Global cancer surgery: delivering safe, affordable, and timely cancer surgery

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Surgery is essential for global cancer care in all resource settings. Of the 15·2 million new cases of cancer in 2015, over 80% of cases will need surgery, some several times. By 2030, we estimate that annually 45 million surgical procedures will be needed worldwide. Yet, less than 25% of patients with cancer worldwide actually get safe, affordable, or timely surgery. This Commission on global cancer surgery, building on Global Surgery 2030, has examined the state of global cancer surgery through an analysis of the burden of surgical disease and breadth of cancer surgery, economics and financing, factors for strengthening surgical systems for cancer with multiple-country studies, the research agenda, and the political factors that frame policy making in this area. We found wide equity and economic gaps in global cancer surgery. Many patients throughout the world do not have access to cancer surgery, and the failure to train more cancer surgeons and strengthen systems could result in as much as US$6·2 trillion in lost cumulative gross domestic product by 2030. Many of the key adjunct treatment modalities for cancer surgery—eg, pathology and imaging—are also inadequate. Our analysis identified substantial issues, but also highlights solutions and innovations. Issues of access, a paucity of investment in public surgical systems, low investment in research, and training and education gaps are remarkably widespread. Solutions include better regulated public systems, international partnerships, super-centralisation of surgical services, novel surgical clinical trials, and new approaches to improve quality and scale up cancer surgical systems through education and training. Our key messages are directed at many global stakeholders, but the central message is that to deliver safe, affordable, and timely cancer surgery to all, surgery must be at the heart of global and national cancer control planning.

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Introduction

Surgery is essential for cancer treatment, and has a long and distinguished history.[1] This Lancet Oncology Commission on global cancer surgery builds on the foundations laid by the Lancet Commission on global surgery and its report, Global Surgery 2030.[2] Global Surgery 2030 detailed the need to build global surgical systems focusing on the most underserved populations; however, it recognised that many key disease areas, such as cancer, with major surgical burden, needed a more in-depth analysis to provide specific recommendations. This Commission fills this gap, drawing on a global faculty with extensive experience in all income settings and professional domains (eg, education, research, and economics).

Global Surgery 2030[2] showed that surgery interfaces with every primary care disease, from cataracts to pregnancy complications, congenital anomalies, infectious disease, heart disease, and malignancies. In 2010, an estimated 16·9 million lives (32·9% of all deaths worldwide) were lost from disorders that needed surgical care. Additionally, investment in surgery and anaesthesia is affordable and moreover promotes economic development. Without investment in surgical care there will be an estimated cumulative loss to the global economy of US$20·7 trillion, or 1·3% of the global projected economic output by 2030; most of these losses will occur in low-income and middle-income countries (LMICs). With so many cancers being amenable to surgical intervention, the importance of focusing on this area was clear.

Surgery is one of the major pillars of cancer care and control; it can be preventive, diagnostic, curative, supportive, palliative, and reconstructive. In the context of cancer, preventive surgery is performed to remove tissue that is likely to become cancer; for example, colposcopy for atypical cervical lesions. Diagnosis through procedures such as biopsy is essential for correct management of the cancer. Treatment of cancers that present early, such as breast and colon, and a few that present in an advanced state—eg, testicular cancer—always need surgery to be cured. Surgical resection is also crucial for palliative care, such as mastectomy for advanced breast cancers to improve quality of life, palliative stomas for malignant bowel disease, and stenting to relieve a range of malignant obstructions, and reconstructive surgery is used to improve cosmesis after mastectomy and for various head and neck operations.

One of the key challenges of this Commission has been to represent accurately the universals of global cancer surgery and also the differences; differences driven by history, geography, disease burden, economics, and other factors. Cancer surgery encompasses a wide range of surgical procedures at different levels of complexity that need different levels of infrastructure. Although cancer surgery has become increasingly subspecialised in

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high-income countries (HICs), in many LMICs surgeons are often the only health-care professionals treating cancer by delivering chemotherapy and performing endoscopies and even radiological examinations. To address such a broad spectrum, we have taken a practical systems approach to cancer surgery. This approach shows the reality of cancer care, education, and research; these domains are indivisible from one another. Cancer surgery is also part of a system that requires all its crucial parts—eg, pathology, radiotherapy, and imaging—to achieve the best outcomes for patients. Throughout this Commission, when talking about cancer surgery we also mean anaesthesia, as well as the vital role of both imaging and pathology. Although we will continually refer to cancer surgery, we also take this term to encompass the essential preoperative and postoperative care, and the central role of anaesthesia. These parts of the surgical system have been fully explored in Global Surgery 2030.[2]

Surgery is a fundamental method for both curative and palliative treatment of most cancers in countries across all income settings. However, with many competing health priorities and substantial financial constraints in most low-income countries (LICs) and many middle-income countries (MICs), surgical services are given low priority within national cancer plans and are allocated few resources from domestic accounts or international donor assistance programmes. As a result, access to safe, affordable surgical services for cancer is poor, with large proportions of the population unable to access even the most basic surgical care. Locally advanced or metastatic cancer is a common initial disease presentation and surgical resection may be the only available method to achieve reasonable palliative control. In HICs, where the most common solid organ malignant cancers (eg, breast and colon) are more likely to be successfully diagnosed at early stages, surgical resection provides definitive locoregional control of the primary tumour, which has substantial curative potential when combined with appropriately selected adjuvant systemic treatment and radiotherapy.

We have drawn on existing published evidence, findings from Global Surgery 2030,[2] various commissioner meetings, and original analyses to assess the state of global surgery across all income settings with the aim of providing evidenced-based solutions and key messages to strengthen cancer surgical systems, education, and research.

In the first section, we examined the global burden of surgically amenable cancers, the range of procedures that are necessary to treat cancer at all levels of complexity, and the effect that surgery has on patient outcomes. The aim of the second section was to understand the economic and financial issues surrounding cancer surgery; how are patients affected? How can countries deliver affordable surgical systems for cancer, and how should this be regulated? Both of these sections set the scene against which we then explored the complex issue of strengthening surgical systems in different resource settings. We have approached this issue through in-depth country studies and a cross-cutting analysis of the horizontal determinants of systems strengthening, both of which inform the proposed scale-up model and the recommendations for education and training. We also recognised the importance of research, and we dedicated the fourth section to an in-depth analysis. Finally, we placed the issues and solutions for global cancer surgery in the political context of global health and summarised the key messages from this Commission.

Global need for cancer surgery

Measurement of the burden of cancer in a population is essential for delivery of safe, affordable, and timely cancer surgery. Reliable estimates of the cancer burden can provide a comprehensive picture of the variation between geographical areas and population strata. These estimates, in turn, inform the development of cancer control strategies and surgical systems strengthening, as well as economic assessments. Increasingly, survival, mortality, and incidence trends are also being used to assess the efficacy of cancer strategies at reducing the effect of cancer over time. However, linking care activity data such as surgery with outcomes data remains hugely challenging, both in terms of the complex links and interdependencies (ie, intrinsic complexity) and the ability to collect and collate data of sufficient quality. The epidemiology of surgically amenable cancer is extrapolated from existing datasets and use of hospital audits. In trying to tease apart the epidemiology, the need for more thinking about how cancer registration can be better used for surgical systems strengthening for cancer became clear.

As populations age and societies pass through the epidemiological transition, cancer is emerging as a leading cause of death and disability (appendix p 1). By the end of 2015, there will be 15·2 million new cancer cases worldwide and 8·8 million cancer deaths according to GLOBOCAN predictions.[3] 57% of these new cancer cases and 65% of cancer deaths will have occurred in LMICs. Projections for new cancer cases in 2030 are estimated to be 21·6 million, and case fatality rates due to cancer are estimated to be highest in LMICs (75%) compared with in HICs (46%).[4,5] These are not trivial figures and their implications for cancer surgery are even more profound. By 2030, of the 21·6 million patients with cancer, about 17·3 million will need surgery. 10 million of those patients needing surgery in 2030 will be from LMICs. In LMICs, three-quarters of the surgical burden will be from cancers of the breast, head and neck, oesophagus, stomach, lung, cervix, and prostate. Surgery is required in preventive, diagnostic, curative, palliative, and reconstructive settings for most solid cancers. Management of cancer needs a huge range of surgical techniques. In all, we identified 277 different surgical

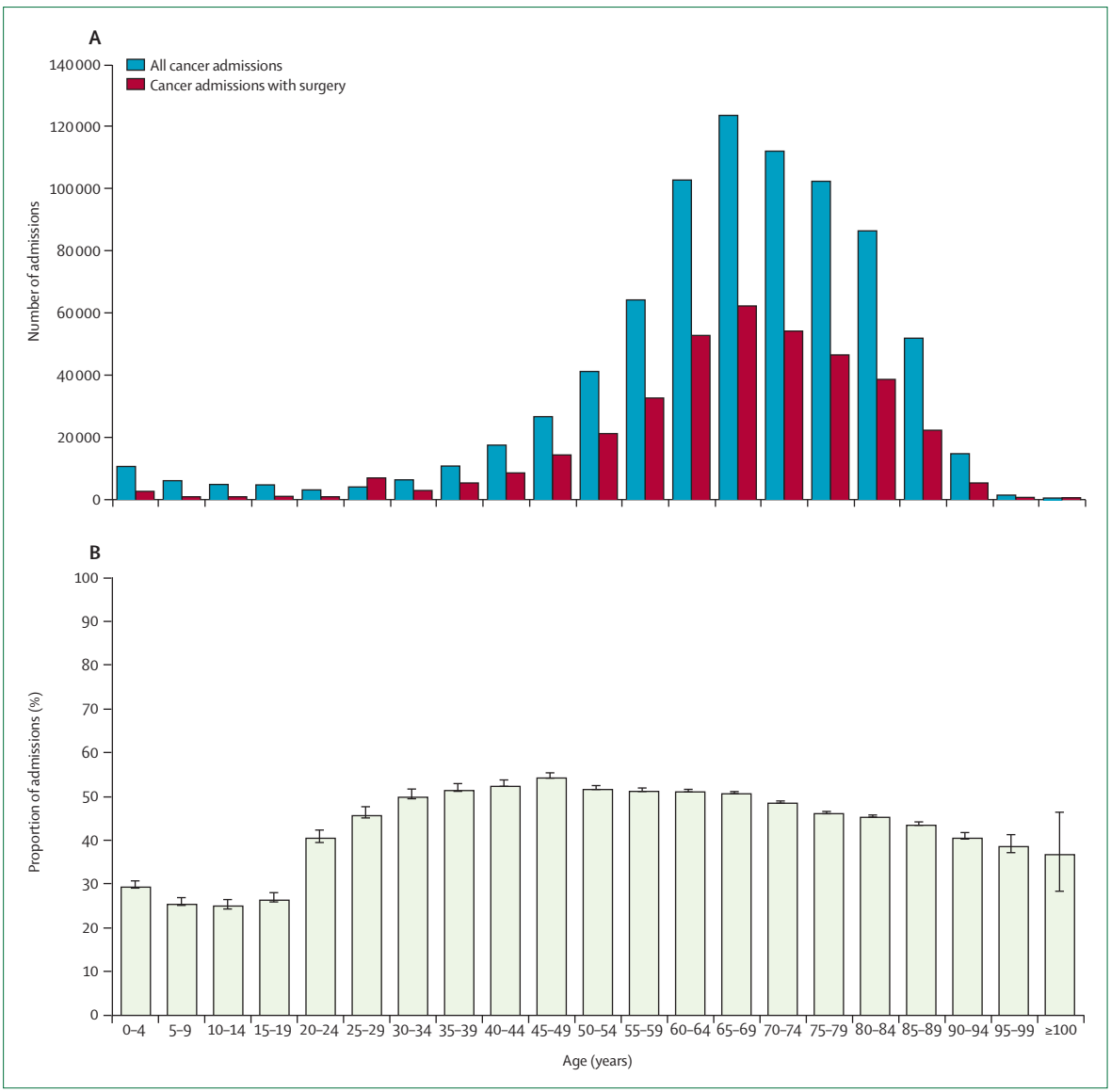

Figure 1: **Who needs cancer surgery?**
(A) Age group analysis of total admissions for cancer (blue bars) and total number of people undergoing surgical intervention (red bars) by age group in Sweden, 2013. (B) Surgery as a percentage of total admissions by age group in Sweden, 2006–13. Data from the Swedish National Board of Health and Welfare's National Patient Register 2013. See appendix (p 18) for further details.

procedures that are needed to treat cancer across six complexity levels (appendix pp 2–8). Of these, 222 are regarded as major resections, with just over half of these (123/222 [54%]) needing a specialist or gynaecological surgeon with that particular site-specific expertise (eg, urology, breast, and upper gastrointestinal; appendix pp 9–14). Our analysis has found a complex relation between surgical procedures and resource stratification. Many LMICs have major cancer centres that are resourced to undertake all cancer surgical procedures, even though there might be major shortages or no availability of even basic surgery in distant rural areas. Obviously, in most low-resource settings only basic surgery and some basic (level I–III) procedures are available in public hospitals, but an increasing number of countries have centres that, contrary to their resource band, can perform many specialist major resections. However, unlike Global Surgery 2030,[2] there are no bellwether surgical procedures that can show the general state of development of cancer surgical systems; rather, we must look across a range of outcomes and systems for the major surgically amenable cancers in each country, particularly for surgical provision for the most common cancers.

Our analysis has found that cancer surgery is needed in all age cohorts, with a plateau from age 30 years onwards; nearly half of admissions for cancer in a HIC

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For the **Lancet Commission on global surgery** see http://www.globalsurgery.info/

See **Online** for appendix

for the **Swedish National Board of Health and Welfare** see http://www.socialstyrelsen.se

such as Sweden needed some form of surgical intervention (figure 1). The proportion of admissions requiring any type of surgery in adult cancers varied dramatically, from as low as 25% for bone to over 70% for all bladder and breast admissions, in well-resourced and developed high-income systems (figure 2). The same is also true of surgery for childhood cancers (appendix pp 15–16). We know already from the work in the Global Surgery 2030 Commission[2] how serious the scarcity of access to general surgery is globally. In the most resource-poor settings, where patients present with an advanced stage of cancer, palliative surgery is still needed (eg, stomas, palliative mastectomies, and surgical bypass for pancreatic cancer). We estimate that over 80% of all cancers need some form of surgical intervention, in many cases several times. In 2015, we estimate that the global need for cancer surgery will be at least 32 million operations. In 2030, we estimate this will reach 45 million (figure 3). The largest proportional increase in the need for cancer surgery will occur in the low human development category (59% between 2015 and 2030) because of both higher overall incidence and higher relative incidence of cancer types that more often need surgical procedures (figure 3). According to the International Agency for Research on Cancer, Cancer Incidence in Five Continents (IARC CI5), worldwide, the need will probably be greatest for cancer surgery for prostate (an estimated 6 472 074 operations in 2015 and 9 459 697 in 2030), bladder (3 725 679 operations in 2015 and 5 379 452 in 2030), and breast cancer (3 022 883 operations in 2015 and 3 810 168 in 2030; appendix pp 17–18).

