



# BMJ Open International consensus recommendations for the optimal prioritisation and distribution of surgical services in low-income and middle-income countries: a modified Delphi process

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## ABSTRACT

**Objectives** To develop consensus statements regarding the regional-level or district-level distribution of surgical services in low and middle-income countries (LMICs) and prioritisation of service scale-up.

**Design** This work was conducted using a modified Delphi consensus process. Initial statements were developed by the International Standards and Guidelines for Quality Safe Surgery and Anesthesia Working Group of the Global Alliance for Surgical, Obstetric, Trauma and Anesthesia Care (G4 Alliance) and the International Society of Surgery based on previously published literature and clinical expertise. The Guidance on Conducting and REporting DElphi Studies framework was applied.

**Setting** The Working Group convened in Suva, Fiji for a meeting hosted by the Ministry of Health and Medical Services to develop the initial statements. Local experts were invited to participate. The modified Delphi process was conducted through an electronically administered anonymised survey.

**Participants** Expert LMIC surgeons were nominated for participation in the modified Delphi process based on criteria developed by the Working Group.

**Primary outcome measures** The consensus panel voted on statements regarding the organisation of surgical services, principles for scale-up and prioritisation of scale-up. Statements reached consensus if there was ≥80% agreement among participants.

**Results** Fifty-three nominated experts from 27 LMICs voted on 27 statements in two rounds. Ultimately, 26 statements reached consensus and comprise the current recommendations. The statements covered three major themes: which surgical services should be decentralised or regionalised; how the implementation of these services should be prioritised; and principles to guide LMIC governments and international visiting teams in scaling up safe, accessible and affordable surgical care.

**Conclusions** These recommendations represent the first step towards the development of international guidelines for the scaling up of surgical services in LMICs. They constitute the best available basis for policymaking,

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ These recommendations represent the only consensus-driven approach using the expertise of low and middle-income country (LMIC) surgeons to inform governmental regional-level or district-level distribution of surgical services in LMICs and prioritisation of service scale-up.
- ⇒ Though the expert panellists represent many years of experience in LMICs, our recommendations do not speak specifically to the current burden of surgical diseases or the current workforce in LMICs.
- ⇒ While the consensus recommendations involve guidelines for international surgical teams, we did not attempt to build consensus around the number of trainees or specific personnel resources required to build capacity.

planning and allocation of resources for strengthening surgical systems.

## INTRODUCTION

As global attention to improve the quality, safety and access to surgical care in low and middle-income countries (LMICs) increases, the need for evidence-based strategies to reliably scale up the quality and quantity of surgical services becomes ever more pertinent. In 2015, the Lancet Commission on Global Surgery called for urgent and accelerated investment in surgical scale-up in LMICs.<sup>1</sup> However, the dearth of proven cost-effective models to inform implementation was a major limitation.<sup>2</sup> Moreover, although proposed surgical scale-up models include increasing the volume of surgical cases per unit population,<sup>3</sup> prioritising certain essential surgical interventions<sup>4–7</sup> and training

essential workforce<sup>489</sup>; there remains a lack of consensus on how these models can be implemented in LMICs, a lack of understanding of who is ultimately responsible and a lack of evidence on how ‘what works’ can be applied in the practical setting. The term, ‘scale-up’ is used in intervention science to mean the system-wide implementation of an intervention that has demonstrated positive results locally. For the purposes of our work, we use the term ‘scale-up’ more broadly to refer to the expansion of the quality and quantity of surgical services in LMICs.

The majority of global surgical lenses are focused on national governments and their strategic roles in increasing access to surgical care.<sup>10</sup> In reality, subnational and local governments carry the burden of implementation. This is especially true for most of developing and some developed nations who are moving closer and closer to decentralisation and devolution, which are strategies aimed to redistribute authority, responsibility and financial resources for providing public services among different levels of government.<sup>11</sup> The goal is to move services closer to the people, lower overall costs, increase access and ultimately improve outcomes.<sup>12</sup>

To date, no formal expert consensus on the optimal distribution of surgical services in LMICs or strategic prioritisation of scale-up exists. Challenges include differing levels of resources within each country and the lack of transferability of high-income country (HIC) models of care to contexts applicable to LMICs. Healthcare and surgical infrastructure in LMICs, as is in HICs, are interwoven networks of private and public institutions, non-governmental organisations (NGOs) and many local organisations, making coordinated efforts to scale up surgery difficult.

