

State of Training for Surgery in Austere Environments – A Review of the Literature

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Abstract

The findings of the Lancet Commission have brought to light the diminished state of surgical care in low- and middle-income countries, especially the availability of surgical care in rural areas. Rural surgeons require different skillsets, and traditional surgical training is geared toward urban hospital practice. Little is known of the current state of educational support and training for rural surgery. The present study sought to investigate the state of training for surgery in austere environments by performing a review of the literature on existing courses and evaluations of their successes. The study aims to assess if there is a need for more formal resources to provide austere or rural environment surgical training. A literature search was performed on existing courses and training programs for surgery in austere environments. Courses or fellowships that imparted surgical skill for practice in rural/austere environments were included; programs that were not skill based, had no formal educational component, were nonsurgical or nonrural/austere environment related were excluded. Sixteen articles were included in the analysis. Eight pertained to short courses and eight pertained to long courses. Evaluation of outcome was performed through a mixture of knowledge assessment, competency assessment, as well as participant's assessment of usefulness. There remains a paucity of reported courses or programs focused on providing surgical education in low-resource settings. Existing interventions are largely inadequately evaluated, with a lack of focus on real-world impact. Future interventions should focus on being collaborative and systems based with longitudinal real-world evaluation to assess for meaningful impact toward achieving the 2030 Lancet Commission goals.

Keywords: Global surgery, low- and middle-income countries, rural surgery, surgery in austere environment, surgical education

INTRODUCTION

The findings of the Lancet Commission have brought to light the dire state of surgical care in low- and middle-income countries (LMICs), where an estimated five billion people lack access to safe, prompt, and affordable surgical care.^[1] This has resulted in approximately 16.9 million deaths per year, exceeding the combined mortality rates of human immunodeficiency virus, malaria, and tuberculosis,^[2] and accounts for at least 77.2 million disability-adjusted life years.^[3] The critical problem is much more pronounced in rural areas of LMICs. A major barrier to achieving safe surgery in this population is the lack of surgical specialists in LMICs, where 48% of the global population are served by an estimate of 19% of surgeons, with an estimate of 5.5 medical providers per 100,000 population in LMICs compared to 56.9 in high-income countries (HICs).^[4]

In response to this need, the Lancet Commission has made several recommendations in workforce, training, and education. At the national level, countries are encouraged to achieve a surgical workforce density of 20–40 per 100,000 population with sufficient distribution to the rural community and have mandatory rural training components within their training programs. International partners are encouraged to collaborate with local institutions through training, education, and improvement of surgical capacity.^[1]

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Submitted: 13-Apr-2025

Revised: 31-Jul-2025

Accepted: 07-Aug-2025

Published: 13-Oct-2025

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How to cite this article: Linn YL, Khoo NX, Lie DT, Chan YW, Chong TW, Tan HK, *et al.* State of training for surgery in austere environments – A review of the literature. *J Surg Spec Rural Pract* 2025;6:56-62.

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DOI:
10.4103/jssrp.jssrp_9_25

Surgical specialists typically train in tertiary teaching hospitals, and local training programs are designed to equip them for these roles. Many are reluctant to work in rural areas.^[1] The skillsets required for surgical care in the rural setting is quite different from those need in urban hospitals. The rural surgeon is faced with different challenges such as poor resources, lack of ancillary hospital support, requirement to provide more diverse services, and logistically prohibitive distances to the nearest tertiary center. As such, many surgeons are poorly equipped to perform work in an austere environment.

At present, little is known of the collective state of global educational support for austere environment surgical care in LMICs. Scattered courses and training programs of various durations, targeting various population, of different subspecialties, categorized to various loose entities such as “global surgery,” “rural surgery,” “wartime surgery,” or “surgery in austere environments” exist.^[5] The effects of these interventions, including more prominent ones such as Surgical Training for Austere Environments (STAE) by the David Nott foundation,^[6] have made promising attempts to provide this type of surgical training. The present study sought to investigate the state of training for surgery in austere environments by performing a review of the literature on existing courses and evaluations of their successes.

