



Mortality from Surgical Conditions in Children: An Insight from a Tertiary-Level Government Hospital in Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Author TKC designed the study, managed the literature search, performed the statistical analysis, and wrote the first and final draft of the manuscript. Author SMHK edited the first draft of the manuscript. Author MAAF wrote the first draft. Authors MKAS and RK performed critical analysis. Author MMS reviewed the final draft. All authors read and approved the final manuscript.

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ABSTRACT

Aims: While the developed world has significantly reduced mortality from surgical conditions in children, there is lack of adequate data on the outcome of children's surgical conditions in the developing world. This study aims at assessing the spectrum of mortalities from children's surgical conditions in a low-middle income country (LMIC).

Methods: Mortality data were collected for a period of 12 years (2008 to 2019) among 0 to 12-year old children to analyse the diseases which had higher mortality trends, age -group specific mortality trends and categorize those according to body system.

Results: Among a total of 30,301 admitted children, 1228 (4.05%) patients died. Among them 53.01% were neonates, 20.28% were infants and 26.71% were children. Male to female ratio was 1.95:1. Mortality from neonatal surgical conditions was 24.21%. Infant mortality rate was 5.65%

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and child mortality rate was 1.41%. Neonatal surgical admission and mortality had a higher yearly trend. Anorectal malformation (ARM) was the most common cause of death (12.05%), followed by intestinal obstruction (11.40%) and gastroschisis (8.63%). Tracheo-oesophageal fistula/oesophageal atresia (TOF/OA) had the highest mortality rate (83.33%), followed by gastroschisis (80.92%) and intestinal atresia (42.535) among the respective admissions. Other important causes of mortality were jejuno-ileal atresia (5.37%), trauma (5.05%), Hirschsprung disease (4.64%), intestinal perforation (4.48%), omphalocele (4.15%), burn (4.07%) and posterior urethral valves (PUV), 3.58%.

Conclusion: Overall mortality rate was much higher than developed countries and lower than some African countries. Neonatal mortality rate was very high and among them TOF/OA and gastroschisis had extremely high mortality rates.

Keywords: Mortality; low-middle income countries; children; neonate; infant; global surgery; Bangladesh.

ABBREVIATIONS

LMIC: Low-middle income country; ARM: Anorectal malformation; TOF/OA: Tracheo-oesophageal fistula/ Oesophageal atresia; PUV: Posterior urethral valves; HIC: High income countries; NSQIP: National Surgical Quality Improvement Programs; NICU: Neonatal intensive care unit; IO: Intestinal obstruction; J-I:Jejuno-ileal; HD: Hirschsprung disease; NIO: Neonatal intestinal obstruction; NEC: Necrotising enterocolitis; IHPS: infantile hypertrophic pyloric stenosis; CDH: Congenital diaphragmatic hernia; GU: Genitourinary; NETS: Neonatal emergency transport system; TPN: Total parenteral nutrition

1. INTRODUCTION

There has been growing body of evidence that surgical care is a cost-effective intervention for low- and middle-income countries (LMICs) and surgery should receive more support on the global health agenda [1,2]. About 11% of global burden of diseases can be treated with surgery [3]. However, many correctable surgical conditions are not treated and many potentially curable diseases are causing mortalities among people in these countries. Children are no exceptions, rather, they are more neglected when the access to optimum surgical care comes into questions [4]. High income countries (HICs) have extensively reduced their surgical mortalities both in adults and in children. There has been a 47% and a 42% reduction in 30-day postoperative mortality and morbidity, respectively, in adult surgery after the adoption of National Surgical Quality Improvement Programs (NSQIP) in the USA [5]. The American College of Surgeons' "National Surgical Quality Improvement Program-Pediatric (NSQIP-