The aim of this paper, therefore, is to provide a structured framework using the modified Delphi methodology to derive a process by which local surgical experts can inform LMIC governments on how certain essential surgical services can be organised within their respective government units. Such guidance can provide a foundation for the development of global surgical policy and can be useful to LMIC governments that face challenges in the prioritisation and allocation of scarce resources.

## METHODS

### Project design

We used a modified Delphi process involving an international panel of surgeon experts from LMICs hosted by the Global Alliance for Surgical, Obstetric, Trauma and Anesthesia Care (G4 Alliance) to assess whether consensus can be achieved on how to prioritise and distribute surgical services in LMICs.

The G4 Alliance is a 67-member organisation representing over 300 international societies, academic and NGOs in 160 countries worldwide.<sup>13</sup> In response to the need for a unified scale-up plan, the G4 Alliance partnered with the International Society of Surgery, forming the International Standards and Guidelines for Quality

Safe Surgery and Anesthesia (ISG-QSSA) Working Group. The Working Group convened an international roster of experts to assess a series of statements proposing a framework for the optimal prioritisation and distribution of surgical services in LMICs based on their experience in preparation for a modified Delphi process as previously described.<sup>14</sup>

### Modified Delphi process

*Literature review and synthesis of the evidence:* the initial statements for assessment in the modified Delphi process were developed by the ISG-QSSA Working Group (‘ISG-QSSA’), comprised of 13 members from varying surgical specialties, a statistician and an LMIC Minister of Health. A literature review of published data on the evidence surrounding the efficacy of decentralising or regionalising surgical services in LMICs and several commentaries that were published in response<sup>15–19</sup> were analysed by this group. The proposed three-point model using the dimensions of complexity, volume and acuity of surgical conditions in order to derive a simple decision-making algorithm regarding the optimal prioritisation of surgical services was ultimately adopted by unanimous vote. A matrix of recommendations around which surgical services should be decentralised or regionalised ensued (table 1). These were then codified into the modified Delphi statements that were presented to the local participants during a meeting hosted by the Ministry of Health and Medical Services of Fiji convened in Suva, Fiji, from 6 March to 8 March 2020, and included 33 international surgical experts.

Members of the ISG-QSSA then provided further discussion during a roundtable session on their needs and the potential utility of the modified Delphi statements, subsequent findings and expanded the scope to include the role of visiting surgical teams and how to maximise their involvement. Twenty-seven statements were ultimately refined that covered four main categories:

1. Global definitions on the organisation of surgical services in developing countries.
2. Optimal distribution of surgical services.
3. Principles for scaling up safe, accessible and affordable surgical care.
4. Recommendations for the prioritisation of surgical service organisation

*Selection of participants:* after the initial modified Delphi statements were revised and accepted, a panel of international LMIC experts was chosen according to criteria developed by the Working Group: a surgeon from an LMIC (World Bank criteria), relevant expertise in surgery and public health, preferably working in public service, have previously set up a surgical service in an LMIC and considered to have substantial experience in their particular surgical field. The process was initiated with an open call to all G4 Alliance members and Ministries of Health to submit nominations of LMIC experts. The Working Group sought adequate representation by ensuring that panellists from Africa, Asia and Latin

**Table 1** Decentralisation and regionalisation of surgical services according to a three-point matrix

Complexity	Volume	Acuity	Example service	Organisation
Low	High	Low	Preventive/screening Basic general surgery (eg, hernia, common benign tumours) Basic ophthalmologic surgery (eg, cataracts)	Decentralised
Low	High	High	Basic trauma services Basic emergency obstetric services Basic emergency surgery services (eg, appendectomy)	Decentralised
Low	Low	High	Basic emergency surgery services	Decentralised
Low	Low	Low	Nontrauma orthopaedic service	Decentralised
High	High	Low	Common cancers (eg, lung and breast cancer)	Regionalised
High	Low	Low	Complex oncologic and reconstructive services (eg, pancreatic, liver cancer surgery)	Regionalised
High	Low	High	Complex emergency surgical services	Regionalised
High	High	High	Complex trauma services	Regionalised

America were included in the nominations. A survey was sent to the nominees determining their credentials and experience. The final participants in the modified Delphi panel were selected using seven more specific criteria developed by the Working Group (box 1).

*Modified Delphi Process:* the panellists rated each of the statements two times, in a two-round ‘modified Delphi process’.<sup>20</sup> In the first round, the ratings were made individually online with no interaction among the panellists. In the second round, the panellists had access to the deidentified comments made by the other individuals as well as a detailed description of how the statements were revised for the second round but had no interaction with each other. Due to the high level of agreement in both rounds, the process was terminated after two rounds.

