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Pediatric intestinal obstruction: analysis of etiologies and factors influencing short-term outcomes in Rwanda

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ABSTRACT

Background Intestinal obstruction is a common presentation in pediatric surgical emergencies and presents with different etiologies depending on country or region. Its morbidity and mortality are high in low-income and middle-income countries, with variable influencing factors. The aims of this study were to determine the etiologies, morbidity and mortality of pediatric intestinal obstruction and to assess the factors associated with the outcomes of these conditions in Rwanda.

Methods This was a cross-sectional study conducted on pediatric patients with intestinal obstruction in two Rwandan university teaching hospitals. The patients were followed from admission until discharge, and we documented their basic characteristics, diagnosis, operative details and postoperative outcomes. Data were collected using data collection form and were electronically captured and analysed using SPSS software.

Results A total of 65 patients were enrolled in this study. They were predominantly male (n=49, 75.4%), and the majority of patients (86.2%) were below age 6 years. Intussusception was the most common etiology (n=22, 33.8%). Other common etiologies were Hirschsprung's disease (n=13, 20%), incarcerated inguinal and umbilical hernias (n=6, 9.2%), intestinal worms' impaction (n=5, 7.7%) and adhesions (n=5, 7.7%). Mortality and morbidity were 9.2% and 39.7%, respectively. The most common complications were surgical site infection (n=6, 9.5%) and sepsis (n=6, 9.5%). Preoperative anemia (p=0.001), finding of gangrenous bowels (p=0.003) and bowel resection at the time of laparotomy (p=0.039) were factors associated with postoperative complications.

Conclusions The etiologies of intestinal obstruction are variable and common in children below 6 years in Rwanda. The associated morbidly is high and is influenced by the preoperative anemia, finding of gangrenous bowels and bowel resection.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Etiologies of intestinal obstruction in children are variable depending on each country and are unknown in Rwanda and other sub-Saharan countries.

WHAT THIS STUDY ADDS

⇒ Intussusception is the common etiology in Rwanda.
⇒ Children with anemia are at high risk of complications following emergency laparotomy for intestinal obstruction.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Future research might focus on the management of mild-to-moderate anemia in children to undergo laparotomy.

INTRODUCTION

Intestinal obstruction is defined as an interruption of forward flow of contents within the intestinal lumen and affects patients of all ages.[1 2] Intestinal obstruction is among common causes of emergency admissions in children all over the world.[3] There is a male predominance with a male-to-female ratio ranging between 1.8 and 3.5:1, and the majority of patients present before 5 years.[3–7] There is a high variability in etiologies of intestinal obstruction in children, which is noted in different parts of the world, geographic region, among age and socioeconomic groups.[5 7 8] In studies carried out in different countries of Africa, Hirschsprung's disease was the most common cause in Malawi and intussusception was a common cause in Uganda and Ghana,[9 10] whereas ascaris plug was the leading cause in Kenya.[4 5] In studies done elsewhere, intussusception was the main cause in India, China and Nepal.[6 11 12]

Reported mortality of intestinal obstruction in children ranges from 3% to 11.2%,[3 7 10] and the morbidity varies from 4% to 60%.[7 12] The common morbidities include surgical site infection (SSI), sepsis, fascial dehiscence, stoma-related complications and enterocutaneous fistula.[7 13] In low-income and middle-income countries, there is a high burden of unmet surgical need in general, but specifically very high in the pediatric population.[14–17] In Africa, there is only 1 general surgeon per million and 0.26 pediatric surgeons per million.[5 18 19] In East Africa, there is 0.53 pediatric surgeons per 100 000, and those available mostly reside in cities.[20] These factors

may contribute to late presentation and associated poor outcomes. Other known burdens of conditions such as malnutrition, HIV/AIDS and tuberculosis also may be contributing factors to morbidity and mortality of children with intestinal obstruction in low-income and middle-income countries.

There are still limited data on pediatric intestinal obstruction in sub-Saharan countries. In this cross-sectional study, our aim was to assess the etiologies and factors influencing outcome of pediatric intestinal obstruction in Rwanda. This will help to understand disease context in Rwanda and similar settings of low-income and middle-income countries.

MATERIALS AND METHODS

Patients and data collection

Rwanda is an East African country with about 12 million populations, and approximately 40% of the population is below 15 years. In the current referral system, there are five major national referral hospitals that manage patients from district, provincial and regional referral hospitals. Our study was conducted in two university teaching hospitals, University Teaching Hospital of Butare (CHUB), which is a 500-bed hospital, and University Teaching Hospital of Kigali (CHUK), which has a capacity of 519 beds. The settings in both hospitals are similar, equipped with intensive care units and all supportive medications for children in need.