Pediatric)" dataset provides information on both inpatient and outpatient operations on children from birth to 18 years of age; and 30-day mortality after surgery was only about 0.3% [6]. Unfortunately, there are no such broad-based quality improvement programs in most LMICs, if not all, which can quantify the spectrum of surgical conditions in children and measure their outcome. While not only measurable, mortality is an important outcome in surgery. The objectives of the study were to assess the mortality associated with paediatric surgical conditions in our setting and to find out the diseases that had the highest mortality rates; with an aim of providing evidence for the diseases that need priorities to improve survival.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was a hospital based retrospective study carried out in the Department of Paediatric Surgery, Chattogram Medical College Hospital, which is a tertiary-level government academic hospital in Chattogram, Bangladesh; and is the largest referral center for paediatric surgical services for about one fifth (about 28.4 million) of the population of the country (161.4 million). Chattogram (former Chittagong) is the second largest city in the country, situated at its south-east part. All admitted patients of 0 to 12 years of age between January 2008 and December 2019 (12 years) were included in this study. The age limit for admission in this department is 12 years and patients older than that are admitted in adult surgical wards. The hospital has a neonatal intensive care unit (NICU) and a paediatric intensive care unit which are run by neonatologists and paediatricians, respectively.

The general objective of the study was to report the most common causes of death in children from surgical conditions in a LMIC. The specific objectives were to find out the most common mortality burdens, the age-group specific mortalities, and the diseases with highest mortality rates in our department, and to categorize those according to body systems.

2.2 Data Collection

Records of demography, age, diagnosis, and outcome for any admitted patient are preserved in excel sheets in our department. Every month these records are summarized and presented as monthly audit by a resident in the presence of all the faculties and these records are also preserved in excel files. Every year these records are again compiled in a yearly audit. For the purpose of the study, we fed the field of year of admission, age, diagnosis and mortality records of all the patients who were admitted between 2008 and 2019 in an excel sheet. Patients, who had received treatment in the outpatient department or emergency room but were not admitted in the ward, were not included in the study.

2.3 Data Analysis

Upon entry on an excel sheet, we alphabetically sorted all the diagnoses and corrected any inaccurate data with the help of the paper records. Frequency and percentage of mortalities, diseases, age-group specific mortalities, yearly trends, and systemic

distribution of mortalities were calculated. Data were analyzed using both Microsoft Excel 2019 and SPSS version 22 and cross checked to correct errors. Data were expressed as frequency and percentage.

3. RESULTS

During this 12-year period, a total of 30,301 patients were admitted in this department. Among them, 1228 (4.05%) patients died during in-hospital admission. Male to female ratio was 1.91:1 among admitted patients and 1.95:1 among the mortalities. Among admissions, 2689 (8.87%) were neonates, 4409 (14.55%) were infants, and 23,203 (76.58%) were children. Fig. 1 depicts the percent contribution of neonatal, infant and child deaths among all mortalities. Mortality rate was highest among the admitted surgical neonates (24.21%, 651 neonatal deaths among 2689 neonatal admissions). Infant mortality rate was 5.65% (249 infant-deaths among 4409 infant admissions) and child mortality rate was 1.41% (328 child deaths among 23,203 admitted children).

Yearly mortality rates ranged from 2.83% to 5.43% (mean 4.05%). Both the number of mortality and the mortality rate had a slightly upward trend line. This was because of gradually increasing trend in the neonatal admission which also had an almost parallel mortality trend. There was only a slight increase in the trend of infant admission and child-admission trend remained almost flat (Fig. 2).

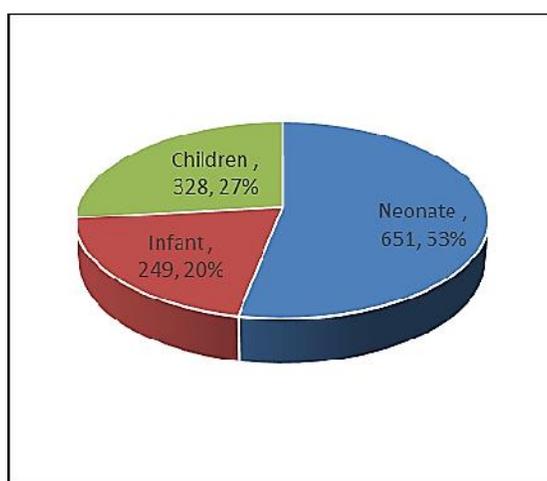


Fig. 1. Age distribution of mortalities (percentages are among the total number of mortalities, N=1228)

