Global children's surgery: recent advances and future directions

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Purpose of review
Two-thirds of the world's population lacks access to surgical care, many of them being children. This review provides an update on recent advances in global children's surgery.

Recent findings
Surgery is being increasingly recognized as an essential component of global and child health. There is a greater focus on sustainable collaborations between high-income countries (HICs) and low-and-middle-income countries (HICs and LMICs). Recent work provides greater insight into the global disease burden, perioperative outcomes and effective context-specific solutions. Surgery has continued to be identified as a cost-effective intervention in LMICs. There have also been substantial advances in research and advocacy for a number of childhood surgical conditions.

Summary
Substantial global disparities persist in the care of childhood surgical conditions. Recent work has provided greater visibility to the challenges and solutions for children's surgery in LMICs. Capacity-building and scale up of children's surgical care, more robust implementation research and ongoing advocacy are needed to increase access to children's surgical care worldwide.

Keywords
Africa, congenital anomalies, global surgery, pediatric surgery

INTRODUCTION

An estimated 30% of global disease burden is treatable with surgery [1]. However, five billion people worldwide lack access to safe and affordable surgical care whenever needed [2]. The majority of these people live in low-and-middle-income countries (LMICs), where 50–60% of the population are children. Recent work has promoted the recognition of surgery as an essential component of global health, and specifically, global child health. We will review recent advances in global surgery as well as global pediatric surgery with a focus on advocacy, global engagement, service delivery, training and research.

ADVOCACY

The year 2015 saw significant progress in advocacy for global surgery, with the Lancet Commission on Global Surgery (LCoGS) Report, the third edition of the Disease Control Priorities Project (DCP3) and the World Health Assembly Resolution on Essential Surgery [2,3▪▪,4▪▪,5,6]. Although these developments galvanized surgery within the global health space, children's surgery has been under-emphasized. Global targets, such as those to provide universal health coverage, reduce poverty, improve gender equity and reduce neonatal, infant and under-five mortality will all require children's surgical care [4▪▪]. The Global Initiative for Children's Surgery (GICS), a consortium of providers from HICs and LMICs, was formed in 2016 to tackle some of these gaps [7].

GICS has had three international meetings since its inception. Integration of multiple children's surgical care specialties and focus on leadership and priority-setting by LMIC providers have been unique areas of emphasis. GICS has recently proposed guidelines for optimal resources for surgical care at all levels of the health system, which can be

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KEY POINTS

- Significant advances in advocacy for global surgery as a whole and global pediatric surgery have occurred recently.
- Increasing pediatric surgical capacity worldwide will require a multifaced approach with interventions prioritizing long-term collaborations between HICs and LMICs that are targeted at workforce expansion, building infrastructure and research.
- Implementation and cost-effectiveness studies are essential to inform resource allocation and scale-up of training and service delivery.
- Resource limitations have required LMIC providers to develop low-cost, innovative strategies that should be more easily fostered, studied and disseminated.

used to incorporate children's surgical care into LMICs' national surgical plans [8▪,9,10▪].

Although significant progress has been made, there are still challenges to making surgical access a political priority [11▪,12]. The global surgery community is fragmented, with a narrow coalition of advocates who lack unifying leadership. Greater consensus is needed to market surgery among other global health challenges. Donors continue to prefer 'vertical' causes treating single diseases or groups of conditions, whereas global surgery is a 'horizontal' issue involving health systems. Data on successful implementation of surgical programs is limited and surgery continues to be viewed as expensive and a luxury despite robust evidence to the contrary.

GLOBAL ENGAGEMENT AND BUILDING PARTNERSHIPS

Sustainable partnerships between HICs and LMICs are essential to increase surgical capacity worldwide. In general, HIC partners should consider the needs of the communities they are working with and facilitate local ownership as well as long-term collaborations [13▪,14]. Clinical care 'missions' in LMICs should be viewed as opportunities for capacity building and training [15▪▪]. Research should establish the evidence base for implementation and cost-effective models [16▪]. Even on short-term trips, there should be a focus on long-term collaborations and impact evaluation. Regional pediatric surgical organizations have increased global engagement by supporting research collaborations, LIC provider training and the development of context-appropriate educational courses [17▪,18▪].

SERVICE DELIVERY AND TRAINING

It is estimated that by 2030, the world will need over one million new surgical providers to meet the recommended surgical workforce density of 20 per 100 000 population [19]. Unsurprisingly, this deficit is not evenly distributed between HICs and LMICs [20]. For example, there is a 90-fold difference between the average physician anesthesia provider workforce density in HICs and LICs [21▪,22▪]. Multiple pediatric surgical specialties are facing a severe workforce crisis in LMICs [23▪,24▪,25–27].

One hundred and forty-three million additional surgical procedures are needed each year, but the ideal proportion of adult to pediatric procedures is unknown [2]. Although the LCoGS proposed bellwether conditions, these have yet to be validated for children. A cross sectional, population-based study in four LICs estimated that 19% of children had a surgical need and that 62% of children's surgical needs were unmet [28▪▪,29▪]. The estimated backlog for treatable pediatric surgery conditions in African LMICs averages 2 years [30▪▪]. Delay in seeking care was identified as the largest contributor to a delay in surgical treatment in a regional referral hospital in western Uganda [31▪].

Recent studies have examined the challenges to safe surgery in LMICs, such as poverty, infrastructure and policies, while acknowledging the resilience of local providers [32▪,33▪▪,34▪,35]. In Malawi, a multicenter study identified surgical team motivation as an additional potential barrier [32▪]. In Rwanda, resource variability, rather than resource limitation, was responsible for most of the challenges to performing safe surgery [33▪▪]. The Ugandan public hospital system has similar obstacles and does not meet the LCoGS targets for surgical access, workforce, or volume [34▪,35,36]. The same barriers exist for the provision of children's surgery – significant staffing shortages, lack of infrastructure and educational deficits predominate [23▪]. Mobile pediatric surgical services, such as those provided in Ghana to rural communities, represent another model for possible scale up in addition to more common surgical outreach models [37,38].

Numerous efforts are underway to address the pediatric surgical and anesthesia workforce crisis. Pilot training courses for children's surgical emergencies and common conditions are currently being taught by groups in Vietnam, Uganda and India [39–41]. Standardized courses in pediatric critical care may be useful [42]. Such courses need to be flexible and conform to the local context. Task-sharing with less specialized healthcare workers is widespread in many LMICs, but evaluation specific to pediatric surgery is minimal [43]. 'Brain Drain',

the migration of medical professionals from LMICs to HICs, is a well documented challenge for LMICs, with ongoing controversy around effective mitigation strategies [44]. In a 20-year follow-up of African surgeons trained in rural Africa through the Pan-African Academy of Christian Surgeons, 100% of former trainees are still practicing in Africa [45▪▪]. In Haiti, a pediatric surgical program among general surgery residents has resulted in increased care provision, improved trainee knowledge and skill and has increased research capacity [46▪]. There remains controversy around the optimal exposure of LMIC trainees to HIC training experiences, with some advocating for home country training only and others for more hybrid training models. Debate also continues regarding exposure and involvement of HIC trainees in global surgery [18▪].

Many LMICs, even those with more favorable economic indicators, have severe gaps in infrastructure [47,48]. Direct increase in infrastructure is an effective way to expand pediatric surgical capacity, ensuring more children have access to operating theaters and perioperative care that is equipped with well tolerated and functional equipment. KidsOR, a Non-Governmental Organization based in Scotland, has built operating theaters and perioperative care units at six sites in Africa with plans for over 10 more globally in 2019 [49]. At one such site in Tanzania, a 3-year waiting list for elective surgery was eliminated in 3 months [50]. Economic evaluation of one site in Uganda demonstrated that the installation of a dedicated pediatric operating theater was a more cost-effective intervention than antiretroviral therapy treatment for HIV in Sub-Saharan Africa and was well within accepted thresholds for cost-effective interventions in LMICs [51▪].