For the **IARC CI5** see http://ci5.iarc.fr

In most HICs, data from staffing and cancer outcomes suggest that cancer surgical needs in terms of human resources are mostly being met; however, the paucity of basic surgery in many LMICs also means that there is a serious shortage of cancer surgical provision in most of these countries. Less than 5% of patients in low-income settings have access to safe, affordable, and timely cancer surgery. Our equivalent modelling suggests that for MICs this figure is marginally higher, but still only 22%.

But what is the effect of surgery on patient outcomes? Historically, surgery has constituted the primary and often the only available treatment for malignant cancer. Paradoxically, the number of cancer-related deaths averted by surgery is not easy to estimate. The effect of surgery with curative intent on the risk of cancer death has seldom been assessed in randomised trials. Observational studies are fraught with biases—mainly patient selection for surgery. Most randomised trials of surgery for cancer done in the past two decades investigated the efficacy of less surgery (eg, lumpectomy instead of mastectomy for breast cancer), modifications of surgical procedures (eg, for surgery of rectal cancer), surgical methods for administration of chemotherapy (eg, limb perfusion for limb sarcoma and melanoma), and the clinical value of sentinel lymph node removal. A substantial difficulty with LMICs is the paucity of data relevant to the role of surgery in the treatment of cancer.

For further study, we selected breast and colorectal cancer—two diseases for which surgery has always represented the primary treatment. We looked for data on cancer survival according to stage collected in years when effective non-surgical treatment was rare, and

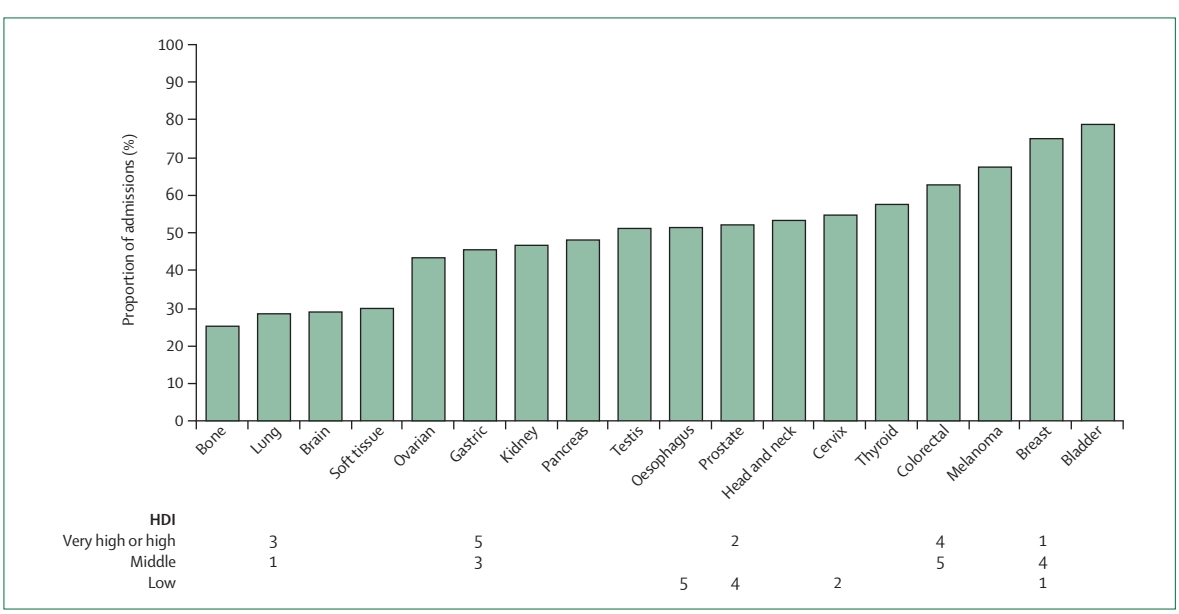

Figure 2: **Proportion of admissions requiring surgery by site-specific cancer and ranking of cancer incidence according to Human Development Index**
See UN Human Development Reports for further details of HDI. HDI=Human Development Index. Data from GLOBOCAN 2012,[3] the Swedish National Board of Health and Welfare's National Patient Register, and the International Agency for Research on Cancer, Cancer Incidence in Five Continents. See appendix (pp 18–19) for further details.

For the **UN Human Development Reports** see http://hdr.undp.org

when screening was not widespread. Thus, we went back to stage-specific incidence, survival, or mortality data for cancers diagnosed in the 1980s and early 1990s. We assumed that cancer growth followed the chronological multistep model by which the accumulation over time of biological lesions (eg, genetic mutations and epigenetic alterations) leads to the formation of a cancer precursor lesion, then to an invasive cancer that eventually metastasises to the lymph nodes and distant organs.[6] According to this model, in the absence of treatment, an early-stage clinical cancer inexorably progresses to more advanced stages and metastasises, leading ultimately to death.

Our approach suggests that for 561 of 1000 patients with breast cancer, surgery could have prevented death occurring within 5 years after diagnosis (appendix p 19).[7] This might be a slight overestimation because cancer takes some time to progress from one stage to a more advanced stage and a high proportion of early-stage disease (maybe up to 30%) progresses and becomes fatal. We also applied the same model to stage-specific 3-year survival of patients with colorectal cancer.[7] Our approach suggests that for 357 of 1000 patients, surgery could have prevented death occurring within 3 years after diagnosis (appendix p 19).[7] The limitations of this estimate are the same as for breast cancer.

Surgery plays a substantial part in the prevention of cancer death, and in these two case studies high-quality surgery, along with pathology and imaging, contributed to between 30% and 55% of the survival effect. However, these examples show the ideal situation in high-income settings. We know that most breast cancers in LMICs and in deprived regions in HICs are diagnosed at an advanced stage,[8] when surgery is palliative rather than curative.

In summary, of the 15·2 million new global cancer cases projected for 2015, over 80% will need some form of surgical intervention, but on the basis of evidence from Global Surgery 2030,[2] around three-quarters will not receive safe, affordable, or timely surgery. The frequency of any type of surgery, modelled from high-income settings, varies dramatically depending on cancer type, from as low as 25% for brain and bone cancer up to nearly 80% for cancers such as breast and bladder. Cancer surgery encompasses a wide range of procedures, of which just over a third need specialised surgery. Finally, surgery is essential for all aspects of cancer management, and in the curative setting it has a major effect on outcomes.

Economics and financing of cancer surgery

The ability to deliver safe, affordable, and timely cancer surgery to all is crucially dependent on economics and financing, particularly investment policies that are framed by national and international regulation and law (panel 1). We examined these areas with a view to asking what policymakers should be undertaking in terms of investment and financial risk protection for patients with cancer who are undergoing surgery, and how could, or should, the law be used to ensure both fiscal probity and clinical governance. Cancer is a major economic burden on all countries, particularly LMICs, but surgery is the main method of cure and control. Investments in resource-stratified surgical systems are both cost effective and affordable.

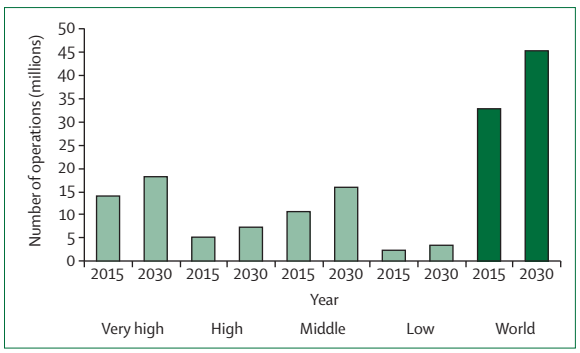

Figure 3: **Estimated need for cancer surgery in 2015 and 2030, by Human Development Index category**
Data derived by modelling known surgical need for individual site-specific cancers against projected burden. Data from GLOBOCAN 2012[3] and the International Agency for Research on Cancer, Cancer Incidence in Five Continents. See appendix (pp 18–19) for further details.

Panel 1: Cancer surgery and the right to health

Access to health care, including cancer surgery, should be a basic human right. Indeed, the "right of everyone to the enjoyment of the highest attainable standard of physical and mental health" is recognised under international law[9] and is also recognised in the Convention on the Rights of the Child[10] and the Constitution of the WHO.[11] The right to health is also protected in many domestic constitutions or charters of rights, and in regional agreements. Regarding health care—including cancer surgery—as a basic right can affect the framing of public debates and political deliberations about the provision and financing of health care, particularly for the most disadvantaged and vulnerable members of communities. The delivery of cancer surgery can be substantially affected by a large number of legal frameworks, both international and domestic. For example, intellectual property laws, controlled drugs laws,[12] equality and anti-discrimination laws,[13] anti-corruption laws, privacy laws (ie, how privacy laws and policies that were designed to protect the rights of individuals can affect both the sharing of patient records between practitioners and population-level research, eg, by impeding surgical research that cannot be done using fully de-identified personal information),[14] negligence laws (ie, whether legal recourse is available for breaches of professional duties of care), and international trade agreements. Judicious application of the law and regulations can drive strengthening of surgical systems for cancer and protect patients from harm, both economic and clinical.[15]

The economic burden of surgically amenable cancer

Microeconomic effects

The negative effect of cancer on personal and household income—the microeconomic effect—has been well documented.[16–18] Patients in LMICs are at greatest risk because of the heavy reliance on out-of-pocket payment. In any country, whether high or low income, the risk of impoverishment or financial catastrophe from cancer is greatest among the poor and underinsured; globally, 25% of those undergoing surgery will face catastrophic expenditure.[16,19,20]

Patients with cancer, and specifically cancers that need surgical treatment, face two major types of costs: (1) direct costs associated with accessing treatment, including both the costs of surgery (eg, imaging, pathology, and blood tests) and the non-medical costs associated with accessing treatment, such as transport and food costs; and (2) indirect costs as a result of lost productivity secondary to the illness itself and time and labour losses associated with seeking treatment.

Few studies have investigated the specific micro-economic effects of care for cancers amenable to surgical treatment (hereafter referred to as surgical cancers), or how the costs patients face in accessing this care affect their outcome, including their financial ability to complete overall cancer treatment. The most comprehensive study so far on the microeconomic effect of surgical treatment for cancer in LMICs is the ACTION study.[18] This study prospectively assessed out-of-pocket costs, catastrophic expenditure, and discontinuation of treatment in 4585 patients who presented with surgically operable cancer—most commonly breast (36%), colorectal (14%), oral (8%), and cervical (7%)—in eight southeast Asian countries in 2012–13.[18] 31% of all patients presenting with surgically operable cancer experienced financial catastrophe (out-of-pocket costs >30% of annual household income) within the first 3 months of diagnosis and 23% had discontinued treatment. Women and those of low socioeconomic status were at high risk of both financial catastrophe and treatment discontinuation. Financial catastrophe varied between countries: in Indonesia 10% of patients experienced financial catastrophe, 3% in Malaysia, 33% in the Philippines, 2% in Thailand, and 73% in Vietnam.

The low rates of financial catastrophe from surgical cancers in Malaysia and Thailand found in the ACTION study[18] are not surprising, because both countries have achieved universal health coverage.[21] When the results from all eight countries were pooled, health insurance status was associated with lower odds of treatment discontinuation, but not with lower odds of financial catastrophe. This paradoxical finding might be explained by the limited benefits packages for cancer care in the health insurance programmes of some countries such as Vietnam and the Philippines, which are probably not sufficient to protect against financial catastrophe, but provide just enough coverage to allow patients to continue with treatment. Out-of-pocket payments for surgical cancer care also limit service uptake. In a smaller study in Cameroon,[17] a surgical procedure for cancer and preoperative payment greater than $310 significantly increased the likelihood that patients would not undergo the recommended surgical treatment.[17]

Macroeconomic effects

Cancer exerts substantial economic effects not only at the household level (ie, microeconomic), but also at national, regional, and global levels, affecting economic productivity and growth in countries at all stages of development (ie, macroeconomic).[22] Many attempts have been made to quantify the macroeconomic effect of different types of cancer, particularly in high-income regions.[23–26] One of the most comprehensive macro-economic analyses of the societal costs of cancer, including surgical cancers, was undertaken by Luengo-Fernandez and colleagues.[27] They assessed the economic burden of cancer across the 27 countries in the European Union (EU) in 2009 and estimated that the combined direct health-care costs, informal costs, and economic losses due to cancer cost the EU about €126 billion annually, with almost €43 billion in lost productivity as a result of early death.[27] However, there is a paucity of research into the economic cost of cancers stratified by treatment method or into productivity and welfare losses as a result of failure to access appropriate, timely surgical care.

An examination of the macroeconomic effects of surgical conditions, defined as diseases that need to be managed by a surgeon, was done to permit greater understanding of the economic burden of surgical cancers. Surgical cancers are estimated to cause 2·7 million years of life lost to disability worldwide.[28] This heavy burden of morbidity and mortality is accompanied by substantial, but widely under-recognised, economic and welfare effects. Using a value-of-lost-output approach, which describes the economic burden of surgical cancers in terms of gross domestic product (GDP) losses as a result of labour supply and capital stock, Alkire and colleagues[29] estimated that between 2015 and 2030, surgical cancers will result in cumulative GDP losses of $12 trillion globally (lower uncertainty bound $7·5 trillion; upper uncertainty bound $18 trillion). Expressed in terms of annual GDP losses by World Bank income group, HICs are projected to lose 1·0–1·5% of GDP annually by 2030 from surgical cancers, MICs 1·0–1·2% of GDP, and LICs 0·5–1·0% of GDP (figure 4).

However, GDP alone cannot capture the full value of health losses from surgical cancers. Individuals place value on living longer and in better health, which is not considered in the value of market losses. Alkire and colleagues[29] therefore also assessed the burden of

mortality and morbidity from surgical cancers using a broader economic welfare measure—the value of a statistical life (VSL). The VSL assesses the monetary value individuals place on changes in their risk of dying.[29] Although VSLs do not represent actual monetary losses, they can be expressed relative to GDP to provide a better sense of their effect. Global annual economic welfare losses are estimated at $7 trillion from surgical cancer mortality and $400 billion from surgical cancer morbidity. HICs and upper-MICs experience the greatest economic welfare losses from surgical cancer, as measured by VSLs, equivalent to upwards of 10% and 6% of GDP, respectively.

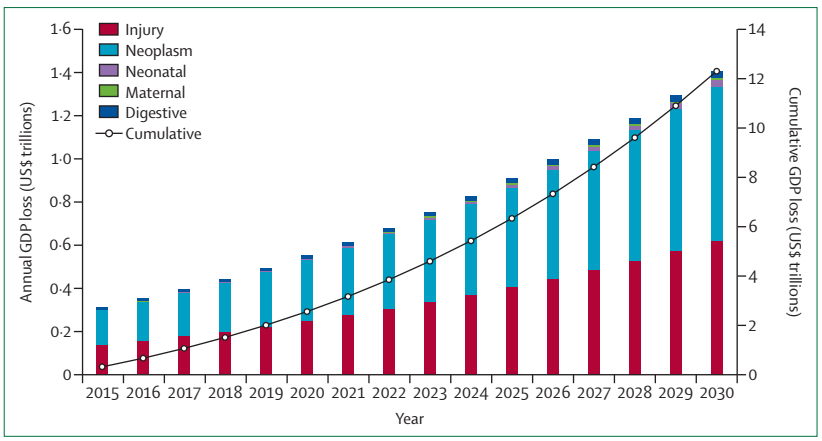

Figure 4: **The economic effect of not investing in cancer surgery in low-income and middle-income countries**
Annual and cumulative GDP lost in low-income and middle-income countries from cancer, and four other categories of surgical conditions for comparison. Data are based on WHO's Projecting the Economic Cost of Ill-Health (EPIC) model (2010 US$, purchasing power parity). Reproduced with permission from Meara and colleagues.[2] GDP=gross domestic product.

