Outcomes of Neonates Requiring Surgical Interventions in Eldoret

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Abstract

Background: Neonatal surgical conditions account for 11% of the Global Burden of Diseases (GBD), and neglecting their management has been reported though most are amenable to surgery. Timely surgical interventions play a major role in determining better outcomes, thus improving quality of life and reducing disability. Several factors including sepsis control, care in newborn intensive care unit and availability of total parenteral nutrition have been shown to improve the outcomes of neonates with surgical conditions. **Objective:** To evaluate the outcomes of neonates with conditions requiring surgical interventions. **Methods:** A prospective descriptive study was done in the Newborn Unit, Moi Teaching and Referral Hospital (MTRH). Data on the following study variables were obtained and analyzed: maternal age, place and mode of delivery, newborn's age at admission, birth weight, surgical condition, co-morbid conditions, treatment outcomes (discharge, death or referral to Kenyatta National Hospital for specialized care), surgical complications, time-to-initiation of oral feeds post-operatively, antenatal history and laboratory parameters; and length of hospital stay. **Results:** A total of 124 neonates were recruited, with a male to female ratio of 1.1:1 and median age at admission was 2 days (IQR 1, 5). Most (59.7%) were in the birth weight range of 2.5–3.9kg. The leading neonatal surgical conditions were gastroschisis 33(26.6%), neural tube defects 25(20.2%) and ARM 25(20.2%). The overall mortality rate was 31.5%. Antenatal clinic attendance was associated with decreased odds of mortality (OR 0.126; 95% CI 0.025–0.6429; p= 0.013), while neonatal sepsis, respiratory distress and electrolyte imbalance were associated with increased odds of mortality ([OR 3.4; 95% CI 1.09–22.06; p=0.049], [OR 4.9; CI 0.91–11.61; p=0.001] and [OR 3.1; CI 1.21–31.60; p=0.029], respectively). The median length of hospital stay was 14.5 days. **Conclusions:** The overall mortality rate of neonates requiring surgical interventions at MTRH was 31.5% and the median length of hospital stay was 14.5 days. Co-morbid conditions that increased the odds of mortality among these neonates were neonatal sepsis, respiratory distress and electrolyte imbalance.

Key words: Neonates, Surgical, Interventions, Outcomes
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Introduction

The World Health Organization defines a neonate as child less than 28 days of age, a critical period during which the child is at the highest risk of dying (1). Neonatal surgical conditions account for 11% of the Global Burden of Diseases (GBD), most of which are congenital anomalies (2). Despite this, neglect is reported in their management, yet most of these conditions are amenable to surgery (3).

This is because the global focus has for long been on the top 3 leading causes of neonatal mortality: prematurity, sepsis and perinatal asphyxia (4). Surgical interventions are important in improving the outcomes of many neonatal surgical diseases as timely interventions lead to better outcomes, improve quality of life and reduce disability. Successful management of neonates with surgical conditions requires a multidisciplinary approach especially the post-operative care. Factors such as sepsis control, care in the newborn intensive care unit (NICU) and availability of total parenteral nutrition (TPN) have been shown to improve the outcomes. Mortality rates from neonatal surgical cases remain high in most developing countries largely due to lack of NICU, scarcity of surgical specialists and unavailability of TPN (5–9).

High-income countries (HICs) however continue to report

lower mortality rates despite an apparent increase in neonatal surgical cases (2). Good surgical outcomes that have been achieved in HICs are feasible in developing countries only if some of the associated adverse factors are addressed (2, 3). A study done at Kenyatta National Hospital (KNH) in 2015 reported a mortality rate of 33% (10). This study set out to evaluate the outcomes (mortality and length of hospital stay) of neonates requiring surgical interventions at Moi Teaching Referral Hospital (MTRH).