Though surgery has proven to be a cost-effective intervention, many families are at risk of spending more than 10% of their total income on surgical care (catastrophic expenditure) [52▪]. It is estimated that 43.9% of the population, particularly in LICs, is at risk for catastrophic expenditure should they need surgery. These costs include the direct costs of medical care, such as paying for the hospitalization, medications, surgical supplies and laboratory tests as well as indirect medical costs, such as lost wages, food, transportation and lodging. In Zambia, surgical care was less expensive at a district hospital than a referral hospital [53]. Scaling-up services at the district level should make surgery even more cost effective. Economic evaluations of pediatric surgery in particular have been limited. Short-term pediatric cardiac surgery 'missions' have been shown to be cost-effective with substantial humanitarian benefit [54▪]. Families of children undergoing inguinal hernia repair in private hospitals in Bangladesh sustained greater medical costs than nonmedical costs [55▪]. Overall, surgery was less expensive in public hospitals. In Uganda, the rates of catastrophic expenditure by families of children undergoing surgery are high [51▪,56,57].

RESEARCH

Here we review recent advances in research for global children's surgery.

Prospective databases

Several recent prospective short-term studies have provided greater in-depth single and multicenter data on a wide range of conditions. In a recent Kenyan study, pediatric status was not associated with higher mortality [58▪▪]. In the African Surgical Outcomes Study (ASOS), despite a lower risk profile and lower perioperative complications, patients were twice as likely to die, compared with HICs [59▪▪].

Meanwhile, the GlobalSurg collaborative has supported multiinstitutional, international surgical outcomes research [60,61▪▪,62–64]. In their study of emergency abdominal surgery, children in LICs had an adjusted mortality seven-fold higher than those in HICs [61▪▪]. Additionally, children who underwent surgery for gastrointestinal typhoid had a higher 30-day mortality rate than adults and were less likely to receive an ileostomy [64]. In addition, the Global PaedSurg trial, an international multicenter prospective cohort study of common congenital anomalies, is underway [65].

Despite these advances, an estimated 1.7 billion of the world's children currently lack surgical access [66]. Addressing this disparity will require a multifaced approach. Concerted efforts in advocacy, service delivery, global engagement and research should be prioritized (Table 1). Most LMICs lack metrics for pediatric surgical conditions including burden of disease, perioperative outcomes, backlog, effective coverage, cost effectiveness and the LCoGS indicators [67▪]. Newer assessment tools are being developed [68].

Cancer

Although surgery is an essential part of comprehensive cancer care, global childhood cancer programs have focused more on essential medications than surgery [69]. The WHO Childhood Cancer Initiative was recently launched with the goal of decreasing childhood cancer mortality by improving access to care and developing country-specific strategic plans [70,71]. Five index cancers, which represented a high burden of disease with reasonably good treatment outcomes, were identified in the DCP3. Of

Table 1. Challenges and solutions facing global children's surgery

Key areas	Challenges	Emerging solutions
Advocacy	Large-scale movements have not focused on children's surgery	Formation of GICS
	Surgery still not consistently recognized as a global health priority	Improved marketing of surgical investment in LMICs, aligning stakeholders, focusing on children
	Need for indicators specific to pediatric surgery	Incorporation of children's surgery into National Surgical Plans
		Publication of consensus guidelines for optimal resources for pediatric surgical care at all levels of the health system
		Ongoing assessment of ideal volume and composition of children's surgical procedures and proportion of emergency cases
Service delivery	Severe shortage of pediatric surgical and anesthesia providers	Implementation of training courses for children's surgical emergencies, pediatric anesthesia, perioperative medicine and common conditions
		Development of local fellowship training programs in LMICs
		Engagement of nonphysician providers as context-appropriate
	Lack of material resources and infrastructure	Direct increase in surgical infrastructure (such as KidsOR)
		Strategic rural outreach efforts
		Programs to improve early detection of visible congenital anomalies in the community
Global engagement	Prevalence of short-term surgical missions as aid from HICs to LMICs	Consensus recommendations for short-term trips with focus on developing lasting collaborations
		Development of sustainable training and research collaborations with regional pediatric surgical associations
Research	Limited national data on pediatric surgical outcomes	Global PaedSurg Trial – multicenter prospective cohort study of common congenital anomalies
	Limited implementation research	Improved assessment tools for pediatric surgery at the population level
		Economic evaluation and impact on Sustainable Development Goals

GICS, Global Initiative for Children's Surgery; HIC, high-income countries; LMIC, low-and-middle-income countries.

these, Wilms Tumor and Retinoblastoma are solid tumors for which surgery is a crucial aspect of treatment. The International Society for Pediatric Oncology (SIOP) has released comprehensive, standardized guidelines for optimal treatment regimens in LMICs organized by level of care and service availability [72,73]. For Wilms tumor in Africa, the SIOP protocol rather than the COG protocol has generally been followed because of the advanced stage of disease of most tumors at presentation that would preclude primary resection. In African centers that adopted the SIOP Wilms' protocol, there was an increase in disease-free survival, decrease in treatment abandonment and decrease in mortality compared with baseline outcomes before a treatment protocol was introduced [74▪▪]. There is some evidence that Wilms' Tumor displays a uniquely aggressive tumor biology in certain Kesnyan tribes as compared with others [75]. Research regarding the epidemiology and tumor biology of other pediatric solid tumors, including hepatoblastoma and neuroblastoma, is lacking [76▪]. Tumor registries would help to provide better insight into these cancers.

Injury

The most common cause of death in children over 1 year old is injury [77,78]. This burden is shouldered disproportionately by LMICs, where 95% of injury deaths occur [79]. Though injury has been gaining increasing recognition as a public health issue, the epidemiology and outcomes of childhood injury in LMICs remains poorly understood. The Pan-African Paediatric Surgery Association recently found that injury was the most common cause of pediatric surgical admissions [80▪▪,81].

Burns are also responsible for a significant burden of disease but remain poorly characterized [82]. Children under age 5 years are at the greatest risk of suffering a burn injury in Africa [83]. In a recent Gambian study, children made up more than half of all burn admissions and were less likely to die of burn injuries than adults [84]. Recent studies have emphasized the lack of comprehensive rehabilitation programs in LMICs and the effect on outcomes [85▪,86].

There are significant challenges to providing trauma and emergency surgical care in resource-limited settings. A recent survey in Ghana highlighted significant deficiencies in material resources [87]. Injury prevention initiatives, prehospital care systems and staff education and training are areas that should be prioritized for intervention and resource allocation [88▪,89]. Providers staffing emergency departments lack training in basic resuscitation skills, such as cardiopulmonary

resuscitation (CPR) and airway management, which could serve as targets for educational interventions [90▪].

Surgical subspecialties

Musculoskeletal disease is a significant cause of morbidity and mortality in LMICs, yet research on optimal treatment and outcomes is lacking [91▪,92▪]. Scaling up of Ponseti treatment for clubfoot has provided a number of valuable lessons for children's surgery, such as disease identification, treatment by nonphysician providers and an e-learning platform [93,94▪,95,96]. Similarly, endoscopic third ventriculostomy for pediatric hydrocephalus has been found to be cost-effective and to have equivalent 12-month cognitive outcomes as compared with ventriculoperitoneal shunting [97,98▪▪]. Large-scale efforts to address cleft lip and palate have provided useful lessons and models for service delivery and capacity building, and have shown economic benefit [99▪,100].

Congenital anomalies

Birth defects are the leading cause of death in children less than 1 year of age. Though mortality for children under 5 years has decreased, deaths attributable to birth defects have increased [77,101,102]. Congenital anomalies disproportionately affect LMICs, in which over 90% of birth defects occur [103]. A recent estimation of disability weights for a large variety of congenital conditions may help characterize their global burden [104▪]. This section will cover some of the common anomalies in pediatric general surgery.

