

Original Investigation

Surgical Care of Pediatric Patients in the Humanitarian Setting

The Médecins Sans Frontières Experience, 2012-2013

Maeve O'Neill Trudeau, MD; Emmanuel Baron, MD; Patrick Hérard, MD; Amy S. Labar, MS; Xavier Lassalle, CRNA; Carrie Lee Teicher, MD, MPH; David H. Rothstein, MD, MS

IMPORTANCE Little is known about the scope of practice and outcomes in pediatric surgery performed by humanitarian organizations in resource-poor settings and conflict zones. This study provides the largest report to date detailing such data for a major nongovernmental organization providing humanitarian surgical relief support in these settings.

OBJECTIVE To characterize pediatric surgical care provision by a major nongovernmental organization in specialized humanitarian settings and conflict zones.

DESIGN, SETTING, AND PARTICIPANTS A retrospective cohort study was conducted from August 15, 2014, to March 9, 2015, of 59 928 surgical interventions carried out from January 1, 2012, to December 31, 2013, by the Médecins Sans Frontières Operational Centre Paris (MSF-OCP) program in 20 locations, including South Sudan, Yemen, Syria, Gaza, Pakistan, Nigeria, Central African Republic, Democratic Republic of Congo, and the Philippines. Surgical interventions were primarily for general surgical, traumatic, and obstetric emergencies and were categorized by mechanism, type of intervention, American Society of Anesthesia risk classification, and urgency of intervention.

MAIN OUTCOMES AND MEASURES Operative indications, type of intervention, and operative case mortality.

RESULTS Among all age groups, 59 928 surgical interventions were performed in dedicated trauma, obstetric, and reconstructive centers for 2 years. Nearly one-third of interventions (18 040 [30.1%]) involved preteen patients (aged <13 years) and 4571 (7.6%) involved teenaged patients (aged 13-17 years). The proportion of violence-related injuries in the preteen group was significantly lower than in the teenage group (4.8% vs 17.5%; $P < .001$). Burns (50.1%), other accidental injuries (16.4%), and infections (23.4%) composed the bulk of indications in the preteen group. Interventions in the teenage group were principally caused by trauma-related injuries (burns, 22.9%; traffic accidents, 10.1%; gunshot wounds, 8.0%). Crude perioperative case mortality rates were 0.07% in the preteen group, 0.15% in the teenage group, and 0.22% in the adult group (>17 years) ($P = .001$). One-third of the cases (33.4%) were deemed urgent, while most of the remaining cases (57.7%) were deemed semielective (surgical intervention to be performed within 48 hours).

CONCLUSIONS AND RELEVANCE When examining surgical interventions in a population of pediatric patients cared for in the specialized setting of humanitarian aid and conflict zones, burns, other accidental injuries, and infection composed the bulk of indications in the preteen group; interventions in the teenage group were principally caused by trauma-related injuries. Crude perioperative case mortality rates in the preteen group were significantly lower than in the adult group. Further work is needed to examine long-term outcomes of pediatric operations in these settings and to guide context-specific surgical program development.

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Author Affiliations: Department of Surgery, University of Toronto, Toronto, Ontario, Canada (Trudeau); Harvard T. H. Chan School of Public Health, Boston, Massachusetts (Trudeau); Epicentre, Paris, France (Baron); Médecins Sans Frontières, Paris, France (Hérard, Lassalle); Epicentre, New York, New York (Labar, Teicher); Médecins Sans Frontières, New York, New York (Rothstein); Department of Surgery, University at Buffalo, Buffalo, New York (Rothstein); Department of Pediatric Surgery, Women & Children's Hospital of Buffalo, Buffalo, New York (Rothstein).

Corresponding Author: David H. Rothstein, MD, MS, Department of Pediatric Surgery, Women & Children's Hospital of Buffalo, 219 Bryant St, Buffalo, NY 14222 (drothstein@kaleidahealth.org).

Nongovernmental organizations (NGOs) provide surgical services in a variety of humanitarian settings. While multiple publications have addressed necessity, feasibility, and strategy for providing surgical services in resource-poor and otherwise austere clinical settings,¹⁻⁹ it is only recently that attention has focused on defining pediatric surgical needs and outcomes.¹⁰⁻¹⁸

The recognition of the need for safe pediatric surgical care has increased dramatically in the past decade, spurred both by improved understanding of the global burden of disease that can be treated surgically and the growth of pediatric populations in resource-poor areas of the world.¹⁹ Médecins Sans Frontières (MSF) is an international NGO that has provided emergency surgical services for more than 40 years in a wide range of humanitarian settings, including areas of civil conflict and war, natural disasters, and medical professional shortage. The Operational Centre Paris (OCP), an arm of MSF, currently manages more than a dozen surgical projects and maintains a database of surgical operations, which is among the largest reported in the literature.²⁰⁻²²

This study used MSF-OCP data from 2012-2013 to examine the range of surgical indications and procedures provided to patients younger than 18 years to better characterize the needs and outcomes in pediatric surgery. The results are intended to further stimulate the global conversation surrounding the provision of comprehensive care to children residing in conflict zones and other resource-poor areas of the world.