Methods

This was a prospective descriptive study carried out at the Newborn Unit of MTRH, between February and November 2016. The study aimed to evaluate the outcomes (mortality and length of hospital stay) of neonates requiring surgical interventions. The study population comprised neonates with conditions requiring surgical interventions in the neonatal period. The unit has a capacity of 60 beds and provides care to neonates with both medical and surgical problems. The approximate nurse to patient ratio is 1:20. The neonates are reviewed regularly by surgical specialists (general pediatric surgeons, neurosurgeons, orthopedic surgeons and ENT surgeons) upon admission. Once the decision for surgical interventions on their conditions was made, the neonates were recruited into the study consecutively, once written informed consent was obtained from the parents/guardians. Ethical approval was obtained from the Institutional Review and Ethics Committee. Data on maternal age, place and mode of delivery, newborn's age at admission, birth weight, surgical conditions, co-morbid conditions, treatment outcomes (discharge, death or referral to KNH for specialized care), surgical complications and time-to-initiation of oral feeds post-operatively were recorded. Antenatal history and laboratory parameters were also obtained. The length of hospital stay was determined following the final disposition of the newborn, which was either discharge after recovery, death or referral to KNH for specialized surgery. Data were analyzed using STATA® version 13 at 95% confidence interval. Data were presented using frequency tables. Simple logical regression was done to test for independent associations, and Mann Whitney U test for comparison of two medians. P-values of less than 0.05 were considered statistically significant.

Results

A total of 124 neonates were recruited into the study. During the study period 1,096 neonates were admitted to the unit: neonatal surgical conditions accounted for 11.3%. The male to female ratio was 1.1:1. Most mothers attended ante-natal clinics (82.3%) and nutritional supplements were issued to 84 (82.4%) mothers during pregnancy. None of the mothers received nutritional supplements during the first trimester. Routine antenatal ultrasound scans were done on only 4% of the mothers and no congenital anomaly was detected in the ante-partum period. Most neonates (83%) were delivered in other health facilities and were then referred to MTRH for surgical care; 9 (7%) were delivered at MTRH, and 12 (10%) at home. The median age at admission was 2 days (IQR 1, 5) with a range of 1 to 26 days; 59.7% of the neonates had birth weights of between 2.5 and 3.9kg, 31.5% between 1.5 and 2.4 kg, and 4% were >3.9 kg.

Surgical interventions offered

Most neonates (87.1%) who required surgical interventions had surgery done at MTRH. Of these 65(60.2%) were emergency surgical operations and 43(39.8%) were elective. Reasons cited for not performing surgery on some of the neonates (*n*=16) in MTRH included: too sick to withstand surgery (43.8%), died before surgery (25%), were booked to be seen in pediatric surgical outpatient clinic (18.8%), and referred to KNH for specialized surgery (12.5%).

Treatment outcomes

The overall mortality rate was 31.5%. Eighty-three (66.9%) neonates were discharged home upon recovery and 2 (1.6%) were referred to KNH for specialized surgery.

Spectrum of neonatal surgical conditions

Most (92%) neonatal surgical conditions were congenital anomalies: 70% had surgical conditions affecting the gastrointestinal system, 20% the central nervous system and 10% the musculoskeletal system. Table 1 shows the top 4 diagnoses in this study. The other 19 (15.3%) neonates had diagnoses that included sacrococcygeal teratoma, pyomyositis, cystic hygroma, meconium peritonitis, brain abscess and submandibular abscess (Table 1).

Table 1: Main diagnoses, mortality and discharge/referral rates

Diagnosis	Frequency (*n*/%) (*n*= 124)	Discharge / Referred to KNH (*n*/%) (*n*= 85)	Mortality (*n*/%) (*n*= 39)
Gastroschisis	33 (26.6%)	14 (42.5%)	19 (57.5%)
Neural tube defects	25 (20.2%)	23 (92%)	2 (8%)
ARM	25 (20.2%)	17 (68%)	8 (32%)
Small bowel atresia	18 (14.5%)	13 (72%)	5 (28%)
OA/TEF	4 (3.2%)	1 (25%)	3 (75%)
Others	19 (15.3%)	17 (89.5%)	2 (10.5%)

Co-morbid conditions

Co-morbid conditions were reported in 94 (75.6%) neonates, with anemia being the leading co-morbid condition. On bivariate analysis, there was a significant association between the presence of co-morbid conditions (respiratory distress, electrolytes imbalance, acute kidney injury) and mortality (p = 0.001) (Table 2).

