


## Prevalence and outcomes of pediatric surgical conditions at Connaught Hospital in Freetown: a retrospective study

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## ABSTRACT

**Background** Sub-Saharan Africa experiences a disproportionate amount of pediatric surgical disease, with 80% of children lacking access to timely, affordable, and safe surgical care. This study aims to characterize the burden of disease and outcomes of pediatric surgical conditions at Connaught Hospital, the main pediatric referral hospital in Sierra Leone.

**Methods** This retrospective and hospital-based study included children up to 15 years old who were operated on between 2015 and June 2016 at Connaught Hospital in Freetown, Sierra Leone. Descriptive and inferential statistics were used to characterize the distribution of disease and compare all variables against age category and mortality.

**Findings** A total of 215 patients were included in this study of which 72.5% (n=132) were male and 27.5% (n=50) were female. Most of the patients were diagnosed with congenital anomalies (60.9%; n=131). However, infection was the leading diagnosis (60.5%; n=23) among patients aged 5–10 years (n=38). Inguinal hernia was the leading condition (65.0%; n=85) among patients presenting with a congenital anomaly. The condition with the highest mortality was infections (17.0%; n=8), followed by other conditions (9.1%; n=2) and congenital anomalies (3.1%; n=4). Based on the results of this study, over 7000 children with inguinal hernias remain untreated annually in Freetown, Sierra Leone.

**Conclusion** This study quantifies the burden of surgical disease among children, a foundational step toward the prioritization of pediatric surgical care in national health agendas, the development of evidence-based interventions, and the strategic allocation of resources in Sierra Leone.

## INTRODUCTION

Globally, 1.7 billion children do not have access to safe, affordable, and timely surgical care, with most of these children living in low and middle-income countries (LMICs).<sup>1</sup> An estimated 15%–50% of children in LMICs will require treatment for a surgical condition by 15 years of age.<sup>2,3</sup> In addition, pediatric surgery makes up 6%–12% of all pediatric hospital admissions in sub-Saharan Africa (SSA).<sup>4</sup> As childhood mortality from infectious diseases

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Childhood mortality attributed to infectious diseases has decreased across sub-Saharan Africa, but the burden of surgical conditions is increasing.
- ⇒ The unmet need for surgical conditions in Sierra Leone is high, and the pediatric surgical capacity at governmental hospitals is limited.

## WHAT THIS STUDY ADDS

- ⇒ Congenital abnormalities are the most common pediatric surgical condition treated at Connaught Hospital.
- ⇒ Inguinal hernia was the leading condition among patients presenting with a congenital anomaly.
- ⇒ The study highlights the absence of a large cohort of pediatric patients with high-risk mortality conditions.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Our findings contribute to closing the gap in information on pediatric surgical epidemiology in low and middle-income countries.
- ⇒ Quantifying the burden of surgical disease among children is a key step toward the development of interventions and the strategic allocation of resources at the local and regional levels in Sierra Leone.

falls across SSA, the burden of disease attributed to surgical conditions is increasing.<sup>5</sup> Furthermore, untreated pediatric surgical conditions or delayed hospital presentations may lead to poor outcomes, lifelong disability, or death.<sup>3,6–8</sup>

In the past few years, global initiatives have aimed to reduce surgical disparities in LMICs. The Lancet Commission on Global Surgery emphasized the need for timely, safe, and affordable surgical and anesthesia care in these countries.<sup>1</sup> Quantifying the burden of surgical disease among children is a foundational step toward the prioritization of pediatric surgical care in national health agendas, the development of evidence-based interventions, and the strategic allocation of resources.<sup>9,10</sup>