Investment frameworks for global cancer surgery

The burden of cancer is rising most rapidly in LMICs, where major epidemiological and development transitions are occurring yet cancer control policies, investments, and the overall health system infrastructure, including surgical care, tend to be weak. This combination of factors is poised to substantially alter the economic trajectory of countries and regions. Between 1970 and 2000, an estimated 11% of economic growth in LMICs resulted from reductions in all-cause adult mortality.[30] As the causes of premature adult mortality (ie, death before age 70 years) in many MICs shift from communicable and maternal causes towards non-communicable causes—including cancers—and injuries, ongoing economic growth, welfare, and development in these regions will be dependent in part on the strength and speed with which they are able to address the rising burden of cancer, including surgical cancers.

The provision of affordable and comprehensive cancer care, including surgery, in LMICs will be most effectively accomplished by a coordinated effort to scale-up targeted and strategic investments—the so-called investment framework approach.[31] This method departs from the traditional health advocacy approach, in which different groups compete for scarce government resources through funding of many discrete interventions. Such segregated approaches tend not to facilitate synergisms in the health system and result in fragmented delivery of care.[32] An integrated health systems approach, focused on maximising health outcomes, will more likely achieve implementation of both specific treatments and comprehensive health care, particularly within LMICs.[33] Until now, the availability of surgical cancer care in LMICs has been limited by many factors, including the high perceived cost of providing such services. An investment framework for cancer surgery would help guide governments and decision makers in the process of implementation.

The investment framework approach was popularised in the 2011 Political Declaration on AIDS, which helped reconceptualise health-care costs as health-care investments.[34] The term investment refers to the spending of money now with the hope of realising substantially greater benefits in the future, within a defined timeframe. This approach has since been adopted by the maternal and child health movement,[35] Global Health 2035,[30] and, most recently, by advocacy for more universal access to radiotherapy for cancer care.[36] The creation of an investment framework for cancer surgery is a multistep and multistakeholder process that requires identification of a set of key evidence-based interventions and an understanding of the broader environmental factors that enable their successful delivery. The environmental factors create an enabling environment to maximise the effectiveness of the core interventions such as research and innovation, community empowerment, and health-care worker training. Programmatic efforts—or development synergies—are key factors in other health and development sectors related to cancer surgery, and can include stigma reduction, overall health expenditure, and food security. Social determinants of health, such as education and road infrastructure or transportation, are an example of a cross-cutting issue that can apply to many different types of health system reform.

The investment framework approach can be applied at various regulatory and governmental levels and provides normative guidance for building capacity in conjunction with other non-communicable disease or cancer groups, including pathology, radiology, radiotherapy, and systemic therapy. Furthermore, the inclusion of different stakeholders with varying areas of expertise in surgery, oncology, economics, and global health, both within and outside international institutions such as WHO, is one of the factors that has proven successful in promoting innovation in other areas such as HIV.[33] Application at the national level allows for consideration of specific epidemiological patterns and promotes country-level ownership of the investment plan. Similarly, The Global

	Direct costs of surgical care*(€, millions)	Percentage of total direct costs of cancer care
Breast cancer	2482	40·5%
Colorectal cancer	3022	55·3%
Prostate cancer	845	17·4%
Lung cancer	1164	28·2%

Analysis derived from Luengo-Fernandez and colleagues.[27] *Direct costs of surgical care include associated imaging and pathology, preoperative care (if inpatient), and postoperative care (including readmissions for postoperative complications).

Table 1: **Direct costs of surgical care for breast, colorectal, prostate, and lung cancer in the European Union, 2011–12**

Fund to Fight AIDS, Tuberculosis, and Malaria received guidance and support from international bodies, but allowed governments and non-governmental organisations to be directly responsible for management of the spending of funds.[33] The investment framework approach enabled mobilisation of funding for The Global Fund by showing that, despite the estimated $22 billion investment needed to provide universal access to HIV care by 2015, the framework was actually cost effective as the proportion of healthy people in the workforce increased, with a cost per life-year gained of $1060.[32] This framework does not specify how to finance these interventions, but allows governments to understand, using a common language and metric system, the downstream health and economic benefits of an upfront investment and the components needed to achieve success.

Financing cancer surgery

Spending on cancer surgery: costs, cost-effectiveness, and value

Cancer is one of the most expensive disease challenges that health systems around the world will face in the 21st century. Global spending on cancer drugs alone exceeded $100 billion in 2014.[37] Surgical technology for cancer care is also an important, but lesser studied, driver of cost growth.[38,39] Although gross underinvestment in cancer prevention and treatment has led to poor outcomes in LMICs, in HICs high levels of expenditure do not necessarily equate to better cancer outcomes, and in some cases there is even an inverse relation.[39] Global spending on cancer care is heavily skewed towards HICs. Only an estimated 5% of global spending for cancer occurs in LMICs despite these regions having the highest total burden of attributable mortality.[40] Spending on general surgical services is similarly skewed to high-income regions. Chronic underinvestment in surgical services in LMICs mean some 5 billion people still do not have access to any form of surgical care, including surgical cancer care.[41] The ability of LMICs to rapidly scale up surgical cancer care is substantially limited because much of the basic health systems infrastructure, human resources, and processes that form the building blocks of surgical oncology services are weak or absent.

Rising costs in cancer care in HICs have meant the cost and cost-effectiveness of cancer care have been subject to heightened levels of research and policy attention over the past decade. Although surgery, radiotherapy, and chemotherapy are the mainstay of cancer treatment, most economic assessments have focused on chemotherapy.[42–44] As such, there is a paucity of robust analyses investigating the costs—both direct and indirect—and the cost-effectiveness of surgical interventions for cancer care in high-income settings, and a near-complete absence of any data in LMICs. Published estimates for the treatment costs of cancers needing surgical care—including common surgical cancers such as breast, colorectal, prostate, and cervical cancer—vary widely both within and between countries.[27,45] Most studies do not disaggregate costs by treatment type, but those that do usually report chemotherapy costs associated with treatment that are substantially higher than surgical or radiotherapy costs, even when surgery is the primary treatment method.[45] Using previously published methods and data sources on direct health costs of cancer care in the EU,[27] we investigated the direct costs of surgical care for the four most common cancers (ie, lung, prostate, colorectal, and breast) in the 28 countries of the EU in 2011–12 (table 1). Direct costs of surgical care included not only the costs of the surgical procedure, but also the associated imaging and pathology, preoperative care (if inpatient), and postoperative care (including readmissions for postoperative complications). When the direct costs were estimated based on an entire episode of surgical cancer care, rather than on the surgical procedure alone, the proportion of costs attributable to surgical care made up over half of the total direct cancer care costs for colorectal cancer and over 40% for breast cancer. Proportional costs from surgical care were lower for lung and prostate cancer, as a result of the lower proportion of patients with these cancers who are amenable to surgical intervention.

Heterogeneity in the methods, patient populations (including age, stage, and treatment time), and time periods make comparability and generalisation of costs between studies and across countries extremely difficult. Studies of the cost-effectiveness of surgical interventions have similar limitations, and have typically focused on defining the cost-effectiveness of new technologies (eg, laparoscopic or robotic surgery) relative to published cost-effectiveness thresholds.[38] A 2014 systematic review[42] of cost-effectiveness evidence in high-income settings for surgical interventions in breast, colorectal, and prostate cancer showed a dearth of methodologically robust studies; the investigators concluded that policy and financing decisions for most surgical techniques do not seem to be informed by sound economic evidence. There is also a dearth of studies investigating the cost:benefit ratio and return on investment of cancer spending, including spending

on surgical cancer care. Systematic assessment of the return on investment of different interventions is important, because in many HICs increased financial investment in cancer care is no longer an assurance of improved outcomes at the population level.[46] Furthermore, the cost of different cancer treatments, particularly pharmaceuticals, is also not always consistent with their value to patients, health providers, or society.[47]

In LMICs, data on cancer care costs from both the payer and societal perspective is all but absent. This includes data on the costs of individual surgical interventions and the cost-effectiveness and cost:benefit ratio of different combinations of cancer treatments.[43] In 2015, the WHO Cancer Technical Group began investigating the costs and cost-effectiveness of basic technical packages of surgical cancer care for countries for the purposes of procurement. However, wide-ranging costs between and within countries for operating-room outlay, equipment and supplies, and supporting technology such as imaging has made this a challenging task with little generalisability. Both international and domestic spending on cancer care in emerging economies and LICs seems to be increasing. Evidence of value for money—for payers, patients, and societies—is fundamental to making informed choices regarding the allocation of scarce health resources in these settings. Assessment of both the health and economic benefits of different combinations of treatment methods for cancer care in resource-poor settings is also urgently needed and cannot be easily extrapolated or transferred from experiences in high-income and high-resource countries. One of the main challenges of undertaking economic assessments of this type in LMICs is that longer-term outcomes data, which are required to assess effectiveness, are hard to obtain. In many LMICs, registry data are often very limited, health information systems and reporting are weak, and long-term follow-up of patients in both a clinical and research context can be very difficult.

Financing and payment mechanisms

There are three major sources for national health financing of cancer care: the public sector (ie, general revenues or social insurance contributions), the private sector (ie, out-of-pocket payments and private insurance), and external sources (eg, grants from international funding agencies or concessional loans from development banks).

In most LMICs, direct financing, in which individuals pay out of pocket at the point of care, remains the main financing mechanism for both cancer care and surgical care, even when the stated means of health financing in a country is general taxation.[41,43] Out-of-pocket payment for surgical cancer care acts as a barrier to service uptake and is a major cause of catastrophic expenditure and impoverishment.[18] As countries develop, they tend to transition towards indirect financing mechanisms that pool risks, thereby protecting against unexpected financial shocks from people accessing health care. Therefore, in MICs, a mix of direct and indirect financing for surgical cancer care exists, often within the same country. Unless financing mechanisms in LMICs explicitly address equity or adopt a pro-poor approach—either by targeting the poor or by targeting the types of diseases the poor are most likely to experience—the wealthier tend to have greater access to coverage, whereas the economically and socially disadvantaged are at highest risk of being uninsured or underinsured. For example, in India, chronic underfunding of the public health sector, along with public perceptions that public health care is of poorer quality, has led to the emergence of an expensive and unregulated private sector for cancer care, including surgical procedures. Limited regulation means surgical cancer care in the private sector can be of highly variable quality, and at substantially higher cost than in the public sector. Wealthy patients can afford private insurance or to pay out of pocket for care, and are often better informed in their choice of provider, whereas the disadvantaged are either unable to access cancer care, because the private sector is out of reach for them financially and because access and coverage in the public sector for cancer surgery is often poor and concentrated in urban areas, or, if they are able to access cancer care, incur substantial health expenses and medical impoverishment as a result.[48] Limited quality regulation in both the public and private sector is particularly concerning for surgical treatment of cancer because adequate surgical resection is fundamental to treatment success.[43] Poor quality surgical cancer care not only leads to poor health outcomes in India, but also increases overall costs and reduces efficiency—at one public tertiary cancer centre, for example, as many as 45% of patients who underwent breast cancer surgery at an outside facility needed surgical revision for incomplete primary resection.[49] Panel 2 summarises key questions relating to financing of surgical systems for cancer.

Universal health coverage and surgical cancer care

Increasing recognition of the microeconomic and macroeconomic effects of poor health, and the importance of health financing mechanisms in alleviating this, has seen universal health coverage emerge as a leading health goal for the post-2015 era. Initial universal health coverage policies have focused on primary and preventive care first, typically for child, maternal, and reproductive health, or infectious diseases, with the aim of expanding coverage to secondary care in the future. However, diagnosis of cancer and the need for a surgical procedure are associated with some of the highest rates of out-of-pocket expenditure, financial catastrophe, and

Panel 2: **Financing of surgical systems for cancer: some key questions**

To what extent are current policy and investment decisions in surgical cancer care based on clinical and economic evidence?
- How do we ensure research and development in global cancer surgery is supported, including sound economic assessment?
- How do we ensure existing economic evidence is represented in policy and investment decisions?

How do we define value in surgical cancer care and how is this represented in financing decisions?
- Payer perspective, societal perspective, and patient perspective

Who sets the prices for drugs, technology, and equipment for cancer care, including surgical cancer care?
- How does the price represent patient, provider, and societal value and the costs of research and development?
- How do we ensure fair pricing of the technology, equipment, and consumables needed for surgical cancer care for LMICs?

Which delivery models might facilitate more efficient and cost-effective delivery of cancer care and where does surgical cancer care sit within this?
- What are the systems requirements, the policy and regulatory requirements, and the financing mechanisms needed to support these delivery models?

How can LMICs rapidly scale up surgical cancer care in view of the major deficits that exist in health systems infrastructure and human resources for both surgery and cancer care in these regions?
- What is the cost of meeting population needs for surgical cancer care in the next 15–25 years under different scale-up scenarios?
- Who should finance this and how should it be financed?

LMIC=low-income and middle-income country.

impoverishment of any health intervention, with the poor and disenfranchised at greatest risk. For this reason, there is a strong argument that universal health coverage policies should include high impact, cost-effective cancer treatments from the earliest iterations of any coverage plan in countries at all stages of development.[20,41,43] Global Health 2035[30] recommended an essential package of clinical interventions for cancer care that all countries should aim to cover through universal health coverage, as well as an expansion pathway for scaling up the breadth of interventions covered. Similarly, the Disease Control Priorities Group have suggested that all countries should provide a set of high-impact, cost-effective clinical interventions for priority cancers, including surgical treatment of cervical, breast, oral, and colorectal cancers.[50]

Thailand and Mexico are examples of MICs that have achieved universal health coverage in the past decade, have adopted a pro-poor approach, and have covered surgical cancer care from early within their health-care systems development.[51,52] Universal coverage was financed through tax-based models for Thailand and social insurance models for Mexico. Assessments of the Mexican reforms suggest they have improved access, equity, and uptake of all health services, including for common surgical cancers such as breast cancer.[52] Economic analysis of the policy effects of universal health coverage in Thailand has similarly shown improved access and affordability of cancer care,[53] including surgical procedures.[51] Thailand in particular has coupled the introduction of universal health coverage with a heavy emphasis on the use of locally generated cost-effectiveness analysis, health technology assessment, and the explicit use of multidecision criteria analysis when selecting which procedures to fund.[54]

Purchasing of surgical cancer care

How cancer surgery services are purchased can have substantial effects on quality and efficiency for countries at all stages of development. In many countries, passive purchasing of health services occurs, whereby the government directly funds government-run or government-owned health facilities for cancer surgery by paying for their inputs (eg, human resources, equipment, and supplies) through line item budgets. This method does not link reimbursement to the quality or efficiency of service provision and provides little motivation to providers to improve care or respond to patient demand. By contrast, strategic purchasing involves proactive decisions about which health services or packages are purchased, how, and who from, on the basis of predefined outputs and outcomes. It links payment for services to predefined outcomes that are known to be cost-effective in terms of improving health outcomes, and is designed to select the most qualified and efficient provider to optimise resource allocation. It often uses financial incentives (eg, pay for performance or results-based financing) to drive improvements in the quality of care. Thailand is one example of a country where strategic purchasing has been introduced and has been effectively used to improve quality and efficiency and reduce overall costs for cancer services, including surgical interventions.[55] However, pay for performance must be used cautiously. If financial incentives are tied to the wrong health outcome or proxy indicator they can encourage misuse of the system (eg, surgical providers might decide to only take on low-risk oncology procedures so that they have better outcomes and better financial compensation).[41]

Major challenges exist in the delivery of affordable cancer care including surgical care. Current spending on the delivery of cancer care in HICs is unaffordable for LMICs, and in the absence of major investment in critical health infrastructure and human resources it is likely to be unattainable in the near future.[56] Even in HICs, the cost of cancer care is becoming unaffordable for many countries using current models of care delivery and financing.[57] Many clinical decisions and health policies pertaining to cancer spending are not informed by evidence of clinical efficacy or economic and social evidence of value.

