Glob Health* 2015;3(Suppl 2):S21–7.
- 58 Grimes CE, Law R, Dare A, *et al.* Cost-effectiveness of two government district hospitals in sub-Saharan Africa. *World J Surg* 2017;41:2187–92.
- 59 Chao TE, Sharma K, Mandigo M, *et al.* Cost-effectiveness of surgery and its policy implications for global health: a systematic review and analysis. *Lancet Glob Health* 2014;2:e334–45.
- 60 Grimes CE, Henry JA, Maraka J, *et al.* Cost-effectiveness of surgery in low- and middle-income countries: a systematic review. *World J Surg* 2014;38:252–63.
- 61 Higashi H, Barendregt JJ, Kassebaum NJ, *et al.* Burden of injuries avertable by a basic surgical package in low- and middle-income regions: a systematic analysis from the global burden of disease 2010 study. *World J Surg* 2015;39:1–9.
- 62 Hagander L, Leather A. A realized vision of access to safe, affordable surgical and anaesthesia care. *Br J Surg* 2019;106:e24–6.
- 63 Dube AM, Patel R. The 12 trillion dollar question: is global surgery cost effective? *Bull R Coll Surg Engl* 2019;101:186–8.
- 64 Nepogodiev D, Martin J, Biccard B, *et al.* Global burden of postoperative death. *Lancet* 2019;393:401.
- 65 Kruk ME, Gage AD, Joseph NT, *et al.* Mortality due to low-quality health systems in the universal health coverage era: a systematic analysis of amenable deaths in 137 countries. *Lancet* 2018;392:2203–12.
- 66 GlobalSurg Collaborative. Determinants of morbidity and mortality following emergency abdominal surgery in children in low-income and middle-income countries. *BMJ Glob Health* 2016;1:e000091.
- 67 Watters DA, Hollands MJ, Gruen RL, *et al.* Perioperative mortality rate (POMR): a global indicator of access to safe surgery and anaesthesia. *World J Surg* 2015;39:856–64.
- 68 Citron I, Saluja S, Amundson J, *et al.* Surgical quality indicators in low-resource settings: a new evidence-based tool. *Surgery* 2018;164:946–52.
- 69 Hadler RA, Chawla S, Stewart BT, *et al.* Anesthesia care capacity at health facilities in 22 low- and middle-income countries. *World J Surg* 2016;40:1025–33.
- 70 Bainbridge D, Martin J, Arango M, *et al.* Perioperative and anaesthetic-related mortality in developed and developing countries: a systematic review and meta-analysis. *Lancet* 2012;380:1075–81.
- 71 Enright A. Review article: safety aspects of anesthesia in under-resourced locations. *Can J Anaesth* 2013;60:152–8.
- 72 Walker IA, Bashford T, Fitzgerald JE, *et al.* Improving anesthesia safety in low-income regions of the world. *Curr Anesthesiol Rep* 2014;4:90–9.
- 73 Walker IA, Merry AF, Wilson IH, *et al.* Global oximetry: an international anaesthesia quality improvement project. *Anaesthesia* 2009;64:1051–60.
- 74 Haynes AB, Weiser TG, Berry WR, *et al.* A surgical safety checklist to reduce morbidity and mortality in a global population. *N Engl J Med* 2009;360:491–9.
- 75 Kwok AC, Funk LM, Baltaga R, *et al.* Implementation of the world Health organization surgical safety checklist, including introduction of pulse oximetry, in a resource-limited setting. *Ann Surg* 2013;257:633–9.
- 76 Thomas HS, Weiser TG, Drake TM, *et al.* Pooled analysis of who surgical safety checklist use and mortality after emergency laparotomy. *Br J Surg* 2019;106:e103–12.
- 77 Newton M, Bird P. Impact of parallel anesthesia and surgical provider training in sub-Saharan Africa: a model for a resource-poor setting. *World J Surg* 2010;34:445–52.
- 78 Lipnick M, Mijumbi C, Dubowitz G, *et al.* Surgery and anesthesia capacity-building in resource-poor settings: description of an ongoing academic partnership in Uganda. *World J Surg* 2013;37:488–97.
- 79 Pearse RM, Holt PJE, Grocott MPW. Managing perioperative risk in patients undergoing elective non-cardiac surgery. *BMJ* 2011;343:d5759.
- 80 Price R, Makasa E, Hollands M. World Health Assembly Resolution WHA68.15: 'strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage'—addressing the public health gaps arising from lack of safe, affordable and accessible surgical and anesthetic services. *World J Surg* 2015;39:2115–25.
