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# Providing paediatric surgery in low resource countries



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# Providing paediatric surgery in low resource countries

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**ABSTRACT**

**Title:** Providing paediatric surgery in low resource countries

**Authors:** Emma Bryce, BSc, MPH; Maíra Fedatto, BA, MSc, PhD; David Cunningham, BSc, LLD.

**Key words:** Surgical Systems Strengthening, Paediatric Surgery, Sustainable Development, Global Surgery

**Background:**

Successful health systems comprise good outcomes, accessibility and availability. Surgery is the service that cuts across many treatment scenarios, yet in low- and middle-income countries 90% of people cannot access it. Paediatric surgical services are not at the level they need to be, highlighting an increasing surgical burden on children's health globally with a human cost of morbidity and mortality. Achieving Universal Health Coverage and the Sustainable Development Goals will fail if surgical systems are not strengthened in low resource settings.

**Method:**

A review of current literature using the PubMed central database was done to describe the current paediatric surgical landscape. An internal implementation design review was conducted of a global health charity. This review outlines the current condition of paediatric surgery in low- and middle-income countries, the importance of addressing these systematic issues, and a global health charity's implementation design with focus on its health system strengthening approach.

**Results:**

To ensure that paediatric surgical interventions produce real impact on service delivery, contextual understanding and needs assessment are key. The building of paediatric surgical capacity should align to countries' priorities and wishes. Investing in local health workforce is essential to delivering quality services, supporting resilient health systems and provides integrated, people-centred health services. A competent surgical information system gives the local surgical workforce the tools needed to action evidence-driven decisions.

**Conclusion:**

Strengthening surgical services in a manner aligned to the WHO's fundamental health system building blocks, allows for sustainable and long-lasting change. Confronting bottlenecks that exist in surgical services and establishing multi-faceted development, will allow global, national and local surgical targets to be met.

**KEY MESSAGES**

- In 2018, global health charity Kids Operating Room was founded with a goal of ensuring every child has access to the surgery they need.
- The charity has a four-pillar approach to its work: provision of infrastructure and equipment, paediatric surgical workforce training, data and research, and advocating on behalf of children denied access to safe surgery.
- Contextual understanding and needs assessment are key to producing real impact on paediatric surgical services.
- Strengthening surgical services in a manner aligned to the WHO's fundamental health system building blocks, allows for sustainable and long-lasting change.
- Achieving Universal Health Coverage and the Sustainable Development Goals will fail if surgical systems are not strengthened in low resource settings.

## INTRODUCTION

When we think of a good health system, what do we think of? Most likely good outcomes, accessibility, availability and coverage. A system that is designed to take care of people and their families whatever comes their way. A system that provides a safe place for people to give birth to their children. A system that will treat broken bones, emergency appendicitis and that fearful cancer diagnosis if they ever arise.

Unfortunately, this is not the case in many health systems across the world. Surgery is the service that cuts across all these treatment scenarios and more, yet 5 billion people do not have access to it[1]. This figure is huge and is sometimes hard to contemplate, however it means that in low-income and lower-middle income countries, 90% of people cannot access the surgical care they need[2]. No method to reach the nearest surgical hospital to treat that emergency appendicitis. No availability to have that broken leg fixed before it heals in the wrong position.

This review will outline the current condition of paediatric surgery in low- and middle-income countries (LMICs), why it is important to address these systematic issues with haste, and how to do so with a health system strengthening approach.

## PAEDIATRIC SURGERY IN LOW RESOURCE COUNTRIES: THE CURRENT SITUATION

### The global necessity

While surgical care can save lives, prevent disabilities and engender economies, only 6% of all procedures undertaken worldwide annual take place in the poorest countries where approximately a third of the world's population lives[1]. Likewise, 87% of children who cannot access safe, affordable and timely surgical care are from LMICs[3], making paediatric surgery one of the most overlooked and underfunded areas in child health.

In LMICs across the world, half of their population are children[4]. This means that underdeveloped surgical services have a serious effect on children in these settings, despite its key role in averting death and disability. The LCoGS published in 2015 had an awakening effect on global surgery as a player in wider global health but lost an opportunity to ensure appropriate financial commitments nor to make it a priority – or one of them – in international debates.

### A global epidemiological shift

The global health landscape has been changing substantially in the past 20 years[5,6,7]. Countries in which communicable diseases were the main burden on population health are now seeing a progressively increasing shift to non-communicable diseases (NCDs)[8]. Conditions such as cancer, heart disease and congenital anomalies are causing morbidity and mortality, as well as injuries from road traffic collisions[9].

This epidemiological transition has led to a substantial burden to health care systems as NCDs are now the greatest cause of mortality worldwide with the highest burden falling on people living in poor resource settings[10]. While this epidemiological shift has increased the demand for surgical and anaesthesia care, both have been a neglected part of global health initiatives (GHIs), which although were created to target conditions that affect low-income countries, are still too much focused on transmissible diseases, mainly the so-called 'big three': Malaria, HIV/AIDS and Tuberculosis[11]. It's worth noting that GHIs have been vastly criticised for the misalignment between their own priorities/agenda and countries' needs[12].