Strengthening surgical systems for cancer

In Global Surgery 2030,[2] the factors needed to build surgical systems to deliver surgery to some of the world's most vulnerable populations were described. Building on this, we explored the issues and solutions for strengthening cancer surgical systems across resource settings through generic cross-cutting dimensions, and across specific countries, stratified by income setting.

Multisystems approach for strengthening of surgical systems for cancer

Delivery of cancer surgery to all cannot be achieved without countries having a clear national cancer control plan that integrates the other foundations of cancer health systems, such as community care and radiotherapy, all built around a quality agenda.

Primary and community care

The three pillars of primary and community care—access, coordination, and equity—predict the successful early diagnosis and treatment of cancer.[58] Late-stage disease presentation is common in many LMICs.[59,60] Worse outcomes are linked to late disease stage at presentation—a manifestation of poor cancer awareness among patients and primary care providers.[61] However, in many countries around the world, no organised systems exist for primary care. Referral is haphazard or non-existent, and patients have to navigate their own way to a suitable provider of cancer surgery. Furthermore, traditional medicine and practices often act as major barriers to appropriate and timely presentation. Even when patients present in hospital settings, early cancer diagnosis in many LMICs is compromised by the low positive predictive value of suspicious symptoms without available diagnostic instruments and with undeveloped referral networks. Solutions to these issues are addressed in a complementary Lancet Oncology Commission on primary care and cancer control.[62] Participation by surgeons along the care spectrum is crucial to ensure the shortest interval between symptoms onset or screening to diagnosis and referral to operative care, recognising the effect on outcomes.[63] Although education of the public about cancer-related symptoms is important, the positive predictive value of such symptoms is generally low (eg, 2·4% for rectal bleeding and colorectal cancer and 3·4–7·4% for haematuria and bladder cancer).[64] Unless there is significant morbidity, many patients will not present for care.[64] Rather than solely focusing on symptoms, a key public health message is that cancer can be cured. Surgeons should work with their primary care providers to facilitate prompt assessment, appropriate diagnosis, and timely referral to reduce delays in care.

Imaging

All curative and most palliative cancer surgical procedures need imaging. Radiographic studies are necessary to stage most solid tumours, with increasing levels of complexity and use as resources become available (appendix p 20). Even in resource-constrained countries, chest radiography and ultrasonography are valuable initial examinations for the diagnosis of cancer.[65] About 90% of health facilities able to perform surgical biopsy also have chest radiography capabilities (Ilbawi AM, University of Texas MD Anderson Cancer Center, Houston, TX, USA, personal communication). Introduction of basic diagnostic facilities should be regarded as an early implementation step in facilities with the capability to undertake biopsy for cancer.

In high-resource settings where advanced imaging is widely available, the emphasis has been on appropriate-use criteria—the right test for the right patient—in diagnosis, staging, and surveillance. This framework is also relevant to LMICs. The dramatic rise of diagnostic imaging in the past two decades saw a near doubling of CT use and a tripling of MRI use between 1997 and 2006.[66] Improved access has provided more precise and timely diagnostic information, but often at the cost of overuse.[67] Shortages of suitable imaging equipment remain a major impediment to strengthening of cancer surgery capabilities in many LMICs despite the fact that use of basic and limited equipment is very cost-effective for hospitals (appendix p 19).

Pathology

Cancer surgery is crucially dependent on pathology. In low-resource settings, patients with cancer rarely obtain histological diagnosis and few will receive an appropriate operation. To further complicate matters, all clinicians using biopsy techniques need training to ensure adequate tissue sampling. Mechanisms must be put in place for appropriate specimen labelling and documentation of pathology results and communication between health-care providers and the patient.[68] The greatest obstacle in most LMICs is insufficient human resource expertise.[65] Delays in pathology review are also common, and costs can be prohibitive.[17] Fine-needle aspiration cytology is the most widely used pathology method in many LMICs because of its ease of use, cost-effectiveness, and resource availability (panel 3).[65] However, this method does need greater expertise and offers less data on tumour morphology and architecture than do other pathology techniques. Quality-assurance measures ensure optimum testing and confirm accuracy.[69] Even in high-resource settings, discordance rates between low-volume and high-volume laboratories can exceed 20%.[70] In settings where rigorous quality-assurance measures have been implemented and appropriate management delivered, concordance rates improve; this is a strategy that has been successfully used in low-resource and high-resource settings.[71,72] Directed training programmes can reduce the percentage of missed lesions from 25% to 2%, particularly with fine-needle aspiration biopsy.[73] A regional hub and spoke

Panel 3: **Ten-point minimum pathology provision for cancer surgery**

1. Fine-needle aspiration cytology and biopsy with availability of imaging facilities for deep-seated lesions and masses smaller than 1 cm
2. Collection of specimens in agreed format (eg, margins identified and appropriate fixative used)
3. Cut up and sampling done according to agreed protocol
4. In addition to haematoxylin and eosin sections, availability of agreed minimum set of special stains
5. Agreed synoptic and dataset reports
6. Agreed turnaround time that is clinically relevant
7. Regular, frequent case discussion at multidisciplinary meetings of pathologists and clinicians
8. Agreed minimum staff numbers, responsibilities, and training (eg, of pathologists and technicians)
9. Participation in continuing professional development and external quality assurance, both technical and medical, with a mechanism for provision of a second opinion
10. Archive space and information technology that provides a laboratory information management system (eg, data retrieval, histology–cytology correlation), links to cancer registries, and external communication

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model has been introduced in many countries to improve the availability and timeliness of pathology services while also serving as a viable platform for telepathology.[74] However, the long-term issue is the need to train more pathologists. In sub-Saharan Africa, there are fewer than 80 pathologists for every 1 million population—60 times less than needed.[75] This global paucity of pathology urgently needs to be addressed (appendix pp 20–22).

Palliative and supportive care

Only 14% of people who need palliative care receive it.[76] Surgeons and their anaesthesia colleagues have the capacity to alleviate suffering through palliative procedures or access to opioid analgesia. The use of drugs for pain relief per capita in high-resource settings is about 1000 times that in low-resource settings, showing substantial deficits in access to basic and essential medicines.[76] There is also a substantial surgical need for palliative care; our estimates show that in high-income settings some 15–20% of palliative care cases need surgical intervention (appendix p 18). With late presentation the dominant issue for LMICs, the volumes of palliative surgery are substantial. Furthermore, surgical care at the end of life is an increasingly recognised issue, both in terms of access to surgery and decisions around when and whether surgery is appropriate.[77]

Building high-quality surgical systems for cancer

Quality control is an essential part of strengthening both cancer surgical systems specifically and cancer systems (eg, pathology and imaging) in general.[78,79] There is a growing body of data, mostly from high-income settings, on the importance of surgical volume, processes, and outcomes for delivery of safe and effective cancer surgery.[80–83] Many LMICs are also using methods to assess quality, such as peer review and audit for cancer surgery (eg, the National Cancer Grid of India centre peer review programme; appendix pp 23–30). However, the scarcity of cancer registries remains one of the biggest barriers to improving quality at the population level.

National surgical audits remain a potent method for improving systems of cancer surgical care. For example, for rectal cancer, surgical audits were initially used to assess the effect of standardised total mesorectal excision and to diminish variation in outcome. In Europe, the first national surgical audit for colorectal cancer was initiated in Norway and included more than 99% of patients operated for rectal cancer.[84] Other European countries followed in setting up national surgical audits.[85–92] Another quality improvement initiative is the OSTRiCh Consortium, which consists of a group of health-care institutions in the USA that aim to improve the quality of rectal cancer care in the USA and address equity by improving access to high-quality rectal cancer care for all US citizens. The pattern in most HICs is for joint programmes on the quality of cancer surgical care. These audits all showed remarkable results, confirming the effectiveness of an audit structure with regular feedback at improving the quality of surgical systems.

In high-income settings, more complex programmes for quality are underway. The EUropean REgistration of Cancer Care (EURECCA) aims to develop an outcome-based, multidisciplinary audit registry to modulate variation by the provision of standards in data collection, and feedback on surgical performance in Europe.[93] To improve quality of surgical care for the entire population, a comprehensive audit, in which all patients within a population are included, could be the most effective instrument.[94] Such initiatives also highlight the need for many other HICs and MICs to explore more sophisticated approaches.

The quality of surgical care can also be improved by implementing guidelines for surgical pathways and models of care. Guidelines in HICs, such as those from the National Comprehensive Cancer Network, provide guidance to clinical decision making and pathways. Such approaches are absent in most health facilities in LMICs, but need to be introduced in a resource-appropriate manner to ensure efficient and equitable use of resources if improvements in outcomes are to be gained (Ilbawi AM, University of Texas MD Anderson Cancer Center, Houston, TX, USA, personal communication). Some MICs, such as India and Brazil, are introducing their own guidelines developed through inclusive and iterative work with their own network. Other good practices that we identified include those in Chile, where the use of online Wiki-based technology (ie, iterative,

Panel 4: Key lessons from high-income countries

Cancer systems in high-income countries are some of the most developed cancer surgical systems in the world and have been responsible for leading improvements in mortality and survival. These improvements have come at a price to many health-care systems because costs have continued to escalate, making affordability a major challenge.[98] A case study that focused on minimally invasive surgery describes the challenges that a technological approach to development of cancer surgery systems shows in terms of both costs and quality (appendix pp 32–33). High-income surgical systems are closely associated with screening and early detection, which, although essential for identifying early presentation, have been subject to criticism as systems that over treat; for example, in the case of mammographic-screen-detected breast cancer for which too many women with ductal carcinoma in situ have had unnecessary surgery and adjuvant radiation therapy.[99] Many high-income systems also overinvestigate; for example, breast MRI at the time of diagnosis of ductal carcinoma in situ or early-stage breast cancer[100] does not change local recurrence rates, yet it is used in over 80% of patients before surgery in many high-income countries. Many high-income countries have been active in partnerships that have helped develop cancer surgical systems; for example, Australian institutions and the Pacific Islands (appendix pp 33–34), the Indiana University (Bloomington, IN, USA) and Moi University (Eldoret, Kenya) partnership (AMPATH model),[101] funding from societies and surgical colleges to support training and education, and the development of resource-stratified guidelines such as those from the Breast Health Global Initiative.[102] These partnership models have proved to be beneficial for all parties concerned (ie, bilateral learning), and there is clearly more need for these long-term, sustainable, public sector cancer surgical partnerships. However, many high-income country systems and models of care are not applicable in either resource-limited settings or for the different burden of cancer disease and associated comorbidities that occur in low-income and middle-income countries. Although some high-income countries provide good examples of integrated pathways and models of care, the fiscal structures of many systems (eg, fee for service) has created serious inequalities so that many aspects of high-income country systems should not be replicated in low-income and middle-income countries. Many high-income countries, particularly those with fee-for-service structures, overdiagnose prostate cancer, perhaps by as much as 60%, leading to substantial overtreatment.

context-specific guideline development) has been used to develop evidenced-based, resource-specific guidelines for various cancer surgical pathways. Cancer outcomes can be improved by as much as 30% if accepted standards of care are routinely applied in practice.[82] Global efforts need to improve implementation practices to identify and address factors that cause the knowledge–practice gap in cancer care, to ensure that current good practice and innovations are effectively translated into clinical care.[95]

When thinking about what quality metrics and indicators cancer surgical systems should consider, much has been made of surgical volumes (appendix p 31). However, volume should not be substituted for prospectively monitored and properly risk-adjusted outcomes as comparative measures of the quality of surgical care. The relation between centralisation and outcome is complex.[96] Rather than focusing on volume alone, quality improvement initiatives must address clinical processes of care that can be transferred between high-volume and low-volume centres to improve outcomes across the community.

The knowledge already exists around what minimum standards are important for quality in cancer surgery; the issue is to build these into national cancer control plans and then act on the findings. An effective cancer operation is the sum of complex variables including the biology of the disease, health circumstances of the patient, and resources available, all intertwined with the surgeon's judgment and skill.[97]

Country lessons for strengthening surgical systems for cancer

Country and regional case studies can provide important global lessons. The key lessons from HICs (panel 4) are the importance of developing affordable surgical systems and avoiding overuse of technologies that are not cost effective. HICs also need to build on their global partnership programmes to increase surgical capacity.

Cost-effective technological development is important for systems strengthening—eg, the case of China and use of video-assisted thoracoscopic surgery for lung cancer—but not at the expense of affordability (panel 5). Delivery of basic standards of cancer surgical care at district and general levels, such as good quality open procedures, is essential, as shown by the situation in India (panel 6). Application of peer review, use of resource-specific and context-specific guidelines, and development of proper strategies for cancer surgery with national cancer plans are all essential. Furthermore, national generalisations often do not do justice to the subnational variation in the quality of surgical care. A country can have regions in which cancer surgical care is outstanding and then a few hundred miles away can have regions where there is nothing (eg, Nigeria; appendix p 35). We recognise that the subnational context, infrastructure, economics, and culture can vary dramatically within one country and intra-country variation can be as profound as inter-country variation. Thus, an important consideration

Panel 5: Surgical cancer care in China

China has the largest population in the world—over 1·3 billion people—and some of the highest numbers of cancer surgery cases every year.[103,104] The existing allocation of surgical resources presents an inverted pyramid between urban and rural areas, and even among different hospitals in a particular city depending on the socioeconomic areas they serve. The rural population, which accounts for nearly 70% of the Chinese population, possesses only 30% of the medical resources.[104] In an effort to reach such geographically spread populations, China has adopted the strategy of developing super-centres for its cancer care.