We included all pediatric patients, from 1 month to 15 years admitted with confirmed intestinal obstruction. Enrolled patients were identified through the pediatric emergency department and were followed prospectively from admission until discharge. Intestinal obstruction was confirmed clinically by the surgical team and radiologically if required. The clinical features of intestinal obstruction included, but were not limited to, vomiting, abdominal distention, stool and gas arrest. We excluded patients with functional intestinal obstruction (paralytic ileus) as a complication of another abdominal operation and those transferred to another hospital before formal discharge.

Data were collected over a period of 6 months from August 2020 to February 2021. The collected data included patient demographics (age, gender, socioeconomic status (SES)), duration of symptoms, etiology of obstruction, vital signs at admission, associated medical conditions, basic laboratory results including hemoglobin and electrolytes, modality of management, primary surgeon category (resident or consultant), postoperative disposition, postoperative complications, duration of first feeding after surgery, length of hospital stay and overall outcome (discharged home or died). Age was categorized as infant (1 month to 1 year), toddler (1–3 years), preschool (3–6 years), school age child (6–12 years) and adolescent (12–15 years). SES in Rwanda is based on population income and is divided into four categories. In the present study, we defined categories 1 and 2 as low SES, whereas categories 3 and 4 were defined as high SES.

Outcomes

Our primary outcome of interest was complication, while the secondary outcome was mortality. Postoperative complications were defined according to Clavien-Dindo (C-D) classification from grade I–V.[21] Grade I includes any deviation from normal postoperative course without need of medications or any other intervention. Grade II includes grade I complications that need pharmacological intervention. Grade III includes complications that require surgical, endoscopic or radiological intervention. Grade IV includes life-threatening complications that require intensive care unit (ICU) management. Grade V includes complications that lead to patient's death. The grades I and II were considered minor complications and grades III–V as major complications. Anemia was defined as hemoglobin <100 g/L. Electrolytes imbalance was defined as any of low or high potassium (<3.5 mmol/L or >5.0 mmol/L), chloride (<95 mmol/L or >107 mmol/L) or sodium (<135 mmol/L or >145 mmol/L). For both hemoglobin and electrolytes, we considered preoperative values art admission.

Statistical analysis

Our data were analyzed using statistical package for social sciences (SPSS) V.24. Descriptive statistics were used to generate frequencies and percentages of categorical variables, as well as mean and SD for continuous variables. Symptom duration for congenital versus acquired conditions was reported as median and interquartile range (IQR) and was analyzed using Wilcoxon rank sum test. The relationship between different risk factors and outcome was analyzed using χ^2 test and Fisher's exact test, as appropriate. The result was considered statistically significant if the p value was <0.05.

RESULTS

A total of 65 patients were included in this study. The majority of patients (n=56, 86.1%) were below 6 years (infant, toddler and preschool groups). Patients' characteristic data are all displayed in table 1. There were predominantly male patients with male-to-female ratio of 3:1. Eight patients (12.3%) presented with comorbidities that included malnutrition (n=4), congenital heart disease (n=2), malaria (n=1) and spinal bifida (n=1). Twelve patients had anemia and 27 patients had electrolytes imbalance. The median duration of symptoms was 5 (IQR 2,14) days. This duration of symptoms varied between acquired and congenital conditions. The median duration of symptoms was 3 (IQR 2, 5) days for acquired conditions and 21 (IQR 7, 32.5) days for congenital conditions (p<0.001). The majority of patients (n=38, 58.5%) were in low SES.

The most common etiology of intestinal obstruction in all age group was intussusception, followed by

Table 1 Patients' demographics and characteristics

Variable	Patients (n, %)
Age	
1–12 months	25 (38.5%)
1–3 years	17 (26.2%)
3–6 years	14 (21.5%)
6–12 years	6 (9.2%)
12–15 years	3 (4.6%)
Sex	
Male	49 (75.4%)
Female	16 (24.6%)
Socioeconomic category	
Low (category 1 and 2)	38 (58.5%)
High (category 3 and 4)	27 (41.5%)
Duration of symptoms (days)*	
<5	30 (47.6%)
≥5	33 (52.4%)
Presence of comorbidity	8 (12.3%)
Anemia	12 (18.5%)
Electrolytes imbalance	27 (41.5%)

*Data are presented with ±SD.
SD, Standard deviation.

Hirschsprung's disease, hernias (inguinal and umbilical), adhesions, intestinal worms, hypertrophic pyloric stenosis, malrotation, congenital band, constipation, duodenal atresia, jejunal web, ileosigmoid knotting and imperforate anus (figure 1). About one-third of all etiologies were congenital conditions.