An essential aspect of treating congenital anomalies is identification and referral. The Rashtriya Bal Swasthya Karyakram screening program, launched in India in 2013, has already screened over 100 million children and identified 135 000 congenital defects [105].

Hirschsprung's disease and anorectal malformations are common anomalies that result in significant morbidity and mortality in LMICs [106–110]. There is often a delay in presentation and in many cases, the diagnosis of Hirschsprung's disease is made clinically, because of the inconsistent availability of pathology [111]. Patients often require a three-staged procedure with ostomy for decompression, followed by pull-through or anoplasty and then definitive ostomy closure [112]. Many patients fail to complete all three stages, and children will sometimes wait years before definitive stoma closure, with significant socioeconomic consequences for patients and their families, leading some to advocate still for a one-stage procedure if possible [113▪,114].

Though relatively rare, biliary atresia is fatal if untreated. Patients with biliary atresia have a higher mortality rate than their counterparts in HICs, likely because of delayed presentation and unavailability of liver transplant services [115▪,116,117]. Stool color cards have been found to be a useful and cost-effective screening method in HICs, but have not yet become widespread in LMICs [118].

Cryptorchidism is a relatively common condition, which is best treated before the age of 2 years to avoid complications and best preserve fertility. Patients in LMICs present in a delayed fashion, with a reported mean age at surgery between 3 and 11 years old [119,120]. Delayed presentation has been largely attributable to lack of awareness, in both parents and providers, about the condition [121▪]. Management of nonpalpable undescended testes is particularly challenging in LMICs, given the morbidity associated with exploratory laparotomy. Laparoscopy, which is preferable in HICs, has been shown to be feasible in a resource-limited setting [119,122].

Lack of NICU care contributes to substantial disparities for conditions, such as esophageal atresia with or without tracheoesophageal fistula (EA/TEF) and gastroschisis [123]. A case series in Uganda showed high rates of intestinal atresia and high mortality rates for gastroschisis [124]. Mortality rates for EA/TEF were noted to be high in a 25-year review of cases in India, with lack of NICU care noted as a major contributor [125▪].

Safe anesthesia remains a challenge in LMICs, where perioperative mortality rates have not declined in the past 50 years. In Bangladesh, it has been demonstrated that performing major surgery in neonates with local infiltrative anesthesia is well tolerated and feasibile [126▪]. Context-appropriate training of nonphysician anesthesia providers has proven to be an effective strategy in many LMICs [127,128]. Short courses for pediatric anesthesia and expansion of training programs have also been effective [129▪].

LMIC providers have adapted to resource limitations with novel solutions. A simple protocol reduced gastroschisis mortality by 50% in western Uganda [130]. In the absence of spring-loaded silos, urine bags have generally been sutured to skin or fascia, but alternatives have also included the female condom and the Alexis wound retractor, which also has the advantage of low cost [131▪]. For omphalocele, the use of locally available and affordable escharizing agents, such as honey, iodine or eosin have been shown to be successful [132,133].

Developing innovative ways to improve surgical care of congenital anomalies in LMICs and disseminating existing innovations remains a high priority area for future study (Table 2).

Table 2. Barriers and innovations for specific children's surgical conditions

Specific conditions	Barriers	Innovations
Wilms' tumor	Delayed presentation, large invasive tumors	SIOP PODC protocol: treatment adapted to context
Clubfoot	Lack treatment access	Expanding training in the Ponseti serial casting method to nonphysicians, electronic-based learning, scaling through health system
Hydrocephalus	Limited capacity for hydrocephalus treatment	Endoscopic third ventriculostomy with choroid plexus coagulation as an alternative to VP Shunt with equivalent 12-month cognitive outcomes Economic studies showing cost-effectiveness of treating pediatric hydrocephalus
Hirschprung's disease and Anorectal malformations	Late presentation, unreliable availability of pathology	Operative treatment with three-staged procedure based on context Support for children with ostomies
Biliary atresia	Late presentation and lack of transplant services	Early detection with community education and stool color cards
Gastroschisis	Late presentation, lack of NICU and TPN, high cost of spring-loaded silos	Use of urine bag, Alexis wound retractor or female condom for silo, early enteral feeds Multidisciplinary protocols with nursing teams to ensure early coverage and support
Omphalocele	Operative intervention with high morbidity and mortality because of associated anomalies	Use of locally available escharizing agents, such as honey and iodine to defer surgery to older age
Intussusception	High rates of operative intervention	Ultrasound-guided hydrostatic reduction protocol
Typhoid perforation	Disease present almost exclusively in LMICs High mortality with complicated disease	Stoma placement for critically ill patients Earlier detection in endemic areas Prevention through sanitation and vaccine programs
Inguinal hernia and cryptorchidism	Delayed detection, significant backlogs High rates of incarceration	Earlier detection and treatment Increasing capacity of regional and district hospitals

NICU, neonatal ICU; PODC, the Pediatric Oncology in Developing Countries; SIOP, International Society for Pediatric Oncology.

Pediatric general surgery

Even routine pediatric surgical conditions have severe consequences in LMICs. Ostomies can have significant social and economic consequences for children and their caregivers [113▪]. Intussusception almost universally requires operative intervention in low-resource environments. However, in Ethiopia, the rates of operative reduction for intussusception decreased to 23% after the introduction of an ultrasound-guided hydrostatic reduction protocol [134▪]. Inguinal hernia is responsible for a significant unmet surgical burden, especially in rural regions, and may be inappropriately managed by untrained personnel [135]. In addition, a disproportionate ratio of children may present with incarceration, suggesting that this ratio may be a useful metric for surgical access [136].

CONCLUSION

Though pediatric surgery has historically been a neglected area of global health and global surgery, increasing pediatric surgical capacity in LMICs is essential to achieve global health equity. Although many recent advances have been made, more implementation studies evaluating the effectiveness of interventions from different perspectives are essential. Additionally, more studies are needed focusing on LMICs in Southeast Asia and South America, as much of the research is from Africa. It is crucial for HIC providers to collaborate with their LMIC colleagues to spearhead future efforts to develop effective and sustainable programs to ensure equitable access to surgery for children worldwide.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- ■ of special interest
- ■■ of outstanding interest

1. Shrime MG, Bickler SW, Alkire BC, Mock C. Global burden of surgical disease: an estimation from the provider perspective. Lancet Glob Health 2015; 3(Suppl 2):S8–S9.
2. Meara JG, Leather AJ, Hagander L, *et al.* Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. Lancet 2015; 386:569–624.
3. ■■ Jamison DT, Alwan A, Mock CN, *et al.* Universal health coverage and intersectoral action for health: key messages from Disease Control Priorities, 3rd edition. Lancet 2018; 391:1108–1120.

This is the first of the DCP editions that has included a volume on Essential Surgery. Forty-four surgical procedures, including numerous children's surgical procedures, were deemed 'essential', which should be used to inform national surgical plans as they are developed. Additionally, this publication integrates essential health services to be delivered at all levels of the health system including time critical services, a feature that had not been included in previous reports.

4. ■■ Roa L, Jumbam DT, Makasa E, Meara JG. Global surgery and the sustainable development goals. Br J Surg 2019; 106:e44–e52.

In 2015, the UN transitioned from the Millennium Development Goals to Sustainable Development Goals (SDGs). Achievement of many of the SDGs will require expansion of access to surgical services, including: Goal 1 – No Poverty, Goal 3 – Good Health and Wellbeing, Goal 5 – Gender Equity and Goal 8 – Decent Work and Economic Growth. Specific targets of interest include: Target 1.2 – reduce at least by half the proportion of men, women and children of all ages living in poverty; Target 3.2 – ending preventable deaths of newborns and children under 5 years of age; Target 3.6 – halving the number of deaths and injuries because of road traffic accidents; Target 3.8 – achieving universal health coverage; Target 5.3 – eliminate all harmful practices, such as female genital mutilation; and Target 8.5 – achieving full and productive employment and decent work for all women and men. Ideally research in children's surgery should align with these goals to be most impactful from a public health perspective.