### Box 1 Modified Delphi LMIC surgical expert criteria

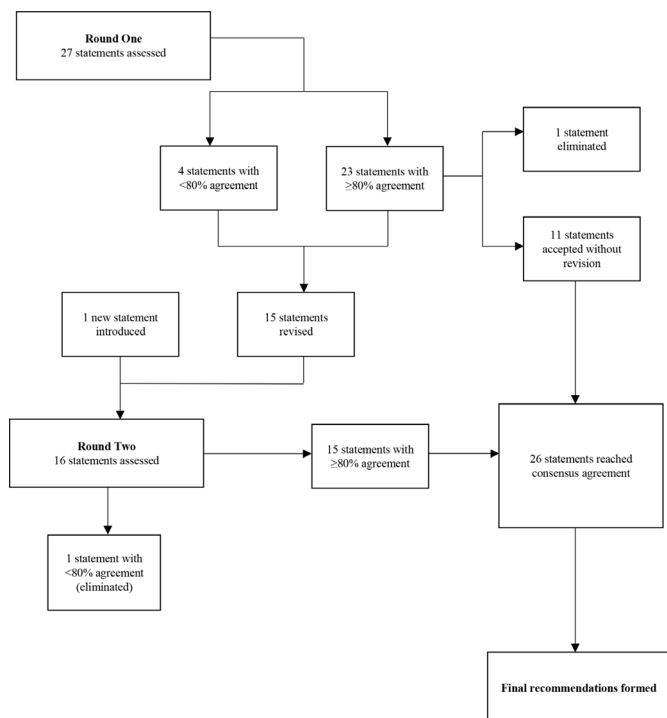
1. Recognised authority: nominated by peers.
2. Member of organisation: G4 alliance member organisation or known international organisation.
3. Willingness to participate: agreed to participate for the duration of the modified Delphi process.
4. Relevant clinical/academic expertise: based on one of the 12 named services.
  - ⇒ Anaesthesiology
  - ⇒ Breast and endocrine surgery
  - ⇒ Colorectal surgery
  - ⇒ General surgery
  - ⇒ Maxillofacial surgery
  - ⇒ Obstetrics and gynaecology
  - ⇒ Surgical oncology
  - ⇒ Ophthalmology
  - ⇒ Orthopaedic surgery
  - ⇒ Paediatric surgery
  - ⇒ Plastic and reconstructive surgery
  - ⇒ Urology.
5. Geographical scope: only from a low and middle-income country.
6. Setting/work field: public and/or private sector.
7. Profession/stakeholder: surgery, obstetric, trauma, anaesthesia, nurse, nurse anaesthetist, clinical officer.

Reporting was performed according to the Guidance on Conducting and REporting DElphi Studies in palliative care: recommendations based on a methodological systematic review, a 15-item checklist representing the minimum set of items that should be reported when conducting studies using the modified Delphi methodology,<sup>21</sup> (online supplemental materials). This included identification and selection of experts, iterative rounds of statement review and voting, anonymous commenting on statements that were shared with participants, revision of statements not achieving consensus between rounds and establishment of criteria for eliminating statements. In person discussion of statements was not included as part of the process.

*Data collection tool:* an online platform, REDCap, was used as the data collection tool for the modified Delphi process, which permitted anonymous individual voting and commenting during each round.<sup>22</sup> The survey link was emailed to the modified Delphi panel. The survey was voluntary and there were no incentives. The survey was conducted from 1 May 2020 to 10 June 2020. Once participants entered the review and voting process, they could save their progress and return at a later time. Survey items were listed by category and were not randomised for each participant. There was no adaptive questioning.

*Voting:* in the first round, participant demographic information was collected and participants were instructed to vote on each of 27 statements, indicating whether they strongly agreed, agreed, were neutral, disagreed or strongly disagreed with a statement. They were offered the opportunity to make comments regarding each statement and were encouraged to include comments on what they felt was right or wrong about the statement. Comments were viewable by other participants but were anonymous. Votes were anonymous and hidden from other participants.

*Data analysis:* after the first round, the initial assessment of comments and votes was done by the coordinator (MM) and the consensus chair (JH). Only the votes for ‘strongly agreed’ and ‘agreed’ were counted towards a positive vote.