All patients except two with adhesions were operated. Table 2 showed intraoperative findings and postoperative complications of 63 patients with operation. Overall, 25 (39.7%) patients had one or more complications after surgery, among which the majority (n=14) were minor complications (C-D grade I and II) and the remaining

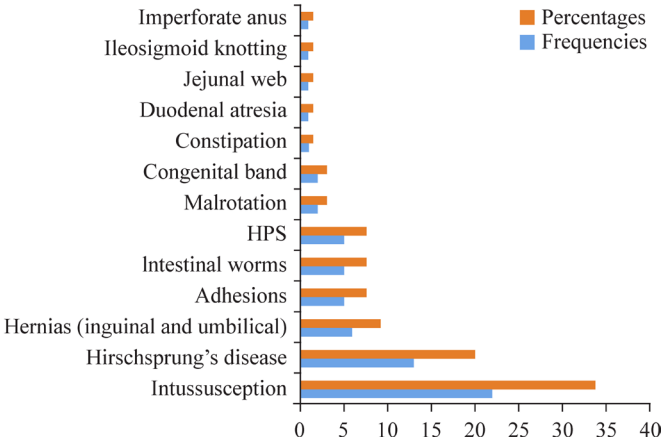

Figure 1 Etiologies of intestinal obstruction. HPS, hypertrophic pyloric stenosis.

Table 2 Management details and postoperative complications of 63 patients with operation

Variable	Patients (n, %)
Bowel status	
Viable	46 (73.0%)
Gangrenous	17 (27.0%)
Procedure performed	
Obstruction relieve without resection	31 (49.2%)
Bowel resection	32 (50.8%)
Procedure after resection	
Resection and anastomosis	14 (22.2%)
Resection and stoma	17 (27.0%)
Resection, stoma and anastomosis	1 (1.6%)
Postoperative disposition	
General ward	49 (77.8%)
ICU	4 (6.3%)
HDU	10 (15.9%)
Postoperative complications	
Yes	25 (39.7%)
No	38 (60.3%)
In-hospital mortality	
Dead	6 (9.2%)
Survived	59 (91.8%)
Hospital stay (days)*	8±6

*Data are presented with mean±SD.
HDU, high dependency unit; ICU, intensive care unit; SD, Standard deviation.

11 patients had major complications. The minor complications included atelectasis, pneumonia, SSI, hematoma, prolonged ileus, anemia, electrolytes imbalance and sepsis. The major complications included wound dehiscence, intra-abdominal abscess, hematoma and stoma-related complications. The common postoperative complications were SSI (n=6, 9.5%) and sepsis (n=6, 9.5%). The mean±SD length of hospital stay was 8±6 days, and it ranged between 1 and 34 days. The overall mortality rate was 9.2% (6/65).

On bivariate analysis, the postoperative complications were associated with anemia before surgery (p=0.001), bowel status at operation (p=0.003) and bowel resection (p=0.039) (table 3). There was no factor significantly associated with mortality.

DISCUSSION

This study evaluated the etiologies of pediatric intestinal obstruction and factors associated with outcome in two Rwandan university teaching hospitals. We found multiple causes of intestinal obstruction in children, and they were predominantly in the group below 6 years of age (86.1%). Intussusception was the most

Table 3 Analysis of factors associated with postoperative complications and mortality of patients with intestinal obstruction

Variable		Postoperative complication			Postoperative mortality		
		No	Yes	P value	No	Yes	P value
Age	≤5 years	32	22	1.000	48	6	0.581
	>5 years	6	3		9	0	
Sex	Male	30	17	0.329	42	5	1.000
	Female	8	8		15	1	
Comorbidity	Yes	4	4	0.701	6	2	0.163
	No	34	21		51	4	
Duration of symptoms	< 5 days	19	11	0.418	28	2	0.674
	≥ 5 days	19	14		29	4	
Socioeconomic Status	Low	23	15	0.967	32	6	0.073
	High	15	10		25	0	
Etiology	Congenital	12	8	0.972	17	3	0.371
	Acquired	26	17		40	3	
Primary surgeon	Consultant	30	19	0.783	44	5	1.000
	Resident	8	6		13	1	
Anemia	Yes	2	10	0.001	9	3	0.077
	No	36	15		48	3	
Electrolyte abnormality	Yes	17	10	0.742	24	3	1.000
	No	20	14		31	3	
Bowel status	Viable	33	13	0.003	42	4	0.657
	Gangrenous	5	12		15	2	
Bowel resection	Yes	15	17	0.039	28	4	0.671
	No	23	8		29	2	

common cause of intestinal obstruction in our study in all age groups.