MATERIALS AND METHODS

Literature search

Literature search on existing courses and training programs for surgery in austere environments was performed in accordance with the guidelines as stipulated by Preferred Reporting Items for Systematic Reviews and Meta-Analyses.^[7] The institutional review board approval was not required.

Definitions

Surgery in austere environment, or global surgery, is defined as per the Lancet Commission as “an area of study, research, practice, and advocacy that seeks to improve health outcomes and achieve health equity for all people who require surgical care, with a special emphasis on undeserved population and populations in crisis.”^[8]

Inclusion and exclusion criteria

Courses, training programs, or fellowships that imparted surgical skills for practice in LMICs were included. Programs were excluded if they lacked a skill-based focus, emphasized partnerships without a formal educational component, or were unrelated to surgical practice or LMIC contexts. The full list of inclusion and exclusion criteria is demonstrated in Table 1.

Information sources

A search of PubMed, Medline, and Embase was performed. Search terms for PubMed and Medline are demonstrated in Table 2. Reference lists of the eligible articles were also screened for additional articles that met the study criteria. In addition, an Internet search for the terms “global surgery course” and “surgery in austere environment course” was

Table 1: Inclusion and exclusion criteria for surgery in austere environment courses

Inclusion criteria	Exclusion criteria
English language literature	Not skills based (eg awareness courses, global health, policy)
Courses which impart skill in managing surgical conditions in LMIC/austere environment	Long-term capacity building/partnerships with no concrete course/training program
Specialties including GS, obstetrics, urology, pediatric surgery, otolaryngology, cardiothoracic, neurosurgery, orthopedic, hand, and plastic surgery	Self-guided training programs (eg lap suture box), online training programs
	Trauma surgery training not pertaining to LMIC/austere environment
	Nonoperative trauma courses (ie ATLS)
LMIC: Low- and middle-income countries, ATLS: Advanced trauma life support, GS: General surgery	

Table 2: PubMed Medline search strategy

((surg*[Title/Abstract]) AND ((low resource [Title/Abstract]) OR (global [Title/Abstract]) OR (austere [Title/Abstract]) OR (rural [Title/Abstract]) OR (humanitarian [Title/Abstract]) OR (LMIC[Title/Abstract]))) AND ((course*[Title/Abstract]) OR (training [Title/Abstract]) OR (education [Title/Abstract]) OR (program [Title/Abstract]))

also performed to include existing courses that have not been published as part of formal literature.

RESULTS

Literature search

A total of 6724 unique articles were identified. Twenty articles (including two web pages on courses on surgery in austere environment that had no corresponding literature) were shortlisted for full-text review. Four articles were excluded as the training involved was purely academic and did not involve surgical training in LMICs. Sixteen articles were included in the analysis [Figure 1].

Short courses on surgery in austere environments

A total of eight sources reported on short courses on surgery in austere environments, including six journal articles^[9-14] and two websites^[6,15] [Table 3]. Two courses were held in LMICs (India and Uganda),^[9-10] while six courses were held in HICs (USA, UK, and France).^[6,11-15] Three courses specifically targeted surgeons in LMICs,^[9-10,13] three courses targeted participants from HICs,^[11-12,14] and two courses were for both LMIC and HIC participants.^[6,15] Three courses served attending surgeons,^[9,13,15] three courses served residents,^[10-12] one course served medical students,^[14] and one course served medical professionals in general.^[6] Five courses provided training in common procedures encountered in LMICs,^[6,10,12,14-15] two courses provided specific training to treating a condition or performing a procedure,^[11,13] and one course provided training on performing minimally invasive techniques in the low-resource setting.^[9] Course fees were often not mentioned and ranged from USD 186 to EUR 1250 per participant.

Long course on surgery in austere environments

A total of eight sources reported on long courses and fellowships for surgery in austere environments^[16-23] [Table 4].