**Figure 1** Flow of statements through modified Delphi consensus process.

Votes for ‘neutral’ to ‘strongly disagreed’ were counted negative. The comments and votes were then reviewed by the modified Delphi methodologist (MKF). The resultant observations and suggested changes were brought to the Working Group for further comments and approval prior to relaunching the next round of the modified Delphi process. We defined consensus as having  $\geq 80\%$  of respondents agree or strongly agree. We planned a maximum of three rounds of voting. **Figure 1** details the flow of statements of the modified Delphi process.

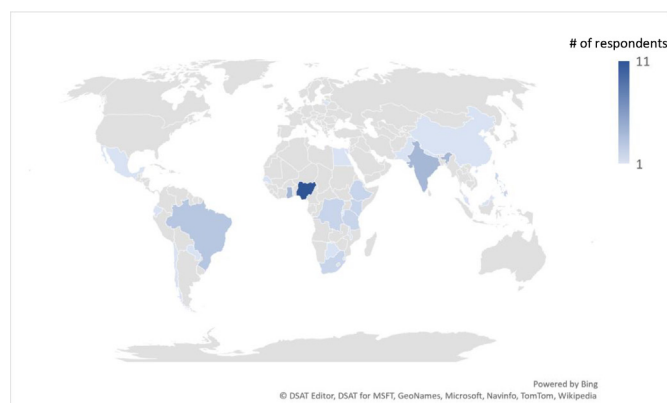
### Patient and public involvement

There was no patient or public involvement in the development of this process, which is a collation of the experience of volunteer experts. Thus, it did not require further review or approval according to the Institutional Review Board of the University of Chicago guidelines.

## RESULTS

### Participants

Seventy-five expert LMIC surgeons were nominated for participation and completed the initial survey determining eligibility. Fifty-six participants met all eligibility criteria and initiated round one. Fifty-three participants (95%) completed round 1 and 51 (91%) participants completed round 2. Of note, three individuals from the overall group of 56 participants initiated round 1 but did not complete the entire survey and, thus, their responses were discarded. Respondents represented 27 LMIC countries over five continents: Africa, Asia, Europe, North America and South America (**figure 2**). Data for



**Figure 2** Geographic distribution of modified Delphi respondents.

the complete breakdown by country are listed in online supplemental Appendix A. Forty-nine per cent of respondents represented general surgery while 51% represented other specialties. Greater than 60% had more than 20 years of experience in the field. Additional demographic data are reported (**table 2**).

Of the respondents, 92.4% reported substantial experience developing surgical services in LMICs. Forty per cent of these respondents reported prior experience implementing WHO guidelines or developing protocols relating to general and trauma surgery, anaesthesia, maternal and fetal health and health and safety.

### Modified Delphi rounds

In round 1 of the modified Delphi process, 53 respondents voted and commented on 27 statements with 52 completing the full survey. Twenty-three statements (85.2%) achieved  $>80\%$  agreement and four statements (14.8%) achieved  $<80\%$  agreement. All statements received comments. We decided to do a post hoc analysis on the content of the comments after noting incongruence between voting and the content of some of the comments. For example, some respondents who voted ‘agree’, later expressed changes they would like to see in the statements. Thus, we decided to revise some statements for the second round based on comments made about the first-round statements, rather than looking solely at the results of the voting. Overall, 11 statements were included in the final consensus statements after round 1 and 15 statements were revised and relaunched in round 2. Supplementary data of revised statements and reasons for revision are available in online supplemental Appendix B. One statement was discarded due to comments criticising the statement for a lack of clarity. One new statement was created based on comments from round 1 which was included in round 2.

In round 2 of the modified Delphi process, 51 respondents voted and commented on 16 statements. Nine statements (56.3%) achieved  $\geq 90\%$  agreement, six statements (37.5%) achieved 80%–89% agreement and one statement (6.2%) achieved  $<80\%$  agreement. Overall, 15 statements from round 2 were included in the final



