

# **OPTIMAL RESOURCES FOR CHILDREN'S SURGICAL CARE**

## **I. Guidelines for Different Levels of Care**



**GICS**

**Global Initiative for Children's Surgery**

*Version 2.0 (January 24, 2019)*

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## 1. KEY MESSAGES

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- Surgical care has an incontrovertible, crosscutting role in achieving child health.
- Children develop different surgical diseases compared to adults, present unique anesthetic challenges, and have special perioperative needs.
- The Optimal Resources for Children's Surgery document provides a strategy for integrating surgical care for children into National Surgical, Obstetric and Anesthesia Plans.
- There is an important opportunity to prevent death and reduce disability in children by scaling up surgical care in low- and middle-income countries.

## 2. SUMMARY

Level of care	Type of facility (DCP3 classification)	Responsibilities	Age Treated	General Anesthesia	OPTIMAL RESOURCES FOR CHILDREN'S SURGICAL CARE				Quality and safety
					Human resources	Required skills	Infrastructure	Equipment & supplies	
Basic	Health center	Screening for surgical disease Resuscitation Referral to higher levels of care	All	No	Non-physician clinician Community Health Workers	Basic assessment and treatment skills	Infrastructure to support basic services	Wound care supplies	CME/CPD Periodic supervision and mentoring
Intermediate	First-level hospital	24/7 Emergency surgical care  Diagnosis and treatment of common surgical diseases	All	Yes, not including complex cases and minimal comorbidity (Limit of ASA I or II)	Physician Anesthesiologist +/- anesthesia provider and perioperative nursing	Skills to treat emergency and essential childhood surgical conditions Anesthesia +perioperative care	Children's ward Functional operating room and recovery area	Emergency and essential surgical equipment & supplies for children	M&M review
Complex/ Advanced	Referral hospital: Second- level	Selected more complex cases	All	Yes, including some complex cases with comorbidities (Limit of ASA III)	General surgeon often present Specialists in some areas of children's surgical care	Surgical, anesthesia, nursing, and ancillary staff with advanced skills in the majority of children's surgical care	Children's clinics High-dependency units	Equipment and supplies to support selected more complex services	Trauma conference  Tumor Board
	Referral hospital: Third-level	Comprehensive surgical care for children <sup>2</sup>	All	Yes, including complex cases with comorbidities (All ASA)	Specialists in all areas of children's surgical care; Advanced nursing/allied health & Pediatric anesthesiologist	Surgical, anesthesia, nursing, and ancillary staff with advanced skills in all areas of children's surgical care	Neonatal and Pediatric Intensive Care Units (NICU/PICU) Burn Unit	Equipment and supplies to support full spectrum of children's surgical care	As above
	Referral hospital: National Children's hospital	Multidisciplinary and chronic care  Training, education, research in all children's surgical specialties  Development of standards of care & Advocacy	All	As above	As above	As above Training in multidisciplinary and chronic care	As above	As above	As above  Multi-disciplinary program review

1. Levels of care defined as Basic (I), Intermediate (II) and Complex/Advanced (III). Higher levels assume presence of infrastructure/ services at lower levels
2. Type of complex/advanced care delivered at second and third level hospital and national children's hospital may vary considerably by resources available in a country
3. CME: Continuing medical education; CPD: Continuing professional development; M&M- Morbidity and Mortality; ASA- American Society of Anesthesia classification

## 3. BACKGROUND

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### 3.1 Introduction

Despite remarkable progress in improving the health of children worldwide during the past 25 years, there are areas in which progress has been much slower.<sup>1</sup> Surgical care of children is one of the most critical examples. In many low-resource settings, surgical care of children continues to be viewed as a non-essential component of maternal-child health programs and a small part of the health needs of the pediatric population. In the absence of surgical care, congenital anomalies go unrepaired, treatable injuries result in lifelong disabilities, and children die of easily correctable surgical problems, e.g., airway foreign bodies, incarcerated inguinal hernias, and abdominal emergencies.<sup>2</sup>

In the past several years, the Essential Surgery Volume of the Disease Control Priorities 3<sup>rd</sup> Edition (DCP3), Lancet Commission on Global Surgery and other stakeholders have highlighted the critical need for improving surgical care worldwide.<sup>3,4</sup> Subsequently, the World Health Assembly (WHO) passed resolution (A68/15) on strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage (UHC).<sup>5,6</sup> None, however, have explicitly addressed the unique surgical needs of children and the resources required to meet these needs in low-resource settings, where children represent up to 40-50% of the population. Global initiatives directed at reducing the high rate of infant and under-five mortality rate of children has also overlooked the surgical needs of children.

The Global Initiative for Children's Surgery (GICS) is a consortium of providers, institutions, and allies from both resource-rich and low-resource settings, who envision a future where every child will have access to surgical care.<sup>7</sup> This optimal resources document has been developed by GICS and represents consensus of worldwide leaders and providers of children's surgery in low-resource settings targeting surgical care in low-resource settings. Importantly, the

recently updated WHO-WFSA (World Federation Of Societies Of Anesthesiologists) document detailing safe practice of anesthesia and perioperative care was incorporated into this work through the anesthesia working group of GICS.<sup>8</sup> This document provides standards for service delivery through the health system and defines types of anesthesia providers. GICS recognizes that surgery, anesthesia, and nursing disciplines must closely align to ensure safe service delivery. Deficiencies in any of these areas compromise care at all levels of the health system.

### **3.2 Goals of the Optimal Resources for Children’s Project**

The goal of the Optimal Resources for Children’s Surgery (OReCS) program is to identify and promote standards of care that will improve the surgical care of children worldwide. The OReCS Program seeks to accomplish this by more clearly defining what essential services should be made available to every child in every region of the world. The OReCS recommendations are also intended to expand upon the World Health Organization’s recently developed standards for improving the quality of care for children and young adolescents in health facilities.<sup>9</sup>

In multiple international GICS meetings, low-resource providers identified 1) training and staffing 2) physical resources 3) quality and safety, and 4) research as thematic areas that need to be addressed to improve children’s surgery globally. Importantly, these thematic areas represent subsets of the WHO health systems building blocks (Workforce, Service Delivery, Medical Products, Vaccines & Technologies, Financing, Leadership & Governance, and Information Systems)<sup>10,11</sup>. The Optimal Resource Project addresses specific aspects of health systems that low resource providers believe must be addressed first.

The Optimal Resource Project also seeks to describe necessary resources by hospital level within a national health system. The resources for different levels of children’s surgical care are outlined in the form of templates, which are designed to support basic, intermediate and complex/advanced surgical care for children in low resource settings. The goal of these templates is to provide a guide for minimum standards for those planning surgical services for children in low-

resource settings. Thus, OReCS is intended to provide pragmatic, yet comprehensive recommendations regarding the resources, training and research priorities required for safe and high-quality surgical services for children. These resources can be adapted to suit local contexts and settings.

These guidelines are intended for:

- Health care professionals: in delivery and providing children's surgical services, and development of general and subspecialty services.
- Hospital managers and administrators: in organization and strengthening of children's surgical services.
- Policy makers: to provide the necessary strategic planning support for children's surgery.
- Health planners: to ensure specific services (i.e., intensive care, blood banking, transport and referral systems, availability of essential medicine) are delivered at appropriate levels of the health system.
- Training institutions and colleges: in planning, education and scale up of training of human resources to support children's surgery.
- Individuals and organizations: in advocating for children's surgery.

### **3.3 Justification**

Approximately five billion people lack access to safe surgical care worldwide, with the majority living in low- and middle-income countries (LMICs).<sup>3,12</sup> Given that children comprise 40% - 50% of LMICs populations, this means that worldwide in 2016 up to 2.0 billion children do not have access to safe surgical care. To attain universal health coverage (UHC) and achieve the specific goals and targets of the sustainable development goals (SDGs), access to safe and affordable surgical and anesthesia care must be provided *for all children*, regardless of geographic location or socioeconomic status. It is therefore crucial that children's surgery becomes a key component of

every country's National Surgical, Obstetric and Anesthesia Plans (NSOAPs) and National Maternal and Child Health Plans. Fully integrating children's surgery into health systems strategic planning both capitalizes on the multiple specialty-specific collaborations necessary in children's surgery and avoids vertical plans that may lead to fragmented health systems. This is particularly important in poorest areas of the world where the surgical needs of children are the greatest.

Published literature and previous work have emphasized that outcomes for children with surgical problems are optimized when treatment is provided by those specifically trained to provide care for this segment of the population<sup>13-15</sup>. Based on these findings, efforts have been made to identify optimal resources for children's surgical care in high-income countries<sup>16-18</sup>, but these do not address low-resource settings, where the needs of children often may be neglected.

Children develop different surgical diseases compared to adults, have unique physiologic needs and require different operations. For example, they have specific anaesthetic risks, difficulties maintaining their body temperature, metabolic differences compared to adults, risk for medication errors, unique transfusion and resuscitation protocols, and challenges in vascular access. Their care before, during and after operations also differs. Good outcomes depend on having the right resources and recognizing that "children are not just small adults". For this reason, children should be treated in child-friendly environments with appropriate resources and properly trained professionals to adequately address and meet their unique needs.