Sierra Leone is one of the poorest countries in the world, ranking 181 out of 188 in the most recent United Nations Development Index.<sup>11</sup> A previous study reported that the unmet surgical need in Sierra Leone was greater than 90%.<sup>12</sup> Other studies have highlighted the limitations of surgical capacity for children in the country, with severe deficiencies in surgical infrastructure, equipment, supplies and procedures.<sup>13–15</sup> Kushner *et al* reported that none of the public hospitals assessed were able to perform common procedures such as cleft lip and clubfoot repairs. Also, essential surgical supplies were available in less than 50% of these hospitals. Despite this high need, surgical care for children remains a low policy priority in Sierra Leone.<sup>15</sup> Finally, one of the most critical issues holding back pediatric surgical care progress in Sierra Leone is the scarcity of population-based epidemiological data.<sup>12</sup> This study aims to characterize the burden of disease and outcomes of pediatric surgical conditions at Connaught Hospital, the main pediatric referral hospital in Sierra Leone.

## METHODS

### Setting

Sierra Leone is a low-income country in SSA, with a total population of 7.9 million people. Children under 15 years old account for 42% of this population.<sup>16</sup> In 2016, the birth rate was 34 births per 1000 people.<sup>17</sup> Sierra Leone is organized into four provinces: Eastern, Northern, Southern, and Western areas. Freetown is the capital of the nation and has a population of 1.2 million people. Although health services for children in Sierra Leone have improved dramatically, the under-five mortality rate in 2016 (125 per 1000 live births) was among the world's highest.<sup>18</sup> Furthermore, access to health services is unevenly distributed in Sierra Leone, with the vast majority of hospitals located in Freetown, the country's capital. Reaching hospitals from rural areas poses many challenges, such as inadequate road infrastructure and transportation costs, leading to delayed arrivals and complicated conditions.<sup>19</sup>

Regarding the composition of the surgical system, a country-wide facility report showed that 67.2% of surgical procedures were performed at private non-profit facilities, 31.3% at governmental facilities and 1.5% at private for-profit facilities.<sup>20</sup> Also, governmental hospitals experience infrastructure and workforce shortages.<sup>13–15</sup> Connaught Hospital is a governmental hospital located in Freetown with 300 beds and 12000 patients presenting to its emergency center annually. There is a pediatric theater with only one pediatric surgeon who was the only specialist pediatric surgeon in the country during the time of the study. This hospital serves as the primary referral hospital for several health facilities in the country. Ola During Children's Hospital, a major referral hospital for children's health, also refers surgical patients to Connaught Hospital.

## Study design, data collection and participants

This is a retrospective and hospital-based study. Data were collected from 1 June 2015 to 30 June 2016 from existing records in theater logbooks. Data from children between 0 and 15 years old were collected. The information retrieved included surgical condition, surgical procedure, date of surgery, sex, age, mortality, and anesthesia type. The outcome of mortality was defined as intraoperative mortality. All data were deidentified and organized in an Excel spreadsheet.

## Data analysis

Descriptive statistics were used to characterize the distribution of disease based on age category and mortality. For the analysis, age was divided into three categories: 0–4, 5–10, and 11–15 years old. Surgical conditions were divided into four categories: congenital anomalies, infections, masses, and others (abdominal problems, acquired deformities, wounds, burns and postoperative complications). Congenital anomalies were further stratified into cleft lip, hydrocele, spina bifida, inguinal hernia, other hernias, other abdominal anomalies, other genitourinary anomalies, and other anomalies (syndactyly, tongue tie, strangulated right inguinal hernia, and trocar site incisional hernia). Infections were stratified into abscess, appendicitis, acute appendicitis, perforated appendicitis, osteomyelitis, chronic osteomyelitis, septic arthritis, typhoid perforation, and other infections (cellulitis, multiple pyomyositis, toxic colitis, gangrene, perforated gall bladder, and operation site pus). Type of anesthesia was divided into three categories: general anesthesia, regional anesthesia (including spinal anesthesia, epidural and nerve blocks), and local anesthesia.  $\chi^2$  tests were used to compare all categorical variables (except surgical procedures) against age category. However, for surgical conditions, only the main categories (congenital anomalies, infections, masses, and others) were included. The subcategories were not included in the  $\chi^2$  analysis due to their small sample size. Statistical significance was determined at the type I error rate of  $\alpha=0.05$ . Outcomes (survived and died) were displayed in granularity for surgical conditions (congenital anomalies, infections and others) and surgical procedures (appendectomy, excision, herniotomy, resection, exploratory laparotomy, total colectomy, splenectomy and retrograde cholecystectomy). All analyses were performed using SAS V.9.4 (SAS Institute).

