World J Surg (2012) 36:2554–2558
DOI 10.1007/s00268-012-1737-3

World Journal of Surgery

Assessment of Pediatric Surgery Capacity at Government Hospitals in Sierra Leone

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Published online: 1 August 2012

Abstract
Background Traditionally, efforts to reduce child mortality in low- and middle-income countries (LMICs) have focused on infectious diseases. However, surgical care is increasingly seen as an important component of primary health care. To understand the baseline surgical capacity in LMICs, a number of studies have recently been published, but none has focused on pediatric surgery.
Methods The Surgeons OverSeas (SOS) Personnel, Infrastructure, Procedures, Equipment and Supplies (PIPES) survey was used to collect surgical capacity data from government hospitals in Sierra Leone. The data were analyzed specifically to identify baseline needs for pediatric surgery.
Results Nine hospitals were assessed, and all had a functioning laboratory to test blood and urine and were capable of undertaking resuscitation, suturing, wound débridement, incision and drainage of an abscess, appendectomy, and male circumcision. However, in only 67 % could a pediatric hernia repair be performed, and in none were more complex procedures such as cleft lip and clubfoot repairs performed. Fewer than 50 % of facilities had sufficient gloves, nasogastric tubes, intravenous cannulas, syringes, needles, sutures, urinary catheters, infusion sets, anesthesia machines, or compressed oxygen.
Conclusions Using the standard PIPES tool, we found severe deficiencies in the pediatric surgical capacity at government hospitals in Sierra Leone. However, a pediatric-specific tool is required to understand more accurately the pediatric surgical situation.

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Introduction

Traditionally, health care for pediatric populations in low- and middle-income countries (LMICs) has concentrated on infectious diseases. However, surgical care is increasingly recognized as an important component of public health [1]. In an effort to highlight the deficiencies in surgical care in LMICs, a number of studies documenting conditions have been published [2–11]. These studies examined factors such as personnel, infrastructure, procedures performed, and equipment and supplies in general, but they did not focus specifically on pediatric surgery.

In April 2010, Sierra Leone's Ministry of Health and Sanitation (MoHS) initiated a program to provide free health care to all children under 5 years old and to pregnant

and lactating women in an effort to reduce the high childhood and maternal mortality rates in the country. The program successfully increased access to health care for many children [12]. It has also, however, led to an increase in the number of pediatric surgery cases at Connaught Hospital, the main tertiary care referral center in the capital city, Freetown [13].

The goal of this study was to document pediatric surgery capacity in Sierra Leone. It was aimed at helping Connaught Hospital and the MoHS identify needs and plan for the increase in pediatric surgery cases.

Methods

Setting

Sierra Leone is a small West African country (area: 72,000 sq km) with an estimated population of 5.8 million. It is one of the poorest countries in the world and ranks 180 of 187 on the 2012 United Nations Development Index [14]. It is estimated that in 2012 the infant mortality rate was 76.64 per 1000 live births—ranking it among the bottom 12 countries [15]. Sierra Leone has one of the lowest physician densities, with a total of only 95 physicians in 2008—0.16 physicians per 10,000 population [16]. It is one of the few countries without a trained pediatric subspecialist surgeon. With the exception of the handful of cases performed by visiting humanitarian surgeons, all procedures in children are performed by local surgeons whose patients are usually adults.

Design

The Surgeons OverSeas (SOS) Personnel, Infrastructure, Procedures, Equipment, and Supplies (PIPES) tool was developed as an easy to administer surgical capacity survey. PIPES consist of 105 items and was designed to be administered rapidly to provide a quick snapshot of surgical capacity at LMIC health facilities. In addition to documenting individual items, an index can be calculated to show changes in capacity over time and differences among facilities. The PIPES tool was first used in Sierra Leone in August 2011 to reevaluate 10 MoHS hospitals initially assessed in 2008. A description of the PIPES tool and results of the changes in PIPES indices was recently published [17].

For this study, unpublished data previously collected during site visits and from interviews of key administrative hospital staff using the PIPES tool were analyzed regarding personnel specifically trained in pediatric procedures, infrastructure, pediatric surgery-specific procedures performed, and supplies and equipment relating to pediatric surgery capacity.

As previously described by Kingham et al., there are only 17 MoHS hospitals in Sierra Leone [2]. Of these government hospitals, one is a pediatric hospital with no surgical services, and six are in rural locations and provide minimal surgical care (limited to minor procedures). Therefore, only 10 hospitals were included in the 2008 assessment and it was data from these 10 hospitals that were reassessed in 2011. As one of these hospitals is a maternity hospital (Princess Christian Maternity Hospital) where no pediatric or general surgery is performed, data collected from this facility were excluded for this study.

Statistics

The data were analyzed using descriptive statistics.

Results

The nine MoHS hospitals assessed include four in Freetown (Connaught, Kingharman, and Rokupa Hospitals and Lumley Health Center) and five in the districts (Bo Regional, Makeni Regional, Port Loko District, Magburka District, and Moyamba District Hospitals). Connaught Hospital is the country's largest health care facility, with 327 beds. It is also the only MoHS tertiary care referral center for medical and surgical conditions.