**The burden of surgical disease**

Surgery is a cross-cutting discipline throughout disease areas. It is used as a method in the treatment of both communicable and non-communicable diseases, which can occur throughout a patient's lifetime. Congenital conditions, however, require surgery early in the child's life to decrease the likelihood of morbidity and mortality and have high incidence in many LMICs[13,14]. This surgical need is largely unmet in many countries across the world[15] and the evidence of this paints a worrying picture. A study published in 2019, estimated that 1.7 billion children globally do not have access to the basic, life-saving surgical care they need, which equates to 92.3% of children in lower-middle income countries and 97.7% of children in low-income countries[2]. The Lancet Commission on Global Surgery (LCoGS) estimates that 143 million additional surgical procedures are required annually, with 38% of these procedures necessary for children[1].

In the opening address to the inaugural 'The Lancet Commission on Global Surgery' meeting in 2014, Dr Jim Yong Kim identified surgery as an "indivisible, indispensable part of health care". This is even more apparent in 2022; the long-standing effects of the COVID-19 pandemic are seen in ever-growing elective waitlists in already overburdened health systems, a ripple effect from frequent surgical service shutdowns[16]. Surgical services are not at the level they need to be. The evidence provided points towards an increasing surgical burden on children's health in LMICs with the human cost of morbidity and mortality. Furthermore, we will fail to achieve Universal Health Coverage (UHC) and the Sustainable Development Goals (SDGs) if surgical systems are not strengthened systematically in low resource settings[17].

**BUILDING CAPACITY FOR PAEDIATRIC SURGERY: A HEALTH SYSTEMS STRENGHTENING APPROACH**

In 2018, the global health charity Kids Operating Room (KidsOR) was founded. The goal of the charity is to ensure that every child has access to timely and quality surgery when they need it. The charity has a four-pillar approach to its theory of change: paediatric surgery capacity building through infrastructure and equipment, paediatric surgical workforce training, paediatric surgery data and research, and paediatric surgery investment advocacy.

KidsOR's Theory of Change shows how the four directions of our work come together to produce short, mid and long-term change in paediatric surgery globally. The understanding of context in this intervention is key, and although a general context is shown, each country has its own contextual factors that are taken into consideration in the needs assessment process. Causal assumptions are complimentary factors that need to be in place for KidsOR's intervention to be efficient and impactful. KidsOR's Theory of Change can be found supplement to this article.

KidsOR's structure of intervention follows the World Health Organization recommendation[18] on how to improve the performance of health systems through the six fundamental 'building blocks'.

**1. Service Delivery**

To ensure that this paediatric surgical intervention produces real impact on service delivery, contextual understanding and needs assessment are key. KidsOR's strategy and the accompanying country action plans are developed through intensive research and extensive consultation with Ministries of Health, surgical colleges, front-line surgeons, relevant Non-Governmental Organisations and other local partners. The objective of this approach is to gain a detailed understanding of the current paediatric surgery landscape and collaborate with partners to identify gaps, respond to opportunities and meet specific needs. Establishing a situational analysis of each country is critical to understanding the structural barriers that exist to access surgery, including cultural and financial challenges. Conclusions regarding target hospitals and the placement of surgeons are shaped by local teams with KidsOR's support, to maximise impact and deliver the greatest return on investment.

As part of the planning stage of this intervention, needs assessment surveys are issued which collect fundamental information about the hospital, the current facilities, the staff and the patient population. The KidsOR design team, based in Scotland, draws up plans for the operating room and lists of potential equipment are discussed with the hospital. An integral part of this process is ensuring that the hospital and operating room infrastructure can sufficiently support the equipment that will be installed, for example, electricity and gas supplies[19]. This is comprehensively evaluated and completed collaboratively between the KidsOR Operations Team and the Hospital teams before each installation. This method of establishing paediatric surgical services ensures that projects are aligned to countries' priorities and wishes.

**2. Health Workforce**

An adequate, equitably distributed, skilled and motivated health workforce is not only key to achieving global goals such as UHC but in ensuring the successful and timely delivery of health services. However, there is chronic

under-investment in education and training[20] which is exacerbated by the phenomenon of 'brain drain' which sees those leaving their home countries for better training and employment opportunities elsewhere[21].

A well-trained and motivated health workforce leverages health, social, gender equality and economic benefits. Apart from that, scaling up surgical workforce can potentially prevent over 500,000 deaths annually of under-5 children[22]. However, the critical lack of surgical workforce mainly in LMICs has left billions of people without access to safe surgical care.

No country in Africa has reached the LCoGS's recommendation of 20 specialist surgeons, anaesthesiologists, and obstetricians (SAO) per 100 000 population[1,23]. The shortage of paediatric surgeons is concerning and to aggravate, the existing specialised surgeons are mostly concentrated in major cities[24]. To contribute to filling this gap, Kids Operating Room in partnership with local institutions such as the College of Surgeons of East, Central and Southern Africa (COSECSA) and the West African College of Surgeons (WACS) provide education grants to countries with scarce number of paediatric surgeons. Alongside local partners and stakeholders, priority countries, regions and hospitals are defined and consequently a specific number of scholarships are publicised each year, with candidates are shortlisted by the surgical colleges.