The expected number of pediatric surgical cases in the hospital's catchment area was calculated to estimate the number of untreated surgical conditions. We used the incidence rate of the conditions treated at Connaught Hospital and the number of children between 0 and 15 years old in the hospital catchment area in 2015 (approximately 496 800). The incidence rate for the following conditions was used: inguinal hernia (10–20 per 1000 live births), spina bifida (2.85 per 1000 live births), and cleft lip (1 per 2500 live births).<sup>21–23</sup> These results were then compared with the number of patients treated at

Connaught Hospital. Since a previous study reported that 68.7% of pediatric surgeries in Sierra Leone take place in private hospitals, an estimated number for these surgeries was calculated and accounted for the total number of untreated conditions.<sup>20</sup>

## RESULTS

A total of 215 pediatric patients underwent surgery at Connaught Hospital between June 2015 and June 2016 (table 1). Of these patients, 72.5% (n=132) were male and 27.5% (n=50) were female. Also, 62.4% (n=132)

**Table 1** Distribution of patients admitted to Connaught Hospital stratified by age

	Total (n=215) % (n)	Age category			P value
		0–4 years old (n=132) % (n)	5–10 years old (n=45) % (n)	11–15 years old (n=38) % (n)	
Sex*					
Female	27.5 (50)	27.3 (30)	19.5 (8)	38.7 (12)	0.195
Male	72.5 (132)	72.7 (80)	80.5 (33)	61.3 (19)	
Surgical condition					
Congenital anomalies	60.9 (131)	78.0 (103)	44.4 (20)	21.1 (8)	<0.0001
Cleft lip	3.8 (5)	4.9 (5)	0.0 (0)	0.0 (0)	
Hydrocele	10.7 (14)	11.7 (12)	25.0 (2)	0.0 (0)	
Spina bifida	60.0 (3)	2.9 (3)	0.0 (0)	0.0 (0)	
Inguinal hernia	64.9 (85)	62.1 (64)	75.0 (6)	75.0 (15)	
Other hernias	4.6 (6)	3.9 (4)	0.0 (0)	10.0 (2)	
Other abdominal anomalies	1.5 (2)	1.9 (2)	0.0 (0)	0.0 (0)	
Other genitourinary anomalies	8.4 (11)	7.8 (8)	0.0 (0)	15.0 (3)	
Other anomalies†	3.8 (5)	4.9 (5)	0.0 (0)	0.0 (0)	
Infections	21.9 (47)	9.9 (13)	24.4 (11)	60.5 (23)	
Abscess	14.9 (7)	30.8 (4)	4.3 (1)	18.2 (2)	
Appendicitis	21.3 (10)	0.0 (0)	34.8 (8)	18.2 (2)	
Acute appendicitis	4.3 (7)	0.0 (0)	8.7 (2)	0.0 (0)	
Perforated appendicitis	14.9 (7)	0.0 (0)	21.7 (5)	18.2 (2)	
Osteomyelitis	12.8 (6)	30.8 (4)	4.3 (1)	9.1 (1)	
Chronic osteomyelitis	10.6 (5)	23.1 (3)	8.7 (2)	0.0 (0)	
Septic arthritis	4.3 (2)	7.7 (1)	0.0 (0)	9.1 (1)	
Typhoid perforation	4.3 (2)	0.0 (0)	0.0 (0)	18.2 (2)	
Other infections‡	12.8 (6)	7.7 (1)	17.4 (4)	9.1 (1)	
Masses§	7.0 (15)	7.6 (10)	4.4 (2)	7.9 (3)	
Other¶	10.2 (22)	4.6 (6)	26.7 (12)	10.5 (4)	
Anesthesia					
GA	77.2 (166)	84.9 (112)	64.4 (29)	65.8 (25)	0.003
GA ITT/ETI	11.2 (24)	6.8 (9)	13.3 (6)	23.7 (9)	
Other**	11.6 (25)	8.3 (11)	22.2 (10)	10.5 (4)	
Outcome					
Survived	93.5 (201)	97.0 (128)	91.1 (41)	84.2 (32)	0.015
Died	6.5 (14)	3.0 (4)	8.9 (4)	15.8 (6)	