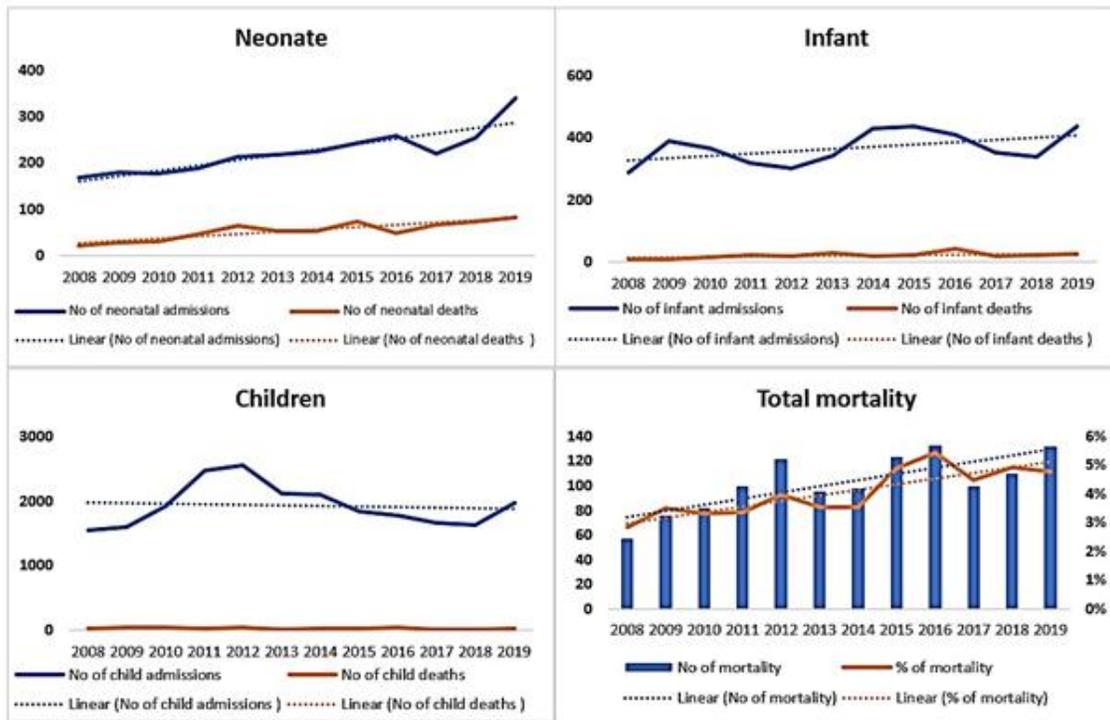


Fig. 2. Yearly trends in age group specific and overall numbers and percentages of mortality

Anorectal Malformation (ARM) was the most common cause of death, which was 12.05% of all mortalities (Table 1), followed by intestinal obstruction (11.40%) and gastroschisis (8.63%). The number of admitted ARMs was also high and ARM had a mortality rate of 11.38% of the admissions for this disease (148 ARM deaths among 1301 ARM admissions, Table 2). ARM had the 8th highest mortality rate considering the mortality percentage among the number of admissions for the respective disease. Although the total number of admitted patients with tracheo-oesophageal fistula/oesophageal atresia (TOF/OA) was small (18 patients), it had the highest mortality rate with 83.33% mortality for all admitted TOF/OA patients. On the other hand, 131 patients were admitted with gastroschisis, and among them 80.92% died. The mortality rate of jejuno-ileal atresia was 42.31% among 156 admitted patients. Table 2 lists ten diseases which had the highest disease specific mortality rates. There were 50 burn deaths which was the 9th highest cause of death. However, patients with burns were admitted in our department until the year 2013, and after that period, the patients were admitted in the department of burn and plastic surgery, and were not included in the calculation.