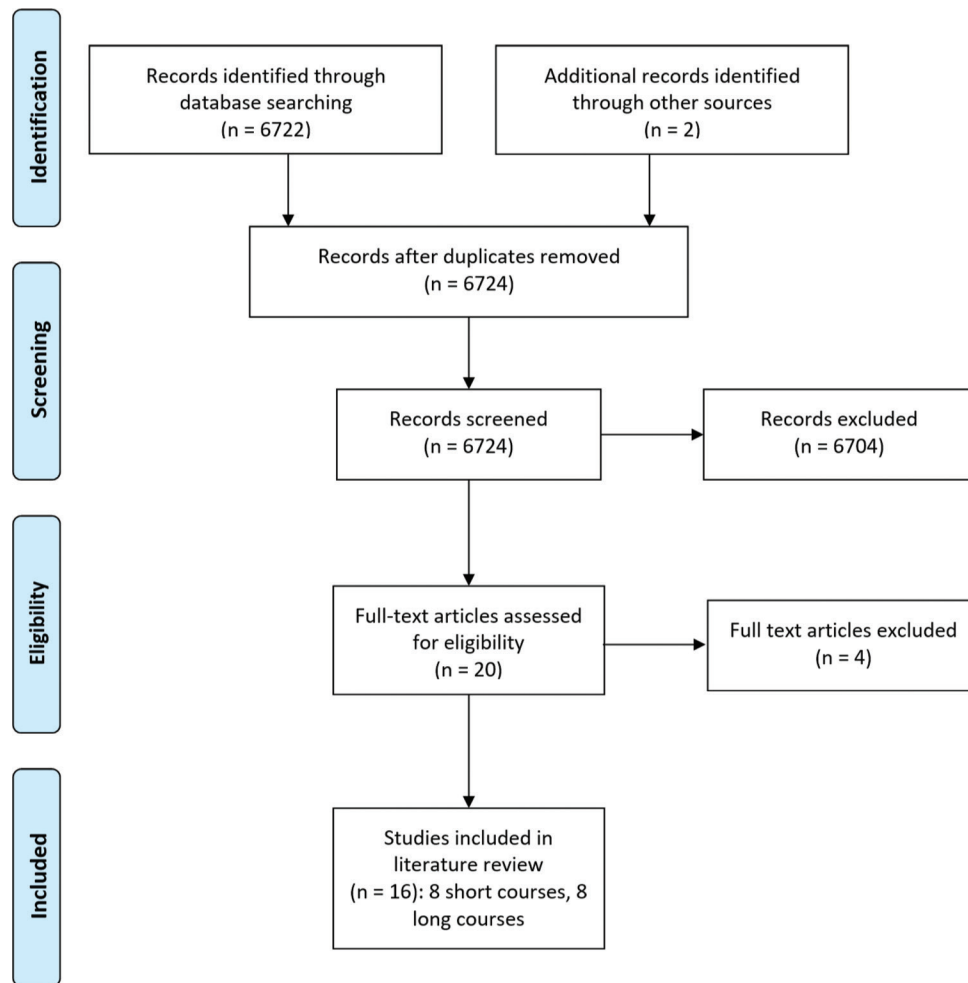


Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart on literature search

Five courses were run in HICs (USA^[16,20-22] and South Korea^[17]) and three courses in LMICs (Uganda,^[19] Cambodia,^[23] and Zimbabwe^[18]). Four courses served HIC personnel,^[16,20-22] three served LMIC personnel,^[17,19,23] and one served a mixture of HIC and LMIC personnel.^[18] Two courses served attending surgeons,^[17,20] three served interns or residents,^[16,19,21] one served medical students,^[18] and two served surgical care providers in general.^[22-23] Duration ranged from 1 month (as part of surgical residency)^[21] to 7 years (full modified residency program).^[16] Course fees were not mentioned for all the courses and fellowships.

Evaluation of courses in surgery in austere environments

4/16 (25%) of the courses had no mention of evaluation or their outcomes. Among the other 12/16 (75%) of courses, evaluation of outcome was performed through a mixture of knowledge assessment, competency assessment, as well as participant's assessment of usefulness^[9-14,17-19,23] [Tables 3 and 4]. These were achieved through a mix of written or multiple-choice questions and participant surveys, administered either before and after or just after the course, and scores on procedural tasks after course completion. Real-world clinical outcomes were rarely assessed. One study assessed participants' uptake

of flap techniques learned during the course, the success rate, and amputation rate 1 year postcourse.^[13] Another course measured the clinical outcomes in terms of in-hospital mortality rates as well as wound infection rates at the end of 4 years of training.^[23]

DISCUSSION

With an increase in awareness and focus on achieving the 2030 Lancet Commission targets of providing access to timely essential surgery, efforts have gone into bridging the gap by governments and institutions in HICs and LMICs worldwide.^[24] The emphasis on education and training has also kept pace, with initiatives and collaborations as demonstrated in this review.^[16] It is pertinent, therefore, to critically evaluate the state of training for surgery in austere environment to establish the effectiveness of our efforts, where the needs are and what more needs to be done.