## **4. SURGICAL NEEDS OF CHILDREN**

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### **4.1 Epidemiology of childhood surgical conditions**

Surgical needs cut across the entire spectrum of children's health problems, with the most common conditions being injuries, congenital anomalies, and infections requiring surgery.<sup>19,20</sup> Further, surgical conditions are exceedingly common, with an estimated 85% of children requiring surgical care at some time before reaching age 15 years.<sup>21</sup> Twenty per cent of children in a recent

multi-country household survey had a surgical need, and 62% of these children had an unmet need, corresponding to 3.7 million children in those countries alone.<sup>22</sup>

While global efforts to improve neonatal survival have expanded, these programs have not included neonatal surgery, and the mandate to ensure treatment of surgical congenital anomalies.<sup>23</sup> Road traffic injuries and associated traumatic brain injuries also exact an extraordinary toll on children, with more children in the 5-14 age group dying of injuries than HIV, tuberculosis, and malaria combined.<sup>24</sup> Globally, 90% of burn injuries occur in low-income countries and children are disproportionately affected.<sup>25</sup> Meanwhile, as global attention has shifted to non-communicable diseases, cancer control efforts are growing, but generally have not emphasized resources required to treat tumors in low- and middle-income countries.<sup>26</sup> For many childhood cancers in these settings, surgery is the primary curative modality required to ensure survival, as chemotherapy and radiation may not be available.

#### **4.2 Benefits of providing children's surgical care**

The provision of surgical care to children within a health system can achieve the following goals:

- Identify and treat correctable congenital anomalies.
- Treat life-threatening injuries promptly to maximize the likelihood of survival.
- Ensure potentially disabling injuries are treated appropriately, in order to minimize functional impairment and to maximize return to independence and participation in community life.
- Minimize acute and long-term pain and suffering.
- Protect from substantial economic losses to entire families due to medical expenses, death, and disability.
- Increase economic productivity in families, communities, and countries.
- Increased physical activities helping to prevent non-communicable diseases.

- Increase school attendance.
- Improve equity in surgical care provision across all age groups, as children are often neglected.

## 5. STRUCTURE OF HEALTH SYSTEMS IN LOW AND MIDDLE-INCOME COUNTRIES

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### 5.1. Overview

Health care in most LMICs is delivered through a network of health care facilities; which vary by the type and complexity of care provided. The most common organizational scheme in LMICs is a national referral hospital supported by provincial general hospitals, district hospitals, health centers, and dispensaries. This network of facilities is often supplemented by privately owned and operated hospitals and clinics and care provided by faith-based organizations. It is important to appreciate that facility terminology may vary considerably worldwide, and that capabilities, and “platforms for service delivery” at each level vary significantly among different countries. It is also acknowledged that the division between different levels is somewhat arbitrary as many times patients seek care for less complicated surgical problems at higher-level facilities. Nevertheless, classification of health facilities is still extremely valuable for allocating resources to the different levels of the health system.

### 5.2 Types of facilities

The OReCS Program builds on the health care facility classification system used in the Disease Control Priorities, 3<sup>rd</sup> Edition (DCP3).<sup>27</sup> DCP3 classifies platforms of delivery into five categories: **1) population based, 2) community level, 3) health center, 4) first-level hospital, and 5) referral hospital.** The OReCS program focuses on the delivery of surgical care at the highest three levels, i.e., levels 3, 4 and 5. In addition, based on recommendations of children’s

surgery providers in LMICs, the OReCS Program further splits the referral hospital levels into second, third level facilities and national children's hospitals. This distinction was important to children's surgery providers in LMICs because of the substantially different complexity of care that is typically provided at second and third-level hospitals. The children's hospital category was added because of the tremendous impact this type of facility can have on training, research and advocacy, both at the national and international level. It is important to appreciate nomenclature of hospital levels can vary by country, or region of the world. As an example of this slightly different nomenclature, the WHO classification system includes three levels of hospitals: small hospital/health center (first-level); second-level (generally the district hospital) and third-level. Table 1 reviews the classification system, as designation and nomenclature of hospital levels have sometimes varied. As the DCP3 and WHO health care facility classification can be confusing, the OReCS document includes both nomenclatures in most tables.

### **5.2.1 Health center**

A health center is typically staffed by non-doctor providers, such as community health workers, nurses, or medical assistants. It is the mainstay of health care throughout many of the rural areas of low-income countries. Health centers serve an important role in the health care system, as they represent the point of first contact for a child with any medical need, including those with surgical problems. Programs exist at this level for recognition and treatment of life-threatening problems at birth and in the neonatal period, but surgical problems have not been targeted.

### **5.2.2 First-level hospital**

This level facility forms an integral part of the health system, as up to 90% of the global population receives their emergency care at this level. How these facilities are staffed, and importantly, the distance and ability to transfer to the next level of care can be highly variable. First-level hospitals should have twenty-four-hour clinical services that can provide emergency

treatment for patients with life-threatening injuries, obstetrical emergencies and other child health, medical and surgical problems that require immediate intervention. Providers at these hospitals should be comfortable with basic resuscitation, initial care and management of injuries, burns, and infections, and be comfortable screening for congenital anomalies. Surgical providers should be familiar with basic pediatric surgical procedures.

As such, first-level hospitals should have a functional operating room with a provider capable of administering a safe general anesthetic as well as availability of oxygen, sterile instruments, anesthetic agents and essential medicines.<sup>8</sup> This is typically the first level of the health care system where a general anesthetic can be provided. A recovery area should be present and nurses should have perioperative care skills. This level of facility should also have the laboratory and diagnostic capabilities that are appropriate for the medical, surgical and outpatient care provided. In some areas, particularly in East Africa, non-physician surgeons have been trained to act in the capacity of general surgeons, performing Caesarean section and other general surgical procedures.

### **5.2.3 Referral hospitals**

Referral hospitals serve the important role of supporting the health care provided at lower levels of care, both in terms of provided care for more complicated patients and for training and education. The OReCS Program includes recommendation for three types of referral hospitals: 1) second-level hospital, 3) third-level hospital, and 4) national children's hospital.

#### **5.2.3.1 Second-level hospital**

Second-level hospitals typically have a least one fully trained general surgeon and an anesthesiologist. The staff at such facilities may also include other specialists such as orthopedic surgeons. More advanced and specialized nurses may be present, along with some allied health personnel supporting surgical services (e.g. physical and occupational therapists). These facilities

are usually referred to as regional hospitals in parts of Africa, community health centers or district hospitals in India, or general hospitals in Latin America and parts of Africa.

### **5.2.3.2 Third-level hospital**

Third-level hospitals have the broadest range of subspecialties and represent the highest level of care within a country or geographic region. The capabilities of third-level hospitals vary widely worldwide. Some third-level hospitals have an extensive range of subspecialties, while others are more limited. Third-level hospitals serve the important additional function of being teaching hospitals. Stand-alone facilities or niche hospitals that focus on a specific specialty, or surgical conditions (e.g. orthopedic, craniofacial, neurosurgery) also belong to this category of facilities. Human resources and skills should include complex care with a wide range of nursing and allied health personnel (See Appendix 1).

### **5.2.3.3 National children's hospital**

Children's hospitals focus exclusively on the health needs of children and adolescents. Such facilities may be part of a second or third level or may be an independent facility. Children's hospitals serve the important role of training, education, and research, and are typically better resourced (spectrum and numbers of available specialists, specialized support services, specialized equipment) for the care of children compared to the regular hospitals at those levels. Ideally, each country should have at least one designated national children's hospital.

**Table 1.** Definition and examples of different types of health care facilities in low- and middle-income countries. Type of facility is based on classification system used in DCP3 (World Bank) and the World Health Organization.

Facility classification		Description	Examples
DCP3 (2017)	WHO (2003)		
Health center	Level 1: Small hospital/health center	Health care facility usually located within a rural community  Provides basic health care services of very general nature.  Proper triage is a key expectation	Community health center Primary health center Comprehensive health center
First-level hospital	Level 2: District/provincial hospital	Services available are of a general nature and not specialized  First level at which general anesthesia is available  Proper triage is a key expectation.	General hospital District hospital Cottage hospital
Referral hospital	Second-level hospital	Level 2: District/provincial hospital  Clinical services are specialized by function, but not all specialties and limited specialized technical equipment are available	Regional hospital Provincial hospital General mission hospital
	Third-level hospital	Level 3: Referral hospital  Highly specialized hospital, with similarly specialized staff and technical equipment to support level of care provided  Clinical services are highly differentiated by function  Training is provided	Academic/teaching/university hospital National hospital Central hospital Niche / Specialized mission hospital
	National children's hospital	Level 3: Referral hospital  Highly specialized hospital, dedicated to the care of children  Highly specialized staff and technical equipment in all children's specialties are available  Complex multidisciplinary and chronic care Specialized teaching and research in all children's specialties provided	Children's hospital

## **6. LEVELS OF CHILDREN'S SURGICAL CARE**

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### **6.1 Overview**

It is neither feasible, nor desirable to provide all types of surgical care at every level of the health care system. As such, it is important to decide which childhood surgical problems can be safely treated at different levels of the health care system. This approach is feasible because children's surgical conditions have variable complexity, with some childhood surgical conditions treatable with less skill and resources, while others require advanced training and greater resources. The majority of childhood surgical conditions are relatively simple to treat, making prevention of death and disability very cost-effective.

### **6.2 Levels of surgical care**

The OReCS program defines three levels of surgical care for children: basic, intermediate and complex/advanced care (Table 2). These categories are based on the complexity of the surgical problem and the resources required to treat the problem.

#### **6.2.1 Basic surgical care**

Many of the most common surgical problems of children are not difficult to treat and require only minimal resources. Examples of basic surgical care include repair of an uncomplicated laceration or splinting of a fracture. Nonetheless, basic surgical care does require a basic knowledge of childhood surgical conditions, such that simple problems can be treated and more complicated problems are recognized and referred to higher levels of care after appropriate stabilization and resuscitation. By definition basic surgical care are problems that do not require general anesthesia.

### **6.2.2 Intermediate surgical care**

This level of care addresses the most common emergency and essential surgical conditions of childhood. Examples include uncomplicated appendicitis, management of the majority of childhood injuries and treatment of common surgical infections (e.g., empyema, uncomplicated osteomyelitis). More complicated surgical conditions, and those with comorbidities are referred to higher levels of care. Surgical problems that fall into this category may or may not require a general anesthetic. Perioperative nursing skills are required at this level.