5. Price R, Makasa E, Hollands M. World Health Assembly Resolution WHA68.15: 'Strengthening Emergency and Essential Surgical Care and Anesthesia as a Component of Universal Health Coverage'-Addressing the Public Health Gaps Arising from Lack of Safe, Affordable and Accessible Surgical and Anesthetic Services. World J Surg 2015; 39:2115–2125.
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This is the first publication describing the GICS process and outputs and the outline for optimal resource guidelines for children's surgical care at all levels of the healthcare system. The Optimal Resources for Children's Surgical Care document is the first comprehensive set of guidelines specific to children's surgery.

9. Global Initiative for Children's Surgery (GICS) Collaborators. Optimal resources for children's surgical care. World J Surg 2018. (in press).
10. ■ Burssa D, Teshome A, Iverson K, *et al.* Safe surgery for all: early lessons from implementing a national government-driven surgical plan in Ethiopia. World J Surg 2017; 41:3038–3045.

This is an example of the design and implementation of a national surgical, obstetric and anesthesia plan (NSOAP), many of which are being developed globally. Tools exist to integrate children's surgery into this process, and many of the plans that have been developed in the recent years are looking for funding sources.

11. ■ Shiffman J. Four challenges that global health networks face. Int J Health Policy Manag 2017; 6:183–189.

In comparing global surgery to other global health challenges, key barriers to generate political priority for surgery include problem definition, positioning, coalition building and governance.

12. Katz MG, Price RR, Nunez JM. Local research catalyzes national surgical planning comment on 'Global Surgery - Informing National Strategies for Scaling Up Surgery in Sub-Saharan Africa'. Int J Health Policy Manage 2018; 7:1058–1060.
13. ■ Roy N. Global surgery: a view from the south. J Pediatr Surg 2017; 52: 203–206.

Here, common pitfalls of HIC providers who seek to provide aid to LMICs are highlighted. The timing and goals of direct provision of surgical care is often determined by HIC provider preference, rather than actual need in LMICs. HIC providers often lack the skill sets necessary to provide optimal care in the resource-constrained setting. Priorities moving forward should focus on building the surgical workforce in LMICs and infrastructure development.

14. Leodoro BM, Beasley SW, Maoate K. Establishing pediatric surgical services in emerging countries: what the first world can learn from Vanuatu. J Pediatr Surg 2015; 50:829–832.
15. ■■ Mock C, Debas H, Balch CM, *et al.* Global surgery: effective involvement of US Academic Surgery: report of the American Surgical Association Working Group on Global Surgery. Ann Surg 2018; 268:557–563.

This is a consensus statement on how to address the high burden of surgical disease worldwide through the tools of academic surgery: clinical care, training and capacity building, research and advocacy. There are substantial benefits to both United States and LMIC surgeons when engaging in ethical, long-term partnerships.

16. ■ Butler M, Drum E, Evans FM, *et al.* Guidelines and checklists for short-term missions in global pediatric surgery: recommendations from the American Academy of Pediatrics Delivery of Surgical Care Global Health Subcommittee, American Pediatric Surgical Association Global Pediatric Surgery Committee, Society for Pediatric Anesthesia Committee on International Education and Service, and American Pediatric Surgical Nurses Association, Inc. Global Health Special Interest Group. Paediatr Anaesth 2018; 28:392–410.

Consensus recommendations from multiple American organizations including trip preparation, patient selection, and perioperative care with health, safety and logistics considerations for short-term mission trips. With adequate preparation, short-term trips can aid in capacity building and the development of long-term partnerships, especially relevant as short-term missions remain the most preferred mode of global engagement by most pediatric surgeons in high-income countries.

17. ■ Lakhoo K, Youngson GG. Global paediatric surgery: meeting an unmet need-the response of the British Association of Paediatric Surgeons. Pediatr Surg Int 2018; 34:1369–1373.

The British Association of Paediatric Surgeons has helped to develop leaders in pediatric surgery from LMICs, share educational programs, and support trainees to improve delivery of surgical care for children globally. This is an example of sustainable engagement between HICs and LMICs and as such should serve as a model for other organizations.

18. ■ Baird R, Pandya K, Lal DR, *et al.* Regarding global pediatric surgery training opportunities. J Pediatr Surg 2018; 53:1256–1258.

Set of global commitments to pediatric surgery from the Canadian Association of Pediatric surgeons that has been adopted by many regional and international organizations. This letter also highlights the positive impacts of exposure to global surgery for trainees in HICs which has recently been a topic of debate among American training programs.

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21. ■ Kempthorne P, Morriss WW, Mellin-Olsen J, Gore-Booth J. The WFSA Global Anesthesia Workforce Survey. Anesth Analg 2017; 125:981–990.

This is the first comprehensive survey of anesthesia providers worldwide, representing 97.5% of the world's population. Anesthesia workforce densities were very low in many countries, with 77 countries reporting a physician anesthesia provider density less than 5 per 100 000 population. Physician and nonphysician anesthesia provider density was lowest in LICs.

22. ■ Davies JI, Vreede E, Onajin-Obembe B, Morriss WW. What is the minimum number of specialist anaesthetists needed in low-income and middle-income countries? BMJ Glob Health 2018; 3:e001005.

Using maternal mortality ratio as a proxy for reasonable standard of healthcare, it was estimated that LMICs should have a threshold of four physician anesthesia providers per 100 000 population, creating a discrete target for nations to consider when developing their national surgical plans.

23. ■ Krishnaswami S, Nwomeh BC, Ameh EA. The pediatric surgery workforce in low- and middle-income countries: problems and priorities. Semin Pediatr Surg 2016; 25:32–42.

This study highlights the significant disparities in the density of pediatric surgeons worldwide – HICs, such as the United States have an overall surplus with double the number of pediatric surgeons needed, whereas most LMICs had a deficit, including some countries with no pediatric surgeon. Factors contributing to this deficit include lack of funding, lack of training centers and limited trainee interest.

24. ■ Toobaie A, Emil S, Ozgediz D, *et al.* Pediatric surgical capacity in Africa: current status and future needs. J Pediatr Surg 2017; 52:843–848.

This is a wide reaching survey of African pediatric surgery providers highlighting the extensive challenges to providing pediatric surgery. Barriers were widespread, including lack of material resources and infrastructure as well as long waitlists. It is important to note that collaborative professional development with HICs, rather than direct clinical care, was of high priority for LIC providers.

25. Dell A, Numanoglu A, Arnold M, Rode H. Pediatric surgeon density in South Africa. J Pediatr Surg 2018; 53:2065–2071.
26. Derbew M. Pediatric surgery in Eastern Africa: the unmet need. J Pediatr Surg 2018; 54:21–26.
27. Dewan MC, Baticulon RE, Rattani A, Johnston JM Jr, *et al.* Pediatric neurosurgical workforce, access to care, equipment and training needs worldwide. Neurosurg Focus 2018; 45:E13.

28. Butler EK, Tran TM, Nagarajan N, *et al.* Epidemiology of pediatric surgical ■■ needs in low-income countries. PLoS One 2017; 12:e0170968.

This was a cross-continental, population-based study examining the epidemiology of pediatric surgical needs in four LICs (Rwanda, Sierra Leone, Nepal and Uganda). It found that 19% of children have a surgical need, and that for children who require surgery, 62% of the need is unmet. Abdominal conditions were the least likely to be treated. Population-based studies, such as this are essential for characterizing the burden on children's surgical conditions globally.