Methods

Context

The MSF-OCP carries out surgical interventions in a variety of conflict and postconflict contexts in addition to natural disaster zones. The work is often done in district hospitals, the equivalent of a community hospital in the United States. The surgeons are typically a combination of expatriate and national staff, while nursing is typically composed of national staff. Anesthesia is provided by a combination of expatriate and national anesthesiologists and nurse anesthetists. Surgical care is almost exclusively of an emergency nature, covering trauma, intestinal obstruction, and obstructed labor or peripartum hemorrhage. The exceptions are a few subspecialized reconstructive surgical projects, with much lower overall patient volume. Patients requiring postoperative care—either for complications of surgery or for planned secondary surgery (such as for intestinal stoma reversal)—are scheduled as possible. Some projects have the ability to refer pediatric patients and those with complex neurosurgical or urologic conditions to capitals of every country for expert care, but this is the exception rather than the rule. Projects covered in this data review included surgical missions in South Sudan, Yemen, Syria, Gaza, Pakistan, Nigeria, Central African Republic, Democratic Republic of Congo, and the Philippines.

Data Collection

The MSF-OCP records data prospectively on its surgical interventions following a predetermined classification system: cat-

egorization by mechanism of injury (obstetric, nontrauma, and trauma, with detailed subcategories), type of intervention (gynecology, obstetrics, and urology; minor surgery; orthopedics; specialized surgery; visceral surgery; and wound surgery), and perioperative outcome (alive or dead). Patient data presented here were not collected beyond the recovery room. Surgical interventions carried out by MSF-OCP from January 1, 2012, to December 31, 2013, were categorized by age, indication, type of operation, American Society of Anesthesia (ASA) risk classifications (1-5), and urgency of intervention. Urgency was stratified into 3 categories: urgent, semielective (operation should be performed within the next 48 hours), and elective (nonurgent). Analysis was conducted from August 15, 2014, to March 9, 2015. This study was deemed exempt from additional ethical approval by the MSF Institutional Review Board because it involves routinely collected programmatic data.

Statistical Analysis

Operative mortality was calculated by dividing the number of deaths occurring intraoperatively (in the operating theater) or in the recovery room by the total number of operations performed, and it is reported as percentages. Fisher exact tests and χ^2 analyses were used to compare categorical variables. Statistical analyses were performed using Stata, version 13 (Stata-Corp LP).

Results

A total of 59 928 surgical interventions was recorded by MSF-OCP in 2012-2013; pediatric surgical interventions (patients <18 years) accounted for 37.7% of all operations recorded by MSF-OCP during this period. Within this group, 18 040 operations (30.1%) were performed on preteens (<13 years) and 4571 (7.6%) were performed on teenagers (13-17 years). Males composed 54.7% of the surgical patient population (Table 1).

Perioperative mortality was 0.17% for all surgical interventions (Table 2). Mortality rates among preteens (0.07%) and teenagers (0.15%) were lower than mortality rates among adults (0.22%) ($P = .001$; χ^2 analysis). Surgical interventions were further classified as minor (minor surgery and wound surgery categories) and major (all other categories of procedures): the overall mortality rate was 0.39% for major surgery and 0.03% for minor surgery. The difference in mortality rates between major and minor surgery was significant for all categories except the teenage group (preteens and adults, $P < .001$) (Table 2). American Society of Anesthesia classification was significantly related to outcome, as expected ($P < .001$; Fisher exact test) (eTable 1 in the Supplement). Perioperative mortality rose sharply as the ASA classification increased, with rates of 9.6% and 92.3% for ASA classifications of 4 and 5, respectively.