### **6.2.3 Complex/advanced surgical care**

Complex/advanced surgical care requires the greatest knowledge of childhood surgical conditions. Examples are neonatal surgery, repair of cleft lips and palates and pediatric neurosurgical and cardiac procedures. Multimodal pediatric oncology care including coordinated care with pediatric oncologists through a cancer care team would be found at this level. Treatment often involves highly specialized care and is often multidisciplinary including more specialized nursing skills and a wide range of allied health professionals.

## **6.3. Suggested levels of care by facility type**

Countries vary markedly in their ability to pay for health care. Recognizing this, individual countries will need to make decisions regarding, where and how surgical resources will be allocated. The resources outlined are standards rather than estimates of current capacity, which may be below standards in some low-income countries. To facilitate this planning process the OReCS program has included the following criteria to help identify which level of care is most appropriate for the type of facility (Table 3). In a fashion similar to that used in *Guidelines for essential trauma care*, the priority for having each level of care was given a designation according to the following criteria:<sup>28</sup>

### **“Essential” (E) care**

An “E” designation means that the stated level of care should be available in all cases. The E designation represents the minimal acceptable level of children’s surgical care common to all regions, including even those where access to resources is most severely restricted. These services could and should be provided to children with surgical problems at the health facility concerned, even in countries with the most limited financial resources (whose Ministries of Health have a total budget of only \$3–4 per capita per year). It is important to recognize that these essential items could be provided primarily through improvements in organization and planning, with a minimal increase in expenditures.

### **“Desirable” (D) care**

The designated item represents a capability that increases the probability of a successful outcome for children with surgical conditions. Such items may not be possible to provide for all facilities in environments with the poorest access to resources. Hence, they are not listed as essential. However, for countries with greater resource availability, such items may ultimately be designated essential in their own national plans.

Finally, the OReCS program anticipates that in the process of developing national surgical plans, many countries, especially with greater resources, will appropriately decide to declare some of the items in the desirable category essential, or provide higher levels of care at lower levels of the health system. The converse is not true, items designated as essential should remain so designated, as a change may result in children’s surgical care below recommended standards.

**Table 2.** Levels of care based on the complexity of the surgical conditions

Level of care	Definition
I: Basic	Recognition and treatment of minor surgical conditions that do not require a general anesthetic. Referral of more complex surgical conditions and patients with important comorbidities to higher levels of care.
II: Intermediate	Recognition and treatment the most common emergency and essential childhood surgical conditions that may or may not require a general anesthetic. Referral of more complicated childhood surgical conditions and patients with important comorbidities to a higher level of care.
II: Complex/Advanced	Treatment of complex children’s surgical conditions. Multidisciplinary and highly specialized care.

**Table 3.** Recommended level of surgical care for children by facility type/platform.

Type of facility (DCP3classification) <sup>a</sup>		Level of care		
		Basic	Intermediate	Complex/Advanced
Health center		E	-	-
First -level hospital		E	E	-
Referral hospital	Second level hospital	E	E	D*
	Third level hospital	E	E	D
	National Children’s hospital	E	E	E

E = Essential; D = Desirable

D\*: depends of available resources and geographic location of facilities

<sup>a</sup> See Table 1 for equivalent health care facilities in the WHO classification system.

## **7. OPTIMAL RESOURCES FOR CHILDREN'S SURGICAL CARE BY LEVEL OF CARE**

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### **7.1 Overview**

In most low resource settings, little consideration has been given to optimizing the resources available for treatment of children with surgical conditions. Many hospitals lack important equipment, some of which is inexpensive. GICS members have observed that the main reason for the absence of such vital equipment and supplies is usually a lack of organization and planning, rather than resource restriction. Programs to assure the supply and maintenance of children's surgical equipment, appropriate to specific country circumstances, could address deficiencies with relatively inexpensive but high-yield resources. Nevertheless, in 2018, these goals should be achievable for most children with surgical needs regardless of geographic location.

### **7.2 Resource templates**

The OReCS program provides resource templates for each of three suggested levels of care (basic, intermediate, complex/advanced). These resource templates offer broad guidelines to how surgical care of children might be organized in a health system. Each template provides an overview of the scope of practice and provides specific resources for optimal children's surgical care. Scope of practice contains information on the function, age and comorbidities of patients, anesthesia required, and procedure type. The templates are organized into three sections: 1) training and staffing, 2) physical resources, and 3) quality and safety. Training implies that medical, nursing and other staff have the requisite skills to perform diagnostic and therapeutic activities safely and successfully. Proper training includes basic education (school and postgraduate training), and a process for continuing education to maintain their skills. Training issues are described in greater detail in Section 8.1.

Physical resources are defined as infrastructure, equipment and supplies. To be effective for a population these items must be available to all who need them without consideration of ability to pay. Equipment and supplies need to be readily available on an ongoing basis; where appropriate, 24 hours a day, seven days a week. It also implies that supply chains within the health system are functional, and that organizational and administrative mechanisms are in place to replace needed items or to accomplish equipment repairs when required.

The resource templates provide a list of childhood procedures that each respective level of the health system should be capable of performing safely. Our procedure recommendations align with and are an extension of the recommendations of the DCP3 essential surgery guidelines of 44 procedures that are both cost effective and essential at each hospital level<sup>29</sup>. Some of the procedural recommendations by the DCP3 that are relevant to children and parallel our recommendations include incision and drainage at the health center level, appendectomy, trauma laparotomy, external fixation and emergency burr hole at the first level hospital, and operative repair of club foot, cleft lip/palate and anorectal malformations at the second and third level hospitals. For ease of reference, Appendix 2 includes a list of childhood procedures by specialty and hospital level. Appendix 3 provides recommended procedures by thematic areas: trauma/injury, congenital anomalies, infections, tumors and other.

### **7.2.1 Optimal resources for basic surgical care (health center)**

The suggested optimal resources for basic surgical care are summarized in Table 4. The optimal resources for this level of care, which would be available at the health center, focus on recognition and triage of childhood surgical conditions. Treatment is limited to uncomplicated conditions that do not require a general anesthetic. The key resources required for this level of care are training, wound care supplies and education including community injury prevention strategies.

### **7.2.2 Optimal resources for intermediate surgical care (first-level hospital)**

The suggested optimal resources for intermediate surgical care are summarized in Table 5. The optimal resources for this level of care should be available at the first level hospital and would focus on supporting emergency and essential surgical care of children. The particular resources required for this level of care are training and supplies needed to support the care, as well as monitoring and evaluation of care. This level of care assumes that a first-level hospital has a functional operating room with support services. Anesthesia and perioperative care providers including nursing is critical at this level. As previously noted, all surgical procedures in children < 1 year old should be referred to higher level of care except for emergent cases where no referral is possible. In the scenario that a child < 1 year old must undergo general anesthesia at this level, the most senior anesthesia provider should care for the child.

### **7.2.3 Optimal resources for advanced/complex surgical care (referral hospital)**

The suggested optimal resources for advanced/complex surgical care are summarized in Tables 6. For this level of care, the key resources are training and the supplies needed to support a broad spectrum of specialized children's surgical care that is often multidisciplinary. Surgical, anesthesia, and nursing providers must have more advanced training, and a broader range of allied health personnel must be present to support specialized services. It must be emphasized that the quantity and type of advanced/complex surgical care delivered at different types of referral hospitals can vary considerably between countries, and depends on resources available as well as geographic location. Thus, individual countries must decide how best to distribute advanced/complex surgical care. To facilitate this decision-making the OReCS program has outlined some of the general differences that should distinguish the type of surgical care for child provided at second and third level facilities, and national children's hospitals (Table 7).

#### **7.2.4 Optimal resources for children's anesthesia care**

In contrast to surgical subspecialties where procedures can be specifically defined by levels of care, anesthesia and peri-operative care must take into account the child's age and risk stratification as determined by the child's co-morbidities. This principle led to the following summary anesthesia recommendations which should be used in addition to the specific surgical recommendations by level of care. Of note, these recommendations include a specific recommendation for the first-level hospital in which all children < 1 year old that require general anesthesia should be transferred to a higher level of care. The only exception is infants requiring emergent surgical procedures in which transfer is not possible. This recommendation comes directly from observational data on adverse outcomes in infants. Children less than 1 month undergoing general anesthesia have an approximately 6 times higher risk of cardiac arrest than do infants between 1 month and 1 year of age and children between 1 month and 1 year have an approximately 4 times higher risk of anesthesia-related cardiac arrest than in children aged 1 to 18 years old<sup>30-32</sup>.

- At any level of care where children's surgery is performed under general anesthesia or regional anesthesia, there should be a trained anesthesiologist or non-physician anesthesia provider available to provide care during the procedure (exception is for minor surgery under local anesthesia).
- GICS and the WFSA view anesthesiology as a medical practice. Wherever and whenever possible, it is highly recommended that anesthesia delivered to a child should be provided, led or overseen by an anesthesiologist. When anesthesia is provided by non-anesthesiologist, these providers should be directed and supervised by anesthesiologists in accordance with their level of training. When an anesthesiologist is not present at a specific hospital level, care should be provided by the most experienced anesthesia provider available.

- Alternatives to general anesthesia should be developed and explored (local and regional anesthesia) at all levels of care whenever applicable.
- Size specific anesthesia monitors and equipment should be available at all care levels and facilities in which general anesthesia is provided to allow for children to be adequately monitored.
- Programs for post-operative pain management should be developed in at all levels where children's surgery occurs.
- Unit sufficient resources are available to ensure that physician anesthesiologists are physically present at every level where children's surgery occurs, pediatric surgical networks for telemedicine, telephone consultation or other communication should be developed and made standard procedure that take into consideration specific anesthesia perspectives in regard to caring for children.