\*Missing data for the sex of 33 patients, 22 patients in the 0-4 age category, 4 patients in the 5-10 age category, and 7 patients in the 11-15 age category.

†Other anomalies include bowel anastomosis, reconstruction, and release.

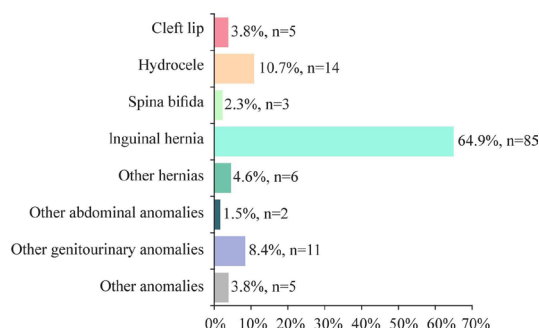
‡Other infections include cellulitis, multiple pyomyositis, toxic colitis, gangrene, perforated gall bladder, and operation site pus.

§Masses include cyst, tumor, hygroma, fibroadenoma, lipoma, and swelling left groin.

¶Other surgical conditions include abdominal problems, acquired deformities, wounds, burns and postoperative complications.

\*\*Other types of anesthesia include halothane, intrathecal narcotics (ITN), ketamine, local anesthesia (LA), and spinal anesthesia.

GA, general anesthesia; GA ITT/ETI, intubation by intention to treat strategy/endotracheal intubation.



**Figure 1** Distribution of congenital anomalies (n=131). Other anomalies include bowel anastomosis, reconstruction, and release.

of the patients were between the ages of 0 and 4 years old (missing data for the sex of 33 patients). The largest gender difference was found among patients from 5 to 10 years old, with 80.5% being male (n=33) vs 19.5% female (n=8). Stratified by age, congenital conditions were the most prevalent in children up to 10 years old, while infections were most common among children between the ages of 11 and 15 years. General anesthesia was the main type of anesthesia used during the surgical procedures (77.2%; n=166) for all age categories. Of the 215 patients, 93.5% (n=201) were discharged, and 6.5% (n=14) died. Congenital conditions comprised 60.9% (n=131) of the cases, followed by infections (21.9%; n=47). Among children presenting with infections, all forms of appendicitis compounded 40.5% (n=24) of all infections, followed by abscess (14.9%; n=7) and osteomyelitis (12.8%; n=6). Among children presenting with congenital conditions, inguinal hernia was the leading condition (65.0%; n=85), followed by hydroceles (11.0%; n=14), other