Table 2: Bivariate analysis showing association between independent variables and mortality (*n* = 122)

	No (*n*/%) *n* = 83	Yes (n/%)*n* = 39	p-value
ANC attendance			
None	12 (54.5%)	10 (45.5%)	0.325
1–3 visits	59 (71%)	24 (29%)	
≥4 visits	12 (70.6%)	5 (29.4%)	
Delivery place			
Home	9 (75%)	3 (25%)	0.750*
Health facility	74 (67.3%)	36 (32.7%)	
Birth weight			
<2.5kg	20 (45.5%)	24 (54.5%)	**0.001**
≥2.5kg	63 (80.8%)	15 (19.2%)	
Sepsis			
Yes	33 (62.3%)	20 (37.7%)	0.230
No	50 (72.5%)	19 (27.5%)	
Respiratory distress			
Yes	12 (35.3%)	22 (64.7%)	0.001
No	71 (80.7%)	17 (19.3%)	
Electrolyte imbalance			
Yes	10 (33.3%)	20 (66.7%)	0.001
No	73 (79.3%)	19 (20.7%)	
AKI			
Yes	2 (25%)	6 (75%)	*0.013
No	81 (71%)	33 (29%)	

***Fishers exact test**

Surgical complications

The surgical complication rate was 26.9%. These included wound sepsis (17.6%), post-operative hemorrhage (5.6%), burst abdomen (2.8%) and bowel perforations (1.9%).

Laboratory parameters

Blood cultures isolated mainly *Klebsiella pneumoniae* species and low platelet count was significantly associated with mortality (p<0.001).

Length of hospital stay

The median length of hospital stay was 14.5 days (IQR 6, 32) with a range of 0 days to 102 days. Time-to-initiation of oral feeds post-operatively ranged from 1 to 24 days and 51.3% of the neonates stayed Nil per Oral for more than 3 days post-operatively. Bivariate analysis using Mann Whitney U test showed a significant association between time-to-initiation of oral feeds post-operatively and length of hospital stay (p<0.05).

Factors associated with outcomes of neonates who required surgical interventions

Antenatal clinic attendance was associated with decreased odds of mortality (OR 0.126; 95% CI 0.025–0.6429; p= 0.013) while neonatal sepsis, respiratory distress and electrolyte imbalance were associated with increased odds of mortality ([OR 3.4; 95% CI 1.09–22.06; p=0.049], [OR 4.9; CI 0.91–11.61; p=0.001] and [OR 03.1; CI 1.21–31.60; p=0.029], respectively) as shown in Table 3.

Table 3: Simple logistic regression showing association of independent variable with mortality

Platelets ($^{x}10^{9}$/L) (50-150 versus <50)	**0.2636**	**0.286**	**0.0227, 3.0598**
Platelets ($^{x}10^{9}$/L) (>150 versus <50)	**0.1199**	**0.042**	0.0156, 0.9252
ANC (attendance versus no attendance)	**0.1262**	**0.013**	0.0248, 0.6429
Birth weight (kg) (≥2.5 versus <2.5)	0.8463	0.792	0.2448, 2.9262
Sepsis (Yes versus No)	**3.3573**	**0.049**	0.9138, 11.6104
Respiratory distress (+ versus -)	**4.9024**	**0.038**	1.0896, 22.0572
Electrolyte imbalance (+ versus -)	**6.1778**	**0.029**	1.2077, 31.6020
AKI (+ versus -)	3.0720	0.381	0.2495, 37.8303

Discussion

The median age at presentation to hospital was 2 days, which is late for most neonatal surgical conditions especially anterior abdominal wall defects and small bowel atresia. This could be due to late referral by the peripheral health facilities. There could also have been delays in transport; MTRH has a large catchment population with some neonates coming from as far as Turkana and West Pokot counties, which have poor geographical terrain.

Care of neonates with surgical conditions is limited to MTRH as the only tertiary facility in the region due to scarcity of pediatric surgeons in the lower level hospitals who would offer such specialized care. The median age at presentation in this study contrasts with that found in Nigeria which was 23.5 hours (11). The Nigerian study looked at neonates with anterior abdominal wall defects only, thus mothers could have rushed the neonates to hospital due to the dramatic presentation of those conditions.