**Table 2** Demographic characteristics of modified Delphi participants

	Round 1 (n=52)	Round 2 (n=51)
Gender		
Male	41 (79.2%)	40 (78.4%)
Female	11 (20.8%)	11 (21.5%)
Age		
Mean age in years (SD)	53.3 (10.57)	53.5 (10.92)
Race		
American Indian or Alaska native	1 (1.9%)	1 (2.0%)
Asian	10 (20.8%)	10 (19.6%)
Black or African American	25 (47.2%)	25 (49%)
Native Hawaiian or Pacific Islander	1 (1.9%)	1 (2.0%)
White	15 (28.3%)	14 (27.4%)
Geographic region*		
Africa	31 (58.5%)	31 (60.8%)
Asia	10 (18.9%)	10 (17.6%)
Europe	1 (1.9%)	1 (2.0%)
North America	1 (1.9%)	1 (2.0%)
South America	7 (13.2%)	6 (11.8%)
Oceania	2 (3.8%)	2 (3.9%)
Years working in field*		
20+	33 (63.5%)	32 (62.7%)
15–19	3 (5.8%)	3 (5.8%)
10–14	8 (15.4%)	8 (15.7%)
4–9	6 (11.5%)	6 (11.8%)
1–3	2 (3.8%)	2 (3.9%)
Global surgical specialty		
Anaesthesiology	1 (1.8%)	1 (1.9%)
Breast and endocrine	1 (1.8%)	1 (1.9%)
Colorectal	1 (1.8%)	1 (1.9%)
General	25 (47.1%)	25 (49%)
Maxillofacial	3 (5.6%)	3 (5.8%)
Obstetrics and gynaecology	5 (9.4%)	5 (9.8%)
Oncology	1 (1.8%)	1 (1.9%)
Ophthalmology	2 (3.7%)	2 (3.9%)
Orthopaedic	2 (3.7%)	2 (3.9%)
Paediatric surgery	4 (9.4%)	4 (7.8%)
Plastic and reconstructive	4 (7.5%)	3 (5.9%)
Trauma	1 (1.8%)	1 (1.9%)
Urology	2 (3.7%)	2 (3.9%)

\*Round 1, N=53, one missing demographic record, number 43, 52 accounted for.

consensus statements and 1 statement was discarded. We elected to forego another round of voting because the single statement that failed to reach consensus during the second round of voting did not receive sufficient votes or comments indicating a clear path for revision that would likely result in consensus during a third voting round. Supplementary data of all statements from both rounds including per cent agreement and comments are available in online supplemental Appendix C.

### Consensus recommendations

The final consensus recommendations are comprised of the 26 statements that reached agreement after two rounds of the modified Delphi process (figure 3, online supplemental Appendix D).

The final recommendations for the distribution and prioritisation of surgical services are presented in terms of the three-point categorisation of surgical conditions (complexity, volume, acuity). We provide a matrix illustration categorising the surgical conditions and associated recommendations (table 3).

#### Recommendations for the optimal distribution of surgical services

Participants recommended that surgical services in LMICs should be distributed based on complexity. Low complexity surgical conditions should be decentralised or managed by district centres close to communities, while high complexity conditions should be regionalised or managed by specialised regional centres. This recommendation stands regardless of surgical case volume and acuity. For example, high complexity, high volume, low acuity conditions such as common cancers (eg, breast cancer, colon cancer) should be managed at specialised centres. Similarly, high complexity, low volume, low acuity conditions such as cancer requiring complex oncologic and reconstructive services should also be managed at specialised centres. Modified Delphi participants established a common definition of acuity: high acuity conditions are those that need to have care provided within 6 hours of arrival to a health facility, low acuity conditions are those that can be treated beyond 6 hours of diagnosis. Participants agreed that high acuity, low complexity conditions such as basic trauma should be managed at district centres. Patients with high acuity, high complexity conditions should be stabilised at district centres and transferred to regional centres for complex management.

#### Recommendations for prioritising district hospital implementation

Recommendations were established for how district centres in LMICs should prioritise the development and implementation of surgical services. Very high priority should be placed on developing low complexity, high volume, low acuity surgical services as well as low complexity, high volume, high acuity surgical services. For both classes of conditions, there was general agreement that managing these conditions at district centres would relieve tertiary centres of these demands. Respondents also recommended that district centres place high priority on developing services for low complexity, low volume, high acuity conditions. Notably, no consensus was reached regarding the prioritisation of low complexity, low volume, low acuity conditions.

Recommendations were also made for the priorities of district centres in managing high complexity conditions. District centres should place priority on establishing systems for screening and referral of high complexity, high volume, low acuity surgical cases and high complexity, low volume, low acuity surgical cases to specialised centres.