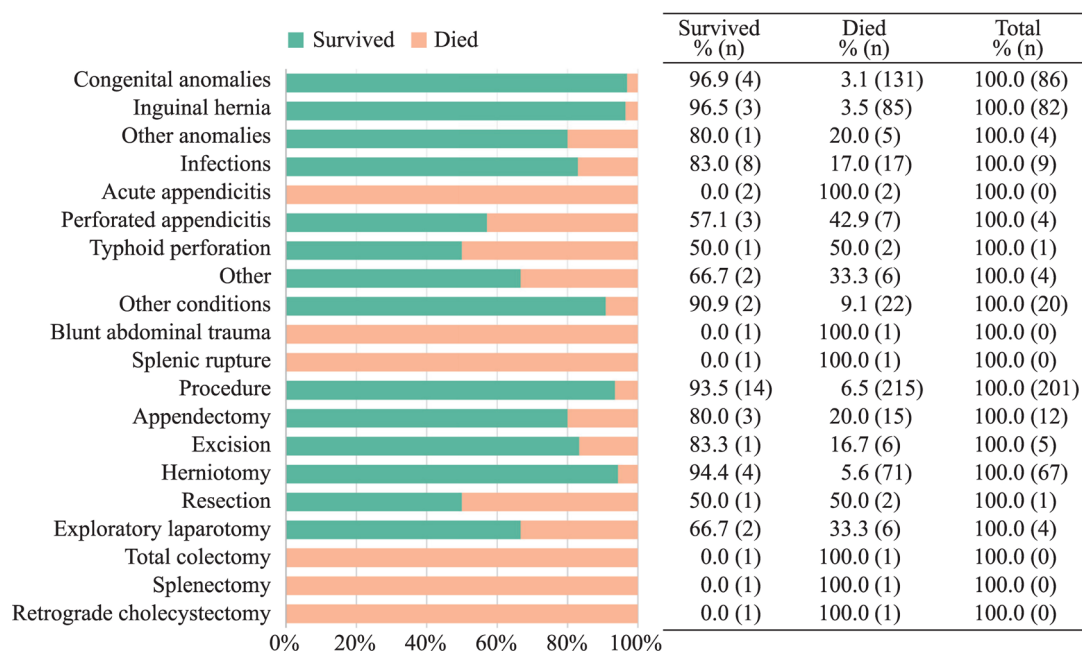
genitourinary anomalies (8.0%; n=10), and other hernias (5.0%; n=7) (figure 1). The condition with the highest mortality was infections (17.0%; n=8), followed by other conditions (9.1%; n=2) and congenital anomalies (3.1%; n=4) (figure 2). A 100% mortality was found for the conditions of acute appendicitis (n=2), blunt abdominal trauma (n=1), and splenic rupture (n=1), as well as for the procedures of total colectomy (n=1), splenectomy (n=1), and retrograde cholecystectomy (n=1). Mortality was not reported among children with masses.

Based on the operations performed at Connaught Hospital, the number of surgical conditions left without treatment in the catchment area was estimated (table 2). For inguinal hernia, 7103 children between 0 and 15 years were estimated to not have received any surgical treatment, for spina bifida 1408 children, and for cleft lip repair 178 children.

## DISCUSSION

This retrospective study summarizes epidemiological data on pediatric surgeries taking place over 1 year at the main pediatric referral hospital in Sierra Leone. Quantifying the burden of surgical disease is an essential step to identify key areas of need and to inform strategies to reduce disparities to reach surgical care. Overall, our data show that the burden of pediatric surgical disease falls on congenital anomalies. We also identified the absence of a cohort of patients with life-threatening conditions and an unequal gender distribution in access to surgical care.

Congenital conditions represented over half of the surgical conditions treated at Connaught Hospital. A



**Figure 2** Surgical outcomes by condition and procedure. Only subcategories that included a 'died' outcome were included in this graph because of space limitations. The subcategories of surgical conditions and procedures not included in this graph reported 100% survival.

**Table 2** Estimation of untreated surgical conditions in Connaught Hospital's catchment area

	Expected incidence in 1 year	Expected number in 1 year in the catchment area*	Number treated at Connaught Hospital (1 year)	Expected number treated at private facilities (non-profit and for-profit)†	Number not treated
Inguinal hernia	10–20 per 1000 live births	7560	85	264	7211
Spina bifida	2.85 per 1000 live births	1436	2	6	1428
Cleft lip	1 per 2500 live births	202	5	16	181

\*Calculation example: Incidence x population 0–14 years old in catchment area = 0.00285 × 504 000=1436.  
†Estimate of surgeries at private facilities<sup>20</sup>: 68.7% (assumed all surgical procedures at governmental tertiary hospitals were only performed at Connaught Hospital: 22.1%).