**TABLE 4.** Optimal resources for basic surgical care. This type of care is designed to be delivered at the Health Center Level<sup>a</sup>.

<b>BASIC SURGICAL CARE</b>		
<b>SCOPE OF PRACTICE</b>		
<b>Function</b>	Screening for surgical disease Resuscitation and Triage Training of health care workers Referral to higher levels of care Community Health Education	
<b>Age of patients</b>	All ages	
<b>Anesthesia</b>	Local anesthesia for minor procedures.	
<b>Examples care provided (See Appendix 1 and 2 for a more detailed list)</b>	<b>Injuries</b>	Resuscitation with basic life support measures, suturing and dressing of simple wounds, splinting of closed, non-displaced fractures 1 <sup>st</sup> degree burns < 10% TBSA and not including face, hands, GCS Score
	<b>Congenital anomalies</b>	Screening for congenital anomalies (e.g., abdominal wall defects, hernias, anorectal and urogenital abnormalities, limb deformities, hip dysplasia, cardiac anomalies, neural tube defects and craniofacial anomalies (cleft lip/palate)
	<b>Infections</b>	Screening for surgical site infections, intra-abdominal infection, bone and joint infections. Treatment of superficial abscess with incision and drainage
	<b>Tumors</b>	Screening for tumors
	<b>Others</b>	Circumcision using a Plastibel Removal of visible foreign bodies in the ear and nose Hearing screening Vision screening
<b>OPTIMAL RESOURCES</b>		
<b>Training &amp; staffing</b>	<b>Human resources</b>	Community health workers, general practice nurses, and others
	<b>Required skills</b>	Screening: congenital anomalies, surgical diseases, surgical site infections Resuscitation and stabilization: basic life support measures including airway management, peripheral vascular access, insertion of nasogastric tube, initial burn management Care of trauma wounds: arrest of bleeding, cleaning, suturing, dressing, splinting Care of postoperative wounds: cleaning, dressing, removal of stitches Pain management: use of non-opioid analgesics
<b>Physical resources</b>	<b>Infrastructure</b>	Infrastructure to support basic services Availability of transportation to higher level of care
	<b>Equipment &amp; supplies</b>	See OReCS: Supplies, Equipment and Infrastructure Document
<b>Quality &amp; Safety</b>	Supervision and mentoring Data collection for Quality Control CME/CPD	

<sup>a</sup> Equivalent to small hospital/health center in the WHO health facility classification system (WHO Level 1).

**TABLE 5.** Optimal resources for intermediate surgical care. This type of care is designed to be delivered at First-Level Hospitals<sup>a</sup>.

INTERMEDIATE SURGICAL CARE		
SCOPE OF PRACTICE		
<b>Function</b>	24/7 emergency surgical care Diagnosis and treatment of the most common pediatric surgical conditions Training of health care workers Referral to next level of care for complex procedures	
<b>Age of patients</b>	All ages <sup>b</sup>	
<b>Anesthesia</b>	General anesthesia (ASA I+II) Referral ASA >2	
<b>Examples of care provided (see Appendix 1 and 2 for a more detailed list)</b>	<b>Injuries</b>	Resuscitation with advanced life support measures including fluid management and nutrition Trauma laparotomy Closed and open fractures Diagnosis and stabilization of neurological trauma (e.g., epidural hematoma, includes emergency burr hole if transfer not possible) Treatment of burns (<10% not involving face, hands and perineum)
	<b>Congenital anomalies</b>	Inguinal hernia repair in older children
	<b>Infections</b>	Incision and drainage of abscesses, pyomyositis and septic arthritis Appendicitis, intestinal perforation Thoracostomy tube for empyema Drainage and debridement of osteomyelitis
	<b>Tumors</b>	Excision of benign tumors
	<b>Others</b>	Intestinal obstruction (e.g., intussusception, enterolysis for adhesions) Foreign body removal from ear, nose, airway and esophagus
OPTIMAL RESOURCES		
<b>Training &amp; staffing</b>	<b>Human resources</b>	General doctor or non-physician surgical provider Anesthesiologist +/- anesthesia provider Perioperative and ward nursing, Physiotherapist
	<b>Required skills</b>	Basic knowledge of common childhood conditions Advanced Trauma Life Support (ATLS); Pediatric Advanced Life Support (PALS); SAFE course Antibiotic stewardship Pediatric pain management Pediatric anesthesia experience
<b>Physical resources</b>	<b>Infrastructure</b>	Operating room, recovery area, and children's ward Availability of transportation to higher level of care
	<b>Equipment &amp; supplies</b>	See OReCS: Supplies, Equipment and Infrastructure Document
<b>Quality &amp; Safety</b>	Supervision and mentoring Data collection for Quality Control CME/CPD	

<sup>a</sup> Equivalent to a district or provincial hospital in the WHO health facility classification system (WHO Level 2).

<sup>b</sup> All babies < 1 year old should be referred to higher levels of care due to increased anesthetic risk. Only exception is life-threatening emergency when transportation is not possible.

**TABLE 6.** Optimal resources for complex/advanced surgical care. This type of care is designed to be delivered at the referral hospital level. Referral hospitals include Second- and Third levels facilities, and National Children’s Hospitals<sup>a</sup>.

COMPLEX/ADVANCED SURGICAL		
SCOPE OF PRACTICE		
<b>Function</b>	Advanced diagnostic services and multidisciplinary specialized care Receive referrals from other hospital levels Training of health care workers Research and Advocacy Develop standards of care	
<b>Age of patients</b>	All ages	
<b>Anesthesia</b>	All types of anesthesia including neonatal, cardiac and neuro anesthesia	
<b>Examples of care provided (See Appendix 1 and 2 for a more detailed list)</b>	<b>Injuries</b>	All traumatic injuries referred from lower levels of care, including neurovascular injuries
	<b>Congenital anomalies</b>	All congenital anomalies referred from lower levels of care, including repair of anorectal malformations, urogenital anomalies, congenital heart disease and meningomyelocele, hydrocephalus
	<b>Infections</b>	All surgical infections referred from lower levels of care, including complex soft tissue infections, osteomyelitis, intracranial infections
	<b>Tumors</b>	All benign and malignant tumors, including abdominal and urological malignancies
	<b>Others</b>	
OPTIMAL REASOURCES		
<b>Training &amp; staffing</b>	<b>Human resources</b>	Trainees: Medical Students, Surgical Residents and Surgical Subspecialty Fellows Physician Human Resources: Pediatric Surgical Specialists: general pediatric surgery; cardiac surgery; ENT surgeon; neurosurgery, ophthalmology; oral and maxillofacial surgery; orthodontics; orthopedic surgery; plastic surgery; urology General pediatricians and pediatric specialists: Anesthesia, Critical Care, Cardiology, Oncology, Gastroenterology, Neurology, Nephrology, Radiology, and others Non-Physician Human Resources: All Support specialists and staff in relevant specialties including perfusionists, Speech pathologist, occupational/physical therapists
	<b>Required skills</b>	Appropriate skills and training necessary to provide such specialized pediatric surgical care including neonatal critical care Structured Education for Trainees (all levels) Management and administrative skills
<b>Physical resources</b>	<b>Infrastructure</b>	Dedicated space for pre-operative and post-operative evaluation Dedicated Children’s inpatient ward, ICU and NICU Endoscopy capability- EGD, colonoscopy, bronchoscopy Complete radiology capability (CT/MRI/Ultrasound/Fluoroscopy) Cardiac catheterization lab, cardiopulmonary bypass
	<b>Equipment &amp; supplies</b>	See OReCS: Supplies, Equipment and Infrastructure Document
<b>Quality &amp; Safety</b>	Supervision and mentoring; Data collection for Quality Control CME/CPD; Morbidity and Mortality Conference Trauma Conference; Tumor Board	

<sup>a</sup> Equivalent to a district/provincial hospital or referral hospital in the WHO health facility classification system (WHO Level 2 or 3)

**TABLE 7.** Suggested distribution of advanced/complex care at different levels of referral hospitals. Higher levels of care assume the infrastructure/services/functions of lower levels of care are present.

Type of referral hospital	Responsibilities	General anesthesia	Human resources	Required skills	Infrastructure
<b>Second- level</b>	24/7 Emergency surgical care, Selected more complex cases  Health care worker training  Appropriate referral	Yes, including some complex cases with comorbidities (Limit of ASA III)	Specialists in some areas of children’s surgical care provided	Advanced surgical, anesthesia, and nursing skills in the majority of children’s surgical care	Children’s wards, clinics, operating rooms, and recovery areas
<b>Third-level</b>	Comprehensive surgical care for children	Yes, including complex cases with comorbidities (All ASA)	Specialists in all areas of children’s surgical care provided Pediatric anesthesiologist	Advanced surgical, anesthesia, and nursing skills in all areas of children’s surgical care	NICU, PICU, burn unit
<b>National Children’s hospital</b>	Multidisciplinary and chronic care  Training, education and research in all children’s surgical specialties  Development of standards of care Advocacy	As above	As above	As above  Training in multidisciplinary and chronic care	As above

## 8. STRATEGIES FOR IMPROVING CHILDREN'S SURGICAL CARE

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### 8.1 Training

There is a critical need to improve the knowledge and skills of those who care for children with surgical conditions at all levels of the healthcare system, from the community health worker to the general doctor and pediatrician, and the surgical, anesthesia, and perioperative care specialists at the tertiary referral hospital. A variety of other professionals are also critical to the treatment of children with surgical conditions including, but not limited to nursing, laboratory and X-ray technicians, operating room personnel, and rehabilitation specialists. A table of recommended human resources at each health care level is provided in Appendix 1.