This system of super-centralisation has created some of the largest concentrations of cancer surgical practice in the world. For example, at Peking University People's Hospital, Beijing, roughly 3200 limb salvage procedures for pelvic cancers and 2300 sacrectomy procedures for sacral tumours are done every year. At Henan Cancer Hospital, Henan, more than 1000 oesophagectomies are done per year. In comparison, a large volume of procedures in a high-income country tertiary referral cancer centre might be defined as around 150–200 procedures per year.

Different patterns of disease have also led to cancer surgical innovations in China; for example, Chinese patients with lung cancer present with more severe adhesions between lymph nodes and blood vessels than do patients in many other countries. This situation has caused Chinese surgeons to develop more efficient and safer ways to undertake these difficult surgeries, such as Wang's technique in video-assisted thoracoscopic surgeries, which emphasises dissection within the vessel sheath with close-range observation and tunnelling dissection of interlobar fissures.[105] National surgical outcome data for Chinese patients with non-small-cell lung cancer showed that 44·5% of resections were done by this novel cancer surgical technique. Despite this culture of innovation, cancer surgery in China is regarded as more conservative than in high-income countries. The cultural context and relationship between the patient and surgeon is such that in China there have been reports of violence against surgeons after adverse or unanticipated outcomes. For this reason, some Chinese cancer surgeons are more circumspect and conservative in their planning of surgical treatment.[106]

Panel 6: Surgical cancer care in India

India experiences many of the challenges faced by middle-income countries in delivering cancer surgery to all,[107] particularly with regards to technologies and costs. For example, India only has one licensed CT scanner per 500 000 population.[108] However, a scarcity of resources can also be a driver for innovation with emphasis on simple solutions. In low rectal cancer,[109] the importance of a rectal examination that is done well and the availability of rigid sigmoidoscopes for earlier diagnosis in districts and villages ahead of promotion of the advantages of the more expensive flexible colonoscopes and CT or MRI scanners is key. The focus on local innovation in surgical technologies as part of surgical systems strengthening also seems to be important since cutting costs for services for which most patients make out-of-pocket payments is of paramount importance. Laparoscopic cancer surgery has rapidly developed across India, not only in the cities, but even in some district hospitals. Costs remain a concern, but reusable laparoscopic instruments are widely used in an effort to contain costs.[110] Conversely, the relentless emphasis on cutting-edge technology, driven largely by industry and congresses all over India, has created an inferiority complex among many surgeons who have limited opportunities to access these technologies in smaller cities and towns. Here again, while strengthening and developing modern infrastructure in smaller towns and villages, there is an urgent need to simultaneously highlight that it is not only possible, but perhaps desirable, to undertake excellent open cancer surgery (eg, radical D2 gastrectomy or major colorectal resections) that does not need expensive technology.

Other issues facing cancer care and surgery in India are the wide variation in quality and cost of care between the resource-starved government hospitals on the one hand and the state-of-the-art, high-tech corporate hospitals, which are out of reach for most of India's population, on the other.[111] General surgeons in district hospitals undertake most of the cancer surgery in India, perhaps nearly 80%. The scarcity of an organised system of referrals and centralisation for complex cancer surgeries results in fragmentation of care. Additionally, geographical challenges exist in some areas (eg, northeast India) where the terrain makes travelling even a few hundred kilometres a formidable exercise.[112] Wide variations across states in the quality of surgical cancer care is a major challenge to improving overall outcomes. Cancer surgical systems in India are the responsibility of states, and there is wide variation in the strength and economic levels of each of these states. This complexity has necessitated a greater drive by the National Cancer Grid of India to promote better use of prospective epidemiological studies to compensate for the scarcity of population registries to inform cancer surgical service and guideline development,[113–116] and to use new collegiate systems of peer review.

when scaling up cancer surgery is the need for equitable delivery throughout a country, not just to urban areas.

For national cancer control plans, various organisational and structural approaches can be considered when strengthening cancer surgery, from super-centralisation

Panel 7: Surgical cancer care in Brazil

Brazil is the largest Latin American country, with over 26 states and a population of over 200 million. 84·8% of the population are concentrated in urban areas, but the remainder are spread over huge distances, which poses substantial challenges to delivery of cancer surgery.[117] Although Brazil has a dominant social funding system, public expenditure is imbalanced, with only 9% of national funding for cancer treatment designated for surgical procedures, by contrast with 74% for chemotherapy and 12% for radiation therapy.[118] All reimbursements for cancer treatments are subject to a specific national coding system,[119] and the acquisition of new technologies or procedures in cancer surgery is regulated by CONITEC (Comissão Nacional de Incorporação de Tecnologias no SUS). This regulation has allowed most common cancer surgery procedures to be reimbursed under a regulated system. However, Brazil has not seen an increase in funding for surgical procedures proportional to inflation over the past 10 years, leaving many cancer centres to deliver cancer surgery without sufficient reimbursement to cover the costs. Additionally, new coverage programmes have been added to the Brazilian cancer surgery system under specific national regulation. For example, since 1998, all women referred for a partial or total mastectomy should have the opportunity to undergo breast reconstructive surgery for free, provided by the government or by the private health-care providers.[120] However, the extensive regulations mean that the assessment of new surgical procedures for inclusion in the public health system remains slow. The issues in Brazil are representative of a problem across most low-income and middle-income countries, in which the level of public funding has not kept pace with the need for cancer surgery, particularly for poorer segments of society.

Cancer surgery in Brazil has benefited from a strengthened national commitment to a regulated system of universal health coverage, granted by law, which shows the importance of regulation in helping countries deliver on their cancer service commitments. Moreover, like much of Latin America (appendix pp 36–37) and many other high-income countries and low-income and middle-income countries, there is growing imbalance in resourcing for public sector cancer surgical systems, with most resources flowing through and to the private sector, thus creating increasing inequality.

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through to a highly regulated distributed model such as in Brazil (panel 7). Long-term survival data across cancer subtypes have shown up to 25% improved outcomes when patients receive care at high-volume hospitals.[121] Centralisation of care may also result in reduced budgetary expenditures, perhaps related to reduced complications and high-quality and more efficient care, although this has not been shown conclusively.[122,123] However, the reality is that many patients will only be able to access district general hospitals. Therefore, ensuring sufficient cancer surgical capacity at these locations is also essential. The use of networks between major cancer centres and rural district hospitals to train and build capacity is one model that has worked in countries such as India. The importance of building cancer surgical expertise into general and district hospitals cannot be overstated, and many procedures could be done in a suitably resourced and trained environment. Recent data have shown improvements in cancer care are attained by improving care at each volume level rather than shifting referral patterns only to high-volume centres.[124] For delivery of cancer surgery to countries with small isolated populations, a case study of the Pacific Islands (appendix pp 33–34) shows the need to build up some local capacity, but the necessity of shared care with a well-resourced country to whom patients can be sent for more advanced care when needed.

To receive comprehensive and effective cancer care, surgical services must also meet all the criteria of access, which is a recurring lesson from all the country case studies—care must be geographically accessible, timely, affordable, of the highest possible quality, and coordinated among providers and services. Sociocultural and sociopolitical factors are also major barriers to strengthening of surgical systems, often in very specific areas. For example, our case study of the Middle East identified gender inequality issues in terms of surgical services and outcomes for women (appendix pp 38–39). Long travel distances also pose challenges for many patients and their families.[125] Greater transportation distances and related treatment delays are associated with worse survival.[126] Women with breast cancer in South Africa had a 25% higher likelihood of presenting with metastatic disease for each 30 km distance from the treatment facility.[127] The ability of countries to reach distant, rural areas is a major challenge for most LMICs. However, for LICs (panel 8), our case studies of Uganda and Ethiopia show that there remains a major paucity of capacity and infrastructure to deliver even basic surgery (appendix 39–40). Although building basic general surgery must take precedent, building concurrently the ability to deliver basic cancer surgery is also possible.

Lastly, the needs of cancer surgery for children must not be forgotten. Many global initiatives are actively working in this area and these global partnerships serve as important frameworks onto which new strategies for delivery of cancer surgery for children in resource-limited settings can be built (panel 9).

Scaling up surgical systems for cancer

Although the need for surgical oncology services is being felt universally in resource-constrained countries,

Panel 8: Surgical cancer care in low-income countries

In most low-income countries, surgeons are often the only available cancer professional and are responsible for diagnosis, surgical and non-surgical (chemotherapy) treatment, and palliation.[65] However, despite the important role of surgery in cancer care in low-income countries, few efforts are being made to improve access to surgery, expand training for surgeons, or bolster surgical oncology research, and this is leading to increasing gaps between the cancer surgical needs of these countries' populations and provision, with multisystem problems at almost all levels, as our case studies of Uganda and Ethiopia show (appendix pp 39–40). Clinical examination, chest radiography, and ultrasound are often the only available resources for staging a patient. However, even these limited resources can be effective. In one study,[128] practitioners using ultrasound were able to differentiate between solid and cystic masses with 100% sensitivity and specificity. However, with such limited infrastructure in most low-income countries, surgery is the main means not only of visual diagnosis, but also of treatment or palliation. For example, patients with advanced colorectal cancer often present with obstructive symptoms and are diagnosed at laparotomy, staged by examining for peritoneal and liver metastases intraoperatively, and palliated with a stoma or colonic resection. Patients often present with lymphadenopathy of benign or infectious causes in low-income countries and many middle-income countries, which can be challenging to differentiate from malignant lymphadenopathy. Thus, in these settings substantial overtreatment of non-cancer disorders will occur if the proper diagnosis is not made, which, without improving pathology systems, is the case in most low-income countries. For most low-income countries, the major issues are, as Global Surgery 2030[7] reported, simply a serious paucity of general surgical capability. Where such capability is to be found, there is clearly a need to begin to train general surgeons in a limited repertoire of cancer surgical procedures and improve the general cancer systems infrastructure, particularly for pathology.

Panel 9: Children with cancer: the forgotten role of surgery

Children with cancer are frequently forgotten in policy and planning,[129] particularly in the context of surgery. The issue of surgical systems for childhood cancer is made more challenging by the fact that 80% of children diagnosed with cancer live in a low-income or middle-income country.[130] Roughly 20% of all children admitted to hospital with cancer will need surgery at some point during their inpatient care, but because of underdiagnosis and limited access to specialised care, most children in low-income or middle-income countries will not get the surgery they need. Surgery is essential for many aspects of childhood cancer care. First, surgical tissue sampling is often needed for correct diagnosis, tumour staging, and optimisation of medical treatment. Second, the completeness of surgical resection of solid tumours is closely associated with long-term survival and is often a prerequisite for cure. Third, surgical expertise is crucial for the supportive and palliative care of children with cancer.[131] Paediatric surgery and anaesthesia also have a part to play in prevention, such as in the case of timely corrective surgery for common undescended testes to reduce the incidence of testicular cancer.[132] Comprehensive cancer care and cancer surgery for children is increasingly appropriate as a public health measure in low-income and middle-income countries, but innovative cost-effective solutions are needed and many issues remain unsolved. Treatment strategies from high-income settings are often prohibitively unaffordable, unattainable, and unsafe when applied to low-resource settings, and clinicians and decision-makers must understand the paradox that increased protocol efficacy in one setting might lead to reduced effectiveness in another.[133] Many global initiatives are actively working to address the needs of children with cancer in low-income and middle-income countries, and these global partnerships serve as important frameworks on which new strategies for delivery of cancer surgery for childhood cancer in resource-limited settings can be built.

very few efforts have been made to address how cancer surgical systems can be brought to scale in these settings, particularly for non-fragile LICs.[134–136] We developed a conceptual framework of the factors national cancer control plans need to address to develop sustainable strategies for strengthening their surgical systems for cancer (figure 5). Enhanced training and education through several strategies has been a consistent theme throughout this Commission, from building general surgical capacity, to training general and gynaecological surgeons in basic cancer procedures, to specialisation (panel 10).

A prerequisite to scaling up cancer surgical services is also an assessment of the specific country's cancer burden and state of cancer care. Interviews with providers and members of civil society, inclusive, for example, of patients and their families, community workers, traditional healers, and tribal chiefs, are crucial to identifying the gaps and establishing local and national priorities. Emphasis placed on uncovering factors that (1) delay the decisions of patients to seek care, (2) delay arrival at health facilities, and (3) delay the provision of adequate care provide the basis for targeting scarce resources.[144] The quantity, quality, and functionality of equipment and supplies; availability of running water and electricity; access to banked blood, chemotherapy, and radiation therapy; presence of postoperative facilities; and numbers, types, and qualifications of health-care personnel are examples of information that should be collected in the assessment.[18] The desired end result is a data-driven map of problems,

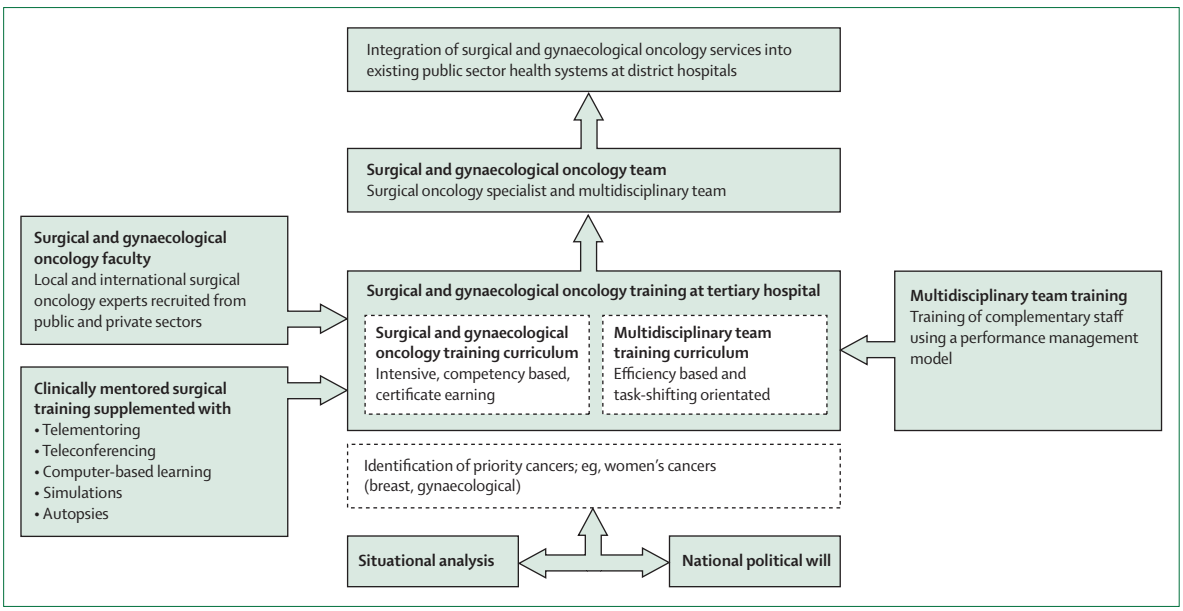

Figure 5: **Conceptual framework for scaling up surgical and gynaecological cancer services in resource-limited settings**

gaps, and needs specific to each country or region, which in turn constitutes the pathway for developing, planning, implementing, assessing, and further modifying the surgical intervention (panel 11).