significant number of these conditions were inguinal hernias (65.0%), with 78.8% of this condition present in the 0–4 years age group. Our result is consistent with a previous study that reported hernia repair as the common pediatric surgical procedure in Sierra Leone.<sup>20</sup> Similarly, at the national referral hospital in Kampala, 50.7% of pediatric surgical admissions were congenital anomalies, with the highest number managed in the 0–4 years age group.<sup>24</sup> Despite this concurrence with previous data, some differences were found regarding the gender distribution of the patients undergoing a herniotomy. At Connaught Hospital, two-thirds of the procedures were done for male children. In Uganda, the number of male and female children managed for surgical conditions was almost equal. The pattern of gender distribution in our study could indicate disparities in seeking and accessing surgical care for female children with inguinal hernia in Freetown. Gender disparities in healthcare-seeking behavior have been previously reported in SSA. Mothers of male children suffering from acute conditions were more likely to seek care than mothers of female children.<sup>25</sup> The greater value placed on sons due to cultural and traditional beliefs in some countries appeared to play a role in the decision to provide care for male children.<sup>25–27</sup> Further research on health-seeking and reaching behaviors is needed to better understand the reasons behind the gender disparities in Connaught Hospital.

Our data suggested a distinct mismatch in the observed presentations of pediatric surgical patients at Connaught Hospital and the expected presentations. For instance, our estimates indicate that approximately 7103 children between the ages of 0 and 14 have been left without treatment for inguinal hernia. Given that many of the pediatric surgical procedures occur in private facilities in Sierra Leone, our estimates also include the private sector. Such a discrepancy implies the presence of a large cohort of missing patients and a significant unmet need for these procedures. This finding also agrees with a previous study reporting that the unmet need for inguinal hernia in Sierra Leone could be as high as 88%.<sup>20</sup>

We also found a distinct lack of life-threatening gastrointestinal congenital anomalies, such as gastroschisis. This is in contrast to a previous multisite study

that reported that approximately 7.9% of pediatric surgical admissions result from gastroschisis with a steep mortality rate of 75.5%.<sup>4</sup> Other literature has even suggested a 98% mortality rate for pediatric patients presenting with gastroschisis.<sup>28–29</sup> Also, our previous work in northern Ghana reported that only 6% of expected gastroschisis cases reached care at the hospital level.<sup>30</sup> As Connaught Hospital is the only pediatric surgery center in the region, further research is critical to recognize this discrepancy in patient presentations and consider whether these patients are dying in the community or receiving care elsewhere.

However, the existence of a missing cohort could also be supported by the mortality trends found in this study. The overall mortality rate during this study period was only 6.5% (n=14), an unusual rate in this context. Since antenatal and neonatal health services are scarce, clinical deterioration and complications occur before patients arrive at the hospital.<sup>29</sup> Long travel to arrive at the referral facility, most of the time without ambulance or hospital transportation, also increases the chances of mortality outside of the surgical center. Furthermore, there may be a lack of a perceived need for surgery and the belief that the condition could resolve on its own or by medication alone. This could lead to an underestimation of congenital anomalies and their associated mortality in Sierra Leone.

### Recommendations

Strides must be made in the Sierra Leonean surgical ecosystem, with a focus on early diagnosis, referral systems and appropriate outreach at the community level. After the Ebola virus disease outbreak and with the purpose of reducing maternal and infant mortality, the country introduced the Free Health Care Initiative for children under 5 years old. This initiative included a surgical care package with access to treatments and drugs free of cost, making surgical care more accessible.<sup>31</sup> However, children 6–15 years old were excluded from this program. Approximately 50% of the 1.7 billion children without access to surgical care worldwide fall within the 5–14 age group.<sup>32</sup> Thus, it is important to include these children in national interventions such as the Free Health Care Initiative. Efforts to advocate for policy changes to make

surgical care more accessible for this group of the population should be made.