29. Burgos CM, Bolkan HA, Bash-Taqi D, *et al.* The met needs for pediatric ■ surgical conditions in Sierra Leone: estimating the gap. World J Surg 2018; 42:652–665.

A nationwide facility-based survey that estimated the volume and unmet need for pediatric surgery in Sierra Leone. Inguinal hernia was the most common surgical procedure. The unmet need of inguinal hernia was 88%. Similar nationwide studies in other LMICs would be informative and allow for equitable resource allocation when developing national surgical plans.

30. Yousef Y, Lee A, Ayele F, Poenaru D. Delayed access to care and unmet ■■ burden of pediaric surgical disease in resource-constrained African countries. J Pediatr Surg 2018. [Epub ahead of print]

There is a significant backlog of surgical conditions worldwide, however, not much is known about which elective procedures are most needed. A review of data from multiple African countries revealed that the most pronounced backlog was for cryptorchidism in Nigeria and hypospadias in Ethiopia.

31. Pilkington M, Situma M, Winthrop A, Poenaru D. Quantifying delays and self- ■ identified barriers to timely access to pediatric surgery at Mbarara Regional Referral Hospital, Uganda. J Pediatr Surg 2018; 53:1073–1079.

A hospital-based survey examining the '3 delays' model (decision to seek care, reaching care, receiving care) identified care-seeking delays as the most prominent barrier to accessing pediatric surgery. This can be used to inform effective outreach and advocacy strategies.

32. Gajewski J, Bijlmakers L, Mwapasa G, *et al.* I think we are going to leave these ■ cases. Obstacles to surgery in rural Malawi: a qualitative study of provider perspectives. Trop Med Int Health 2018; 23:1141–1147.

The barriers to providing safe surgery in limited-resource settings are vast and multifactorial. Qualitative interviews of surgical providers in Malawi identified that in addition to infrastructure and material limitations, the motivation of surgical teams was a potential barrier to performing operations. Scale-up of the surgical workforce and additional measures to reduce burnout should serve as targets for future intervention.

33. Scott JW, Lin Y, Ntakiyiruta G, Mutabazi ZA, *et al.* Contextual challenges to ■■ safe surgery in a resource-limited setting: a multicenter, multiprofessional qualitative study. Ann Surg 2018; 267:461–467.

A multiinstitutional study in Rwanda probed a variety of surgical providers to examine the barriers to surgical care. Resource variability, rather than lack of resources, is underlying many of the challenges to providing safe surgical care in LMICs, and has led to the use of the term 'resource-variable' rather than simply 'resource-limited' as a more accurate way to portray the situation.

34. Raykar NP, Yorlets RR, Liu C, *et al.* The how project: understanding ■ contextual challenges to global surgical care provision in low-resource settings. BMJ Glob Health 2016; 1:e000075.

The LCoGS multicountry 'How Project' examined challenges to providing surgical care in LMICs and identified four essential themes: poverty impedes patients' access to surgical care; lack of infrastructure impedes providers from delivering quality care; policies and regulations are often not contextually appropriate; providers are resilient and work with what they have. This framework can be used for future studies.

35. Albutt K, Yorlets RR, Punchak M, *et al.* You pray to your god: a qualitative analysis of challenges in the provision of safe, timely, and affordable surgical care in Uganda. PLoS One 2018; 13:e0195986.

36. Albutt K, Punchak M, Kayima P, *et al.* Access to safe, timely, and affordable surgical care in Uganda: a stratified randomized evaluation of nationwide public sector surgical capacity and core surgical indicators. World J Surg 2018; 42:2303–2313.

37. Budde-Schwartzman B. Children's surgery in rural Ghana. GICS III 2018; Vellore, India. [Abstract].

38. Galukande M, Kituuka O, Elobu E, *et al.* Improving surgical access in rural Africa through a surgical camp model. Surg Res Pract 2016; 2016:9021945.

39. Holterman A, Barton, G., Deshpande G, *et al.* Pediatric Acute Surgical Support (PASS) - Initial Assessment of the Multimodal Course for Teaching the Initial Response to Acute Pediatric Surgical Emergencies to Medical Professionals in a Developing Country. American Pediatric Surgical Association Annual Meeting; 2018; Palm Desert, California [Abstract].

40. Ruzgar NCM, Ozgediz D, Kisa P. Pediatric Emergency surgical care: evaluating need and value of a rural provider course in Uganda. American College of Surgeons Clinical Congress; 2018, Boston, MA, USA.

41. Royal College of Surgeons – Christian Medical College Pilot June 2017. Available at: http://www.globalchildrenssurgery.org/pertnerships/. [Accessed 7 December 2018]

42. Canarie MF, Shenoi AN. Teaching the principles of pediatric critical care to non-intensivists in resource limited settings: challenges and opportunities. Front Pediatr 2018; 6:44.

43. Federspiel F, Mukhopadhyay S, Milsom PJ, *et al.* Global surgical, obstetric, and anesthetic task shifting: a systematic literature review. Surgery 2018; 164:553–558.

44. Lantz A, Holmer H, Finlayson S, *et al.* International migration of surgeons, anaesthesiologists, and obstetricians. Lancet Glob Health 2015; 3(Suppl 2):S11–S12.

45. Van Essen C, Steffes BC, Thelander K, *et al.* Increasing and retaining African ■■ surgeons working in rural hospitals: an analysis of PAACS surgeons with twenty-year program follow-up. World J Surg 2018; 43:75–86.

This evaluation of 20 years of experience with PAACS training programs in Africa demonstrated a high retention rate posttraining with 100% of surgeons still practicing in Africa and 79% practicing in their home country. Some programs train general surgeons in pediatric surgery, and several sites have pediatric surgery fellowship programs. This data emphasizes the importance of local training to minimize brain drain.

46. Kaseje N, Jenny H, Jeudy AP, *et al.* Pediatric surgical capacity building - a ■ pathway to improving access to pediatric surgical care in Haiti. J Pediatr Surg 2018; 53:298–301.

A pediatric surgical program among general surgery residents has resulted in increased pediatric surgical care provision, increased surgical trainee knowledge and skill and increased research capacity. This demonstrated feasibility of such a program in a resource-constrained environment.

47. Okoye MT, Nguyen ET, Kushner AL, *et al.* Can economic performance predict pediatric surgical capacity in sub-Saharan Africa? World J Surg 2016; 40:1336–1343.

48. Cairo SB, Kalisya LM, Bigabwa R, *et al.* Characterizing pediatric surgical capacity in the Eastern Democratic Republic of Congo: results of a pilot study. Pediatr Surg Int 2018; 34:343–351.

49. Cunningham D. KidsOR. COSECSA AGM, Graduation Ceremony & Scientific Conference; 2018; Kigali, Rwanda.

50. Wood G. BBC KidsOR Tanzania 2018. Available at: https://vimeo.com/290927951. [Accessed 7 December 2018]

51. Yap A, Muzira A, Cheung M, *et al.* A cost-effectiveness analysis of a pediatric ■ operating room in Uganda. Surgery 2018; 164:953–959.

An in-depth analysis of a dedicated pediatric operating room in Uganda. The OR averted 6447 disability-adjusted life-years per year with a net economic benefit of $5 336 920 for a year of operation, or $16 371 per patient, reinforcing the notion that directly building infrastructure is cost effective with substantial economic benefit.

52. Shrime MG, Dare A, Alkire BC, Meara JG. A global country-level comparison ■ of the financial burden of surgery. Br J Surg 2016; 103:1453–1461.

A modelling study examining financial burden of surgery using publicly available data. Four measures of financial catastrophe were examined. Catastrophic expenditure was defined as when out-of-pocket cost of the service is greater than 10% of the family's presurgery income.