Research and global cancer surgery

We examined key aspects of global research into cancer surgery, both from a qualitative and quantitative perspective. We also examined how cancer surgery is integral to the wider cancer research agenda. This view is framed by an in-depth analysis of the current state of global cancer surgery,[155] specifically to understand the gaps, opportunities, and innovations for cancer surgery over the next decade.

The central role of cancer surgery in cancer research

Cancer surgery: a critical part of personalised cancer medicine

The practice of contemporary cancer surgery is part of the complexities of personalised cancer medicine, making cancer surgery research and care distinct from many other branches of surgery.[156]

Research into cancer biomarkers, whether prognostic (ie, associated with the outcome of cancer) or predictive (ie, markers to select patient subgroups most likely to respond to a particular treatment), is one of the most active domains of cancer research, and cancer surgery has a crucial part to play.[156,157] The availability of, and access to, biological material of appropriate quality before, after, and during surgery or other treatments is crucial for biomarker research, and integration of the cancer surgical community into these studies is essential.[156] Besides this genomic analysis, high-technology diagnostic methods leading to more precise diagnosis also feed back to guide surgical treatment. Furthermore, as imaging technologies have developed further, clinical staging in terms of defining resectability has improved, with substantial advantages for surgical stratification of patients.

Innovations in cancer surgical techniques result directly in a greater ability for translational medicine to sample tissues, and greater precision through molecular stratification, imaging, and non-surgical treatment in the neoadjuvant setting has made cancer surgery more personalised.

Technology research and cancer surgery

Technological innovation in surgery has become a major research area in cancer. Laparoscopic surgery is an innovative minimally invasive surgical method that has been successfully implemented in oncology for the past two decades. The laparoscopic approach minimises several short-term side-effects, such as postoperative pain, and reduces the length of stay, thus reducing expensive inpatient costs. Surgical oncology technological research has not only been focused on the instrumentation and procedures for minimally invasive surgery, but also the issues of process and outcomes quality, including patient selection taking into account obesity, tumour extension to other organs or vessels, and previous abdominal surgeries, which increase the complexity of laparoscopy.[158–161]

Furthermore, minimally invasive approaches represent an ideal setting for the use of novel imaging methods such as near-infrared spectroscopy in oncological surgery.[161,162] Cancer surgery has been a major driver for new techniques, such as single-incision laparoscopy, in which only one port is used to perform the surgery. Robotic approaches in minimally invasive

***Panel 10:* Education and training to strengthen surgical systems for cancer**

Education and training for cancer surgery must be built on solid foundations. Global Surgery 2030[2] clearly showed a huge gap in basic surgical provision worldwide, with many low-income and middle-income countries, particularly in sub-Saharan Africa and southeast Asia, acutely short of the 20 surgical, anaesthesia, and obstetric specialists target per 100 000 population, and with only 12% of the specialist surgical workforce serving a third of the world's population. For these countries, this target must be the priority. A basic model of the data from the Lancet Commission on global surgery shows that 82% of countries globally, particularly focused in low-income and middle-income countries, cannot have adequate numbers of trained cancer surgeons. However, planning and building capacity for cancer surgery must also start now. A strong focus on training and education is needed to improve standards and systems of care for cancer surgery in the challenging contexts of low-income and middle-income countries. In addition to ensuring surgical oncology is a specialist postgraduate qualification, other well-tried and tested ways of building cancer surgical expertise exist, such as masterclasses.[137] This approach has been well used in India via the National Knowledge Commission, and workshops are already being developed with other cancer centres and general hospitals.[138] Such approaches are expected to educate and enable well-trained general surgeons and general surgical oncologists to undertake procedures such as radical gastrectomy, colon resections, and even low anterior resections in district and other similar level hospitals. Few institutes in low-income and middle-income countries have formal education and training opportunities in oncology and specifically surgical oncology. In response to this shortage, many governments, particularly in middle-income countries, are increasing the number of surgical oncology positions, but demand continues to outstrip supply, and often public sector remuneration is so low that these trainees rapidly enter the private sector.[112,139] Although hands-on surgical training is increasing both in number and diversity of surgery,[140] questions remain about the quality and nature (ie, minimally invasive *vs* open) of training. Suggestions to increase exposure to surgical oncology during general surgical training have not yet been adopted in many countries.[141]

Although high-income countries are driving greater specialisation, globally there is a need for surgeons with much wider training who also have experience of the wider context of global health. We describe some solutions in depth (appendix pp 41–42) and focus on the need for surgical professional societies to play an enhanced part in this area and for acceptance by high-income country education systems of experience gained in low-income countries toward accreditation. High-income and middle-income countries have a duty and opportunity to expand their educational offerings on cancer surgery through bilateral exchanges (ie, education that benefits all parties), greater use of technology-enhanced learning such as eCancer, and partnerships to develop specific curriculum content on cancer into the general surgery residency training programmes.[142] Various models, particularly multilateral collaborations (eg, between Malawi, Norway, and the USA), have been aimed at improving national capacity to draw lessons for future capacity building.[143]

surgery are also increasingly used for prostatectomy and pelvic lymphadenectomy and for trans-anal total mesorectal excision for rectal cancer surgery. Natural orifice transluminal endoscopic surgery is an experimental surgical technique in which abdominal surgery can be done with an endoscope passed through a natural orifice, thereby avoiding any external incisions or scars.[163] However, such technological innovation has thrown up two different issues: the first is the substantial expertise that needs to be developed in these complex techniques, and the second, from a health systems perspective, is how these advanced technologies can be made cost effective for the public sector in HICs and MICs, as we discuss in greater length in the appendix (pp 33–34) and in the preceding country case studies (eg, India).

Improvement of complete surgical margins in cancer surgery is another important example of technological innovation in an area of clinical need. Conventional techniques, palpation, and subtle visual changes to judge the border between normal cells and tumour cells lead to high positive tumour resection margin rates of 15–60%.[162,164] Residual disease is associated with an increased risk of locoregional recurrence and distant relapse and poorer overall survival. Intraoperative frozen section and imprint cytology have been applied in some cancers, but have not found universal acceptance because of the cut surface of the tumour specimen or wound bed being too large, procedures being time consuming, manpower needed being unavailable, and inaccuracy of the methods used to assess margins of resection—major challenges in the high-income setting, and almost insurmountable in most LMIC settings. The need for cost-effective, on-table approaches to address surgical margins in cancer surgery provides a potent drive for novel technologies. For example, in breast cancer surgery, current methods of ensuring adequate tumour clearance—including visual confirmation, manual palpation, ultrasound-guided resection, and wire localisation—all have limitations in terms of accurately defining the extent of tumour in the breast. Hence, there is a clear unmet need for novel techniques to accurately and adequately assess tumour margins intraoperatively, thereby aiming to reduce the number of patients undergoing a re-operation—a huge expense, particularly in LMICs.

Panel 11: **Scaling up systems for cancer surgery: considerations for national cancer control plans**

1 Start by doing what's best and easiest to do

Focus on cancers that have the greatest burden in the population, and for which surgery has a substantial effect. Simultaneous implementation of contextually appropriate screening and early detection programmes for such priority cancers is a necessity. Examples of such interventions for women's cancers include screen and treat procedures by visual inspection of the cervix using acetic acid and cryotherapy, cold coagulation, and loop electrosurgical excision for prevention of cervical cancer; and clinical breast examination and ultrasound-guided biopsy of palpable breast masses for early detection of breast cancer. Initially choosing only a few sites for testing the scale-up model would facilitate success.

2 Select a surgical intervention model that is safe, achievable, resource appropriate, and sustainable in the environment

Use of resource-stratified guidelines and cost-effectiveness as the basis for treatment algorithms (eg, Breast Health Global Initiative for breast cancer[145] and National Comprehensive Cancer Network[146] for cervical cancer) is crucial. Centralisation of complex surgical procedures that are resource and infrastructure dependent to a central training centre and initially scaling up only the less complex surgical procedures to district hospitals will lead to a sustainable and cost-efficient approach for scaling up.[147–149]

3 Train local groups of women's surgical oncology specialists and multidisciplinary care teams

A crucial component of the global response to the HIV/AIDS epidemic has been delivery of care by multidisciplinary teams.[150] Borrowing from this successful model, local mid-to-senior-level general surgeons or gynaecologists would undergo intense, competency-based training designed to produce groups of surgical oncology specialists capable of managing priority cancers across the whole care pathway. Training would take place at a central training centre under the tutelage of expert surgical oncology faculty. Classic bedside and intraoperative teaching could be enhanced with computer-based learning, telementoring, low-cost simulations, and post-mortem anatomical dissections, if allowable, to decrease training time.[151] The surgical skills acquired during training can be used to improve the surgical care of other diseases; for example, in women with genitourinary fistulae and difficult caesarean sections.

4 Find innovative approaches to rectify the severe shortage of health-care workers

One approach to expansion of surgical oncology care in the face of limited numbers of surgeons is to shift selected responsibilities to non-physicians under close guidance and monitoring—ie, task shifting. For example, in district hospitals, women's surgical oncology experts would be directly supported by groups of less specialised physicians (eg, family physicians or general medical officers) or physician assistants (eg, clinical officers or licentiates) to whom well-defined clinical tasks can be redistributed, according to specific national or regional regulations and local contextual needs.[37,151,152]

5 Harness and incorporate affordable technology into the surgical oncology platform

The adoption of point-of-care tests that generate real-time diagnoses without the need for sophisticated laboratory platforms can greatly enhance surgical care accessibility without the need for repeat visits—a factor regarded as crucial for unhampered access to cancer health care. The use of telepathology for both training or mentoring and immediate expert distance consultation,[153] and the use of low-cost mobile-health technologies to support patient follow-up and community-wide education, can be vital adjuncts to the success of any surgical oncology care system.

6 Set up a rigorous process to collect data, monitor and assess interim outcomes metrics, and make adaptations for programme expansion

Several models for peer review and integrated quality improvement systems exist and need to be adapted to the low-income context. Use of checklists for standardised surgical procedures,[154] morbidity and mortality conferences, clinical audits, and the use of multidisciplinary conferences to discuss case management have all been used in high-income countries to improve internal procedural quality.

Use of intraoperative imaging methods offers an attractive solution to the problem of intraoperative tumour margin assessment because they are fast and non-destructive. Several cancer-specific imaging methods have recently been developed and tested to improve intraoperative cancer identification;[162] for example, near-infrared spectroscopy. Although the limited tissue penetration of these probes is not well suited for whole-body imaging, the excellent tissue definition—in the absence of overlying tissue—makes near-infrared spectroscopy probes uniquely suited for real-time imaging during cancer surgery.[162] Various different methods of optical imaging are being researched, including intraoperative radiography, radiofrequency spectroscopy, Raman spectroscopy, fluorescence spectroscopy, and optical coherence tomography. Each has its limitations, but all have potential in resource-limited environments as novel and cost-effective approaches to clear cancer surgical margins.

Cancer surgery covers a wide spectrum of research domains, from recognised areas such as surgical innovation to the less obvious, but crucial, part surgical research has to play in personalised cancer medicine.

Cancer surgery in the changing landscape of cancer clinical trials

Window-of-opportunity studies

Cancer surgery plays a key part in window-of-opportunity clinical studies that assess the response or resistance of a tumour to neoadjuvant systemic therapy. The waiting period to surgery represents a valuable window of opportunity to assess novel therapeutic strategies. The introduction of newer therapeutic agents including molecularly targeted agents and cancer vaccines has generated alternative clinical trial designs such as window trials, which are better suited to assess the therapeutic efficacy of these agents. In window trials, patients receive the therapeutic agent for a window of time before starting standard treatment—usually surgical resection—thereby allowing the assessment of the agent in tumours undisturbed by surgical treatment. It also facilitates the study of tumours in situ by functional imaging and serial tissue core biopsies to examine biomarkers that might be indicative of resistance or response. Interventional studies done during this period need substantial multidisciplinary collaboration to overcome logistical hurdles. However, window studies can provide invaluable predictive and prognostic information. For example, the PeriOperative Endocrine Therapy for Individualizing Care (POETIC) trial included 4486 patients who received either perioperative therapy with an aromatase inhibitor for 4 weeks (2 weeks before and 2 weeks after surgery) or no perioperative treatment (NCT02338310). It provides a unique opportunity to study in detail the determinants of response and resistance to oestrogen deprivation and test the role of presurgical treatment for improved biomarker-based estimates of prognosis. In future, more window-of-opportunity studies will be needed to assess novel therapeutic agents, which will need substantial input and collaboration between oncology and surgery teams.

Neoadjuvant studies

Rapid advances in radiotherapy, systemic treatment, and combined modality treatment have enabled more neoadjuvant clinical research, which has altered the timing of surgery and also the proportion of patients being downstaged to resectable cases. For example, with respect to non-metastatic rectal cancer, a large proportion of patients now have an indication for preoperative radiotherapy, depending on the size of the tumour, whether the circumferential margin is threatened, and the detection of possible invaded lymph nodes. In these patients, preoperative treatment is preferred over post-operative treatment because toxicity is lower and local control by shrinking of the tumour load and compliance are improved. This type of research framework has marked a major change in the way surgical research in cancer integrates with both systematic and radiotherapy. Beyond high-income settings, neoadjuvant surgical trials have become crucial in being able to develop models of care that can downstage traditionally unresectable tumours. With so much of the burden of cancer presenting at more advanced stages in LMICs, there is a clear clinical need for development of this research focus.

Clinical trials

The picture for global cancer surgery in large-scale clinical trials is mixed. In some site-specific cancers, notably breast, the research community have been particularly successful. For example, six randomised controlled trials have been done on sentinel node biopsy in breast cancer.[165–171] Together, findings from these large-scale surgical clinical trials have shown that sentinel node biopsy is a safe and effective alternative to routine axillary lymph node dissection in women with early breast cancer, resulting in reduced physical and psychological morbidity. Longer-term follow-up has shown a low axillary nodal recurrence rate.[172]

The ability to undertake large-scale cancer surgical clinical trials has also been dependent on the development of major transnational clinical trial networks, such as the European Organisation for Research and Treatment of Cancer, which has been key.[173–175] Over the past decade, surgical clinical trials in cancer have focused particularly on the use of lymph node biology, including lymphadenectomy, in several settings. For example, ongoing trials in patients with intermediate-thickness cutaneous melanoma provide important prognostic information on improving survival in patients who undergo early surgical intervention by immediate lymphadenectomy (NCT02434107). In a further example, in patients with colon cancer, the United States Military Cancer Institute Clinical Trials Group[176] assessed lymph node assessment and found that ultra-staging was associated with a higher nodal yield, better staging accuracy, and improved disease-free survival. Furthermore, surgical trials in cancers with high metastatic potential such as gastric cancers are crucial for improving survival. However, the complexities of trial designs means that for many areas evidence is often contradictory and takes time and several studies to resolve.