A significant problem with pediatric surgical care in Sierra Leone is a general lack of knowledge on the care of children with surgical conditions.<sup>12 20</sup> Experience in this area should be increased at all levels. In this respect, village health workers should also be included, as they are on the frontline to promptly identify and refer children with surgical conditions, such as congenital anomalies and infections, to the appropriate healthcare centers. Providing community health workers (CHWs) with the recently published WHO handbook '*Birth defects surveillance: quick reference handbook of selected congenital anomalies and infections*', which is designed for front-line health professionals, would be a helpful tool towards achieving early diagnosis. The development of the WHO Global Birth Defects Surveillance Toolkit has highlighted the need for comprehensive and population-based studies to identify and monitor missing cohorts, as reported in our study. Implementing quality surveillance systems at the hospital and population levels can allow countries such as Sierra Leone to improve interventions to prevent, treat and support all children with pediatric surgical needs. Digital health can be another way in which CHWs can improve surgical outcomes, especially during postoperative care.<sup>33</sup> Previous studies have provided evidence that CHWs are able to correctly diagnose surgical site infections using an app-based questionnaire and pictures of the incision site in LMICs.<sup>34 35</sup> These interventions could help avoid poor surgical outcomes.

As in other SSA countries, we suspect that Sierra Leone has an overwhelming surgical backlog at each step of the patient's journey to access care.<sup>8</sup> The seeking and reaching healthcare stages might be influenced by awareness of the disease, personal beliefs, financial constraints and travel barriers. Patients who finally reach a hospital might end their journey without accessing the care they need because of hospital capacity limitations. At the time of data collection, there was only one pediatric surgeon in the entire country. Infrastructure limitations are also well reported in the literature.<sup>13–15</sup> Therefore, scaling up the surgical workforce and infrastructure is another essential requirement to have an efficient surgical system.<sup>1</sup> Although most pediatric surgical procedures are performed at high-level hospitals, access to care should start at the community level. CHWs play a crucial role in the surgical cascade by successfully linking patients to community resources such as education and counseling services.<sup>33</sup> Because CHWs spend more time with patients than other surgical healthcare providers, long-standing relationships can be made, and a deeper understanding of their needs can be achieved.<sup>33</sup> Overall, CHWs have the potential to bring unique strengths to decentralize the surgical care system.

Specialists in pediatric surgery are needed to manage more complex cases, set practice standards, and educate other healthcare providers. However, pediatric surgical education should be wide ranging and cover common

surgical diseases, infections, traumas, and malignancies in Sierra Leone. Most pediatric surgical problems, traumas, uncomplicated congenital anomalies, and surgical infections can be managed at primary or secondary care levels. In a rural hospital in Nigeria, 95% of operations were considered simple enough to be performed by general duty doctors if they had experience in general surgery.<sup>12</sup> Rather than only training pediatric surgeons as a short-term goal, the solution may be to re-establish general surgery to address the operative management of common pediatric surgical conditions.<sup>20 36</sup>

### Limitations

Some limitations warrant discussion. First, this retrospective study does not provide a population estimate of the burden of surgical disease. It is likely that many children with life-threatening surgical conditions were not treated at Connaught Hospital and possibly died before reaching surgical care or sought care at a different type of facility, such as private hospitals. Our reported estimates for underdiagnosed children account for the number of children seeking care at private hospitals. Second, the data collected for this study had disease descriptions that could have been non-specific toward the exact condition since they were recorded in the surgical logbook. For example, swelling of the left groin represents an ambiguous diagnosis. Since the procedure was an excisional biopsy, it was included in the category of masses. Third, the hospital-based characteristic of this study is a limitation to generalizing our results at the regional or national level. However, it is worth noting that Connaught Hospital is the main governmental referral hospital at a national level and is a fundamental piece of the centralized pediatric surgical ecosystem in Sierra Leone. Fourth, the data used for this study are nearly 6 years old, limiting the contemporaneity of our conclusions.

### Conclusion

Our study provides a baseline of the types of surgeries that children are undergoing at Connaught Hospital, as well as an estimate of the unmet burden of disease. Improving the management of congenital anomalies, increasing efforts to expand access to care for children with high mortality conditions, and reducing gender disparities are the identified priority areas.

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