The scale of the global surgery workforce problem is perhaps best illustrated by estimation of the Lancet Commission on Global Surgery (LCoGS) that there could be a deficit of 2.3 million surgical providers by the year 2030. Krishnaswami *et al.* have recently reviewed pediatric surgical workforce needs with similarly dire conclusions.<sup>33</sup> Anesthesia providers and perioperative nursing staff are also severely limited.<sup>34</sup> Lack of funding, limited training opportunities and deficient political support, in combination with a critical lack of mentors, were identified as important limiting factors.

Greater attention is needed worldwide to define and optimize the training of doctors, non-physician providers, nurses, and allied health professionals in the surgical care of children. This includes developing means of improving knowledge and skills imparted during undergraduate medical education, as well as the knowledge and skills acquired during postgraduate training. There is a need to integrate the surgical care of children into basic medical school curriculum and house-officer training, as well as in specialist training, for example, in anesthesia, orthopedics, neurosurgery, among other disciplines. This expanded education would assure that all graduates assigned to work in rural hospitals would have the skills needed to assess and treat children with

the most common surgical conditions. Existing educational resources may be used and new integrated modules may be developed.<sup>35-41</sup> Standardization of curricula that focus on improving children's surgical care skills could be an important tool for raising the standard of such care worldwide. There is also a clear need to increase the number of fellowships that focus on children's surgical care after completion of formal surgical residency training.

Training should reflect the surgical needs of the pediatric population served. Rather than a vertical approach that focuses on specific diseases, a holistic approach based on packages of conditions is recommended. There is a need to define a specific set of diagnostic and therapeutic skills to care for children with surgical conditions at every level of the health care system (Table 8). Such training could be provided to all levels of the health system by professional associations in countries where this type of organization is possible. Alternatively, training packages could be delivered regionally when not possible in individual countries.

Finally, there is need for continuing medical education (CME) for all practitioners caring for children with surgical conditions. CME is critical to prevent decay of knowledge and skills, especially among those who do not see large numbers of children with surgical problems daily. It also helps staff to maintain competence and learn about new and developing areas, technology, and innovations in their respective fields. Teamwork, staff and inter- and intra-departmental relationships are enhanced and thereby overall competencies and performance improves as well. In addition, CME courses offer the opportunity to better define the core essential elements of children's surgery for any environment. By so doing, they can influence the knowledge and skills imparted in undergraduate and postgraduate training. Adequate and appropriate resources should, therefore be committed to CME in a planned and ongoing manner within and between hospitals and levels of care.

**TABLE 8.** Training objectives for different types of facilities

Type of facility (DCP3 classification) <sup>a</sup>		Level of Care <sup>b</sup>	Training Objectives
Health center		<b>I</b>	<p>Train birth attendants and community health workers to recognize the most common (often visible) congenital anomalies and provide basic counseling. This has been done successfully for conditions such as clubfoot, cleft lip, and cleft palate. Training could be expanded so that birth attendants screen for conditions such as hydrocephalus, spina bifida, hernia, anorectal malformation, hip dysplasia and undescended testes.</p> <p>Create community health worker manual focused on identifying and addressing surgical conditions and injury prevention</p>
First-level hospital		<b>I-II</b>	<p>Emphasis on training the workforce to identify and treat an essential package of children’s surgical conditions. This would include some emergencies that must be treated at this first level of the health system where surgical services are provided.</p> <p>A major emphasis would be resuscitation and emergency care and transfer children to a higher level of the system where more definitive care can be provided.</p> <p>Safe anesthesia and perioperative care training and training of perioperative nursing</p> <p>Consider conducting training sessions at second or third level hospitals to aid in creation of links of referral.</p>
Referral hospital	Second- level hospital	<b>I, II, III</b>	Essential children’s surgical services and selected more complex conditions. Skills and procedural training to address a selection of more complex surgical needs
	Third level hospital	<b>I, II, III</b>	Definitive treatment for comprehensive children’s surgical services. Skills and procedural training to meet this need, across disciplines. May be met through separate specialists, or through surgical, anesthesia, and nursing providers trained across disciplines for specific procedures.
	National children’s hospital	<b>I, II, III</b>	Subspecialist training to meet comprehensive and more super-specialized surgical needs (e.g., cardiac or neurosurgery) Multi-disciplinary focused training integrating all members of the advanced health-care delivery team.

<sup>a</sup> See Table 1 for equivalent health care facilities in the WHO classification system.

<sup>b</sup> Levels of care is based on the complexity of surgical care (see Table 2 for details)

## **8.2 Quality improvement**

A variety of strategies can be used to improve the quality of healthcare delivered to children.<sup>9</sup> Perhaps most important is medical audit, which improves medical care by routinely monitoring the elements of diagnosis, treatment and outcome. By always examining the outcomes of patients, it is possible to evaluate the performance of individual providers as well as the system in which they work. Quality improvement for children's surgical care should take several forms, including routine, systematic review of the structure, process and outcomes of care (Figure 1). For quality improvement activities to be effective they must be predictable and done an ongoing manner, with feedback provided to all stakeholders so that appropriate action can be taken. Reporting requirements are likely to be less intensive at basic and intermediate levels, and more extensive at advanced/complex levels.

### **8.2.1 Structural improvement**

This refers to the physical and human resources available for care. By periodically assessing the available resources (e.g. number of trained specialists, procedure volume, availability of equipment and supplies) gaps and limitations can be identified and addressed to improve the quality of care. This also helps in planning and allocation of resources to ensure optimal utilization and cost effectiveness.

### **8.2.2 Process improvement**

This relates to the care that patients receive. By assessing the process of care, tasks can be standardized and checklists and guidelines can be developed based on identified gaps and problems. This will help to improve the quality of surgical care. Process improvement includes monitoring and tracking of outcome measures and peer review; it helps to improve the quality of surgical care. This also helps to establish benchmarks against which proposed improvements can be compared as well as for future aspiration. Many outcomes can be monitored; some take little time while others are more complex.

### **8.2.3 Morbidity and mortality conferences**

The field of surgery has a long tradition of discussing deaths and complications in search of identifying preventable factors. Morbidity and mortality conferences are based on open, non-punitive education focused on peer review with the goal of identifying correctable problems with the individual practitioners and systems, all designed to improve performance. Predetermined audit filters (e.g., anesthetic complications, inpatient deaths, surgical site infections) can help determine which cases need peer review. Actionable factors should be identified and acted upon to improve subsequent outcomes. This last process is referred to as “loop closure” and is a critical component of all quality improvement work.

### **8.2.4 Preventable death studies**

Reviewing the deaths that occur at an individual hospital or within a health system is an essential tool for quality improvement. When a preventable death is identified, steps can be undertaken to prevent similar problems in the future.

### **8.2.5 Complications**

Tracking complications is an important tool for assessing quality of care. This process attempts to identify complication rates that are higher than would normally be expected. Surgical site infections, for example, are gaining greater emphasis, but more work is needed to define optimal quality metrics in resource-limited settings.

### **8.2.6 Risk-adjusted mortality**

This strategy allows hospitals to compare their outcomes based on the type of patients they treat. Comparisons can be made against other hospitals and predetermined national norms and benchmarks. Identifying hospitals with higher risk-adjusted death rates can be an important first step in the performance improvement process. Risk-adjusted mortality rates are commonly used to evaluate trauma programs. These can serve as the basis for specific quality improvement interventions.

### **8.2.7 Data collection and surveillance**

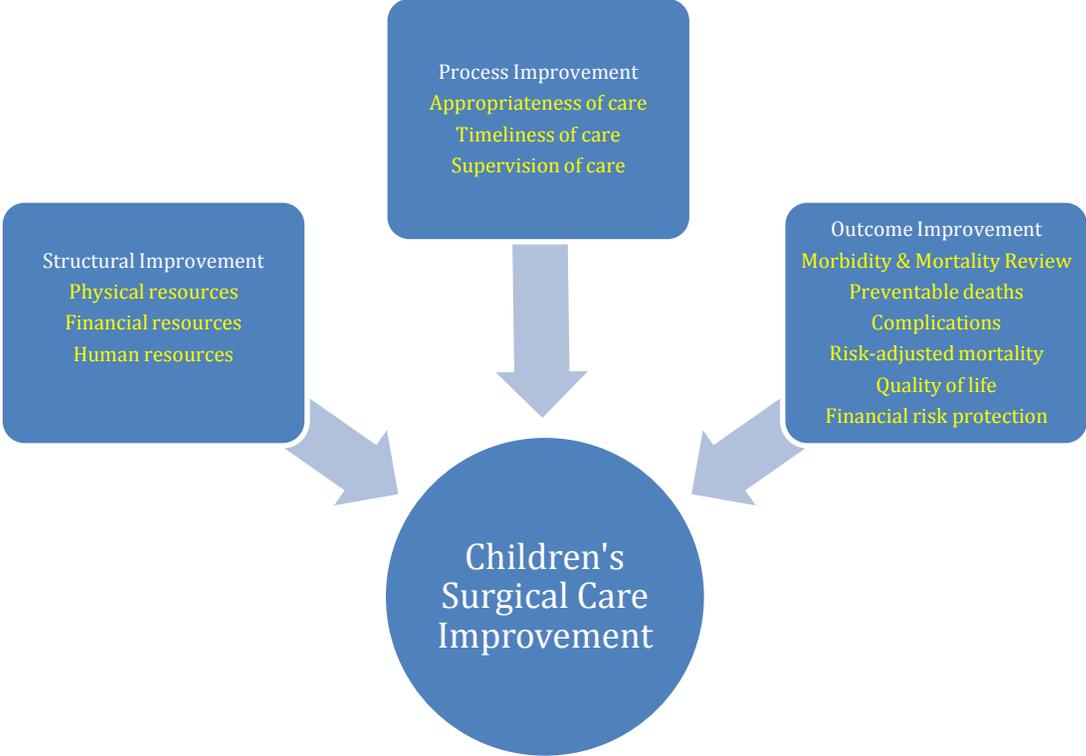
Children's surgical services must incorporate ongoing collection of data at hospital and national levels. Data on surgical epidemiology, disease trends and patterns, treatments and outcome, as well as resources should be continuously evaluated. This will help in planning and modification of treatment strategies, resource allocation and training, as well as prevention and control measures. Such data collection and surveillance should include the deployment of electronic medical records system, disease specific registries (e.g. congenital anomalies, trauma, cancer, etc.) and trainee databases. Integrating this data collection with existing public health surveillance will be critical to linking with broader child health initiatives.