The review of literature has demonstrated that there were limited published courses or courses advertised on the Internet pertaining to surgical skills training for low-resource settings. Certain programs concentrated on specific procedures, including external fixations and flap reconstructions, in

Table 3: Short courses on surgery in austere environments

Author (year) or centre	Country	Duration	Audience	Curriculum/ intervention	Cost	Nature of evaluation	Findings
Aruparayil <i>et al.</i> (2021) ^[9]	India	3 days	Rural surgeons in India	FLS training, use of gasless laparoscopy	USD236	Knowledge (pre–post-MCQ) Competency (time taken for tasks, structured assessment of task performance scores)	Improved MCQ score postintervention Improved scores on tasks at the end of training
Ullrich <i>et al.</i> (2020) ^[10]	Uganda	3 days	2 nd year surgical residents in Uganda	Operative and nonoperative trauma: Didactic lectures, practical sessions, and operative anatomy. Cadaveric training	USD1500 per participant to run, participants charged USD186	Knowledge (pre–posttest) Competency (Management of cases 1-month pre- and postcourse)	Improvement in knowledge/test scores Improvement in the confidence of subject Increase use of techniques taught, e.g., four-quadrant packing
Coleman <i>et al.</i> (2019) ^[11]	USA	2 days	Senior residents from the USA	Powerless external fixation	USD20 000 to run	Competence (Score on quality of fixation at the end of the workshop) Confidence (postcourse survey)	Improvement in competence score, time taken Improved confidence in performing fixation
Lin <i>et al.</i> (2018) ^[12]	USA	2 days	GS and obstetric senior residents from the USA interested in global surgery	Cadaveric sessions on common procedures, e.g., mesh free hernia, powerless external fixation, craniotomy etc	Not mentioned	Knowledge (pre–posttest) Competence (pre–postskill assessment in fixation) Confidence (pre–postsurvey)	Improvement in knowledge/test scores Improvement in the quality of fixation Improvement in comfort level performing task
Wu <i>et al.</i> (2016) ^[13]	USA	2 days	Orthopedic surgeons from LMIC	Surgical manage soft-tissue defects	Not mentioned	Usefulness (postcourse survey on quality of teaching materials) Impact on flap utilisation and amputation rate (survey 1 year post on flap use, success, amputation rate)	Participants found the course effective 100% participants used techniques learnt at 1 year, 97% taught techniques to colleagues, 28 other nontrainees adopted skills learnt due to dissemination 116 amputations prevented due to the flap technique learnt
Hugar <i>et al.</i> (2014) ^[14]	USA	1 month	Medical students interested in global surgery	Lectures, GS, and urological procedures in Haiti	Self-funded by students	Usefulness (postcourse survey)	Students felt increased ownership, gained postoperative care experience
David Nott Foundation ^[6]	UK	5 days	Medical professionals working in traveling to conflict/ catastrophe zone	Cadaveric, GS, facial trauma, plastics, orthopedics, obstetric procedures	Not mentioned	Not mentioned	Not mentioned
UCLouvain ^[15]	France	6 days	Surgeons with 3 years clinical experience	Humanitarian, war, otolaryngology, plastic, thoracic, vascular, obstetric, abdominal, urological, pediatric, orthopedic surgery	EUR1250	Knowledge (examination, case discussion)	Not mentioned

USA: United States of America, UK: United Kingdom, LMIC: Low- and middle-income countries, USD: US Dollar; EUR: Euro, MCQ: Multiple-choice question, GS: General surgery