Diseases of the digestive system had the highest mortality rate which was 64.74% of all mortalities (Table 3). It was followed by abdominal wall defects (13.68%). However, patients with multiple congenital anomalies and cardiac anomalies had the highest mortality rates (14.46% and 12.82%, respectively) considering the mortality among the admissions for respective diseases (Table 3). Anterior abdominal wall defects and diseases of digestive system had mortality rates of 8.43% and 6.48%, respectively among the respective admitted patients. Trauma was the third highest causes of death which was 9.12% of all deaths; and 2.67% of the patients who were admitted with trauma, died.

Among the 795 deaths from digestive system, more than one fourth were from ARM and other unconfirmed intestinal obstructions. Gastroschisis (106 patients, 63.10%) had the most common mortality among abdominal wall defects followed by omphalocele (51 patients, 30.36%). Among the 63 deaths from genitourinary (GU) system, 44 patients had posterior urethral valves (PUV) which was the 10th highest cause of death. Most common causes of death among skin and soft tissue, head-neck, haematologic/vascular and cardiac systems were multiple pyaemic abscesses (7),

meningomyelocele (3), macrocystic lymphatic malformation (5), and congenital cyanotic heart diseases (10), respectively. There were 112 deaths from trauma including burns; and 32 deaths from malignant conditions.

4. DISCUSSION

This study shows that mortality rate was about 13 times more in our centre in comparison to the US NSQIP-Paediatric data (4.05% vs 0.3%, respectively). Our result is comparable to the scenario of other LMICs. In a study in Uganda, mortality was 15% among 2,090 children who were admitted with surgical conditions over a period of four years [7]. According to UNICEF child mortality report (2019), children living in sub-Saharan Africa were 16 times more likely to die before the age of five in comparison to children in HICs [8]. Moreover, there has not been substantial decline in deaths in under-5 children over the years from surgical conditions in the LMICs in comparison to deaths from infectious diseases [9]. It was reported that surgical conditions represented about 6–12% of all paediatric admissions in sub-Saharan Africa, and about 87% of the surgical needs in children in LMICs remains unmet [7].

Although neonatal admissions represented only 8.87% of all admissions in this study, neonatal mortality was responsible for 53.01% of all mortalities. There has been a gradually increasing trend of neonatal admission over the years with corresponding increasing trend in neonatal mortality. This caused a gradual increase in the overall mortality trend in spite of the fact that trend of infant and child mortality remained almost flat. A systematic review in African countries found that the neonatal surgical mortality rate reduced from 36.9% in previous decade to 29.1% in the subsequent decade [10]. On the contrary, neonatal mortality in a report from Australia was 3.6% over 16 years [11]. In Japan, mortality linearly declined from 12% in 1993 to 6.6% in 2013 [12]. In a large study from South Korea, neonatal surgical mortality was 6.7% [13]. According to UNICEF child mortality report (2019), neonatal deaths accounted for 47 per cent of all under-five deaths and it has been predicted that 26 million new-borns would die between 2019 and 2030, and 80 per cent of these deaths would occur in Southern Asia and sub-Saharan Africa [8]. Studies showed that the outcome of neonatal surgical conditions in these regions is also dismal [3,7,10,14–16]. This clearly

denotes that some babies born in the LMICs are very unfortunate, and had they been born in any developed world, a large portion of them could have led a normal life. This death toll will continue until major changes are brought in the set-up of neonatal surgical facilities in the LMICs as had been done in the HICs. A narrative review of neonatal surgery in Africa noted a variety of causes of high mortality in this setting such as, poor transportation, late presentation, inadequate equipment and facilities, insufficient manpower, inadequate documentation, and poor follow-up; which are also pertinent to other LMICs [17]. Early and proper new born referral (such as NETS, baby-lance, mobile NICU), proper NICU support, dedicated neonatal surgical team, neonatal anaesthesiologists with equipment support, neonatal total parenteral nutrition (TPN) facilities and central lines, NICU support in the theatre or surgery in the NICU are some of the factors suggested by different studies for the improvement of neonatal surgical mortality [18–20].