Personnel

None of the facilities surveyed had a pediatric surgeon or other personnel specifically trained to perform pediatric surgical procedures. General surgeons or other adult-specialty surgeons performed all the procedures in children. Nurse anesthetists administered most of the anesthesia.

Infrastructure

The assessed facilities had between 30 and 327 beds. Six facilities had only one functioning operating room. Connaught and Bo Hospitals each had three functioning operating rooms, and Moyamba District Hospital had two. All facilities had a laboratory to test blood and urine, and seven (78 %) had a generator to provide power. Only five (56 %) had a recovery room, ultrasonography machine, and blood bank. Plain radiography was available in three (33 %) hospitals. Only one hospital (Connaught) offered computed tomography and had an intensive care unit (Table 1).

Procedures

From the 2011 assessment, it was noted that all facilities could perform resuscitation, suturing, incision and drainage

Table 1 Percentage of selected Sierra Leone government hospitals with available infrastructure ($n = 9$)

Infrastructure items	%
Laboratory (blood and urine)	100
Generator	78
Recovery room	56
Ultrasonography	56
Blood bank	56
Running water	44
Plain radiography	33
Electricity	22
Computed tomography	11
Intensive care unit	11

Table 2 Percentage of selected Sierra Leone government hospitals that had performed procedures at least once ($n = 9$)

Procedure	%
Resuscitation	100
Suturing	100
Wound débridement	100
Incision and drainage of abscess	100
Appendectomy	100
Male circumcision	100
Splinting fracture	89
Burn management	78
Casting a fracture	78
Bowel resection and anastomosis	67
Pediatric hernia repair	67
Traction fracture	44
Contracture release	33
Open treatment of fracture	33
Management of osteomyelitis	22
Pediatric abdominal wall defects	11
Clubfoot repair	0
Cleft lip repair	0
Imperforate anus repair	0

of abscesses, débridement, appendectomy, and male circumcision. Splinting of a fracture was done in eight facilities (89 %), burn management and casting of fractures in seven (78 %), bowel resection and anastomosis and pediatric hernia repair in six (67 %), traction for fractures in four (44 %), contracture release and open fracture management in three (33 %), and management of osteomyelitis in two (22 %). Only Connaught Hospital attempted repair of pediatric abdominal wall defects. No facility performed cleft lip, clubfoot, or imperforate anus repairs (Table 2).

Table 3 Percentage of selected Sierra Leone government hospitals with equipment and supplies always available ($n = 9$)

Equipment and supplies	%
Bag-valve mask (pediatric)	89
Oxygen concentrator	78
Pulse oximeter	78
Oropharyngeal airway (pediatric)	78
Endotrachael tubes (pediatric)	78
Scalpel blades	67
Gauze (sterile)	67
Bandages (sterile)	56
Gloves (examination)	44
Nasogastric tubes	44
Intravenous cannulas	44
Syringes	44
Disposable needles	44
Gloves (sterile)	44
Suture	
Absorbable	44
Nonabsorbable	44
Urinary catheters	44
Anesthesia machine	33
Intravenous infusion sets	33
Compressed oxygen in cylinder	22

Equipment and supplies

Equipment and supplies related to pediatric surgery that were sufficiently available at the hospitals included pediatric bag valve masks in eight (89 %) hospitals; oxygen concentrators, pulse oximeters, pediatric oropharyngeal airways, and pediatric endotracheal tubes in seven (78 %); scalpel blades and sterile gauze in six (67 %); sterile bandages in five (56 %); examination gloves, nasogastric tubes, intravenous cannulas, syringes, disposable needles, sterile gloves, absorbable and nonabsorbable sutures, and urinary catheters in four (44 %); intravenous infusion sets in three (33 %); and compressed oxygen in only two (22 %) hospitals (Table 3).

Discussion

Although surgical care is increasingly recognized as an important component of public health [1] and a number of studies have documented the overall lack of surgical capacity in LMICs [2–11], little is known about the capacity of these countries to provide surgical care to children, who constitute nearly half of the population. In fact, data extrapolated from a study in The Gambia by Bickler and Sanno-Duanda estimated that 85 % of children

in LIMCs need some form of surgical care before their 15th birthday [18]. There are no comprehensive surveys of pediatric surgical disease burden, although needed. However, several reports provide an insight into the number of children undergoing surgery and the types of cases treated. A cross-sectional survey in 29 hospitals in south-western Uganda estimated an annual rate of surgery for children <15 years of age to be 180 operations per 100,000 population [10]. In Rwanda, a representative survey of district and regional hospitals across the country found that pediatric surgical cases constituted only 1 % of the 45,759 cases performed each year [19].