Table 4: Long courses and fellowships for surgery in austere environments

Author (year)	Centre	Country	Duration	Audience	Curriculum	Nature of evaluation	Findings
Davis <i>et al.</i> (2021) ^[16]	Baylor College of Medicine	USA	7 years	USA surgery residents	Residency with special rotations geared towards surgery in LMIC	Not mentioned	Increased exposure to surgeries critical in LMICs, meaningful international partnerships, contribution of global surgery scholarship, and establishment of sustainable activities
Kim <i>et al.</i> (2020) ^[17]	Seoul National University Hospital	South Korea	3 months	Myanmar subspecialty surgeons	Knowledge and skills relevant to surgical care in the region	Competency (weekly self-assessment)	High satisfaction ratings of course Improved self-assessed competency
Anderson <i>et al.</i> (2019) ^[18]	Lund University, Harvard Medical School	Sweden, US, Zimbabwe	5 weeks	Final year medical students from Sweden, USA, Zimbabwe	Lectures, group discussion, and clinical skills in LMIC	Knowledge (Pre-posttest) Skill (self-assessment pre/post/1 month/1 year)	Improved comfort in operative trauma Improved comfort level 1 year postcourse
Anderson <i>et al.</i> (2018) ^[19]	Uganda	Uganda	1 year	Ugandan interns	Trauma skills and techniques for low-resource setting	Knowledge (MCQ test)	Improvement in knowledge of global surgery
Merchant <i>et al.</i> (2017) ^[20]	Vanderbilt University	USA	2 years	General surgeon	Critical care, trauma, emergency surgery	Not mentioned	Not mentioned
Zhang <i>et al.</i> (2016) ^[21]	Icahn SOM, Mt Sinai	USA	1 month	Year 3 Mount Sinai GS residents	1 month posting in the Dominican Republic	Not mentioned	Not mentioned
Arabi <i>et al.</i> (2015) ^[22]	University of Washington	USA	1 year	Surgical volunteer from HIC	Bread and butter adult and pediatric surgery in Haiti	Not mentioned	Not mentioned
Van Heng <i>et al.</i> (2008) ^[23]	Trauma care foundation	Cambodia	4 years	21 Cambodian surgical care providers	5 courses focusing on surgical skill training	Clinical outcome (mortality rate, wound infection) Competency (self-rated)	Reduced in-hospital mortality, wound infection

USA: United States of America, LMIC: Low- and middle-income countries, MCQ: Multiple-choice question, GS: General surgery, HIC: High-income countries

response to clearly documented clinical needs within the local population.^[11,13] Some courses addressed issues pertaining to the upskilling of existing surgical services in LMICs, such as the use of laparoscopy.^[9] There was also a general large range of target audiences, from students doing a medical elective to attending surgeons. There were efforts in training both LMIC surgeons as well as HIC surgeons wishing to practice in rural/austere settings. For LMIC staff, some interventions employ the use of task-shifting and train other groups, such as nonsurgical medical professionals, students, and residents, to take on the surgical tasks.^[18,19,22,23] While the paucity of literature raises concerns that the problem of lack of access to safe surgery in LMICs is not being adequately addressed, there is potential in ongoing and unpublished work by institutions in partnership with LMIC governments and hospitals, as well as by educational bodies such as student groups, universities, and residency programs. In such cases, every effort should be made to achieve peer-reviewed reporting of these endeavors in academic journals to enable a meaningful assessment of the work that is being done in each setting and allow the

academic community to learn and capitalize on the collective experiences.

Program evaluation of surgery in austere environment courses is inconsistent at best. Each program, if self-assessed, typically employed a combination of self-crafted noninternationally validated questionnaires. The evaluation primarily aimed to assess participant satisfaction and attitudes, using multiple-choice and short-answer questions to measure knowledge acquisition, alongside task-based scoring to evaluate procedural competency. While these are useful in demonstrating short-term satisfaction and comprehension of the materials presented, they did not guarantee that the skills learned were retained after a period of time or that they were practiced to good effect in the participants' site of practice. What is seldom assessed but would be critically useful, is to see if the training made eventual differences to the surgical services in the rural locations of the respective participants. Other factors, such as the presence of appropriate equipment and infrastructure, the ability to troubleshoot when problems

were encountered, the presence of available mentors, or the presence of ancillary trained support staff, could also have played a role in the successful employment of a new technique taught. Where employed, longitudinal studies of real-world outcomes were useful to demonstrate tangible benefits of the course for the participants' patients and hospital systems, such as in terms of procedural success, complications, and mortality rate.^[13,23]