- 81 Peck GL, Hanna JS. The National Surgical, Obstetric, and Anesthesia Plan (NSOAP): recognition and definition of an empirically evolving global surgery systems science comment on 'global surgery - informing national strategies for scaling up surgery in Sub-Saharan Africa'. *Int J Health Policy Manag* 2018;7:1151–4.
- 82 World Health Organisation. *Surgical care systems strengthening: developing national surgical, obstetric and anaesthesia plans.* World Health Organization, 2017.
- 83 Mukhopadhyay S, Lin Y, Mwaba P, *et al.* Implementing World Health Assembly Resolution 68.15: National surgical, obstetric, and anesthesia strategic plan development—the Zambian experience. *Bull Am Coll Surg* 2017;102:28–35.
- 84 Reddy C, Patterson R, Caddell L, *et al.* Global surgery and the World Health Organization: indispensable partners to achieve triple billion goals. *Can J Anaesth* 2019.
- 85 Albutt K, Sonderman K, Citron I, *et al.* Healthcare leaders develop strategies for expanding national surgical, obstetric, and anaesthesia plans in who AFRO and EMRO regions. *World J Surg* 2019;43:360–7.
- 86 The World Bank. Transcript of recorded video remarks by Jim Yong Kim, president of the world bank group, to the Lancet Commission on global surgery, January 17, 2014. Available: <http://www.globalsurgery.info/wp-content/uploads/2014/01/Jim-Kim-Global-Surgery-Transcribed.pdf> [Accessed 28 Apr 2019].
- 87 Finch LC, Kim RY, Ttendo S, *et al.* Evaluation of a large-scale donation of Lifebox pulse oximeters to Non-physician anaesthetists in Uganda. *Anaesthesia* 2014;69:445–51.
- 88 Parry EHO, Percy DB. Anaesthesia and hospital links: strengthening healthcare through South-North Hospital partnerships. *Anaesthesia* 2007;62(Suppl 1):15–20.

- 89 Gutnik L, Dieleman J, Dare AJ, *et al*. Funding allocation to surgery in low and middle-income countries: a retrospective analysis of contributions from the USA. *BMJ Open* 2015;5:e008780.
- 90 Gutnik L, Yamey G, Riviello R, *et al*. Financial contributions to global surgery: an analysis of 160 international charitable organizations. *Springerplus* 2016;5:1558.
- 91 Shrimel MG, Sleemi A, Ravilla TD. Charitable platforms in global surgery: a systematic review of their effectiveness, cost-effectiveness, sustainability, and role training. *World J Surg* 2015;39:10–20.
- 92 Coughran AJ, Merrell SB, Pineda C, *et al*. Local and visiting physician perspectives on short term surgical missions in Guatemala: a qualitative study. *Ann Surg* 2019. doi:10.1097/SLA.0000000000003292. [Epub ahead of print: 18 Apr 2019].
- 93 Abou El Ela Bourquin B, Gnanakumar S, Bath MF, *et al*. The international health elective: a stepping stone for tomorrow's global surgeons and anaesthetists. *Perspect Med Educ* 2018;7:228–31.
- 94 World Health Organisation. *Medical devices: managing the mismatch: an outcome of the priority medical devices project*. Switzerland: WHO Press, 2010.
- 95 Kanzaria HK, Fischette S, Jain S. Remedy at UCSF: a sustainable student-run initiative. *Lancet* 2009;374:438–40.
- 96 Rosenblatt WH, Silverman DG, Recovery SDG. Recovery, sterilization, and donation of unused surgical supplies. *JAMA* 1992;268:1441–3.
- 97 Rosenblatt WH, Ariyan C, Gutter V, *et al*. Case-by-case assessment of Recoverable materials for overseas donation from 1318 surgical procedures. *JAMA* 1993;269:2647–9.
- 98 Czajkowski-Beckwith H, Rosenblatt WH. Reprocessing unused surgical supplies for use in developing countries. *Aorn J* 1996;63:236–8.
- 99 Wan EL, Xie L, Barrett M, *et al*. Global public health impact of recovered supplies from operating rooms: a critical analysis with national implications. *World J Surg* 2015;39:29–35.
- 100 Gatrad AR, Gatrad S, Gatrad A. Equipment donation to developing countries. *Anaesthesia* 2007;62(Suppl 1):90–5.
- 101 World Health Organisation. *Medical device donations: considerations for solicitation and provision*. World Health Organisation, 2011.
- 102 World Health Organisation. *Barriers to innovation in the field of medical devices 2010*.
- 103 Marks IH, Thomas H, Bakhet M, *et al*. Medical equipment donation in low-resource settings: a review of the literature and guidelines for surgery and anaesthesia in low-income and middle-income countries. *BMJ Glob Health*. In Press 2019;4.