Randomised trials, systematic reviews, and meta-analyses are regarded as the highest level of evidence. However, randomised trials are costly and time consuming in cancer surgery. More importantly, some research questions cannot be studied within this framework and subgroups such as elderly people and patients with comorbidities are often excluded from trials, which limits the extrapolation of trial results to these subgroups. Large prospective population-based datasets can provide information on optimum treatment strategies for subgroups of patients or for research questions that cannot be studied within a randomised controlled trial. Audits are extremely useful in providing detailed clinical information to compare treatment strategies, and the results can be fed back to hospitals

and clinicians, resulting in continuous quality improvement. However, globally, high-income research agendas dominate the cancer surgery trial landscape, despite many being of little relevance to LMIC settings. This is a major failure of research funding organisations to invest in the global cancer surgical research agenda.[177] However, the opportunity now exists to reverse this trend in underfunding such important research for global cancer control, particularly since many LMICs have now developed substantial cancer surgical research networks that are delivering major clinical-management-changing trials. Emerging powers, such as Brazil, Russia, India, and China, and LMICs, can fill the void that exists in the published work. These countries have a high incidence of some cancers (eg, oral, cervical, and nasopharyngeal), large populations and high patient volumes, adequate infrastructure, well-trained professionals, and most importantly low overheads, which makes the undertaking of such trials feasible. Also, these countries would be the ideal platform to research cost-effective strategies with global applicability.[178,179]

Mapping research into cancer surgery: informing policy makers

Despite surgery being one of the main methods for cancer control and cure, investment in cancer surgical research in all income settings is very low.[180] The prevailing culture of cancer research has been driven by the evolution of personalised (also termed stratified and precision) medicine, with its focus on molecularly targeted drugs and biomarkers.[181] Worldwide cancer surgical research is an orphan area and this has major implications for clinical care.[182] Solid evidence exists that low research activity holds back progress in delivery of better patient outcomes.[155]

We found that 93% of global cancer surgery research is undertaken by only 35 countries worldwide, with only eight LMICs contributing just 15·2% of the worldwide total output in cancer surgical research (table 2). Although China is the exception to this pattern,[183] the reality for other emerging powers in the middle-income setting is more worrying. India and Brazil have been leaders in cancer surgery innovation, yet overall research activity in cancer surgery remains low, probably because of limited funding.

Understanding the culture, organisation, and policy frames for cancer surgery research and development in the top-performing countries would be a valuable benchmarking exercise for many others.[184] However, there is also evidence that poorly cited research is also due to cultural bias or context-specific research into cancer surgery. For example, in the latter case, India's portfolio includes many research projects on low-cost surgical interventions applicable to other LMICs, but not necessarily to the systems and disease burden that occur in HICs (appendix p 42). The relation between international collaboration and high-impact research is more controversial. Although international collaboration in cancer surgery research and development follows traditional cultural–linguistic routes, other interesting links do occur. This finding suggests that, at least for some countries, international collaboration promotes and represents high-impact cancer surgery research and a greater emphasis on international collaborations, particularly LMIC to LMIC, could pay dividends.[185]

These research output trends are in the most part linked to the low long-term investments in cancer surgical research. Findings from previous studies have shown that around only 1·3% of the annual global

	Cancer	Cancer surgery	General surgery
USA	33·2%	31·8%	30·8%
China*	12·6%	6·6%	8·2%
Japan	8·4%	7·3%	11·7%
Germany	7·6%	8·1%	7·3%
UK	6·6%	7·4%	6·0%
Italy	6·4%	5·5%	7·2%
France	5·2%	4·5%	4·7%
South Korea	4·5%	4·5%	6·4%
Canada	4·3%	4·2%	3·8%
Netherlands	3·2%	3·0%	2·9%
Spain	3·1%	2·6%	2·3%
Australia	2·8%	2·4%	2·2%
Turkey*	1·8%	3·6%	2·4%
India*	2·4%	2·1%	1·7%
Taiwan	2·3%	1·7%	2·1%
Brazil*	1·7%	2·3%	1·5%
Switzerland	1·7%	2·1%	1·4%
Sweden	1·9%	1·4%	1·2%
Belgium	1·4%	1·4%	1·1%
Poland	1·4%	1·2%	1·1%
Greece	1·2%	1·1%	1·2%
Austria	1·1%	1·2%	1·%
Denmark	1·1%	0·8%	0·6%
Israel	0·9%	0·8%	0·7%
Iran*	0·8%	0·9%	0·5%
Norway	0·9%	0·6%	0·7%
Finland	0·7%	0·6%	0·4%
Czech Republic	0·7%	0·7%	0·6%
Singapore	0·7%	0·5%	0·5%
Egypt*	0·5%	0·5%	0·4%
Ireland	0·5%	0·5%	0·5%
Russia*	0·5%	0·4%	0·2%
Romania	0·4%	0·4%	0·5%
New Zealand	0·3%	0·4%	0·3%
Pakistan*	0·2%	0·5%	0·4%

*Middle-income country. For further details, see appendix p 43. Data from Web of Science.

Table 2: **Presence of top 35 countries active in cancer and cancer surgery research compared with general surgery research between 2009 and 2013**

For **Web of Science** see http://webofknowledge.com

research and development budget into cancer research supports cancer surgery.[180] This extraordinary disconnect between the effect of cancer surgery on control and cure and the very low levels of funding are a major issue for global research funders. Public policy failure towards surgical research in cancer has occurred at both national and supranational levels. For example, in the UK, less than 1% of cancer research spending went towards surgery in 2008,[186] and this figure for the last fiscal year has only climbed to 2·1%. Low levels of allocated research funding and low levels of overall research activity create a reinforcing negative cycle that can only be broken by sustained inward investment.[44]

There is a clear need to ensure that surgical research into cancer does not continue to be missed off the agendas of multilateral organisations such as WHO[187] or major research funding organisations such as the UK's Cancer Research UK and Medical Research Council or the USA's National Cancer Institute.[188] Research to address the needs of cancer surgery in LMICs also requires specific funding from both national and international sources. Although some of this can come from inward investment into existing structures (eg, National Cancer Grid of India), there is also a need for some creative donor funding from HICs into surgical systems research in low-resource settings.

In an era of compressed public budgets but expanding clinical and research needs, the downward pressures on the economics of cancer research have the potential to further erode research into cancer surgery, but this must be resisted and reversed.[189] As all countries wrestle with the delivery of affordable cancer care, surgery ranks as one of the most important areas for research.

Political framing of global cancer surgery

To deliver cancer surgery to all, international and national cancer control planning needs to address several political issues to ensure the effective translation of evidence into practice. Despite substantial recent political and policy activity directed at non-communicable diseases, and cancer in particular, surgery has not been a prioritised area for organisations and advocacy. Generation of a political priority for global cancer surgery is crucial to increase investment and build systems of education, care, and research for cancer surgery.[190]

In this section of the Commission, we have analysed global cancer surgery through the politics of agenda setting—the topics that governments or individuals prioritise in policy making—which can be broken down into five political streams: organisational, symbolic, economic, scientific, and politicians' politics.[191] Understanding the issues and solutions to effective political action can help strengthen global cancer surgery through effective political action.

Organisational politics

Organisational politics—efforts by organisations to use their resources and power to influence decisions and policies—is an important strategy in the integration of surgical care into cancer control agendas.[191] The Lancet Commission on Global Surgery used this strategy to increase the visibility and priority of surgery in global health agendas. Mobilising academic institutions, the Commission leveraged a multidisciplinary international team across 110 countries and six continents—including clinicians, academicians, public health practitioners, economists, and researchers—who created five key messages that identified gaps in surgical care, listed a set of surgical indicators, and provided a template for national surgical plans.[41] Parallel organisations working in concert with the commission—the G4 alliance, DCP3 group, and Royal Society of Medicine—advocated strongly for transnational recognition of surgery and anaesthesia care as integral components of universal health coverage by WHO, leading to the recent passage of resolution WHA 68/31, which makes explicit the importance of essential surgical care.[192] The international cancer surgery community should capitalise on the momentum and the multi-institutional transnational relationships built by these groups to promote surgery as an integral component of national cancer control plans, including research funding and the global training agenda.

Global partnerships will also be important in implementing cancer surgery programmes. Major institutions responsible for cancer care or research in every country can support health-care providers (eg, doctors, nurses, pharmacists, and researchers) to form bilateral educational and research training partnerships with other institutions. For example, partnerships between the Indiana University (Bloomington, IN, USA) and Moi University (Eldoret, Kenya) and between the University of Washington Fred Hutchinson Cancer Institute (Seattle, WA, USA) and Uganda Cancer Institute (Kampala, Uganda).[193–195] Cancer centres that are part of the National Cancer Grid of India also have substantial international partnerships. Such programmes can increase the surgical cancer workforce and the quality of care they deliver, and drive the research agenda, particularly in underserved countries.

Symbolic politics

Symbolic politics—in which individuals and organisations use images and language as symbols to garner the support and power of the mass public—has been an effective method for breast cancer advocacy.[191] These approaches use cause-related marketing strategies that can promote cancer surgery as the only curative treatment for cancers such as breast and colon.[196,197] The advocacy and activism that stemmed from symbolic politics, along with support from philanthropic

organisations, has demonstrably altered the way breast cancer is funded and perceived by the general public in many parts of the world.[196,197]

Development of symbolic politics to promote cancer surgery, particularly in LMICs, could create a powerful discourse, possibly increasing advocacy and funding for programmes through consumer-oriented philanthropic funding. In turn, this advocacy by civil society could increase federal and international funding for global cancer surgery. As more international corporations adopt social enterprises, cause-related marketing is important and the global cancer surgery community should embrace symbolic philanthropy as a financial and advocacy strategy.

Economic politics

Economic politics—the politics of leveraging finances to shape priorities in health policy agendas—will be crucial for the promotion of surgery as an integral component of national cancer control plans.[191] Economic politics is an important agenda-setting priority to consider when advocating for a framework that includes the costs of surgical services. Different systems will need different approaches, but there are well-developed models for countries to assess and adopt within national frameworks for strengthening both surgery in general and cancer surgery specifically.[198,199] Misperceptions still persist that surgery is an expensive health-care service that is a luxury.[41,200,201] In fact, surgical care has been shown to be affordable and it returns patients to the workforce and promotes societal economic productivity.[41] This political messaging needs to be constantly reinforced.

Scientific politics

Scientific politics recognises that health policy agendas and sources of financial support for health policy priorities are based on scientific evidence.[191,202] Examples include HIV/AIDS, which was regarded as a global epidemic. It was viewed as a disease that could spread uncontrollably if the world did not address the burden. So HIV/AIDS became a health priority. Vertical funding programmes, such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria and The United States President's Emergency Plan for AIDS Relief, led to progress in prevention, diagnosis, and treatment of HIV/AIDS; however, overall health systems were not necessarily strengthened by vertical funding streams.[198,199] New evidence suggests that cancer is emerging as a leading cause of death and disability.[203] Recent shifts in global health development show recognition that effective approaches to control cancer need whole-systems approaches.[199] This presents cancer surgery advocates with an opportunity to ensure that policy makers understand how much this approach can and does contribute to improvements in cancer outcomes.

However, accurate data are needed to track cancer epidemiology and guide global and national cancer policies.[204–206] Data and guidelines adapted from HICs for management of patients with cancer in LMICs may not be ideal since health systems differ in access and use of preventive, diagnostic, and treatment resources.[207] As of 2006, 80% of the world's population was not covered by population-based cancer registries; however, most of these communities exist in LMICs.[203] Thus, global cancer surgery also needs to ensure that it supports the parallel development of the other key aspects of the cancer care system, including health intelligence, and not be seen as engaging in zero-sum politics, in which gains in cancer surgery happen at the expense of other treatment modalities.[208]

Politicians' politics

Politicians are key change agents and leaders whose actions influence the provision of public goods to their constituents. The policies they design and implement determine how resources become available for oncology care. On the international level, politicians at WHO responded to the cancer epidemic and adopted a resolution on cancer prevention and control (WHA58.22) in May, 2005.[209] Their strategies focused mainly on multidisciplinary care, which should include development of surgical services. The UN General Assembly adopted a resolution (A/Res/66/2) in 2011 that was a political declaration on the prevention and control of non-communicable diseases, including cancer.[210] These resolutions by WHO and the UN show that cancer is viewed as a global epidemic and that cancer services are basic amenities that should be provided to the general public, which provides a fertile platform for ensuring the surgical agenda is also prioritised.

Although strong political commitment has been established at the international level, a similar commitment is also needed at the country level to ensure implementation and scaling of cancer services. In many countries, the scarcity of an effective national cancer control plan is a barrier to strengthening of cancer surgery. In these instances, a powerful argument can be made for investment in surgery for cancer control.

Use of symbolic politics in political campaigning can further generate constituent support. By promoting solidarity in health through symbolic political advocacy for marginalised populations with cancer, politicians can build trust in their constituency. Such positive stewardship through good governance promotes trust within a community.[211,212] The former Secretary General of the UN, Kofi Annan, stated that "good governance is perhaps the single most important factor in eradicating poverty and promoting development".[213] This notion is crucial for working towards controlling cancer and promoting development of comprehensive cancer services to which surgery must be included to reduce