Other reports in the literature documenting pediatric surgery from sub-Saharan Africa are mostly from single institutions, and they report only procedures, providing little information on facility and personnel [18, 20, 21] More information on overall personnel has been provided by Chirdan et al. in a survey of eight African countries representing 402 million people, approximately one-third of the population of the continent. In these countries, there were a total of 231 pediatric surgeons—only a fraction of the estimated 1006 needed for their populations. Compared to Europe and North America, which have two to three pediatric surgeons per million people, Nigeria, the most populous country in Africa, has 0.43 per million and Malawi only 0.06 per million. Some countries, such as Sierra Leone, do not have a single pediatric surgeon [22].

Thus, an increase in resources is needed to address the shortfalls in personnel, infrastructure, procedures, equipment, and supplies pediatric surgical care in LMICs is to provided. However, before policymakers and donors will fund and support such programs, the baseline conditions must be sufficiently documented and an assessment of the community's needs undertaken. Only by understanding the magnitude of the problem will it be possible to begin to develop programs and measure the effects of interventions.

A high proportion of the population in LMICs are infants and children, with nearly 50 % of the population in Sierra Leone <15 years of age [23]. With increasing recognition of the importance of noncommunicable diseases—congenital malformations, malignant diseases, injuries—surgery plays an increasingly important role. Common conditions for which surgical interventions can offer a cure, palliate, or reduce disability include traumatic injuries, cancer, and congenital malformations such as cleft lip and clubfoot [24]. Despite the increasing evidence, improving surgical care in general and especially for children is rarely a priority for policymakers.

In Sierra Leone, where there are no trained pediatric surgeons, local general surgeons perform the operations done in children, and nurse anesthetists give most of the anesthesia. The surgery performed is mostly limited to hernia repairs, orchiopexies, burns, and fracture repair, although these surgeons also perform more complex operations (e.g., Wilms tumor resection, major abdominal operations for conditions such as typhoid perforation). These cases are not specifically documented in the current version of the PIPES tool [17]. PIPES was developed as a modification of the World Health Organization (WHO) Tool for the Situational Analysis of Emergency and Essential Surgical Care that was originally introduced in 2008 [2]. PIPES is more concise (105 items vs. 256 for the WHO tool), has a binary system of measurement for ease of data collection, and permits easier calculation of an index to compare facilities or follow longitudinal trends. The differences between PIPES and the WHO tool have been discussed in detail elsewhere [17]. Although neither tool was specifically designed for pediatric use, we found it easier to select items from PIPES that could provide a snapshot of pediatric surgical capacity. However, once we had removed the "adult-specific" items, it was not possible to determine a true PIPES index. We suggest that a pediatric version of PIPES be created and include more procedures commonly found in pediatric populations.

Congenital anomalies contribute to childhood death and disability in LMICs. In this study, however, we documented only the congenital conditions that require specialized surgical expertise, such as cleft lip, clubfoot, and imperforate anus. Currently, these conditions cannot be treated at the government hospitals. More complex anomalies, such as tracheoesophageal fistula repairs, congenital diaphragmatic hernia, and congenital cardiac abnormalities, are even less likely to be treated in LMICs such as Sierra Leone. These conditions, although treatable in competent hands and with sufficient resources, are beyond the scope of most surgeons and anesthetists in LMICs and are therefore not included as data points in the current version of the PIPES tool.

On a positive note, all of the government hospitals assessed in this study were capable of providing resuscitation, suturing, wound débridement, incision and drainage of abscesses, appendectomy, and male circumcision; and six facilities undertook pediatric hernia repair.

There are a number of limitations in this study. First, it is only a snapshot of the MoHS hospitals where surgery is performed. It does not take into account that at different times supplies are available or not or that infrastructure improves or deteriorates. It is therefore important that such assessments be repeated over time and that trends be documented. Second, this study did not document the capacity of the limited number of nongovernmental organization, mission, or private hospitals or the short-term medical missions that periodically provide care for children with congenital anomalies. Third, the PIPES survey is not specifically designed to assess pediatric surgery needs, so it likely overestimates the availability of items such as

intravenous and urinary catheters if adult sizes are in sufficient supply but pediatric sizes are not. As such, even though the results of this survey were useful to Connaught Hospital and to the MoHS in identifying deficiencies, it would be preferable to have a tool that could specifically measure pediatric surgery capacity. In light of the findings of this study, such a survey is being developed that will include documenting the number of pediatric surgeons if there are any, recording if a greater array of pediatric surgical procedures are performed, and documenting more pediatric surgery-specific equipment and supplies such as nasogastric tubes ($\leq$14F), intravenous cannulas ($\geq$22 gauge), and sutures (4/0 and higher). Ideally, such a pediatric PIPES survey would also be undertaken in conjunction with a review of the operating room logbook and physical inspection of the stock.

Conclusions

Surgical care is increasingly recognized as an important part of public health. This study documents the great deficiencies in the infrastructure, procedures, equipment, and supplies for pediatric surgery identified during an assessment of government hospitals in Sierra Leone. It is hoped that the results of this survey will help direct policymakers and donors to provide additional resources for improving the surgical care of the pediatric population in LMICs and help plan interventions. We recommend that such surveys be undertaken in other countries and be repeated over time. We also recommend that a survey be developed that specifically documents pediatric surgery capacity.

Conflict of interest None.

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