Statement	Global definitions: Assumptions	Consensus agreement score
1.	The volume of surgical care is conditional on geographic region and population demographics.	85%
2.	A high acuity condition needs to have care provided within 6 hours upon arrival to a health care facility.	84%
3.	A low acuity condition can be scheduled for treatment beyond 6 hours of diagnosis	90%
<b>Recommendations for the Optimal Distribution of Surgical Services</b>		
4.	Low complexity, high volume, and low acuity surgical conditions that can be secondarily prevented should have screening or preventive services at district centers.	89%
5.	Low complexity, low volume, and low acuity surgical conditions should be managed at district centers.	85%
6.	Low complexity, high volume, and high acuity surgical conditions amenable to basic services should be managed at district centers	94%
7.	Low complexity, low volume, and high acuity surgical conditions amenable to basic services should be managed at district centers.	96%
8.	High complexity, high volume, and low acuity surgical conditions such as common cancers should be managed in specialized centers.	91%
9.	High complexity, low volume, and low acuity surgical conditions requiring complex oncologic and reconstructive services should be managed in specialized centers.	94%
10.	High complexity, low volume, and high acuity surgical conditions should be stabilized in district centers then transferred to regional centers.	96%
11.	High complexity, high volume, and high acuity surgical conditions should be stabilized in district centers then transferred to regional centers.	84%
<b>Principles for scaling up safe, accessible, and affordable surgical care</b>		
12.	Emergency and essential surgical care should be integrated within national Universal Health Coverage (UHC) frameworks.	96%
13.	Effective national referral policies decrease delays in care, lower the cost of care, and improve outcomes.	94%
14.	International surgical partnerships assist local surgical training, build capacity, and encourage investments in local surgical care.	89%
15.	Each low- and middle-income country (LMIC) should coordinate international surgical partnerships and in-country surgical activity in communication with relevant local and /or regional professional societies.	84%
16.	International surgical visiting teams should ensure formal engagement with local surgeons and community leaders prior to arrival.	94%
17.	International surgical visiting teams should ensure formulation of a proper post-operative follow-up plan for each surgical patient.	91%
18.	International surgical visiting teams should coordinate with local surgeons in collecting and reporting surgical outcomes data with the appropriate government agency and / or local professional society.	90%
19.	Each LMIC surgical society and/or college is encouraged to conduct in-country outreach to enhance capacity and reduce the backlog of neglected surgical diseases in underserved areas.	91%
<b>Recommendations on prioritizing district hospital implementation</b>		
20.	All district centers should place a very high priority on developing low complexity, high volume, low acuity surgical services.	94%
21.	All district centers should place a very high priority on developing low complexity, high volume, high acuity surgical services.	88%
22.	All district centers should place a high priority on developing low complexity, low volume, high acuity surgical services in district centers.	84%
23.	All district centers should prioritize establishment of a system for screening and referring all high complexity, high volume, low acuity surgical cases to specialized centers.	90%
24.	All district centers should prioritize establishment of a system for screening and referring all high complexity, low volume, low acuity surgical cases to specialized centers.	90%
25.	All district centers should prioritize establishment of a system for stabilizing high complexity, high volume, high acuity cases prior to transport to a regional or specialist center.	90%
26.	New statement: All district centers should prioritize establishment of a system for stabilizing high complexity, low volume, high acuity cases prior to transport to a regional or specialist center.	96%

**Figure 3** Final consensus statements.

Finally, for high acuity cases of high complexity, district centres should prioritise establishing systems for stabilising patients and for ensuring safe, timely transport to regional or specialised centres.

#### Principles for governments, surgical societies and universities

A set of principles for governments and organisations implementing surgical scale-up were developed. At the national level, participants recommended that emergency and essential surgical care should be integrated within existing national Universal Health Coverage (UHC) frameworks. They also agreed that establishing national referral policies decreases delays in care, lower the cost of care, and improve outcomes. For surgical societies and university surgical programmes in LMICs, they encouraged in-country outreach to enhance surgical capacity and reduce the backlog of neglected surgical diseases in underserved areas. Surgical societies or governments should prioritise the establishment of registries and databases to enable collection of information permitting assessment of disease burden and specific facility

performance, forming the backbone of performance assessment and monitoring. International surgical partnerships should be coordinated in communication with surgical societies and universities in LMICs.

#### Principles for international visiting teams

Respondents agreed that international surgical partnerships can assist in local surgical training, build capacity and encourage investments in local surgical care. There was also agreement that international visiting teams should formally engage with local surgeons and community leaders prior to arrival in the host country. They also recommended that visiting teams be responsible for certain logistics. For example, international surgical visiting teams should ensure that a proper postoperative follow-up plan has been formulated for each patient. Teams should also coordinate with local surgeons in collecting and reporting surgical outcome data with appropriate government agencies or local professional societies.