In the preteen and teenage groups, trauma was the most prevalent mechanism of injury (71.0% and 58.7%, respectively), followed by nontrauma (28.6% and 23.1%, respectively) and obstetric etiologies (0.4% and 18.2%, respectively) (eTable 2 in the Supplement). In the preteen group, burns

Table 1. Patient Demographics, 2012-2013

Demographic	Preteen (<13 y)	Teenage (13-17 y)	Adult (>17 y)
Age, median (IQR), y	4 (2-8)	15 (14-17)	30 (24-39)
Sex, No. (%) ^a			
Female	7903 (43.9)	2083 (45.7)	16 961 (45.6)
Male	10 093 (56.1)	2479 (54.3)	20 222 (54.4)
Total (% total cases)	18 040 (30.1)	4571 (7.6)	37 317 (62.3)

Abbreviation: IQR, interquartile range.

^a Data are missing for 187 patients.

Table 2. Crude Perioperative Mortality Rates by Age Group and Surgical Complexity

Characteristic	Value ^a		
	Preteen (<13 y)	Teenage (13-17 y)	Adult (>17 y)
Outcome			
Alive	16 131 (99.93)	4005 (99.85)	33 203 (99.78)
Dead ^b	12 (0.07)	6 (0.15)	73 (0.22)
Major surgery			
Alive	1979 (99.55)	1730 (99.77)	16 283 (99.60)
Dead	9 (0.45)	4 (0.23)	66 (0.40)
Minor surgery			
Alive	13 400 (99.98)	2196 (99.95)	16 051 (99.97)
Dead	3 (0.02)	1 (0.05)	5 (0.03)
P value ^c	<.001	.18	<.001

^a Data are presented as number (percentage) of patients unless otherwise indicated.

Subcategorization strata may not sum to overall mortality data as procedure categorization and/or age data were not available for all outcome data.

^b Overall mortality data are missing for 6498 patients.

^c Fisher exact test comparing minor with major surgery mortality rates.

accounted for 50.1% of cases by indication, followed by infection (23.4%) and other accidental trauma (16.4%). Among teenagers, burns composed 22.9% of indications, followed by traffic accidents (10.1%) and gunshot wounds (8.0%). Higher proportions of trauma injuries as operative indications were seen in the preteen and teenage groups compared with the adult group.

Almost half of the surgical interventions carried out in the preteen group were surgical procedures for wounds (49.4%), most of which were burn dressings (42.2% of total interventions) (eTable 3 in the Supplement). The second most common interventions in the preteen group were minor surgical procedures (36.8%), involving burn and wound dressings, drains, or simple suturing (Table 3). In the teenage group, the most common intervention was burn dressings (18.3%), followed by simple suturing (16.6%), cesarean sections (11.9%), and burn and wound dressings (11.9%) (eTable 3 in the Supplement).

Visceral surgical procedures were performed in 3.4% of the preteen group and 6.8% of the teenage group. Orthopedic interventions were performed in 6.2% of the preteen group and 10.5% of the teenage group. Gynecologic, obstetric, and urologic interventions were rare in the preteen group (0.7%) but increased dramatically in the teenage group (18.6%) (Figure). Within specialized surgery, the most common intervention was plastic and reconstructive surgery (3.2% of the preteen group and 4.4% of the teenage group).

Approximately one-third of operations were deemed urgent (33.4%), while 57.7% of cases were semielective and 8.9% were elective (Table 4). Results of χ^2 analysis showed significant differences in urgency of interventions by age group ($P < .001$). The highest percentage of urgent cases (40.0%) was

seen in the adult group compared with the preteen and teenage groups; the preteen group had the lowest percentage of elective surgical procedures (5.9%) and the highest proportion of semielective procedures (74.8%) compared with the adult and teenage groups. The highest numbers of urgent cases overall were attributed to obstetric emergencies (eTable 4 in the Supplement). Urgency of cases differed significantly across intervention types ($P < .001$; Pearson χ^2 analysis). Most important, 81 of 91 deaths (89.0%) occurred in cases categorized as urgent ($P < .001$; Fisher exact test).

Discussion

Multiple publications have sought to characterize the provision of surgical care in humanitarian settings, providing data on what surgical skills are most useful in such environments as well as what quality improvement initiatives may be most useful in optimizing surgical care.²⁰⁻²² Few of these studies have specifically addressed pediatric surgical needs, and, to our knowledge, our report is the largest to date on pediatric surgery-specific care in the humanitarian setting.