### **8.3 Hospital assessment**

Hospital assessment with verification of resources has proven to be a necessary tool for improving quality of care in high-income countries. Most low-resource settings also have some mechanism for monitoring the function of their hospitals, but the completeness and effectiveness of this monitoring is variable.<sup>42</sup> Government-run hospitals may be more likely to have monitoring systems in place than private facilities. Hence, there is a precedent for the concept of assessment and verification as a mechanism for improving and monitoring children's surgical services in most low-resource settings.

The GICS program recommends assessment and evaluation of hospitals to be done by internal country accreditation mechanisms, where they exist (e.g. Ministry of Health, training colleges). In the absence of in-country accreditation programs, invited external reviewers could assist with assessment and evaluation.

**Figure 1:** Quality improvement for children’s surgical care



## 9. RESEARCH

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### 9.1 Overview

The importance of research in improving surgical care of children in low-resource settings cannot be overstated. Its roles are multiple: providing relevant information for management in low-resource settings, quantifying global burden of surgical disease in children, identifying gaps in provision of care, and generating data for advocacy for equitable resource allocation for the surgical care of children.<sup>43</sup> While research may be through academically affiliated institutions, non-academic institutions providing children's surgical care may also be engaging in important scholarly activity, as the range of facilities providing children's surgical care is diverse. The key research needs identified by the GICS were (1) the creation of regional research hubs, and (2) the deployment of appropriate institutional patient databases.

### 9.2 Regional research hubs

These hubs would each cover and support several related countries in one region. Ideally, they would include one or several health care researchers. Their roles would be to provide research support to children's surgical providers, including seeking funding, project design, IRB requirements, research ethics, data management and analysis, and manuscript writing and publication. They would also be able to deploy and assist in the adoption and maintenance of the institutional databases. They would offer training for providers and trainees, primarily through workshops and hands-on, on-site research fellowships mentoring providers through all the stages of a research project completion. The governance and financing of these regional hubs would ideally develop through existing collaborations between countries or may be coordinated through GICS or similar international organization. The regional research hubs should also align with the regional offices of the WHO Emergency and Essential Surgical Care offices and contribute to their

Global Surgery Database <sup>44</sup>. At the national level this data should also be shared with the Ministry of Health to help inform national health policy that is country specific.

### **9.3 Children’s surgical database**

The database requested by GICS providers needs to be simple to use at the point-of-care (therefore mobile-device based), limited in complexity to under 20 fields per case, able to function in both online and offline mode, and stored remotely (cloud-based in the regional research hubs). The target population would be pediatric surgical inpatients, though a similar tool could be used for outpatient clinic patients. Data would be prospectively collected for both ongoing audit/quality management and for actual research – thus, locally the data would contain patient identifiers, while the remote upload would be anonymous. Consent for data collection and research would be obtained on patient admission. The principal crosscutting areas identified for data collection and subsequent research were congenital birth abnormalities, childhood cancer, and injury/critical care. In order to foster long-term adoption of the database collection process and create an institutional culture of continuous data collection, the database would be initially deployed for short-term “sprint audits” and research projects (2-4 weeks), then gradually transitioned to longer-term collection. More specific disease-based registries, may also be established. Detailed research objectives by level of facility are provided in Table 9.

**TABLE 9.** Research objectives for different types of facilities

Type of facility <sup>a</sup> (DCP3 classification)		Level of Care <sup>b</sup>	Research Objectives
Health center		<b>I</b>	<p>Ensure basic birth and death registry</p> <p>Generate population-based data on the prevalence of congenital surgical conditions. The necessary data collection is better achieved by incorporating basic screening for congenital anomalies into the birth and 6-week routine infant vaccination campaigns and well-baby cards.</p> <p>A simple check of a box for suspected abnormality by body area may then engender referral to a regional institution</p> <p>Such population-based data may then be analysed by paediatric surgical providers at higher health care system levels with the assistance of the regional research hubs</p>
First level hospital		<b>I, II</b>	<p>Prevalence, burden of disease and access studies, and injury epidemiology studies.</p> <p>The regional research hubs would provide the technical and logistic support for such studies such as the development of surgical indicators/ data points.</p>
Referral hospital	Second and third-level hospital	<b>I, II, III</b>	<p>Database for surgical conditions in children for both epidemiological and outcome purposes. General surgeons typically provide the surgical care of children with several common conditions, and monitoring the quality of care provided at this level is important for identifying gaps in infrastructure, personnel, and training.</p> <p>Data generated through such databases would again be made available to children’s surgical providers for research projects coordinated through the regional research hubs.</p>
	Children’s Hospital	<b>I, II, III</b>	<p>At the national referral “centre of excellence”, research would be conducted at multiple levels. Epidemiological and outcomes studies on a variety of children’s surgical conditions at the national level would be possible using the standard inpatient database.</p> <p>Disease-based registries may be established</p> <p>Higher-level interventional studies would also be fostered by the regional research hubs in order to identify best practices for low-resource settings and contextualized management solutions</p> <p>Access to care, disparities, and financial risk protection and catastrophic health expenditure due to children’s surgical conditions would be analysed across populations</p> <p>Basic and translational science programs to advance knowledge in local disease processes</p> <p>Hub for research administration and courses in ethical conduct of research</p>

<sup>a</sup> See Table 1 for equivalent health care facilities in the WHO classification system.

<sup>b</sup> Levels of care is based on the complexity of surgical care (see Table 2 for details).

## **10. INTEGRATION OF CHILDREN’S SURGERY INTO HEALTH SYSTEMS**

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Children’s surgery should be integrated into an overall national health plan. This should include children’s surgery being integrated into childhood healthcare plans as well as the National Surgical, Obstetric and Anesthesia Plans (NSOAPs). There are also opportunities to align with obstetric - maternal health initiatives focused around prenatal care and delivery. At the institutional level, children’s surgery should exist as an integral component of child healthcare services to address the social, emotional and psychological needs of children. Such integration also ensures that available physical and human resources are adequately allocated for children’s surgical care. At the national level, this involves political jurisdictions designating hospitals at varying levels of complexity for children’s surgical care. Emergency child health services, transfer criteria and transfer arrangements between levels of care and between hospitals must be planned to ensure timeliness and safety. National children’s surgical plans may also involve discussion of the role of “niche” hospitals, especially for non-emergent specialty care, as these hospitals provide essential care in many low-resource regions of the world. Governance and finance of these hospitals within the health system and the role of public-private partnerships are key areas for discussion.

## **11. INTERACTION WITH AND COORDINATION OF STAKEHOLDERS**

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Global health initiatives have often struggled to implement changes at scale. It is reasonable to expect that introducing the guidelines for the optimal surgical care of children will face similar challenges unless there is close collaboration with multiple stakeholders. This planning will require coordination through ministries of health, promotion through professional societies and networks as well as parent-community groups in grass-roots lobbying efforts. Furthermore, continued integration and coordination of specialties related to children’s surgery is paramount to successful implementation of children’s surgery health initiatives. Stakeholders at different levels of the

hospital system, including community health centers and district hospitals must similarly be represented in order to improve surgical capacity and outcomes for children in low-resource environments.

## REFERENCES

1. Farmer DL, Bickler SW. Preface. *Seminars in pediatric surgery* 2016; 25(1): 1-2.
2. Bickler SW, Sanno-Duanda B. Epidemiology of paediatric surgical admissions to a government referral hospital in the Gambia. *Bulletin of the World Health Organization* 2000; 78(11): 1330-6.
3. Meara JG, Leather AJ, Hagander L, et al. *Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development*. Lancet 2015.
4. Mock CN, Donkor P, Gawande A, et al. *Essential surgery: key messages from Disease Control Priorities, 3rd edition*. Lancet 2015; 385(9983): 2209-19.
5. Henry JA, Abdullah F. *Global Surgical Care in the U.N. Post-2015 Sustainable Development Agenda*. *World journal of surgery* 2016; 40(1): 1-5.
6. *Strengthening emergency and essential surgical care and anaesthesia as a component of universal health coverage*. Geneva: 68th World Health Assembly, 2015.
7. Goodman LF, St-Louis E, Yousef Y, et al. *The Global Initiative for Children's Surgery: Optimal Resources for Improving Care*. *Eur J Pediatr Surg* 2017.
8. Gelb A, Morriss W, Johnson W, Merry A, et al. *WHO-WFSA International Standards for a Safe Practice of Anesthesia Workgroup (epublication)*. Geneva: World Health Organization, 2017.
9. *Standards for improving the quality of care for children and young adolescents in health facilities*. Geneva: World Health Organization; 2018.  
[http://www.who.int/maternal\\_child\\_adolescent/documents/quality-standards-child-adolescent/en/](http://www.who.int/maternal_child_adolescent/documents/quality-standards-child-adolescent/en/) (Accessed September 23, 2018)
10. *Everybody's business - strengthening health systems to improve health outcomes: WHO's framework for action*. Geneva: World Health Organization; 2007.  
[http://www.who.int/healthsystems/strategy/everybodys\\_business.pdf](http://www.who.int/healthsystems/strategy/everybodys_business.pdf) (Accessed August 20, 2018)
11. *Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies*. Geneva, World Health Organization; 2010.  
[http://www.who.int/healthinfo/systems/WHO\\_MBHSS\\_2010\\_full\\_web.pdf](http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_full_web.pdf) (Accessed August 20, 2018)
12. Alkire BC, Raykar NP, Shrimel MG, et al. Global access to surgical care: a modelling study. *The Lancet Global health* 2015; 3(6): e316-23.
13. Rhee D, Papandria D, Yang J, et al. Comparison of pediatric surgical outcomes by the surgeon's degree of specialization in children. *Journal of pediatric surgery* 2013; 48(8): 1657-63.
14. Emil SG, Taylor MB. Appendicitis in children treated by pediatric versus general surgeons. *Journal of the American College of Surgeons* 2007; 204(1): 34-9.
15. McAteer JP, Kwon S, LaRiviere CA, Oldham KT, Goldin AB. Pediatric specialist care is associated with a lower risk of bowel resection in children with intussusception: a population-based analysis. *Journal of the American College of Surgeons* 2013; 217(2): 226-32.e1-3.