**Table 3** Matrix of recommendations for the prioritisation of surgical services in low-income and middle-income countries

Complexity	Volume	Acuity	Example service	Organisation	Priority for district centre implementation	Comment
Low	High	Low	Preventive/screening Basic general surgery (eg, hernia, common benign tumours) Basic ophthalmologic surgery (eg, cataracts)	Decentralised	Very high	All communities need access to low complexity, high volume, low acuity surgical services. The low complexity of these services makes them especially appropriate as the barriers to implementing them are lower.
Low	High	High	Basic trauma services Basic obstetric services Basic emergency surgery services (eg, appendectomy)	Decentralised	Very high	Low complexity, high volume, high acuity services cannot be reasonably handled by referral. Regional centres have volume constraints and these problems are more efficient and cost-effective to handle at the district centre, providing a chance for improved outcomes. Basic services need to be available at the district centre.
Low	Low	High	Basic emergency surgery services	Decentralised	High	Low complexity, low volume, high acuity services are best managed at the district centre using basic services.
Low	Low	Low	Nontrauma orthopaedic service	Decentralised	High	Low complexity, low volume, low acuity surgical services should be within the purview of a district centre since it is a basic level of service.
High	High	Low	Common cancers (eg, lung and breast cancer)	Regionalised	Low	High complexity, high volume, low acuity services are much needed in any community, but the high complexity of management and cost of implementing them becomes a lower priority. A proper screening and referral system at the community level should be implemented.
High	Low	Low	Complex oncologic and reconstructive services (eg, pancreatic, liver cancer surgery)	Regionalised	Low	High complexity, low volume, low acuity services are served best by a national referral service.
High	Low	High	Complex emergency surgical services	Regionalised	Low	High complexity, low volume, high acuity services can be handled by a referral system.
High	High	High	Complex cardiothoracic or trauma services	Regionalised	Low	High complexity, high volume, high acuity services can adequately be handled by a system that can stabilise patients at a district centre and transport them to a regional referral centre.

## DISCUSSION

This set of recommendations established by expert consensus is a step towards scaling up surgical care in LMICs. Such scale-up is critically needed to meet present and projected surgical demands. At the global level, these consensus recommendations on the optimal distribution and prioritisation of services will inform governmental regional and district-level efforts in LMICs to improve safe, accessible and affordable surgical care. Previous studies have pointed to the efficacy of decentralising certain services such as obstetric care with substantial mortality benefits.<sup>15</sup> The dearth of data on the regionalisation of certain services such as trauma or cancer care in LMICs, however, may inadvertently discourage policymakers to consider this strategy despite noted benefits in HICs.<sup>23</sup> Thus, presenting a broad and flexible framework allows countries to apply our strategy (eg, establishing levels of surgical acuity and complexity) to surgical scale-up needs based on their specific geopolitical and socioeconomic climate. We envision that this process will invite collaboration and discourse from relevant government agencies, further catalysing the surgical scale-up process. To our knowledge, this is the only study to establish international consensus guidelines for surgical scale-up in LMICs that draws on the collective wisdom of over 900 combined years of experience from surgeons, anaesthesiologists and

obstetricians from 13 different specialties who have been facing these challenges on a day to day basis.

A recent scoping review regarding ethical collaborations in global surgery noted the lack of formal guidelines informing relevant stakeholders on the ethical challenges of global surgical collaborations and found that more than 80% of published data were from HICs and focused on clinical care and short-term missions.<sup>24</sup> A qualitative systematic review of 30 articles published in the last 10 years from 15 countries (10 middle income and 5 low income) assessing perceptions of visiting teams from HICs noted a significant number of disadvantages of short-term 'surgical missions' such as poor quality of care or lack of follow-up.<sup>3</sup> Of note, over a third of the articles included had no LMIC authorship. This study, therefore, fills an important gap as a starting point for broader discussions regarding ethical global surgical collaboration focused on patient safety and sustainable partnerships led by LMIC surgeons.

Our work resulted in several recommendations. First, we propose that low complexity surgical cases should be decentralised, while high complexity cases should be regionalised. This encompasses high acuity conditions, which should be managed by district centres according to level of complexity. In the case of complex trauma, district centres should have the capacity to stabilise patients and

arrange for timely transportation to a regional centre. Second, we propose that district centres should place highest priority on developing surgical services for high volume, low complexity conditions. Third, we propose that emergency and essential surgical care should be integrated within existing national UHC frameworks to maximise overall access to surgical care. Finally, we propose a set of principles for international visiting teams that may assist in training, capacity building and in-country surgical practice.