Wong et al²⁰ reported in 2014 on a different MSF section's experience with humanitarian surgery and described a pediatric (<18 years old) surgical population of 21.7% (18 069 patients), whereas MSF-OCP's pediatric surgical caseload represented 37.7% (22 611 cases) of all surgical interventions. Differences in the caseload numbers were notable: MSF-OCP's caseloads included significantly more burn dressing interventions than reported by Wong et al²⁰ (21.2% vs 2.5%; $P < .001$), fewer hernia and anogenital interventions (1.7% vs 10.6%; $P < .001$), and fewer cesarean deliveries (11.1% vs 25.9%;

$P < .001$) (eTable 3 in the Supplement), for example. Given the large surgical caseloads included in both analyses, the variation shows that there are likely many confounding factors, including data collection methods, surgical caseloads based on surgeons' comfort with different procedures and populations, and contextual differences regarding surgical cases brought to MSF sites. Common themes that emerged are the broad categories of interventions (pediatric, obstetric, orthopedic, and general surgery).

A 2010 study²¹ reported the overall operative mortality in 13 MSF humanitarian surgical caseloads to be 0.2%, slightly higher than the operative mortality among the current study's patient group. Given the higher number of minor surgical procedures and burn dressing interventions recorded in the preteen group, the low childhood surgical mortality is possibly owing to a lower acuity of the etiologies making up a large portion of the preteen data.

Humanitarian surgical initiatives are increasingly being held to higher standards of professionalism by the development of minimum clinical standards and data collection methods to ensure appropriate evaluation of programmatic efficacy and cost effectiveness.²³⁻²⁷ Studies such as ours may prove helpful in developing a baseline set of competencies, and possibly a competency-based curriculum, to help prepare surgeons and anesthesiologists interested in working in these settings.²⁸⁻³⁴

This study had multiple limitations in data acquisition and processing, as well as in its generalizability beyond the specific settings of MSF-OCP's surgical projects. The classification system is not yet validated, and data are recorded in stressful and resource-poor environments where data fidelity may

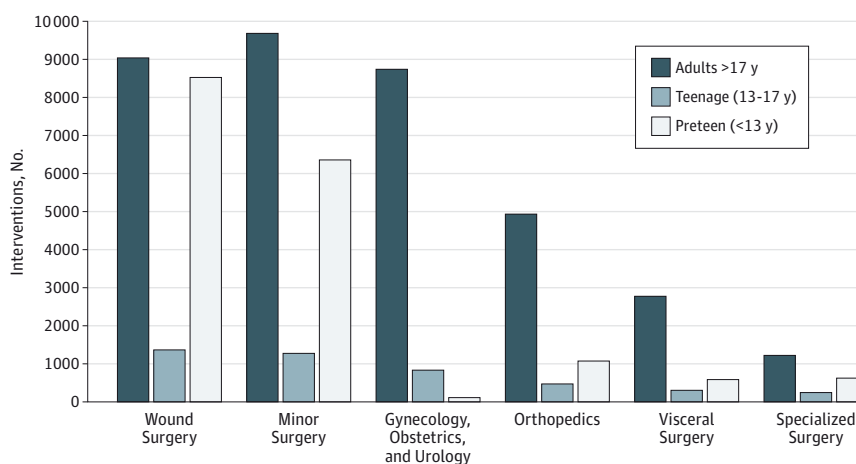
suffer. In addition, these mortality data reflect only the deaths in the operating theater and the immediate recovery room and are not wholly representative of the crude mortality in this population. Also, cause of mortality is currently not recorded. Last, we recognize the limitations of using the ASA classification in the precarious contexts where MSF operates. In general, long-term follow-up in these settings is challenging and uncommonly performed.²¹ Better metrics (such as 30-day mortality rates³⁵) are needed to improve quality assessment and accountability of health care professionals, as well as to better inform resource allocation decisions. Médecins Sans Frontières-Operational Centre Paris is in the process of revis-

Table 3. Summary of Preteen and Teenage Surgical Caseloads

Characteristic	Preteen (<13 y) ^a	Teenage (13-17 y)
Total, No. (%)	18 040 (30.1)	4571 (7.6)
Crude perioperative mortality rate, %	0.07	0.15
Indication, %		
Burn	50.1	22.9
Abscess	23.4	18.4
Trauma (nonviolence)	21.2	36.0
Violence	4.8	17.5
Intervention class, %		
Wound surgery	49.4	30.4
Minor surgery	36.8	28.3
Gynecology, obstetrics, and urology	0.7	18.6
Orthopedic	6.2	10.5

^a Preteen vs teenage group comparisons: all $P < .001$ by χ^2 analysis.

Figure. Types of Surgical Intervention by Age Group



Almost half of the surgical interventions carried out in the preteen group were for wounds (49.4%); the second most common interventions were minor surgical procedures (36.8%). In the teenage group, the most common intervention was wound surgery (30.4%), followed by minor surgical procedures (28.3%). Visceral surgical procedures were performed in 3.4% of the preteen group and 6.8% of the teenage group. Orthopedic interventions were performed in 6.2% of the preteen group and 10.5% of the teenage group. Gynecologic, obstetric, and urologic interventions were rare in the preteen group (0.7%) but increased dramatically in the teenage group (18.6%).