53. Bijlmakers L, Cornelissen D, Cheelo M, *et al.* The cost of providing and scaling up surgery: a comparison of a district hospital and a referral hospital in Zambia. Health Policy Plan 2018; 33:1055–1064.

54. Cardarelli M, Vaikunth S, Mills K, *et al.* Cost-effectiveness of humanitarian ■ pediatric cardiac surgery programs in low- and middle-income countries. JAMA Network Open 2018; 1:e184707.

Short-term pediatric cardiac surgery 'missions' are cost effective with $171 per disability-adjusted life-year averted. Each survivor potentially gained 39.9 disability-adjusted life-years averted, 3.5 years of schooling, and 160 000 USD in gross national income per capita.

55. Banu T, Chowdhury TK, Aziz TT, *et al.* Cost incurred by the family for surgery in ■ their children: a Bangladesh perspective. World J Surg 2018; 42:3841–3848.

This cross sectional study in Bangladesh showed that families of children undergoing inguinal hernia repair had higher medical compared with nonmedical costs in private hospitals and that surgery is less expensive overall in public hospitals. This provides important insight into expenditure for families of children undergoing surgery in LMICs and highlights the need for further studies to better characterize financial protection for children's surgery worldwide.

56. Yap A, Cheung M, Kakembo N, *et al.* From procedure to poverty: out-of-pocket and catastrophic expenditure for pediatric surgery in Uganda. J Surg Res 2018; 232:484–491.

57. MacKinnon N, St-Louis E, Yousef Y, *et al.* Out-of-pocket and catastrophic expenses incurred by seeking pediatric and adult surgical care at a public, tertiary care centre in Uganda. World J Surg 2018; 42:3520–3527.

58. Sileshi B, Newton MW, Kiptanui J, *et al.* Monitoring anesthesia care delivery ■■ and perioperative mortality in Kenya utilizing a provider-driven novel data collection tool. Anesthesiology 2017; 127:250–271.

A Kenyan study examined perioperative 7-day mortality, demonstrating the feasibility of implementing near real-time, point-of-care collection of key perioperative anesthesia and surgical data in a low-resource setting. General surgery, neurosurgery and emergency surgery had higher perioperative mortality rates than caesarian section, whereas pediatric status was not associated with higher mortality at any of the time points observed.

59. Biccard BM, Madiba TE, Kluyts HL, *et al.* Perioperative patient outcomes in ■■ the African Surgical Outcomes Study: a 7-day prospective observational cohort study. Lancet 2018; 391:1589–1598.

A prospective observational cohort tracked 7-day outcomes of patients undergoing inpatient surgery in 25 African countries. Patients undergoing surgery in Africa are younger than the global average. Despite a lower risk profile and lower perioperative complication rates, patients were twice as likely to die, compared with HIC counterparts. Though the ASOS did not include pediatric patients, it is the most comprehensive multicenter study of perioperative outcomes to date.

60. GlobalSurg Collaborative. Mortality of emergency abdominal surgery in high-, middle- and low-income countries. Br J Surg 2016; 103:971–988.

61. ■■ GlobalSurg Collaborative. Determinants of morbidity and mortality following emergency abdominal surgery in children in low-income and middle-income countries. BMJ Glob Health 2016; 1:e000091.

Children in low Human Development Index (HDI) countries are more likely to have a perforated viscus and have a higher rate of emergency surgery for congenital anomalies than children in high HDI countries. Children in low HDI countries also have higher mortality and complication rates. This study reinforces the need for scale-up of safe children's surgery in LMICs.

62. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. Lancet Infect Dis 2018; 18:516–525.

63. GlobalSurg Collaborative. Determining the worldwide epidemiology of surgical site infections after gastrointestinal resection surgery: protocol for a multicentre, international, prospective cohort study (GlobalSurg 2). BMJ Open 2017; 7:e012150.

64. GlobalSurg Collaborative. Management and outcomes following surgery for gastrointestinal typhoid: an international, prospective, multicentre cohort study. World J Surg 2018; 42:3179–3188.

65. Wright, N. Management and outcomes of congenital anomalies in low-, middle- and high-income countries. ongoing. ClinicalTrials.gov Identifier: NCT03666767

66. Mullapudi B, Grabski D, Ameh E, *et al.* Estimates of number of children and adolescents without access to surgical care. Bull World Health Org 2019; 97:; Available at: https://www.who.int/bulletin/online_first/18-216028.pdf?ua=1.

67. ■ Poenaru D, Seyi-Olajide JO. Developing metrics to define progress in children's surgery. World J Surg 2018. [Epub ahead of print]

Defines the need to expand many metrics used to evaluate global surgery to specifically address pediatric surgical conditions – including burden of disease, perioperative outcomes, backlog, effective coverage, cost effectiveness analysis and the LCoGS indicators.

68. Yousef Y, St-Louis E, Baird R, *et al.* A systematic review of capacity assessment tools in pediatric surgery: Global Assessment in Pediatric Surgery (GAPS) Phase I. J Pediatr Surg 2019. [Epub ahead of print]

69. Sullivan R, Alatise OI, Anderson BO, *et al.* Global cancer surgery: delivering safe, affordable, and timely cancer surgery. Lancet Oncol 2015; 16:1193–1224.

70. Gupta S, Howard S, Hunger S, *et al.* Treating childhood cancers in low- and middle-income countries. In: Gelband H, Jha P, Sankaranarayanan R, Horton S, editors. Disease Control Priorities, third edition. Volume 3, Cancer. Washington, DC: World Bank; 2015.

71. World Health Organization. Cancer in children 2018. Available at: https://www.who.int/news-room/fact-sheets/detail/cancer-in-children. [Accessed 12 December 2018]

72. Howard SC, Davidson A, Luna-Fineman S, *et al.* A framework to develop adapted treatment regimens to manage pediatric cancer in low- and middle-income countries: the Pediatric Oncology in Developing Countries (PODC) Committee of the International Pediatric Oncology Society (SIOP). Pediatr Blood Cancer 2017; 64(Suppl 5).

73. Arora RS, Challinor JM, Howard SC, Israels T. Improving care for children with cancer in low- and middle-income countries–a SIOP PODC initiative. Pediatr Blood Cancer 2016; 63:387–391.

74. ■■ Israels T, Paintsil V, Nyirenda D, *et al.* Improved outcome at end of treatment in the collaborative Wilms tumour Africa project. Pediatr Blood Cancer 2018; 65:e26945.

The Collaborative Wilms Tumour (WT) Africa Project has implemented an adapted Wilms tumour treatment guideline in sub-Saharan Africa as a multicenter prospective clinical trial. In centers that adopted the SIOP protocol, there was an increase in disease free survival at the end of treatment, decrease in treatment abandonment and decrease in mortality during treatment. This approach emphasizes the need to adapt cancer treatment protocols to LMICs.

75. Carter NH, Avery AH, Libes J, *et al.* Pediatric solid tumors in resource-constrained settings: a review of available evidence on management, outcomes, and barriers to care. Children (Basel) 2018; 5:; pii: E143.

76. ■ Hadley GP, van Heerden J. High-risk neuroblastoma in a sub-Saharan African country: telling it like it is. Trop Doct 2017; 47:370–374.

There are significant disparities in outcomes for neuroblastoma in sub-Saharan Africa compared with other HICs, with 4% overall survival at 3 years and 73% of cases presenting as stage 4 disease. Studies on the epidemiology and treatment outcomes for neuroblastoma in LMICs are scarce and warrant further investigation.

77. Huang Y, Wu Y, Schwebel DC, *et al.* Disparities in under-five child injury mortality between developing and developed countries: 1990-2013. Int J Environ Res Public Health 2016; 13:pii: E653.