		Analysis	Future actions for cancer surgery
	UN: healthy lives, sustainable development goals, and UHC		
For the **UN High Level Meeting** see http://www.un.org/en/ga/ncdmeeting2011/	UN High Level Meeting on Prevention and Control of NCDs (New York, NY, USA; Sept 19–20, 2011)	Important milestone, mostly attended by civil society, that focused on exposure to risk factors, social determinants, structural issues, advocacy, and use of specific technologies such as mobile phones. No mention of surgery or cancer surgery	Crucial need to engage civil society—patient advocacy groups and organisations—to highlight and educate about the central importance of cancer surgery, because this is often a hugely underestimated and crucial area for improving cure rates from cancer
For the **General Assembly of the UN** see http://www.un.org/en/ga/	General Assembly of the UN	Ongoing comprehensive review and assessment of the progress achieved in the prevention and control of NCDs. Several areas are relevant to surgery and surgical oncology, but are not specifically mentioned	Work to ensure NCD, cancer, and cancer surgery feature in the UN assessment process (2017) and 2018 report on progress
For the **UN Interagency Taskforce** see http://www.who.int/nmh/ncd-task-force/en/	UN Interagency Taskforce on the Prevention and Control of NCDs	Will coordinate the activities of the relevant UN organisations and other inter-governmental organisations to support the realisation of the commitments made by heads of state and government in the 2011 Political Declaration on NCDs	Inform taskforce on global cancer surgery and undertake further analyses of how and where other UN agencies are contributing to the development of cancer surgery systems
For **Rio+20** see https://sustainabledevelopment.un.org/rio20	UN Conference on Sustainable Development, Rio+20	Rio+20 have now set out the 17 Sustainable Development Goals	Cancer surgery advocates need to articulate to the UN and working groups where and how cancer surgery delivers on these. For example, ensuring affordable cancer surgery (goal 1: end poverty in all its forms everywhere) and increasing training and infrastructure for cancer surgery (goal 3: ensure healthy lives)
For **Universal Health Coverage** see http://www.who.int/universal_health_coverage/en/	Universal Health Coverage	A new global coalition of more than 500 leading health and development organisations worldwide that are holding governments to account to accelerate reforms that ensure everyone everywhere can access quality health services without being forced into poverty	Develop cancer surgery systems, improve access, and deliver a well-trained workforce. Work on how cancer surgery UHC can be tracked. Assess how the 19 selected countries for the first wave in policy development for UHC are addressing cancer surgery
	WHO, IARC, and IAEA: national cancer control plans, health systems strengthening, and country review missions		
For the **WHO Global Action Plan** see http://www.who.int/nmh/events/ncd_action_plan/en/	WHO Global Action Plan 2013–20	Global targets to be attained by 2025, covering eight generic domains, including six dedicated to risk factor exposure. Surgery and surgical oncology are crucial in two domains: 25% reduction from premature NCD mortality and 80% coverage of essential NCD drugs and technologies	Work to ensure that the World Health Assembly 2016 update of appendix 3 explicitly recognises surgery and surgical oncology as essential technologies
For the **World Health Assembly resolution on cancer** see http://www.who.int/cancer/eb1143/en/	World Health Assembly resolution on Cancer Prevention and Control, 2005	WHO recognises the rising burden of cancer as the second leading cause of death and disability. Partnerships established with the IARC and member states to develop guidelines, strategies, and interventions to tackle the burden of cancer on societies	Ensure that guidelines, strategies, and interventions include surgical oncology within their frameworks and implementation plans
For the **WHO NCD Division** see http://www.who.int/nmh/en For the **WHO Global Initiative for Emergency and Essential Surgical Care** see http://who.int/surgery/globalinitiative/en/ For the **WHO priority medical devices** see http://www.who.int/medical_devices/access/en	WHO NCD Division (Geneva, Switzerland)	Cancer systems are now increasingly being regarded as an essential aspect of cancer control and planning. A wide range of research and systems initiatives interface with cancer surgery	Engage with NCDs, disability, and violence and injury prevention divisions at Geneva, IARC (Lyon, France), and specific programmes such as WHO Global Initiative for Emergency and Essential Surgical Care and defining priority medical devices for cancer management, targeting low-income and middle-income settings. Need to build indicators and new ways of analysing global cancer surgical burden into WHO IARC
For the **IAEA** see https://www.iaea.org/	IAEA (Vienna, Austria)	PACT, although focused on global radiotherapy, has a wide remit in country missions when assessing needs for future NCCPs	Important opportunity to build a thorough transparent process for understanding the state of cancer surgery in countries undergoing a PACT review mission and also develop better cancer surgical system plans
For the **World Health Assembly resolution on surgery** see http://www.who.int/surgery/en/	World Health Assembly resolution on Strengthening Emergency and Essential Surgical Care and Anaesthesia, 2015	Recognising the crucial importance of surgical services, and the huge gaps in global access, the resolution underlines the importance of building political commitment to expand access, and of strengthening the surgical workforce through training and knowledge exchange	Bring this resolution to national cancer control planning to ensure that all NCCPs specifically address cancer surgery
	Global civil society: *The Lancet*, UICC, and global organisations		
For **Global Surgery 2030** see http://www.globalsurgery.info/	Global Surgery 2030: a Lancet Commission	A landmark report for surgical care in which a shared vision of universal access to safe and affordable surgical and anaesthesia care when needed was recognised. Goals to strengthen surgical services globally and within national health systems	

(Table 3 continues on next page)

	Analysis	Future actions for cancer surgery
(Continued from previous page)		
Global Health 2035: a Lancet Commission	Goal is to strengthen health systems in low-income and middle-income countries, to reduce rates of infectious, child, and maternal deaths by promoting further financial investments and scaling up successful health interventions	Cancer surgery is the only curative treatment for many solid tumours resulting from infectious disease, childhood tumours (eg, Wilms' tumour), or to reduce maternal deaths. Ensure that cancer surgery services are integrated within these policy frameworks
Union for International Cancer Control (World Cancer Declaration, 2013)	The World Cancer Declaration calls for greater equality in health by reducing the global cancer burden and seeks to influence government leaders and policy makers. Although drugs and technologies are explicit targets for improvement, surgery is not on the agenda	Ensure that surgical services become a 2025 target. Cancer surgery saves lives by directly improving cancer cure rates; good surgery is as inexpensive as average surgery
ChiCa and other global childhood cancer groups (eg, St Jude's)	UICC's ChiCa programme, the International Society of Paediatric Oncology, and World Child Cancer have been strong advocates of global childhood cancer, most recently in establishing the essential medicines list for children with cancer. However, all activity so far has focused on drugs. See also the WHO essential medicines list	Develop leadership in global childhood cancer surgery and surgical oncology specifically. Link to existing advocacy and fundraising programmes
The Global Task Force on Expanded Access to Cancer Care and Control in Developing Countries, 2009	Task force that will support design and implementation of global and regional programmes related to the financing and procurement of cancer drugs, vaccines, and innovative service delivery models, which will be monitored and assessed	Ensure that surgical services and supplies are integrated into the financing, procurement, and service delivery models that result from this groups' advocacy efforts and partnerships. Surgery is one of the, if not the most, cost-effective method of cure and control
NCD Alliance	Advocacy group that tries to ensure NCDs are recognised as major contributors to poverty and global economic loss	Collaborate with the NCD Alliance to ensure that surgical voice and services are represented in NCD advocacy efforts. Major push needed to increase advocacy because this is more often directed towards access to drugs
IOM forum. The US Commitment to Global Health: recommendations for the public and private sectors	The US IOM recognises UN goals to tackle NCDs by scaling up existing interventions, generating and sharing knowledge, investing in capacity building, increasing US financial commitments, and engaging in partnerships	Engage with the IOM to ensure that surgical partnerships and services are included in global health priorities, policies, and programmes

ChiCa=Childhood Cancer. IAEA=International Atomic Energy Agency. IARC=International Agency for Research on Cancer. IOM=Institute of Medicine. NCCP=national cancer control programme. NCD=non-communicable disease. PACT=Programme of Action for Cancer Therapy. UHC=universal health coverage. UICC=Union for International Cancer Control.

Table 3: **How does cancer surgery fit into global health: a policy and political analysis for civil society, patient organisations, cancer surgery community, and research funders**

For **Global Health 2035** see http://globalhealth2035.org/

For the **World Cancer Declaration, 2013** see http://www.uicc.org/world-cancer-declaration

For **ChiCa** see http://www.uicc.org/programmes/childhood-cancer

For the **WHO essential medicines list** see http://who.int/selection_medicines/list/en/

For the **Global Task Force on Expanded Access to Cancer Care and Control** see http://gtfccc.harvard.edu/

For the **NCD Alliance** see http://www.ncdalliance.org/

For the **IOM forum** see http://iom.nationalacademies.org/Activities/Global/PublicPrivatePartnershipsForum.aspx

disease burden and economic and social loss that result from cancer.

Our analysis of where cancer surgery interfaces with the global health community suggests a range of actions directed at different policy makers and organisations (table 3). Policy makers at all levels still have low awareness of the central importance of surgery in cancer control. Even recent studies of capacity building for cancer systems in Africa barely recognised the importance of surgery, instead focusing mainly on chemotherapy.[214] Cancer surgery advocates need to better articulate its impact and lead the political movements necessary for improvement. Lastly, cancer surgery must be represented at all levels of cancer control planning and advocacy.

Conclusions

Equity, shared responsibility, and quality cancer surgical delivery to patients, irrespective of ability to pay, are the goals of global cancer and global cancer surgery. This is only achieved via universal health coverage—probably the most widely shared goal in global health. This Commission has described the economic, regulatory, and systems issues and solutions to global cancer surgery. But more is needed to understand transferable systems and models of care, health intelligence to properly plan cancer surgical systems, and affordable innovations in surgical technologies, to name a few. As part of the wider global surgery community, we fully support the indicators to progress as set out by Global Surgery 2030.[2] Indeed, the key messages that we have developed (panel 12), based on the presented evidence in each section and through commissioner consensus meetings should be taken as additional recommendations and reinforce those from Global Surgery 2030.[2] Cancer surgery must be built on the solid foundations of general surgery. Delivery of adequate general surgery will already be a major step forward in improving cancer care. In too many countries, we have found that the inverse care law dominates, whereby the availability of good surgical care for cancer varies inversely with the population need for it.[215] The market-driven private sector distribution of cancer surgical services is a primitive and outdated sociopolitical construct that needs to be replaced by safe, affordable, and timely publicly funded systems of surgery for cancer.

Panel 12: Key messages

1 Over 80% of 15·2 million people diagnosed with cancer worldwide in 2015 will need a surgical procedure at some point in their treatment

The demand for cancer-related surgery is growing. By 2030, there will be an estimated 21·6 million new patients with cancer every year, of whom around 17·3 million will need surgery. 10 million of those patients needing surgery in 2030 will live in LMICs. In LMICs, three-quarters of the surgical burden will be from cancers of the breast, head and neck, oesophagus, stomach, lung, cervix, and prostate. Overall, we estimate that the global surgical community in 2030 will need to deliver an estimated 45 million procedures for cancer, and even low-income countries will experience a 59% increase in need. Surgery, of which there are over 275 procedures needed for cancer care, is essential for prevention, diagnosis, palliation, reconstruction, and cure across all age groups; 20% of children with cancer will need a surgical procedure. Surgery has one of the biggest effects on patient outcomes, with over 50% of survival in breast cancer, for example, attributable to surgery alone. However, estimates from Global Surgery 2030[2] suggest that today over three-quarters of patients globally do not receive safe, affordable, or timely surgery for their cancer.

2 All countries are projected to lose 0·5–1·5% of GDP, annually, between now and 2030 if surgical systems for cancer are not strengthened

Without urgent and strategic investment in surgical services for cancer care, global economic losses from cancers amenable to surgical treatment are estimated to total US$12 trillion by 2030. This equates to annual losses of 1·0–1·5% of GDP in high-income countries and 0·5–1·0% of GDP in LMICs. In countries where there is no universal financial risk protection against the costs of cancer surgery, a diagnosis of a cancer amenable to surgery can be financially devastating for individual patients and their families. In LMICs, about a third of patients experience financial catastrophe and another quarter discontinue treatment because they cannot afford the cost. Scaling up surgical cancer services and ensuring patients are protected from catastrophic health expenditure related to accessing cancer surgery represents a sound health investment, with broader implications for poverty alleviation, economic productivity, and development. Surgical cancers have a major effect on economic output at a national level and scaling up these systems is both cost effective and affordable.

3 National cancer control plans must include the strengthening of surgical systems through investment in public sector infrastructure, education, and training

We have found many similarities around barriers to accessing surgery for cancer. There are also many novel solutions being undertaken from which the global cancer surgery community can learn. Effective cancer surgery can only be delivered if the patient presents early enough; thus, sociocultural barriers and key interdependencies in cancer surgery—imaging and pathology (both of which need marked improvement)—need to be addressed. In the context of inequalities among and within countries in terms of access to surgery services, there is a serious shortage of cancer surgeons in over 82% of countries. There is a crucial need to train general and gynaecological surgeons to deliver basic cancer surgery and to create more specialist surgical oncology training programmes through high-quality, accredited training across a range of site-specific cancers. This is best achieved with country-specific initiatives and by scaling up successful inter-country institutional partnerships and surgical societies, such as the Society of Surgical Oncology and European Society of Surgical Oncology, for global engagement.

4 Less than 5% of global cancer research is devoted to surgery despite its huge effect on patient outcomes and its importance to personalised cancer medicine

Research funding for cancer surgery needs to be increased urgently. Despite its central role in improving patient outcomes, only 1·3% of public cancer research funding goes towards cancer surgery research. Only around 15% of global research in cancer surgery occurs in LMICs, yet these countries urgently need to undertake their own context-specific cancer surgical research. Investment in cancer surgical research has substantial value for health systems because innovations not only have a marked effect on patient outcomes, but they also provide leverage to several other areas of cancer research that are crucial for driving research into personalised cancer medicine.

5 Global cancer surgery needs to be a political priority for policy makers in countries, research funders, international organisations, and global alliances

Policy makers at all levels have low awareness of the central importance of surgery in cancer control. The political and social culture of cancer surgery is shaped by organisational, symbolic, economic, scientific, and politicians' perspectives that need to be better understood by the cancer surgical community. The cancer surgical community needs to better articulate its impact and lead changes necessary for delivering surgery to all. Lastly, cancer surgery must be represented at all levels of cancer control planning and advocacy.

LMIC=low-income and middle-income country.

We end by considering the importance of people in delivering cancer surgery to all. Technologies, buildings, organisation, regulations, and funding are easy targets. What takes time and dedication is training all the health-care personnel needed for cancer surgery and educating the general public. The models and paths to training general surgeons have already been well articulated in the Global Surgery 2030 Commission,[2] but there is also a great unmet need for expansion of surgical oncology, both general and specialist.

Search strategy and selection criteria

References for this Commission were identified through searches of PubMed, Web of Science, Scopus, and grey literature (Google) with the search terms "cancer", "region definitions/country definitions", "surgery", "oncology", "human resource", "capacity building", and "policy" from Jan 1, 1998, to Aug 31, 2015, in various combinations. Articles were also identified through searches of the commissioners' own files and through an extensive bibliometric analysis, as described in the appendix (p 1). Only papers published in English were reviewed. The final reference list was generated on the basis of originality and relevance to the broad scope of this Commission.

Global cancer surgery is complex and complicated. There are no one-size-fits-all system solutions. The pathways that patients take to cancer surgery are numerous and littered with obstacles. Without addressing the social determinants of cancer, the best cancer surgical system in the world will do little to improve population outcomes. Such is the interdependency of surgery on social and other medical disciplines, we have constantly reinforced the need to recognise this as a system, which needs system solutions. But because surgery is so central to patient outcomes, focusing on this as a central part of national cancer control plans is crucial if the targets for sustainable development goals and reductions in premature mortality from cancer are to be achieved.

Contributors

All authors were responsible for key messages and final draft. RS and AP were responsible for the concept and coordination of the Commission and policy analysis. JGM, AJML, LH, AD, AMI, and DW were major contributors to revisions. Specific section leads were as follows: introduction, interdependencies, and link to Global Surgery 2030: AMI, RS, AJML, AA, and JGM; global need for cancer surgery: PA, LH, MS, HH, AJ, and SM; economics and financing of cancer surgery: AD, DR, RT, and JL; global quality in cancer surgery: CvdV and RA; models of care: BOA; role of pathology: KF and AMI; technologies for global cancer surgery: AMI; scale-up of systems: GPP and DKV; childhood cancers: LH; HICs: MFB, TPK, and CB; LICs: TPK and OIA; case studies of cancer surgical systems: Nigeria, OIA and TPK; India, CSP, AD'C, SVS, and DKV; China, SW, J-fJ, and Y-LW; Brazil, ATT, LS, and CAH; Latin America, CAH; Middle East, MZ and SO; Pacific Islands, DW; Uganda and Ethiopia, MS, CB, SM; Research: AMME, AP, UV, CvdV, and RS; training and education: SMG, CB, MFB, and GPP; and politics of cancer surgery: SSM and RR.

Declaration of interests

MS has received personal fees from Ethicon. All other authors declare no competing interests.

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