After either three or five-years of training, these surgeons will graduate as highly skilled, qualified paediatric surgeons, capable of delivering high-quality surgical services in deprived locations while, importantly, being able to understand and address local needs. Investing in the health workforce is not only essential to deliver quality services and support robust and resilient health systems, but provides integrated, people-centred health services as recommended by the WHO[25].

**3. Health Information**

Health information is the data and knowledge, captured from health systems, that allows health professionals to make decisions. Health information systems improve patient outcomes by efficiently capturing, analysing, disseminating and applying data to allow for evidence-driven use of information[26]. Health systems that have capacity for an established health information system can facilitate monitoring and evaluation (M&E) of interventions, support patient and facility management and encourage research, which enables health analyses and global reporting of health challenges and successes[27,28].

Tackling the crisis of surgical systems in LMICs requires health professionals that are experienced and understanding of the cultural, social, economic and political context of their country, as these influencing factors are key to strengthening surgical systems effectively[29]. A competent health information system allows for health professionals to enter the health research workforce and gives them the tools needed to action evidence-driven

decisions. Surgical data is lacking in LMICs, especially so in paediatric surgery[30,31], adding to the numerous barriers towards improving LMICs services. Therefore, the KidsOR Global Data Program was established.

The KidsOR Global Data Program is simultaneously a M&E project and a pillar of KidsOR's global intervention itself. The program provides data analysis capabilities and research capacity building at partner hospitals, working with the surgeons or primary researchers at each facility to develop paediatric surgical databases. The data collection survey tool includes many important data points such as age, diagnosis, type of surgeon performing the procedure, socioeconomic factors, trainee presence and occurrence of surgical site infection. All the data points, aside from socioeconomic, are regularly found in operating room logbooks that are commonly used to capture procedures occurring in partner hospitals. The paediatric surgical databases developed at each hospital are an integral tool to strengthen surgical systems, with uses in clinical quality improvement, diagnoses presentation analysis, surgical information exchange, impact analysis of any intervention programs implemented, training surgical research residents and for abstract presentation and publication.

**4. Access to medicines**

With sustainability and durability as a driving feature in KidsOR's intervention, our model involves providing long-term resources such as infrastructure, equipment and workforce training. Consumables are another important factor in operating rooms, such as personal protective equipment and medicines. The WHO developed an essential medicine list in 1977 and has maintained this on a biennial basis[32]. This list includes those that are integral to surgery and highlights that a resilient surgical system must have a stable and consistent supply of medicines to carry out surgical procedures. Common medicines used in anaesthesia and surgery are antibiotics, sedatives, analgesics, anxiolytics, numbing agents, inhalational gases, paralytics and intravenous agents[33].

Prior to a KidsOR dedicated operating room installation, initial assessments are collected from the partner hospital to inform of the current medical gas and anaesthetic agent availability at the facility. The anaesthetic equipment provided is tailored depending on the anaesthetic agents that the hospital has stable supplies of, with the hospital budget and long-term sustainability in mind. Oxygen concentrators are provided in the initial installation and a reputable local supplier of medical gases is confirmed with the hospital.

As part of the KidsOR data collection, data regarding the availability of anaesthesia and medicines is captured for each operation occurring in the installed theatre. These data are used to inform KidsOR of the efficiency of the anaesthesia equipment supplied and for wider research purposes, such as highlighting the importance of steadily available anaesthesia and surgical medicines to Ministries of Health and wider global health settings.

**5. Leadership and Governance**

Effective leadership and governance require collaboration, oversight and accountability while developing specific health policies. In 2015, the World Health Assembly (WHA) adopted the Resolution WHA68.15 "*Strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage*" to improve surgical care worldwide. Since then, countries have tried to incorporate robust surgical care policies to the wider health plans and in line with UHC efforts mainly through the development of national surgical, obstetric and anaesthesia plans (NSOAP).

The focus has been to understand gaps in both access and delivery of safe and timely surgical care, as well as setting targets and priorities, and establishing an implementation plan. This implementation plan includes a detailed budget and a M&E strategy. However, to achieve its full potential, an NSOAP requires both financial and political support from domestic and international actors. Truché et al. (2020) remind us that since a meaningful portion of health care funding in LMICs comes from external donors, mobilising domestic funds is not enough, even although it would enhance sustainability and accountability[34].

**6. Financing**

According to the WHO, a sustainable health financing system needs to ensure adequate funds not only to provide quality services but also to protect patients from financial catastrophe or impoverishment[35] in line with UHC endeavours of all individuals being able to receive health services without suffering financial hardship.

Despite vast evidence on the critical need for surgical care, on the health and economics benefits from scaling-up surgical services, no national government in LMICs nor external funding bodies have secured appropriate budget to strengthen health systems, which is unachievable without surgery and anesthesia. Inadequate financing, therefore, is a barrier as much as poor infrastructure and insufficient surgical workforce, yet earmarked funds to disease-specific interventions has been prioritised by donor countries and institutions for decades while ignoring the shift in the epidemiology of LMICs.