16. Arca MJ, Goldin AB, Oldham KT. Optimization of care for the pediatric surgical patient: Why now? *Seminars in pediatric surgery* 2015; 24(6): 311-4.
17. Goldin AB, Dasgupta R, Chen LE, et al. Optimizing resources for the surgical care of children: an American Pediatric Surgical Association Outcomes and Clinical Trials Committee consensus statement. *Journal of pediatric surgery* 2014; 49(5): 818-22.
18. Oldham K. Optimal resources for children's surgical care in the United States. *Journal of the American College of Surgeons* 2014; 218(3): 479-87, 87 e1-4.
19. Bickler SW, Rode H. Surgical services for children in developing countries. *Bulletin of the World Health Organization* 2002; 80(10): 829-35.
20. Poenaru D. The burden of pediatric surgical disease in low-resource settings: Discovering it, measuring it, and addressing it. *Journal of pediatric surgery* 2016; 51(2): 216-20.
21. Bickler SW, Telfer ML, Sanno-Duanda B. Need for paediatric surgery care in an urban area of The Gambia. *Tropical doctor* 2003; 33(2): 91-4.
22. Butler EK, Tran TM, Nagarajan N, et al. Epidemiology of pediatric surgical needs in low-income countries. *PloS one* 2017; 12(3): e0170968.
23. Ozgediz D, Langer M, Kisa P, Poenaru D. Pediatric surgery as an essential component of global child health. *Seminars in pediatric surgery* 2016; 25(1): 3-9.
24. Ozgediz D, Poenaru D. The burden of pediatric surgical conditions in low and middle income countries: a call to action. *Journal of pediatric surgery* 2012; 47(12): 2305-11.
25. Sengoelge M, El-Khatib Z, Laflamme L. The global burden of child burn injuries in light of country level economic development and income inequality. *Preventive medicine reports* 2017; 6: 115-20.
26. Howard SC, Davidson A, Luna-Fineman S, et al. A framework to develop adapted treatment regimens to manage pediatric cancer in low- and middle-income countries: The Pediatric Oncology in Developing Countries (PODC) Committee of the International Pediatric Oncology Society (SIOP). *Pediatric blood & cancer* 2017; 64 Suppl 5.
27. Jamison DT, Alwan A, Mock CN, et al. Universal health coverage and intersectoral action for health: key messages from Disease Control Priorities, 3rd edition. *Lancet* 2018 Mar 17;391(10125):1108-1120.
28. Mock C, Lormand J, Goosen J, Joshipura M, Peden M. *Guidelines for Essential Trauma Care*. Geneva: World Health Organization, 2004.
29. Mock CN, Donkor P, Gawande A, Jamison DT, Kruk ME, Debas HT. Essential surgery: key messages from Disease Control Priorities, 3rd edition. *Lancet (London, England)* 2015; 385(9983): 2209-19.
30. Cohen MM, Cameron CB, Duncan PG. Pediatric anesthesia morbidity and mortality in the perioperative period. *Anesthesia and analgesia* 1990; 70(2): 160-7.

31. Gobbo Braz L, Braz JR, Modolo NS, do Nascimento P, Brushi BA, Raquel de Carvalho L. Perioperative cardiac arrest and its mortality in children. A 9-year survey in a Brazilian tertiary teaching hospital. *Paediatric anaesthesia* 2006; 16(8): 860-6.
32. Flick RP, Sprung J, Harrison TE, et al. Perioperative cardiac arrests in children between 1988 and 2005 at a tertiary referral center: a study of 92,881 patients. *Anesthesiology* 2007; 106(2): 226-37; quiz 413-4.
33. Krishnaswami S, Nwomeh BC, Ameh EA. The pediatric surgery workforce in low- and middle-income countries: problems and priorities. *Seminars in pediatric surgery* 2016; 25(1): 32-42.
34. Kempthorne P, Morriss WW, Mellin-Olsen J, Gore-Booth J. The WFSA Global Anesthesia Workforce Survey. *Anesthesia and analgesia* 2017; 125(3): 981-90.
35. Bickler S, Ameh E. *Surgical Care for Children: Guidelines for the primary referral hospital*: Macmillan; 2011.
36. *Pocketbook of hospital care for children*: World Health Organization, 2005.
37. Gosselin R, Spiegel D, Foltz M. *Global Orthopedics*: Springer; 2014.
38. Carter LL. *Principles of Plastic Surgery in Africa*: Pan African Academy of Christian Surgeons; 2003.
39. Semer N. *Practical Plastic Surgery for Nonsurgeons*. New York, Lincoln, and Shanghai: Authors Choice Press; 2007.
40. *Surgical Care at the District Hospital*. Geneva, World Health Organization; 2003. <http://www.who.int/surgery/publications/en/SCDH.pdf?ua=1> (Accessed August 28, 2018).
41. e-SAFE: Safer Anesthesia Through Education. 2014. <http://www.e-safe-anaesthesia.org/> (Accessed August 20, 2018).
42. Galukande M, Katamba A, Nakasujja N, et al. Developing hospital accreditation standards in Uganda. *The International journal of health planning and management* 2016; 31(3): e204-18.
43. Greenberg SL, Ng-Kamstra JS, Ameh EA, Ozgediz DE, Poenaru D, Bickler SW. An investment in knowledge: Research in global pediatric surgery for the 21st century. *Seminars in pediatric surgery* 2016; 25(1): 51-60.
44. *Emergency and Essential Surgical Care- Global Database*. Geneva, World Health Organization. [http://www.who.int/surgery/eesc\\_database/en/](http://www.who.int/surgery/eesc_database/en/) (Accessed on August 20, 2018).

## APPENDIX 1. Human resource for different types of facilities

Type of facility (DCP3 classification) <sup>a</sup>		Level of Care <sup>b</sup>	Human Resources
Health center		I	<u>Non-Physicians</u> : Trained Birth Attendants, Community Health Workers, General Practice Nurse <u>Physicians</u> : General Medical Physician, Clinical Officers
First-level hospital		I-II	<u>Non-Physicians</u> : Perioperative Nurses, Physical and Occupational Therapist, Orthopedic officer, X-ray Technician, Biomed and Laboratory Technician, Anesthesiologist +/- Anesthesia provider, Hospital Administrator <u>Physicians</u> : General Doctor or Non-Physician Surgical Provider
Referral hospital	Second- level hospital	I, II, III	<u>Non-Physicians</u> : In addition to First-level Hospital Requirements, Pediatric Nurse, Orthotics Personnel available (on call basis), Respiratory Care Specialists, Nutritionist, Dental Technologist <u>Physician Resources</u> : Physician Anesthesiologist, General Surgeon, Orthopedic Surgeon, Neonatologist, Pediatric Critical Care Physician, Radiologist (On-call, Pediatric Radiologist Consultation by email)
	Third level hospital	I, II, III	<u>Non-Physicians</u> : In addition to Second-level Hospital Requirements, Cardiac perfusionists and Speech pathologist, Palliative care, Trainees- Nursing, Specialty Staff Students, Medical Students, Residents, Fellows <u>Physician Resources</u> : <u>Pediatric Disciplines</u> : Cardiology (with interventional capability), Oncology, Gastroenterology, Neurology, Nephrology, Radiology, Anesthesiologist; Intensivist; Neonatal Intensivist and Others <u>Pediatric Surgery Disciplines (trained in pediatric subspecialty)</u> : General (Pediatric) Surgeon, Cardiac Surgeon; ENT; Oral and Maxillofacial Surgeon; Orthodontist; Orthopedic Surgeon; Plastic and Reconstructive Surgeon; Urologist, Neurosurgeon with Pediatric Experience, Ophthalmologist
	National children's hospital	I, II, III	<u>Non-Physicians</u> : All Specialists and Staff in First and Second-level Hospital including Cardiac Perfusionists and Speech pathologist, Palliative care, Trainees- Nursing, Specialty Staff, Medical Students, Residents, Fellows <u>Physician Resources</u> : <u>Pediatric Specific Disciplines</u> : Cardiology (with interventional capability), Oncology, Gastroenterology, Neurology, Nephrology, Radiology including neuroradiology, Anesthesiologist including neuro and cardiac; Pediatric Intensivist; Neonatal Intensivist and Others <u>Pediatric Surgery Disciplines (trained in pediatric subspecialty)</u> : General (Pediatric) Surgeon, Cardiac Surgeon; ENT; Oral and Maxillofacial Surgeon; Orthodontist; Orthopedic Surgeon; Plastic and Reconstructive Surgeon; Urologist, Neurosurgeon, Ophthalmologist, Transplant Surgeon

<sup>a</sup> See Table 1 for equivalent health care facilities in the WHO classification system.

<sup>b</sup> Levels of care is based on the complexity of surgical care (see Table 2 for details).