78. Center for Disease Control. Leading causes of death by age group 2016. Available at: https://www.cdc.gov/injury/wisqars/LeadingCauses.html. [Accessed 18 December 2018]

79. World Health Organization. Injury: a leading cause of the global burden of disease. Available at: http://www.who.int/iris/handle/10665/66160. [Accessed 18 December 2018]

80. ■■ Bradshaw CJ, Bandi AS, Muktar Z, *et al.* International study of the epidemiology of paediatric trauma: PAPSA research study. World J Surg 2018; 42:1885–1894.

This was a cross sectional examination of pediatric surgical admissions in HICs and LMICs over a 31-day period. Injury was the most common cause of admission overall. Fracture fixation and wound management made up nearly 70% of surgical interventions required in LMICs compared with 20.6% in HICs. The most common cause of trauma admissions were road traffic accidents and falls. This highlights the high burden of pediatric trauma and emphasizes the need for prevention and capacity building strategies.

81. St-Louis E, Bracco D, Hanley J, *et al.* Development and validation of a new pediatric resuscitation and trauma outcome (PRESTO) model using the U.S. National Trauma Data Bank. J Pediatr Surg 2017. [Epub ahead of print]

82. Sengoelge M, El-Khatib Z, Laflamme L. The global burden of child burn injuries in light of country level economic development and income inequality. Prev Med Rep 2017; 6:115–120.

83. Rybarczyk MM, Schafer JM, Elm CM, Sarvepalli S, *et al.* A systematic review of burn injuries in low- and middle-income countries: epidemiology in the WHO-defined African Region. Afr J Emerg Med 2017; 7:30–37.

84. Sanyang E, Peek-Asa C, Young T, Fuortes L. Child supervision and burn outcome among admitted patients at major trauma hospitals in the Gambia. Int J Environ Res Public Health 2017; 14:; pii: E856.

85. ■ El Ezzi O, Dolci M, Dufour C, *et al.* Surgery on burns sequelae in developing countries. Ann Burns Fire Disasters 2017; 30:47–51.

In a cohort of children who suffered burn injury from Benin and Togo, children who underwent skin grafting for burn injuries had high rates of hypertrophic scarring (47%) and retractions (24%). This highlights the need for comprehensive, multidisciplinary postoperative burn rehabilitation to optimize outcomes.

86. Jagnoor J, Lukaszyk C, Fraser S, *et al.* Rehabilitation practices for burn survivors in low- and middle-income countries: a literature review. Burns 2018; 44:1052–1064.

87. Ankomah J, Stewart BT, Oppong-Nketia V, *et al.* Strategic assessment of the availability of pediatric trauma care equipment, technology and supplies in Ghana. J Pediatr Surg 2015; 50:1922–1927.

88. ■ Kiragu AW, Dunlop SJ, Mwarumba N, *et al.* Pediatric trauma care in low resource settings: challenges, opportunities, and solutions. Front Pediatr 2018; 6:155.

This review highlights the large burden of pediatric trauma in LMICs. Moving forward, it is essential to focus on injury prevention, and develop regional centers of excellence to lower trauma-related morbidity and mortality globally.

89. Ogunrinde G. Emergency pediatric care in resource-constrained settings. Sub-Saharan Afr J Med 2017; 4:1.

90. ■ Shilkofski N, Crichlow A, Rice J, *et al.* A standardized needs assessment tool to inform the curriculum development process for pediatric resuscitation simulation-based education in resource-limited settings. Front Pediatr 2018; 6:37.

This needs assessment showed that many providers staffing emergency departments lack training in basic resuscitation skills, such as CPR and airway management, which could serve as targets for future educational interventions.

91. ■ Alves K, Penny N, Kobusingye O, *et al.* Paediatric musculoskeletal disease in Kumi District, Uganda: a cross-sectional survey. Int Orthop 2018; 42:1967–1973.

A recent audit of pediatric admissions for musculoskeletal conditions in Uganda found that gluteal fibrosis, musculoskeletal infections and angular knee deformities were responsible for a significant portion of surgical burden. Data on optimal treatment strategies and outcomes for many of these conditions is lacking and warrants further investigation.

92. ■ Owen RM, Capper B, Lavy C. Clubfoot treatment in 2015: a global perspective. BMJ Glob Health 2018; 3:e000852.

This survey of clubfoot treatment in multiple LMICs since 2006 showed that only 11% of children had access to Ponseti treatment in 2015. This is, however, an increase from prior years, highlighting the barriers to providing treatment and can inform further scale-up strategies.

93. Drew S, Gooberman-Hill R, Lavy C. What factors impact on the implementation of clubfoot treatment services in low and middle-income countries?: a narrative synthesis of existing qualitative studies. BMC Musculoskelet Disord 2018; 19:72.

94. ■ Vaca SD, Warstadt NM, Ngayomela IH, *et al.* Evaluation of an e-learning course for clubfoot treatment in Tanzania: a multicenter study. J Med Educ Curric Dev 2018; 5:2382120518771913.

This study highlights the successful implementation of an electronic tool to teach the Ponseti treatment to multiple cadres of clinicians. This can potentially serve as a model for widespread scale-up of training in this technique and other surgical interventions.

95. Grimes CE, Holmer H, Maraka J, *et al.* Cost-effectiveness of club-foot treatment in low-income and middle-income countries by the Ponseti method. BMJ Glob Health 2016; 1:e000023.

96. Malhotra R, Mohapatra A, Arora G, *et al.* Ponseti technique for the management of congenital talipes equinovarus in a rural set-up in india: experience of 356 patients. Children (Basel) 2018; 5.

97. Muir RT, Wang S, Warf BC. Global surgery for pediatric hydrocephalus in the developing world: a review of the history, challenges, and future directions. Neurosurg Focus 2016; 41:E11.

98. ■■ Kulkarni AV, Schiff SJ, Mbabazi-Kabachelor E, *et al.* Endoscopic treatment versus shunting for infant hydrocephalus in Uganda. N Engl J Med 2017; 377:2456–2464.

This was a prospective randomized controlled trial in Uganda, which demonstrated that there was no difference in the cognitive outcomes of endoscopic third ventriculostomy with choroid plexus cauterization versus ventriculoperitoneal shunting for postinfectious hydrocephalous. This promotes the use of endoscopic third ventriculostomy with choroid plexus cauterization in the resource limited setting as it is less subject to treatment failure.

99. ■ Jenny HE, Massenburg BB, Saluja S, *et al.* Efficacy of facilitated capacity building in providing cleft lip and palate care in low- and middle-income countries. J Craniofac Surg 2017; 28:1737–1741.

Long term partnership between a non-governmental organization and multiple LMICs led to an increasing number and complexity of procedures, reduced wait times and improved patient follow-up. This demonstrates the feasibility, benefits and sustainability of such partnerships.

100. Corlew DS, Alkire BC, Poenaru D, *et al.* Economic valuation of the impact of a large surgical charity using the value of lost welfare approach. BMJ Glob Health 2016; 1:e000059.

101. GBD 2015 Child Mortality Collaborators. Global, regional, national, and selected subnational levels of stillbirths, neonatal, infant, and under-5 mortality, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016; 388:1725–1774.

102. Wright NJ, Anderson JE, Ozgediz D, *et al.* Addressing paediatric surgical care on World Birth Defects Day. Lancet 2018; 391:1019.

103. World Health Organization. Congenital anomalies fact sheet. Available at: https://www.who.int/news-room/fact-sheets/detail/congenital-anomalies. [Accessed 18 December 2018]

104. ■ Poenaru D, Pemberton J, Frankfurter C, *et al.* Establishing disability weights for congenital pediatric surgical conditions: a multimodal approach. Popul Health Metr 2017; 15:8.

There was previously a lack of disability-weights specific for congenital pediatric surgical conditions. Using a multimodal and multinational approach for a variety of conditions, this will help in better characterizing the burden of pediatric surgical conditions moving forward.