Investing in surgery is highly cost-effective as analyses conducted at two KidsOR sites show. In Uganda where essentially emergent, life-saving cases were served, the cost to save a year of healthy life was US dollars $6.4[36], while in Nigeria, where a pre-existing children's surgical service was already in place and focused more on elective cases, the cost was $77[37]. Likewise, the LCoGS pointed out the monetary benefits of enabling access to safe surgery as an investment of $350 billion until 2030 would avoid an estimated loss of $12.3 trillion in lost productivity and health care expenses[1].

However, it is not only about being cost-effective, due to its cross-cutting nature, surgery provides a solid foundation for entire health-care systems, including being more responsive and resilient for unexpected outbreak as witnessed with COVID-19 pandemic. Investing in surgery is investing in the entire health system and supporting pandemic preparedness.

**THE WAY FORWARD: TOWARDS UNIVERSAL HEALTH COVERAGE**

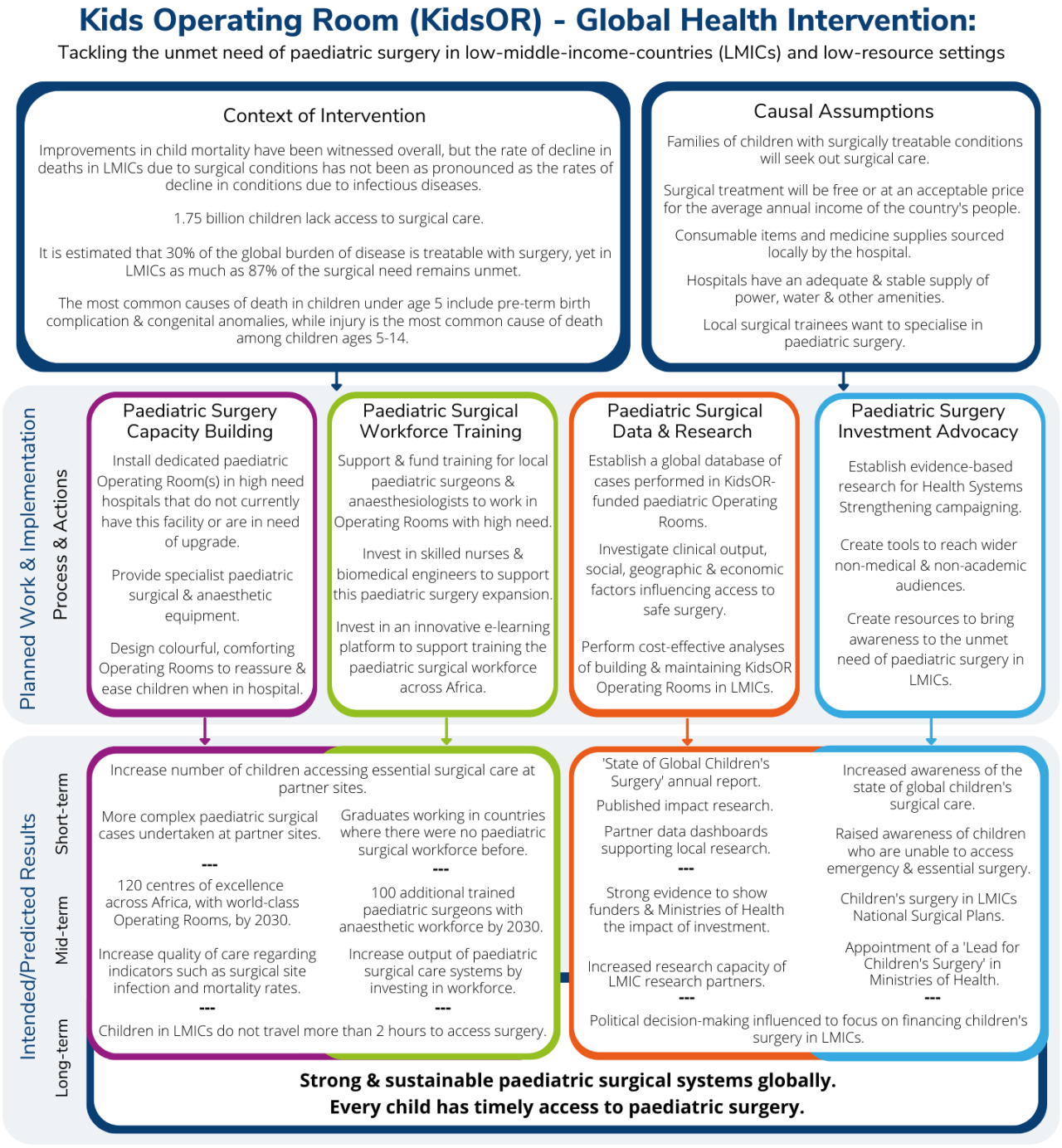
Universal health coverage (UHC) is outlined as the population having access to quality, essential healthcare services they need, regardless of their financial status[38]. If a country wants to achieve UHC, they must invest in surgical care to build a strong foundation for their health systems overall[38,39]. It is now time to invest in an equitable future where every child has access to the healthcare they deserve. Without investment in surgical care, we will never achieve many of the global goals such as the sustainable development goals (SDGs) and we will never achieve Universal Health Coverage[40].