Table 4. Urgency Level by Age Group^a

Urgency Level	No. (%)		
	Preteen (<13 y)	Teenage (13-17 y)	Adult (>17 y)
Urgent	3470 (19.3)	1599 (35.1)	14 862 (40.0)
Semielective	13 463 (74.8)	2456 (53.8)	18 513 (49.9)
Elective	1061 (5.9)	506 (11.1)	3755 (10.1)

^a Urgency data missing for 243 patients.

ing its health information system for data collection, with one important goal being improved surveillance of long-term surgical outcomes.

Because MSF-OCP surgical projects are principally designed to provide emergency care, the results of this study are by no means representative of the overall surgical needs of patients in the resource-poor and austere settings served by MSF and other similar NGOs. Recently, research involving countrywide surveys has been published assessing unmet surgical burdens of disease in low- and middle-income countries.^{3,4,10} In addition, many surgeons working in humanitarian settings are not formally trained as pediatric surgeons, a further consideration when interpreting these caseloads.

Conclusions

Pediatric surgical interventions may represent more than one-third of the surgical caseload in humanitarian settings. Among these cases, trauma (particularly burns) and infection were among the leading indications for emergency and urgent interventions and thus should be a focus for training of surgeons providing care in resource-poor and otherwise austere settings. In addition, a significant proportion of cases required expertise in obstetrics, orthopedics, and general surgery. Further work is necessary to better delineate the nonemergency surgical needs in the humanitarian sphere and to assess long-term outcomes of surgical cases to judge efficacy of surgical intervention programs.

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Study concept and design: Trudeau, Baron, Rothstein.

Acquisition, analysis, or interpretation of data:

Trudeau, Hérard, Labar, Lassalle, Teicher, Rothstein.
Drafting of the manuscript: Trudeau, Teicher, Rothstein.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Trudeau, Labar, Teicher, Rothstein.

Administrative, technical, or material support: Hérard, Teicher.

Study supervision: Baron, Hérard, Teicher, Rothstein.

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Invited Commentary

Building Evidence for Global Surgery One Experience at a Time

Haile T. Debas, MD

The lack of accurate documentation of surgical experiences and outcomes in low- and middle-income countries is significant and constitutes a key barrier in making the case for resource allocation for global surgery to policymakers and global funders. The evidence that



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supports the importance and significance of surgery in global health must be assembled one experience at a time. The article by Trudeau et al¹ in this issue of *JAMA Surgery* describing the experience of the Médecins Sans Frontières Operational Centre Paris program in the surgical care of pediatric patients is, therefore, welcome. Although the Médecins Sans Frontières Operational Centre Paris program refers only to pediatric surgical care provided in specialized humanitarian settings and conflict zones, it adds to the developing body of published experience describing and documenting global surgery.^{2,3}

The task of building a strong case for global surgery, however, goes beyond this descriptive phase. We also must demonstrate the cost-effectiveness of surgery and provide cost-benefit analysis. Two significant publications in 2015 are not

only providing this critical information but have also put global surgery prominently on the global health agenda. The *Essential Surgery* volume of *Disease Control Priorities, Third Edition*,⁴ dispels 2 myths: that surgery is not important in global public health and that it is not cost-effective. The Lancet Commission on Global Surgery's *Global Surgery 2030: Evidence and Solutions for Achieving Health, Welfare, and Economic Development*⁵ is a landmark publication that provides evidence and suggests solutions for achieving health, welfare, and economic development in all low- and middle-income countries.

The data and evidence that need to be accumulated robustly serve another crucial purpose: the development of context-specific surgical care in under-resourced settings or, to quote the tagline from *Global Surgery 2030*, “universal access to safe, affordable surgical and anesthesia care when needed.”^{5(p7)} All organizations (academic, governmental, non-governmental organizations, and faith-based health care professionals) and teams of surgeons and investigators should realize that they can make significant contributions to global surgery by thorough documentation of the surgical care they provide and their outcomes.

ARTICLE INFORMATION

Author Affiliations: Global Health Sciences, University of California, San Francisco; Department of Surgery, University of California, San Francisco.

Corresponding Author: Haile T. Debas, MD, Global Health Sciences, University of California, San Francisco, 550 16th St, Third Floor, Campus Box 1224, San Francisco, CA 94158 (haile.debas@ucsf.edu).

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