**APPENDIX 2: Childhood surgical procedures for different facility types classified by pediatric surgical subspecialty**

Specialty	Health Center	First-level hospital	Referral hospital		
			Second-level hospital	Third-level hospital	National children's hospital
<b>Anesthesia</b>	Local anesthesia	General Anesthesia without invasive monitoring or post-operative ventilation; Children < 3 months old and ASA > 3 referred	General Anesthesia for most Major surgeries; all ages	General Anesthesia for all specialized surgical procedures; all ages and co-morbidities	General Anesthesia for specialized surgical procedures, all ages and co-morbidities
<b>Cardiac Surgery</b>	Cardiovascular examination for congenital heart defects, ECG	Medical treatment (PE2) of PDA-dependent diseases, Basic Echocardiography	Same as First-level hospital	Surgical closure of PDA, Surgical correction of simple coarctation (non-neonatal)	All cardiac surgery procedures including Catheterization for ASD and pulmonary valve stenosis, Palliative treatment of TOF
<b>Critical Care</b>	Recognition of illness severity, Treatment of pneumonia, dehydration	Airway Management, Resuscitation and stabilization, Venous Cut-down, Treatment of sepsis, Pneumonia, Meningitis	Acute pediatric emergencies, Treatment of ARDS, Septic Shock, Coma	All NICU and PICU procedures, Treatment of traumatic brain injury, Meningoencephalitis, Cardiac failure	All NICU and PICU procedures, All co-morbid conditions
<b>General Surgery</b>	I&D of superficial abscess, Simple and minor lacerations	Trauma and Emergency laparotomy, Emergency colostomy, Hernia repair Trauma amputation, Thoracostomy, Anoplasty (cut-back)	Trauma Thoracotomy, ARM & Hirschsprung Disease	All General Surgery procedures including repair of gastroschisis and omphalocele, intraabdominal malignancy	All General Surgery procedures
<b>Neurosurgery</b>	Diagnosis and Triage of Neurotrauma	Exploratory Burr Holes, Trans-fontanelle Ventricular Tap	Trauma Craniotomy	ICP monitor, Intracranial infection, Hydrocephalus, Myelomeningocele, Neuroendoscopy	Vascular Malformations, Complex cranial tumors, Congenital Spinal Deformities, Cranial Malformations, Epilepsy

<b>Ophthalmology</b>	Antibiotic eye drops, Irrigation of eye after chemical injury	Foreign Body, Corneal Scratch, Hyphema	Lid Lacerations, Corneal laceration, Cataract operation (> 10 years old)	Cataract surgery (all ages), squint surgery, primary closure of trauma, Simple ptosis surgery	Glaucoma and corneal procedures, Retinopathy of premature procedures, Oculoplastic procedures
<b>Oral Maxillofacial Surgery</b>	Simple lacerations, Antibiotics	Dental extraction	Repair of cleft lip/palate Fabrication of feeding plates, Pre-surgical naso-alveolar molding,	Facial reconstruction, Distraction osteogenesis, Osteosynthesis	All Oral Maxillofacial Procedures
<b>Orthopedic Surgery</b>	Splinting for simple fractures	Wound care for open fractures, Drainage for orthopedic infections (Osteomyelitis), Ponseti technique for club foot	Closed Reduction for Hip Dysplasia, Pinning slipped capital femoral epiphysis, Fasciotomy, Syndactyly release	Definitive management of osteomyelitis/septic arthritis, All vascular injuries, spina bifida, muscular dystrophy	Excision/Reconstruction of boney tumors, Correction of brachial plexus injury, Tendon transfers, multiple congenital deformities
<b>Otolaryngology</b>	Otoscopy, Rhinoscopy, Removal of foreign body from ear, nose	Drain superficial head and neck abscess, Tonsillitis treatment, Swallowed foreign body, Torticollis	Excision of benign neck mass, tonsillectomy	Parapharyngeal & retropharyngeal abscess, Tympanoplasty, Ossiculoplasty, tympano-mastoidecomty, Bone anchored hearing aids	Laryngotracheal reconstruction, Slide trachoplasty, Complex head and neck mass excision
<b>Plastic Surgery</b>	Simple Laceration Repair, Management of 1 <sup>st</sup> degree burns	Management of 2 <sup>nd</sup> degree burns, Escharotomy, Stabilization of Vascular Trauma and Wound Sepsis	Complex laceration repair, Vascular shunt to preserve inflow in trauma, Revision amputation,	Soft tissue coverage (grafts, local flaps, free tissue transfer), repair of cleft lip/palate, management of craniofacial & congenital hand anomalies	Complex reconstruction after tumor excision, Management of complex cranial vault and hand anomalies
<b>Urology</b>	Urinary Tract Infection, Local wound care after circumcision	Circumcision, Paraphimosis, Orchiopexy, preputial-plasty, Urethral catheterization	Cystostomy, Vesicostomy, Orchiopexy, Imperforate hymen	Hypospadias and epispadias treatment, Urethral valve resection, complex repair of bladder exstrophy, nephrostomy, genitoplasty, Urolithiasis management	Mitroffanoff intervention for spina bifida, Kidney Transplant

Abbreviations- ARDS- Acute Respiratory Distress Syndrome; ARM- Anorectal Malformation; ASA- American Society of Anesthesiologist physical status classification; I&D- Incision and Drainage; NICU- Neonatal Intensive Care Unit; PE2- Prostaglandin E2, PICU- Pediatric Intensive Care Unit; TOF- Tetralogy of Fallot

**APPENDIX 3: Childhood surgical procedures for different facility types classified by Surgical Condition**

Surgical Condition	Health Center	First-level hospital	Referral hospital		
			Second-level hospital	Third-level hospital	National children's hospital
<b>Trauma/ Injuries</b>	<u>Resuscitation:</u> BLS <u>Injuries:</u> Wound care for simple lacerations, <u>Fractures:</u> closed non-displaced <u>Burns:</u> 1 <sup>st</sup> degree	<u>Resuscitation:</u> ALS, ATLS <u>Injuries:</u> Thoracostomy Trauma Laparotomy Trauma-amputation <u>Fractures:</u> Closed reduction, Open I&D with external fixator placement <u>Burns:</u> 1 <sup>st</sup> , 2 <sup>nd</sup> degree < 10% TBSA, excluding face, hands, perineum Simple escharotomy	<u>Resuscitation:</u> All, NICU, PICU <u>Injuries:</u> Trauma Thoracotomy Renal/Urethral trauma Vascular shunt Fasciotomy Craniotomy <u>Fractures:</u> Complex nonunion & malunion, Pinning for slipped capital femoral epiphysis <u>Burns:</u> 1 <sup>st</sup> , 2 <sup>nd</sup> degree < 10% TBSA excluding face, hands, perineum	<u>Resuscitation:</u> All, NICU, PICU <u>Injuries:</u> Complex Neuro-trauma Complex neurovascular extremity injuries including limb sparing operations <u>Fractures:</u> All including Cranial fractures <u>Burns:</u> >10% TBSA Burns including face, hands, perineum	All
<b>Congenital anomalies</b>	<u>Screening:</u> Abdominal hernias, Urogenital abnormalities, Hip dysplasia & limb deformities, Congenital heart defects, Neural tube defects, Craniofacial anomalies	Inguinal hernia/hydrocele repair, Relief of urinary obstruction: catheterization & suprapubic cystostomy, Club foot: non-operative manipulation, Treatment of PDA dependent disease with IV prostaglandin E2	Neonatal intestinal obstruction, Meatal stenosis, Orchidopexy for testicular torsion & palpable undescended testes, Closed reduction and Pavlik harness for hip dysplasia, Club foot operative treatment, Hydrocephalus	Gastroschisis & Omphalocele Anoplasty and Pull through for ARM/Hirschsprung, Hypospadias/epispadias, Development dysplasia of Hip, Clubfoot, PDA, Coarctations, TOF, Spina bifida, myelomeningocele, meningocele, dysmorphic syndromes, craniofacial abnormalities, syndactyly	All

<b>Infections</b>	I&D of superficial abscess	Thoracostomy for empyema Laparotomy for Appendectomy, typhoid complications, I&D of superficial, pyomyositis, perianal, anorectal abscess, Septic arthritis, Osteomyelitis, Extraction, drainage of abscess, caries	Leprosy, Tonsillectomy I&D of neck abscess	Advanced osteomyelitis, tenosynovitis, sepsis and septic shock, I&D of retropharyngeal abscess, treatment for intracranial infections (hydrocephalus, subdural empyema)	All
<b>Tumors</b>	Screening for all abdominal tumors	Biopsy of palpable or U/S visualized mass Excision of benign tumors/cysts	Biopsy of all tumors, Excision of benign tumors/cysts Diagnosis of malignant tumors	Abdominal and urologic malignant tumors Malignant tumors of extremities Head and neck tumors Simple intracranial tumors	All
<b>Others</b>	Male circumcision using plastibel, Rectal prolapse reduction Foreign body removal from ears, nose, mouth	Central venous line Laparotomy for Intestinal obstruction	Functional and obstructive urinary pathology (pelvic-ureteral obstruction) Arthrotomy synovectomy Shunt Tap & Trans-fontanelle Ventricle Tap	Muscular dystrophy, limb reconstruction ureteral duplication anomalies, vesico-ureteral reflux Free Tissue Transfer, Local Flaps, Amniotic band release tympanoplasty, Ossiculoplasty,	All

Abbreviations-ALS- Advanced Life Support; ATLS- Advanced Trauma Life Support; BLS- Basic Life Support; ARM- Anorectal Malformation; I&D- Incision and Drainage; NICU- Neonatal Intensive Care Unit; PICU- Pediatric Intensive Care Unit; PDA- Patent Ductus Arteriosus, TBSA- Total Body Surface Area; TOF- Tetralogy of Fallot; U/S- Ultrasound