**CONCLUSIONS**

Resource-limited countries and people will continue to suffer the consequences of the lack of prioritization of surgical care within the global health agenda and external financial commitments. Strengthening surgical services in a manner that is aligned to the WHO's fundamental health system building blocks, allows for sustainable and long-lasting change. Confronting the numerous bottlenecks that exist in surgical services and establishing multi-faceted development, will allow global, national and local surgical targets to be met.

**SUPPLEMENT**

**KidsOR Theory of Change**



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Successful health systems comprise good outcomes, accessibility and availability. Surgery is the service that cuts across many treatment scenarios, yet in low- and middle-income countries 90% of people cannot access it. Estimates using most recent population data suggest that 1.75 billion children lack access to surgical care. Additionally, 30% of the global burden of disease is treatable with surgery, yet in LMICs as much as 87% of the surgical need remains unmet. Paediatric surgical services are not at the level they need to be, highlighting an increasing surgical burden on children's health globally with a human cost of morbidity and mortality. Achieving Universal Health Coverage and the Sustainable Development Goals will fail if surgical systems are not strengthened in low resource settings.

**In 2018, global health charity Kids Operating Room was founded with a goal of ensuring every child has access to the surgery they need. The charity has a four-pillar approach to its work: provision of infrastructure and equipment, paediatric surgical workforce training, database development and research capacity strengthening, and advocating on behalf of children denied access to safe surgery.** To ensure that paediatric surgical interventions produce real impact on service delivery, contextual understanding and needs assessment are key. The building of paediatric surgical capacity should align to countries' priorities and wishes. Investing in local health workforce is essential to delivering quality services, supporting resilient health systems and provides integrated, people-centred health services. A competent surgical information system gives the local surgical workforce the tools needed to action evidence-driven decisions.

Strengthening surgical services in a manner aligned to the WHO's fundamental health system building blocks, allows for sustainable and long-lasting change. Confronting bottlenecks that exist in surgical services and establishing multi-faceted development, will allow global, national and local surgical targets to be met.

**KEY MESSAGES**

- In 2018, global health charity Kids Operating Room was founded with a goal of ensuring every child has access to the surgery they need.
- The charity has a four-pillar approach to its work: provision of infrastructure and equipment, paediatric surgical workforce training, data and research, and advocating on behalf of children denied access to safe surgery.
- 1.75 billion children lack access to surgical care.
- It is estimated that 30% of the global burden of disease is treatable with surgery, yet in LMICs as much as 87% of the surgical need remains unmet.
- Strengthening surgical services in a manner aligned to the WHO's fundamental health system building blocks, allows for sustainable and long-lasting change.
- Achieving Universal Health Coverage and the Sustainable Development Goals will fail if surgical systems are not strengthened in low resource settings.

## INTRODUCTION

When we think of a good health system, what do we think of? Most likely good outcomes, accessibility, availability and coverage. A system that is designed to take care of people and their families whatever comes their way. A system that provides a safe place for people to give birth to their children. A system that will treat broken bones, emergency appendicitis and that fearful cancer diagnosis if they ever arise.

Unfortunately, this is not the case in many health systems across the world. Surgery is the service that cuts across all these treatment scenarios and more, yet 5 billion people do not have access to it[1]. This figure is huge and is sometimes hard to contemplate, however it means that in low-income and lower-middle income countries, 90% of people cannot access the surgical care they need[2]. No method to reach the nearest surgical hospital to treat that emergency appendicitis. No availability to have that broken leg fixed before it heals in the wrong position.

This review will outline the current condition of paediatric surgery in low- and middle-income countries (LMICs), as per the World Bank country classifications which is the classification system most often used in global surgery publications. This review will highlight why it is important to address these systematic issues with haste, and how to do so with a health system strengthening approach.

## PAEDIATRIC SURGERY IN LOW RESOURCE COUNTRIES: THE CURRENT SITUATION

### The global necessity

While surgical care can save lives, prevent disabilities and engender economies, only 6% of all procedures undertaken worldwide annual take place in the poorest countries where approximately a third of the world's population lives[1]. Likewise, 87% of children who cannot access safe, affordable and timely surgical care are from LMICs[3], making paediatric surgery one of the most overlooked and underfunded areas in child health.

In LMICs across the world, half of their population are children[4]. This means that underdeveloped surgical services have a serious effect on children in these settings, despite its key role in averting death and disability. The LCoGS published in 2015 had an awakening effect on global surgery as a player in wider global health but lost an opportunity to ensure appropriate financial commitments or to make it a priority – or one of them – in international debates.

### A global epidemiological shift

The global health landscape has been changing substantially in the past 20 years[5,6,7]. Countries in which communicable diseases were the main burden on population health are now seeing a progressively increasing shift to non-communicable diseases (NCDs)[8]. Conditions such as cancer, heart disease and congenital anomalies are causing morbidity and mortality, as well as injuries from road traffic collisions[9].