- 104 Harfouche M, Krowsoski L, Goldberg A, *et al*. Global surgical electives in residency: the impact on training and future practice. *Am J Surg* 2018;215:200–3.
- 105 Johnston PF, Scholer A, Bailey JA, *et al*. Exploring residents' interest and career aspirations in global surgery. *Journal of Surgical Research* 2018;228:112–7.
- 106 Bale AG, Sifri ZC. Surgery resident participation in short-term humanitarian international surgical missions can supplement exposure where program case volumes are low. *Am J Surg* 2016;211:294–9.
- 107 Jayaraman SP, Ayzengart AL, Goetz LH, *et al*. Global health in general surgery residency: a national survey. *J Am Coll Surg* 2009;208:426–33.
- 108 Mohan HM, Fitzgerald E, Gokani V, *et al*. Engagement and role of surgical trainees in global surgery: consensus statement and recommendations from the association of surgeons in training. *Int J Surg* 2018;52:366–70.
- 109 Yeomans D, Le G, Pandit H, *et al*. Is overseas volunteering beneficial to the NHS? the analysis of volunteers' responses to a feedback questionnaire following experiences in low-income and middle-income countries. *BMJ Open* 2017;7:e017517.
- 110 Citron I, Chokotho L, Lavy C. Prioritisation of surgery in the National health strategic plans of Africa: a systematic review. *World J Surg* 2016;40:779–83.
- 111 Galukande M, von Schreeb J, Wladis A, *et al*. Essential surgery at the district Hospital: a retrospective descriptive analysis in three African countries. *PLoS Med* 2010;7:e1000243.
- 112 Luboga S, Macfarlane SB, von Schreeb J, *et al*. Increasing access to surgical services in sub-Saharan Africa: priorities for national and international agencies recommended by the Bellagio essential surgery group. *PLoS Med* 2009;6:e1000200.
- 113 Howitt P, Darzi A, Yang G-Z, *et al*. Technologies for global health. *Lancet* 2012;380:507–35.
- 114 Finlayson SRG. How should academic surgeons respond to enthusiasts of global surgery? *Surgery* 2013;153:871–2.
- 115 NIHR Global Health Research Unit on Global Surgery, 2019. Available: <https://globalsurg.org/about> [Accessed 15 Apr 2019].
- 116 NIHR Global Health Research Group on Neurotrauma. Global neurotrauma outcomes study, 2019. Available: <http://neurotrauma.world> [Accessed 15 Apr 2019].
- 117 National Institute for Health Research Global Health Research Unit on Global Surgery. Prioritizing research for patients requiring surgery in low- and middle-income countries. *Br J Surg* 2019;106:e113–20.
- 118 Bhangu A, Fitzgerald JE, Fergusson S, *et al*. Determining universal processes related to best outcome in emergency abdominal surgery: a multicentre, international, prospective cohort study. *BMJ Open* 2014;4:e006239.
- 119 Bhangu A, Fitzgerald JE, Koliass AG. Trainee-led research Collaboratives: a novel model for delivering multi-centre studies. *ANZ J Surg* 2014;84:902–3.
- 120 Steyn E, Edge J. Ethical considerations in global surgery. *Br J Surg* 2019;106:e17–19.
- 121 Bashford T, Vercueil A. Anaesthetic research in low- and middle-income countries. *Anaesthesia* 2019;74:143–6.
- 122 GlobalSurg Collaborative. Management and outcomes following surgery for gastrointestinal typhoid: an international, prospective, multicentre cohort study. *World J Surg* 2018;42:3179–88.
- 123 GlobalSurg Collaborative. Laparoscopy in management of appendicitis in high-, middle-, and low-income countries: a multicenter, prospective, cohort study. *Surg Endosc* 2018;32:3450–66.
- 124 NIHR Unit on Global Surgery. Global variation in end stoma formation following left sided colorectal resection. *Int J Surg* 2018;55:S48–9.
- 125 Mock C, Cherian M, Juillard C, *et al*. Developing priorities for addressing surgical conditions globally: furthering the link between surgery and public health policy. *World J Surg* 2010;34:381–5.
- 126 Shawar YR, Shiffman J, Spiegel DA. Generation of political priority for global surgery: a qualitative policy analysis. *Lancet Glob Health* 2015;3:e487–95.
- 127 Ng-Kamstra JS, Greenberg SLM, Abdullah F, *et al*. Global surgery 2030: a roadmap for high income country actors. *BMJ Glob Health* 2016;1:e000011.