Our study findings confirmed the variability of etiologies of intestinal obstruction in different regions. Intussusception was the most common cause in our settings as in many other centers, including studies in the UK, India, Nigeria and Nepal.[2 3 7 12] Hirschsprung's disease was the second cause of intestinal obstruction in our study. This condition has been prevalent in pediatric patients, especially in centers of low-income and middle-income countries like Malawi and Nigeria.[22–24] Different to low-income and middle-income countries, this condition commonly present in neonatal period or early infancy in high-income settings. Intestinal worms, which is a common cause of intestinal obstruction in some of low-income and middle-income countries like Kenyan and Indian centers,[4 13] accounted only for 7.6% in our study population. This may be a result of different measures put in place in Rwanda for hygiene and sanitation.

The outcomes of our patients were measured in terms of morbidity and mortality and were 39.7% and 9.2%, respectively. Most complications were minor, whereas the major complications accounted for 17.5%. The most common complications were surgical SSI and sepsis, both accounting for 48% of all complications. This finding was similar to that of other researchers including Ogundoyin *et al*, who found that in Nigeria and Khursheed *et al*, who found in an Indian center, SSI and sepsis were the common complications representing 40.8% and 25.1%, respectively.[7 13] Apart from death, the common major complications were intra-abdominal abscess, stoma-related complications and wound/fascia dehiscence all requiring reoperation. The major complications represented 16.2% in the study by Ogundoyin *et al*.[7] Such complications represented 10% in the study by Khursheed *et al*, including burst abdomen, fecal fistula and acute renal failure.[13]

The morbidity in our study was high (39.7%) compared with many study findings (4%–33%).[12 13 18] This difference may be attributed to the variability of patient's characteristics and the definition of morbidity. The reviewed previous studies[12 13 18] did not use C-D classification of surgical complications as in our study, and this may overlook minor complications.

The finding of gangrenous bowels at the time of operation, bowel resection and low hemoglobin at admission were associated with increased risk of morbidity. Bowel strangulation in case of intestinal obstruction may depend on nature of etiology, but it is often due to time spent from onset to intervention. The patients presenting with intestinal strangulation

will often come with severe dehydration and electrolytes imbalance secondary to longstanding vomiting or fluids shift. In addition, the level of bacterial load and contamination during bowel resection are high, which leads to systemic or abdominal sepsis. All these factors explain high rates of complications in this category of patients. Initial assessment should focus on identifying the patients with strangulated bowels because it is important for communication with parents before surgery for possibility of high morbidity. Preoperative anemia is a known modifiable risk factor associated with increased complications after emergency laparotomy.[25] Anemia in our patients can be related to other prevalent comorbidities in our population including malnutrition and malaria, and if combined can result in observed high morbidity. So far, there is no valid recommendation on management of mild-to-moderate anemia in patients undergoing laparotomy.

The mortality of 9.2% in our study is lower than the findings in previous local study of 2012 by Ngendahayo *et al*, where the mortality rate was 28% among patients with intussusception.[26] This mortality was comparable to that found from the retrospective review of 11.2% in Ghana,[10] but it was higher compared with other study findings in different countries like Kenya, Malawi, Nigeria and India, ranging from 2.9% to 7.8%.[3–7 13] This difference in mortality can be attributed to the fact that each country or center has different patient characteristics and facility settings. There was no factor significantly associated with mortality in our study. One review reported different factors associated with mortality including delayed diagnosis, low SES, anesthesia complications and lack of ICU.[27]

Our study has several limitations. Due to intermittent technical problems in laboratory, we did not get some investigations, such as liver and renal function tests, of a large number of patients. Consequently, we were unable to analyze the effect of organ failure at admission on outcome. The sample size in our study may not have detected the statistical difference, which can be detected with a bigger sample. The definition of the pediatric population is different through the literature, and this also can explain the variability of results in different studies.

In conclusion, intussusception is the most common cause of pediatric intestinal obstruction in Rwanda. Intestinal obstruction is common in male, low SES and below 6 years old patients. The morbidity is high in our patients and is associated with low hemoglobin at admission, finding of gangrenous bowels at the time of surgery and bowel resection.

Contributors IT is the guarantor and designed the study protocol, collected and analyzed data, drafted the manuscript. MN contributed to study design and critically revised the manuscript. JR contributed to study design, contributed to data analysis and critically analyzed the manuscript. EN designed the study, contributed to data analysis and critically revised the manuscript. CN contributed to data collection, data analysis and revised the manuscript. All authors agreed to the final version of the manuscript and agreed to be accountable for all aspects of the work.

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Competing interests None declared.

Patient consent for publication Consent obtained from parent(s)/guardian(s)

Ethics approval This study was approved by University of Rwanda, College of Medicine and Health Sciences institutional review board (ID: 076/CMHS IRB/2020), University Teaching Hospital of Kigali ethics committee (ID: EC/CHUK/054/2020) and University Teaching Hospital of Butare ethics committee (ID: CHUB/DG/SA/07/1231/2020). Participants gave informed consent to participate in the study before taking part.

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