105. Singh AK, Kumar R, Mishra CK, *et al.* Moving from survival to healthy survival through child health screening and early intervention services under Rashtriya Bal Swasthya Karyakram (RBSK). Indian J Pediatr 2015; 82: 1012–1018.

106. Shah M, Gallaher J, Msiska N, *et al.* Pediatric intestinal obstruction in Malawi: characteristics and outcomes. Am J Surg 2016; 211:722–726.

107. Govender S, Wiersma R. Delayed diagnosis of anorectal malformations (ARM): causes and consequences in a resource-constrained environment. Pediatr Surg Int 2016; 32:369–375.

108. Mohammed M, Amezene T, Tamirat M. Intestinal obstruction in early neonatal period: a 3-year review of admitted cases from a tertiary hospital in Ethiopia. Ethiop J Health Sci 2017; 27:393–400.

109. Lawal TA, Olulana DI, Ogundoyin OO. Spectrum of colorectal surgery operations performed in a single paediatric surgery unit in sub-Saharan Africa. Afr J Paediatr Surg 2014; 11:128–131.

110. Adamou H, Magagi IA, Habou O, *et al.* Acute mechanical intestinal obstruction in children at zinder national hospital, Niger: aetiologies and prognosis. Afr J Paediatr Surg 2017; 14:49–52.

111. Das K, Mohanty S. Hirschsprung disease - current diagnosis and management. Indian J Pediatr 2017; 84:618–623.

112. Ouladsaiad M. How to manage a late diagnosed Hirschsprung's disease. Afr J Paediatr Surg 2016; 13:82–87.

113. ■ Muzira A, Kakembo N, Kisa P, *et al.* The socioeconomic impact of a pediatric ostomy in Uganda: a pilot study. Pediatr Surg Int 2018; 34:457–466.

A survey of caregivers for children with ostomies in Uganda demonstrated that pediatric ostomy has significant social and economic consequences for children and their families. Often, the caregiver's spouse will leave the family and they will lose employment or wages. This study highlights the burden of surgical conditions beyond what is captured in DALYs.

114. Menon P, Rao KLN, Sinha AK, *et al.* Anorectal malformations in Males: pros and cons of neonatal versus staged reconstruction for high and intermediate varieties. J Indian Assoc Pediatr Surg 2017; 22:83–86.

115. ■ Liu MB, Huong TB, Hoang X, *et al.* Biliary atresia in Vietnam: management and the burden of disease. Surgery 2017; 161:533–537.

Patients with biliary atresia in Vietnam have a higher mortality rate than their counterparts in HICs, likely because of delayed presentation and unavailability of liver transplant services. This emphasizes the need for more widespread screening programs to minimize delayed presentation.

116. Ramachandran P, Safwan M, Reddy MS, Rela M. Recent trends in the diagnosis and management of biliary atresia in developing countries. Indian Pediatr 2015; 52:871–879.

117. Witt M, van Wessel DBE, de Kleine RHJ, *et al.*, NeSBAR (Netherlands Study group on Biliary Atresia Registry). Prognosis of biliary atresia after 2-year survival with native liver: a nationwide cohort analysis. J Pediatr Gastroenterol Nutr 2018; 67:689–694.

118. Mogul D, Zhou M, Intihar P, *et al.* Cost-effective analysis of screening for biliary atresia with the stool color card. J Pediatr Gastroenterol Nutr 2015; 60:91–98.

119. Chauhan VS, Niranjan A. Post pubertal cryptorchidism in developing countries: fertility outcomes and challenges in management. Indian J Public Health Res Dev 2015; 6:93–97.

120. Adesanya OA, Ademuyiwa AO, Elebute OA, *et al.* The undescended testes in children: a prospective epidemiological study. East Central Afr J Surg 2013; 18:45–49.

121. ■ Ekwunife OH, Ugwu JO, Onwurah C, *et al.* Undescended testes: contemporary factors accounting for late presentation. Afr J Urol 2018; 24: 206–211.

Delayed presentation of cryptorchidism, which has implications for health and fertility, has been largely attributable to lack of awareness, in both parents and providers, about the condition. These can serve as targets for community educational interventions.

122. Ekwunife OH, Modekwe VI, Ugwu JO, Ugwunne CA. Early experience with laparoscopic management of nonpalpable undescended testes. Niger J Surg 2017; 23:115–118.

123. Osei-Nketiah S, Hesse AA, Appeadu-Mensah W, *et al.* Management of oesophageal atresia in a developing country: is primary repair forbidden? Afr J Paediatr Surg 2016; 13:114–119.

124. Cairo S, Kakembo N, Kisa P, *et al.* Disparity in access and outcomes for emergency neonatal surgery: intestinal atresia in Kampala, Uganda. Pediatr Surg Int 2017; 33:907–915.

125. ■ Rattan K, Singh J, Dalal P. Clinical profile and short-term outcome of neonates with esophageal atresia and tracheoesophageal fistula at tertiary care center in a developing country: a 25-year experience. J Clin Neonatol 2017; 6:225–230.

Mortality rates for esophageal atresia with or without tracheoesophageal fistula were noted to be high at 57% but had improved over the review period. Lack of NICU support was noted as a major contributor. Expansion of NICU care is an essential aspect of the scale-up of surgical services in LMICs.

126. ■ Hagander L, Kabir M, Chowdhury MZ, *et al.* Major neonatal surgery under local anesthesia: a cohort study from Bangladesh. World J Surg 2015; 39:953–960.

This is a report of a group in Bangladesh, who were able to safely perform major abdominal surgery, such as colostomy, laparotomy and anoplasty when safe anesthesia was unavailable. The use of local anesthesia should be considered when safe anesthesia is not available for urgent or emergent procedures.

127. Lipnick MS, Bulamba F, Ttendo S, Gelb AW. The need for a global perspective on task-sharing in anesthesia. Anesth Analg 2017; 125: 1049–1052.

128. Enright A, Newton M. Human resources in anesthesia: the road to 2030. Anesth Analg 2017; 125:734–736.

129. ■ Morriss WW, Milenovic MS, Evans FM. Education: the heart of the matter. Anesth Analg 2018; 126:1298–1304.

Educational programs are needed to increase anesthesia provider numbers, improve provider skill and knowledge, and develop future leaders and teachers. There have been a number of anesthesia educational interventions, including pediatric anesthesia fellowships, the SAFE KIDS course, an OR nursing course, and the Essential Pain Management course. The scale-up of such courses will help to mitigate the surgical and anesthesia workforce crisis facing many LMICs.

130. Situma M. Reducing gastroschisis mortality: a quality improvement initiative at a Ugandan pediatric surgery unit. Pan African Pediatric Surgery Association Meeting, 2018.

131. ■ Tongsin A, Niramis R, Buranakitjaroen V, *et al.* Staged closure of gastroschisis using alexis wound retractor and protector. World J Surg Surg Res 2018; 1:1036.

Gastroschisis has a strikingly high mortality rate in LICs. Low-cost alternatives to spring-loaded silos can be used to treat gastroschisis. It is essential to develop innovative, low-cost solutions, such as this to treat surgical conditions in resource-limited settings.

132. Ekot EA, Emordi VC, Osifo DO. Does omphalocele major undergo spontaneous closure? J Surg Case Rep 2017; 2017:rjx156.

133. Habou O, Adamou H, Magagi IA, *et al.* The conservative treatment of giant omphalocele by tanning with povidone iodine and aqueous 2% eosin solutions. Ann Pediatr Surg 2017; 13:125–128.

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In many LMICs, intussusception is treated exclusively with exploratory laparotomy and operative reduction with significant morbidity compared with high-income countries. An ultrasound-guided hydrostatic reduction protocol in Ethiopia led to successful reduction in 88.7% of cases, with only 23% of patients needing operative intervention at any point.

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