This epidemiological transition has led to a substantial burden to health care systems as NCDs are now the greatest cause of mortality worldwide with the highest burden falling on people living in poor resource settings[10]. While this epidemiological shift has increased the demand for surgical and anaesthesia care, both have been a neglected part of global health initiatives (GHIs), which although were created to target conditions that affect low-income countries, are still too much focused on transmissible diseases, mainly the so-called 'big three': Malaria, HIV/AIDS and Tuberculosis[11]. It's worth noting that GHIs have been vastly criticised for the misalignment between their own priorities/agenda and countries' needs[12].

**The burden of surgical disease**

Surgery is a cross-cutting discipline throughout disease areas. It is used as a method in the treatment of both communicable and non-communicable diseases, which can occur throughout a patient's lifetime. Congenital conditions, however, require surgery early in the child's life to decrease the likelihood of morbidity and mortality and have high incidence in many LMICs[13,14]. This surgical need is largely unmet in many countries across the world[15] and the evidence of this paints a worrying picture. A study published in 2019, estimated that 1.7 billion children globally do not have access to the basic, life-saving surgical care they need, which equates to 92.3% of children in lower-middle income countries and 97.7% of children in low-income countries[2]. The Lancet Commission on Global Surgery (LCoGS) estimates that 143 million additional surgical procedures are required annually, with 38% of these procedures necessary for children[1].

In the opening address to the inaugural 'The Lancet Commission on Global Surgery' meeting in 2014, Dr Jim Yong Kim identified surgery as an "indivisible, indispensable part of health care". This is even more apparent in 2022; the long-standing effects of the COVID-19 pandemic are seen in ever-growing elective waitlists in already overburdened health systems, a ripple effect from frequent surgical service shutdowns[16]. Surgical services are not at the level they need to be. The evidence provided points towards an increasing surgical burden on children's health in LMICs with the human cost of morbidity and mortality. Furthermore, we will fail to achieve Universal Health Coverage (UHC) and the Sustainable Development Goals (SDGs) if surgical systems are not strengthened systematically in low resource settings[17].

**BUILDING CAPACITY FOR PAEDIATRIC SURGERY: A HEALTH SYSTEMS STRENGHTENING APPROACH**

In 2018, the global health charity Kids Operating Room (KidsOR) was founded. The goal of the charity is to ensure that every child has access to timely and quality surgery when they need it. The charity has a four-pillar approach to its theory of change: paediatric surgery capacity building through infrastructure and equipment, paediatric surgical workforce training, paediatric surgery data and research, and paediatric surgery investment advocacy.

KidsOR's Theory of Change shows how the four directions of our work come together to produce short, mid and long-term change in paediatric surgery globally. The understanding of context in this intervention is key, and although a general context is shown, each country has its own contextual factors that are taken into consideration in the needs assessment process. Causal assumptions are complimentary factors that need to be in place for KidsOR's intervention to be efficient and impactful.

KidsOR's structure of intervention follows the World Health Organization recommendation[18] on how to improve the performance of health systems through the six fundamental 'building blocks'.

**1. Service Delivery**

To ensure that this paediatric surgical intervention produces real impact on service delivery, contextual understanding and needs assessment are key. KidsOR's strategy and the accompanying country action plans are developed through intensive research and extensive consultation with Ministries of Health, surgical colleges, front-line surgeons, relevant Non-Governmental Organisations and other local partners. The objective of this approach is to gain a detailed understanding of the current paediatric surgery landscape and collaborate with partners to identify gaps, respond to opportunities and meet specific needs. Establishing a situational analysis of each country is critical to understanding the structural barriers that exist to access surgery, including cultural and financial challenges. Conclusions regarding target hospitals and the placement of surgeons are shaped by local teams with KidsOR's support, to maximise impact and deliver the greatest return on investment.

Table 1: Example of how Kids Operating Room's work in paediatric surgical capacity building aligns with the service delivery building block.

| **Kids Operating Room's Paediatric Surgery Capacity Building aligning with Service Delivery** | |
|---|---|
| Processes & actions | Install dedicated paediatric operating rooms in high need hospitals that do not currently have this facility or need upgrade. |
| | Provide specialist paediatric surgical & anaesthetic equipment. |

| | |
|---|---|
| | Design colourful, comforting operating rooms to reassure & ease children when in hospital. |
| Intended & predicted results | Increase number of children accessing essential surgical care at partner sites. |
| | More complex paediatric surgical cases undertaken at partner sites. |
| | Increase quality of care regarding indicators such as surgical site infection & mortality rates. |
| | Children in LMICs do not travel more than 2 hours to access surgery. |

As part of the planning stage of this intervention, needs assessment surveys are issued which collect fundamental information about the hospital, the current facilities, the staff and the patient population. The KidsOR design team, based in Scotland, draws up plans for the operating room and lists of potential equipment are discussed with the hospital. An integral part of this process is ensuring that the hospital and operating room infrastructure can sufficiently support the equipment that will be installed, for example, electricity and gas supplies[19]. This is comprehensively evaluated and completed collaboratively between the KidsOR Operations Team and the Hospital teams before each installation. This method of establishing paediatric surgical services ensures that projects are aligned to countries' priorities and wishes.