The three-point model which uses the dimensions of complexity, volume and acuity was a useful adjunct in formulating these recommendations.<sup>15 16</sup> The model provides a flexible and replicable framework, which countries may use; however, they deem fit for their particular local context. Our findings are also consistent with prior evidence illustrating the inability to translate high-income country models of regionalised trauma care to LMICs.<sup>25</sup> The translatability of regionalised trauma care depends on the strength of referral systems, transportation mechanisms and information systems in the country. Thus, we recommend that LMIC governments support initiatives to strengthen decentralised trauma care while simultaneously working to strengthen national emergency response systems. This is consonant with the demonstrated success of averting the burden of morbidity and mortality of trauma through initial district-level interventions.<sup>26</sup> Our recommendation that district centres place highest priority on developing services for low complexity, high volume cases is akin to what the Disease Control Priorities third edition has discussed as essential surgical care and we urge governments to integrate these initiatives into strategic national healthcare plans.<sup>27</sup> With respect to complexity, our recommendation for regionalising high complexity cases is founded on the premise that cost tends to be a key determinant in LMIC prioritisation. Regionalisation is often argued to be an effective approach for these procedures due to economies of scale.<sup>19</sup> However, the financial burden on patients for transportation and accommodations at regional centres should not be ignored.<sup>28</sup> For highly complex cases, optimal distribution may be examined on a continuum based on characteristics that exist within a surgical system.<sup>29</sup> For example, surgery for common cancers which we consider high complexity in terms of oncologic management, high volume procedures may be optimally performed at the district level in some LMICs depending on the local economy and resources. For high complexity, low volume procedures such as surgery for pancreatic and hepatobiliary cancers, the consensus for regionalisation at specialised centres was stronger. This recommendation is supported by several studies from HICs, which have linked higher surgical volumes with improved patient outcomes.<sup>30 31</sup> Overall, our recommendations offer a realistic, practical framework to help countries move forward in scaling up safe, affordable and accessible surgical care.

Our report has several limitations. First, our recommendations do not speak specifically to the current burden of

surgical diseases nor the current workforce and surgical capacity in LMICs. Though the expert panellists represent many years of experience in LMICs, further research is required to understand local disease burden and workforce capacity. Second, the distribution of LMICs that our respondents represent may be skewed to particular contexts. Almost 50% of respondents were from African countries while less than 10% were from South American countries. However, our recommendations offer a translatable framework that each country may uniquely apply to their own context to drive local policymaking, planning and allocation of resources. In addition, representation of modified Delphi participants was skewed towards general surgery (table 2), which may raise concerns about appropriate expertise among the participants. Most participants labelled as general surgeons had a subspecialty focus in one or more areas, typically oncology or trauma, which we believe provided a good balance to the group's expertise. Finally, while the panel reached consensus on recommendations involving international surgical teams, we did not attempt to build consensus around the number of trainees or specific personnel resources required to build capacity. However, we believe that the surgical workforce is specific to each local and national context. Ongoing research is needed to determine the optimal surgical workforce in specific LMICs.

## CONCLUSION

These recommendations represent the only consensus-driven approach seeking to galvanise LMIC expert experience to inform LMIC governments. We believe that such an approach is invaluable in providing practical solutions that foster commitment to the veracity of the recommendations. The adoption of this framework provides a backdrop for mobilising the vast network of global surgical communities into organised strategy groups willing and able to provide training and resources for setting up complex regionalised centres of excellence alongside motivated governments. Smaller groups can focus on increasing the capacities of district hospitals in providing high volume, low complexity surgical services. Further research is warranted in terms of ascertaining the minimum number of regionalised and/or district centres for a particular population density and surgical epidemiologic climate, the optimal annual surgical volume parameters to determine whether an institution should be deemed a regional versus a local surgical centre, and the minimum levels of quality benchmarks that district hospitals should have to be deemed safe. This matrix provides the necessary tools for a unique country-led surgical scale-up strategy that can practically draw on the invaluable expertise of LMIC surgeons who are on the frontlines of surgical care in their respective regions. Furthermore, the recommendations redirect visiting teams into optimising their resources and presence to attain a more sustainable and scalable solution to improving the quality and quantity of surgical care in LMICs.



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