In infants, intussusception was the most common cause of death. Worldwide, the commonest age of occurrence of intussusception is during infancy, and it can be successfully treated with non-surgical reduction if they present within first few days of onset. In children, major cause of death was intestinal obstruction. These are the cases who presented late with established sepsis and died before a definite diagnosis could be made or surgeries could be performed. This emphasizes the need for early diagnosis and timely referral for these conditions to improve survival.

Although ARM was the highest (12.05%) cause of death, the deadliest disease in our setting was TOF/OA (83.33% mortality). However, there were only 18 admissions of TOF/OA over this 12-year period. The overall prevalence of TOF/OA is 1 in about 4000 live births, which suggests that most patients of TOF/OA in our setting died before even reaching a tertiary centre or having a diagnosis [21]. Report from a large private corporate hospital in the capital city, which had modern NICU, neonatal anaesthesiologist, and could use single lung ventilation, and which involves a lot of out-of-pocket money for the surgeries, showed a mortality rate of 36% for TOF/OA patients over a period of 8 years [22]. Gastroschisis was the second deadliest surgical condition (80.92% deaths). Ford et al. termed gastroschisis as a bellwether for neonatal surgery capacity in low resource

settings [23]. There are extreme disparities in the outcome of gastroschisis between HICs and LMICs. A 2-year retrospective review of “Gastroschisis International” centre showed that mortality from gastroschisis was 100% in Uganda and Cote d'Ivoire, 75% in Nigeria and 60% in Malawi, 29% in South Africa and 0% in

the UK. Most centres in the HICs have a mortality rate of less than 10% for gastroschisis [23]. In the HICs, antenatal diagnosis, planned delivery, diligent perinatal resuscitation, NICU, TPN and surgical advances have dramatically improved survival rates for gastroschisis [23].

Table 1. Ten major causes of death in all ages and among age groups according to number of deaths

SL	Mortality in all age groups (N=1228)	Mortality in neonates (N=651)	Mortality in infants (n=249)	Mortality in children (n=328)
	Diagnosis, No of death (%)	Diagnosis, No of death (%)	Diagnosis, No of death (%)	Diagnosis, No of death (%)
1	ARM, 148 (12.05%)	ARM, 127 (19.51%)	Intussusception, 22 (8.84%)	IO, 118 (35.98%)
2	IO, 140 (11.40%)	Gastroschisis, 106 (16.28%)	ARM, 15 (6.02%)	Trauma, 57 (17.38%)
3	Gastroschisis, 106 (8.63%)	J-I atresia, 57 (8.76%)	HD, 11 (4.42%)	Ascariasis, 44 (13.41%)
4	J-I atresia, 66 (5.37%)	Omphalocele, 50 (7.68%)	PUV, 9 (3.61%)	Burn, 42 (12.80%)
5	Trauma, 62 (5.05%)	NIO, 41 (6.30%)	Malrotation, 9 (3.61%)	Malignancy, 24 (7.32%)
6	HD, 57 (4.64%)	HD, 39 (5.99%)	IO, 8 (3.21%)	PUV, 21 (6.40%)
7	Perforation, 55 (4.48%)	NEC, 24 (3.69%)	IHPS, 7 (2.81%)	Sepsis, 13 (3.96%)
8	Omphalocele, 51 (4.15%)	M. ileus, 23 (3.53%)	CDH, 6 (2.41%)	Malrotation, 10 (3.05%)
9	Burn, 50 (4.07%)	Perforation, 15 (2.30%)	Perforation, 5 (2.01%)	Abscess, 7 (2.13%)
10	PUV, 44 (3.58%)	PUV, 14 (2.15%)	Burn, 4 (1.61%)	HD, 7 (2.13%)