**2. Health Workforce**

An adequate, equitably distributed, skilled and motivated health workforce is not only key to achieving global goals such as UHC but in ensuring the successful and timely delivery of health services. However, there is chronic under-investment in education and training[20] which is exacerbated by the phenomenon of 'brain drain' which sees those leaving their home countries for better training and employment opportunities elsewhere[21].

A well-trained and motivated health workforce leverages health, social, gender equality and economic benefits. Apart from that, scaling up surgical workforce can potentially prevent over 500,000 deaths annually of under-5 children[22]. However, the critical lack of surgical workforce mainly in LMICs has left billions of people without access to safe surgical care.

No country in Africa has reached the LCoGS's recommendation of 20 specialist surgeons, anaesthesiologists, and obstetricians (SAO) per 100 000 population[1,23]. The shortage of paediatric surgeons is concerning and to aggravate, the existing specialised surgeons are mostly concentrated in major cities[24]. To contribute to filling this

gap, Kids Operating Room in partnership with local institutions such as the College of Surgeons of East, Central and Southern Africa (COSECSA) and the West African College of Surgeons (WACS) provide education grants to countries with scarce number of paediatric surgeons and the intended results of this work are found below in Table 2. Alongside local partners and stakeholders, priority countries, regions and hospitals are defined and consequently a specific number of scholarships are publicised each year, with candidates are shortlisted by the surgical colleges.

Table 2: Example of how Kids Operating Room's work in paediatric surgical workforce training aligns within the health workforce building block.

| **Kids Operating Room's Paediatric Surgery Workforce Training aligning with Health Workforce Building Block** | |
|---|---|
| Processes & actions | Support & funding training for local paediatric surgeons & anaesthesiologists to work on operating rooms with high need. |
| | Invest in training surgical nurses & biomedical engineers to support this paediatric surgery expansion. |
| | Invest in an innovative e-learning platform to support training the paediatric surgical workforce. |
| Intended & predicted results | Graduates working in countries where there was no paediatric surgical workforce previously. |
| | 100 additional trained paediatric surgeons with anaesthetic workforce by 2030. |
| | Increase output of paediatric surgical care systems by investing in workforce. |

After either three or five-years of training, these surgeons will graduate as highly skilled, qualified paediatric surgeons, capable of delivering high-quality surgical services in deprived locations while, importantly, being able to understand and address local needs. Investing in the health workforce is not only essential to deliver quality services and support robust and resilient health systems, but provides integrated, people-centred health services as recommended by the WHO[25].

**3. Health Information**

Health information is the data and knowledge, captured from health systems, that allows health professionals to make decisions. Health information systems improve patient outcomes by efficiently capturing, analysing,

disseminating and applying data to allow for evidence-driven use of information[26]. Health systems that have capacity for an established health information system can facilitate monitoring and evaluation (M&E) of interventions, support patient and facility management and encourage research, which enables health analyses and global reporting of health challenges and successes[27,28].

Tackling the crisis of surgical systems in LMICs requires health professionals that are experienced and understanding of the cultural, social, economic and political context of their country, as these influencing factors are key to strengthening surgical systems effectively[29]. A competent health information system allows for health professionals to enter the health research workforce and gives them the tools needed to action evidence-driven decisions. Surgical data is lacking in LMICs, especially so in paediatric surgery[30,31], adding to the numerous barriers towards improving LMICs services. Therefore, the KidsOR Global Data Program was established with the processes and intended results highlighted in Table 3 below.

Table 3: Example of how Kids Operating Room's work in data and research capacity building aligns within the health information building block.

| **Kids Operating Room's Data & Research Capacity Building aligning with Health Information Building Block** | |
|---|---|
| Processes & actions | Establish a global database of cases performed in KidsOR-funded paediatric operating rooms. |
| | Investigate clinical output, social, geographic & economic factors influencing access to safe surgery. |
| | Perform cost-effective analyses of building & maintaining KidsOR operating rooms in LMICs. |
| Intended & predicted results | Published evaluation research to show the impact of strengthening paediatric surgical systems. |
| | Strong evidence to show funders & Ministries of Health the impact of investment, |
| | Increased research capacity of LMIC research partners. |

The KidsOR Global Data Program is simultaneously a M&E project and a pillar of KidsOR's global intervention itself. The program provides data analysis capabilities and research capacity building at partner hospitals, working with the surgeons or primary researchers at each facility to develop paediatric surgical databases. The data collection survey tool includes many important data points such as age, diagnosis, type of surgeon performing the procedure, socioeconomic factors, trainee presence and occurrence of surgical site infection. All the data points, aside from

socioeconomic, are regularly found in operating room logbooks that are commonly used to capture procedures occurring in partner hospitals. The paediatric surgical databases developed at each hospital are an integral tool to strengthen surgical systems, with uses in clinical quality improvement, diagnoses presentation analysis, surgical information exchange, impact analysis of any intervention programs implemented, training surgical research residents and for abstract presentation and publication.