There was a large variety of duration for the training courses, ranging from 2-day workshops to 7-year residency programs. Long courses have its benefits of being able to comprehensively train a participant in surgery in LMIC beyond merely learning the steps in performing common procedures as well as providing participants with clinical experience and insight. However, they may also run the risk of excluding participants who may be among the few sole healthcare providers for their region and would hence be unable to commit to training for a long duration of time.^[25] In addition, funding might have also been an issue hindering the LMIC surgeon from participating in a course for extended durations.^[26] The location at which the training was held likely mattered as well, with an LMIC surgeon being less likely able to attend a course held in an HIC country compared to at the place of their practice.^[25-6] For instance, few courses are held in Asia, where there is a significant rural population, with a majority of courses held in the US. LMIC surgeons may be better served by holding training at a local or regional site, where funding and time off work may not play such a big role in their ability to commit. On the other hand, HIC surgeons may also benefit from attending training courses as close as possible to the region where they intend to practice so as to be able to have a better appreciation of the burden of disease, culture, and resources available for the LMICs they intend to labor at.

It is also imperative that efforts by HIC surgeons and institutions to tackle education and training to address the lack of healthcare personnel in rural LMIC communities be done in a concerted manner, in conjunction with local governance and hospital systems.^[1] Thorough assessments of a community's needs and capabilities ought to be performed, and a collaborative approach with the LMIC health systems would best uncover the ideal interventions that would best benefit the LMIC healthcare workers and population.^[27] For instance, our study has demonstrated paucity of interventions in Southeast Asia, with just a previous training program published in 2008 in Cambodia^[23] and more recently in 2020 in Myanmar.^[17] Comprising 11 countries with diverse ethnicities and unique population distribution, including remote island conditions, Southeast Asia has an estimated unmet need of 5627 cases per 100,000 population for surgical procedure.^[27] Collaborative, systems-based interventions—particularly those centered on training programs for prevalent surgical conditions—have the potential to significantly strengthen surgical care capacity in the region.^[28]

Training courses and programs would also benefit from more thorough evaluations beyond participants' satisfaction and

short-term ability to perform a task, as well as knowledge. Longitudinal evaluation beyond that which currently exists,^[13,23] such as measurement of adoption, complication rate, and potential mortalities averted, would be helpful in assessing the success of the interventions. It would also inform regarding where additional resources should be channeled, for instance, if providing training for nurses and operating technicians with regard to equipment care or providing additional proctoring beyond the duration of the training would help improve uptake of techniques taught and the longevity of the intervention.^[5] Metrics such as the propagation of techniques taught to colleagues and juniors can also be useful in assessing the success in the impartation of a safe operating technique to practitioners in a low-resource setting.^[13] Relevant metrics would also inform on the success of achieving the goals set out by the Lancet Commission, in particular having 2-h access to Bellwether procedures, surgeon workforce, surgical volume, and mortality rate.^[8]

As the field of global surgery matures, it would be useful to further differentiate efforts based on the needs of the low-resource setting. For instance, the skillset required to provide surgical care would be different for achieving access to Bellwether procedures in LMICs compared to maximizing access to elective surgeries such as thyroidectomies for goiter, contracture releases for burns, hernia, and hydrocele repairs in low-resource settings, to performing trauma surgery in a wartime setting. Having the clarity of definition would allow more granularity as we channel efforts to addressing these unmet needs.^[29] In addition, future endeavours should also capitalize on technology and innovation, with tools such as remote proctoring, or maintaining a web-based bank of educational resources and videos to support ongoing education and training in the low-resource setting.^[30]

CONCLUSION

There remains a paucity of reported courses or programs focused on providing education on surgery in the low-resource setting. These interventions are largely inadequately evaluated *post hoc*, with a lack of focus on real-world impact. We believe that future interventions should focus on being collaborative and systems based with longitudinal real-world evaluation to assess for meaningful impact toward achieving the 2030 goals for the Lancet Commission.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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