Abbreviations: ARM: anorectal malformation, IO: intestinal obstruction, J-I: Jejuno-ileal, HD: Hirschsprung disease, PUV: posterior urethral valves, NIO: neonatal intestinal obstruction, IHPS: infantile hypertrophic pyloric stenosis, NEC: necrotizing enterocolitis, M. ileus: Meconium ileus, CDH: congenital diaphragmatic hernia

Table 2. Diseases with highest mortality rates among admissions for respective diseases

Cause of death	No of deaths	% among all deaths (N= 1228)	No of Admissions for respective disease	% of death among admission for respective disease
1. TOF/OA	15	1.22%	18	83.33%
2. Gastroschisis	106	8.63%	131	80.92%
3. J-I atresia	66	5.37%	156	42.31%
4. Omphalocele	51	4.15%	157	32.48%
5. CDH	20	1.63%	72	27.78%
6. Meconium ileus	28	2.28%	118	23.73%
7. PUV	44	3.58%	330	13.33%
8. ARM	148	12.05%	1301	11.38%
9. Malrotation	17	1.38%	150	11.33%
10. HD	57	4.64%	823	6.93%

Abbreviation: TOF/OA: Tracheo-oesophageal fistula/Oesophageal atresia, J-I: Jejuno-ileal, CDH: congenital diaphragmatic hernia; PUV: posterior urethral valves; ARM: anorectal malformation; HD: Hirschsprung disease.

Table 3. Systemic distribution of mortality

Body System	No of deaths	No of admissions	Death % among respective admissions	Death % among total no of deaths (N=1228)
Digestive	795	12,270	6.48%	64.74%
Anterior abdominal wall	168	1,992	8.43%	13.68%
Trauma (including burn)	112	4,201	2.67%	9.12%
Genito-urinary	63	5,280	1.19%	5.13%
Neoplasm	32	546	5.86%	2.61%
Skin and soft tissue	16	4,023	0.40%	1.30%
Vascular	12	886	1.35%	0.98%
Multiple congenital anomalies	12	83	14.46%	0.98%
Cardiac anomalies	10	78	12.82%	0.81%
Head and neck	8	206	3.88%	0.65%
Orofacial	0	579	0.00%	0.00%
Musculoskeletal	0	157	0.00%	0.00%
Total	1,228	30,301	4.05%	100.00%

Similar to our findings, ARM, jejuno-ileal atresia, Hirschsprung disease and other intestinal obstructions are common among children reported by many series and are major causes of mortality. Reports from HICs shows high mortality from NEC; however NEC is mostly managed by the neonatologist in the NICU and surgeries for NEC are not common in our setting [24,25]. Trauma was another important cause of mortality which has an increasing global trend and ranks among the top causes of death and lifelong disability among children aged 5–14 years [8]. More than 90% of deaths from injuries occur in low- and middle-income countries [1].

There is an urgent need for improvement in some neonatal and paediatric surgical outcomes in LMICs. Surgical conditions in children in these settings constitute an invisible disease burden, the socioeconomic impact of which is substantial [26]. A recent population-based survey in Rwanda found that 40% of surgical conditions affected children less than 15 years old [16]. Since surgeries have been proven to be cost-effective by several studies; partnerships and research efforts between HICs and LMICs to acquire data to shape surgical policy, advocacy and service delivery are needed as has been suggested by the Lancet Commission for Global Surgery [2,27].

5. CONCLUSION

There was high mortality rate for overall paediatric surgical conditions in comparison to HICs. Mortalities from neonatal surgical conditions were less than some African countries

but far more than the HICs. Diseases such as TOF/OA and gastroschisis had extremely high mortality rates. Trauma was also an important cause of death. Countries in the LMICs should increase their efforts to improve the outcome, especially for neonatal surgical conditions.

CONSENT

It is not applicable.

ETHICAL APPROVAL

This retrospective study did not involve any patient-contact, exposure of patients' identity or photograph. Permission for publication was taken from the Head of the department and the Head of the institute.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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