**4. Access to medicines**

With sustainability and durability as a driving feature in KidsOR's intervention, our model involves providing long-term resources such as infrastructure, equipment and workforce training. Consumables are another important factor in operating rooms, such as personal protective equipment and medicines. The WHO developed an essential medicine list in 1977 and has maintained this on a biennial basis[32]. This list includes those that are integral to surgery and highlights that a resilient surgical system must have a stable and consistent supply of medicines to carry out surgical procedures. Common medicines used in anaesthesia and surgery are antibiotics, sedatives, analgesics, anxiolytics, numbing agents, inhalational gases, paralytics and intravenous agents[33].

Prior to a KidsOR dedicated operating room installation, initial assessments are collected from the partner hospital to inform of the current medical gas and anaesthetic agent availability at the facility. The anaesthetic equipment provided is tailored depending on the anaesthetic agents that the hospital has stable supplies of, with the hospital budget and long-term sustainability in mind. Oxygen concentrators are provided in the initial installation and a reputable local supplier of medical gases is confirmed with the hospital.

As part of the KidsOR data collection, data regarding the availability of anaesthesia and medicines is captured for each operation occurring in the installed theatre. These data are used to inform KidsOR of the efficiency of the anaesthesia equipment supplied and for wider research purposes, such as highlighting the importance of steadily available anaesthesia and surgical medicines to Ministries of Health and wider global health settings.

**5. Leadership and Governance**

Effective leadership and governance require collaboration, oversight and accountability while developing specific health policies. In 2015, the World Health Assembly (WHA) adopted the Resolution WHA68.15 "*Strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage*" to improve surgical care worldwide. Since then, countries have tried to incorporate robust surgical care policies to the wider health plans and in line with UHC efforts mainly through the development of national surgical, obstetric and anaesthesia plans (NSOAP).

The focus has been to understand gaps in both access and delivery of safe and timely surgical care, as well as setting targets and priorities, and establishing an implementation plan. This implementation plan includes a detailed budget and a M&E strategy. However, to achieve its full potential, an NSOAP requires both financial and political support from domestic and international actors. Truché et al. (2020) remind us that since a meaningful portion of health care funding in LMICs comes from external donors, mobilising domestic funds is not enough, even although it would enhance sustainability and accountability[34].

**6. Financing**

According to the WHO, a sustainable health financing system needs to ensure adequate funds not only to provide quality services but also to protect patients from financial catastrophe or impoverishment[35] in line with UHC endeavours of all individuals being able to receive health services without suffering financial hardship.

Despite vast evidence on the critical need for surgical care, on the health and economics benefits from scaling-up surgical services, no national government in LMICs nor external funding bodies have secured appropriate budget to strengthen health systems, which is unachievable without surgery and anesthesia. Inadequate financing, therefore, is a barrier as much as poor infrastructure and insufficient surgical workforce, yet earmarked funds to disease-specific interventions has been prioritised by donor countries and institutions for decades while ignoring the shift in the epidemiology of LMICs.

Investing in surgery is highly cost-effective as analyses conducted at two KidsOR sites show. In Uganda where essentially emergent, life-saving cases were served, the cost to save a year of healthy life was US dollars $6.4[36], while in Nigeria, where a pre-existing children's surgical service was already in place and focused more on elective cases, the cost was $77[37]. Likewise, the LCoGS pointed out the monetary benefits of enabling access to safe surgery as an investment of $350 billion until 2030 would avoid an estimated loss of $12.3 trillion in lost productivity and health care expenses[1].

However, it is not only about being cost-effective, due to its cross-cutting nature, surgery provides a solid foundation for entire health-care systems, including being more responsive and resilient for unexpected outbreak as witnessed with COVID-19 pandemic. Investing in surgery is investing in the entire health system and supporting pandemic preparedness.

**A CALL TO ACTION: TOWARDS UNIVERSAL HEALTH COVERAGE**

Training local surgeons and investing in high-quality surgical infrastructure strengthens healthcare systems. It allows nations to start moving towards independent delivery of care for their children. Globally children are dying at an astonishing rate because they cannot access the safe surgery they need. These are preventable deaths and

every pound moved into surgery creates stringer health systems, moving children closer to a time when achieving their potential is to be fully expected, not simply dreamed about.

Universal health coverage (UHC) is outlined as the population having access to quality, essential healthcare services they need, regardless of their financial status[38]. If a country wants to achieve UHC, they must invest in surgical care to build a strong foundation for their health systems overall[38,39]. It is now time to invest in an equitable future where every child has access to the healthcare they deserve. Without investment in surgical care, we will never achieve many of the global goals such as the sustainable development goals (SDGs) and we will never achieve Universal Health Coverage[40].

**CONCLUSIONS**

LMICs will continue to suffer the consequences of the lack of prioritisation of surgical care within the global health agenda and external financial commitments. Strengthening surgical services in a manner that is aligned to the WHO's fundamental health system building blocks, allows for sustainable and long-lasting change. Confronting the numerous bottlenecks that exist in surgical services and establishing multi-faceted development, will allow global, national and local surgical targets to be met and will allow children across the world to access safe surgery when they need.

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