The mortality rate observed in this study was 31.5%, which is almost similar to the rate in a study done at KNH whose overall mortality rate was 33% (10). KNH and MTRH are

the only national referral hospitals in the country and also both centers are tertiary level hospitals managing neonates with surgical disorders referred from peripheral facilities within their catchment populations. The delays in presentation may have led to complications, more so, fluid and electrolyte imbalances, hence the higher mortality rate in both hospitals. The almost similar findings could also be due to the smaller number of neonates studied in both hospitals and the short durations of both studies.

A study done at MTRH in 2008 found an overall mortality rate of 24%, implying a shift in the outcomes over the 10 years. However, that study was retrospectively done over a 3-year period on a smaller sample of neonates with surgical conditions. It was carried out at the old unit which had a bed capacity of 20 compared with this study done at the new unit with a bed capacity of 60 and brings together disciplines like neuro-surgery, orthopedics and plastic surgery (12). However, this apparent increase in the number of admission of neonates with surgical conditions over the years has led to congestion in the unit, which could explain the change in the mortality rate: neonatal sepsis is one of the factors significantly associated with mortality. This study reported a lower mortality rate compared with a study by Ugwu in Nigeria that reported a mortality rate of 48.2% after surgical interventions (5). In contrast, a study done by Kouame in Abidjan reported a higher mortality rate of 52% (13).

Lower mortality rates were reported in a survey done to compare outcomes in low income countries (LICs) and high income countries (HICs). Mortality rates lower than 25% were reported in HICs, 50–75% in middle income countries (MICs) and more than 75% in some LICs (2). This discrepancy could be explained by the fact that this was a survey done during an annual scientific conference with self-reported questionnaires from the respondents, thus a possibility of recall bias influencing the validity of the study findings. The lower mortality rates reported in HICs could also be because of NICU and TPN are availability which are important adjuncts of the peri-operative care of surgical neonates.

The most common diagnosis was gastroschisis, which was in contrast to a study done in the same center 10 years earlier where ARM was the commonest condition (34%) (12). It is also in contrast to the KNH study (10) which reported ARM at the top (19.2%) followed by anterior abdominal wall defects (17.2%). This could be explained by the global shift in the incidence of neonatal surgical conditions. Gastroschisis for instance is reported to have increased from 6% in 2003 to 15% in 2007 in Durban (6). There has also been a global increase in the incidence of anterior abdominal wall defects, with the incidence of gastroschisis increasing from 2.5/10,000 in 1994 to 4.4/10,000 in 2004 according to the British Register on anomalies (14). There was also a large catchment population for neonates with gastroschisis in this study, with some coming from as far as Kiambu, Turkana and Nakuru counties, thus reflecting the rise in gastroschisis cases managed at MTRH.

Lack of proper nutritional supplement use like folic acid before conception and during pregnancy has also been associated with the occurrence of anterior abdominal wall defects and neural tube defects. Most neonates were delivered to mothers who did not use folic acid during the first trimester and in the pre-conceptual period as recommended. Over 50% of participants' mothers used supplements like folic acid and iron during the second trimester of pregnancy, when organogenesis is presumably already complete in the fetus thus use of these supplements could not have been of benefit in preventing neural tube defects.

Majority of participants were delivered in peripheral health facilities and later referred to MTRH for surgical care. This was comparable to other studies as the majority of those studies were done in tertiary hospitals where such care of neonates with surgical conditions is offered (5, 7, 11, 12, 15, 16). Most referred neonates had poor outcomes with a mortality rate that was similar to other studies (5, 11, 12).

Although ANC attendance was significantly associated with low mortality, attendance was inadequate with only 13.7% of mothers completing the recommended 4 ANC visits during pregnancy. Low ANC attendance in some studies and improper use of nutritional supplements in the peri-conception period as recommended could also have contributed to a rise in some conditions like gastroschisis and neural tube defects (5, 17, 18).

No neonatal surgical condition was diagnosed in-utero, probably because almost half of the participants' mothers went for their first ANC visit in the second trimester and only 4% had an obstetric ultrasound done during pregnancy with no congenital anomaly being diagnosed prenatally. An explanation could be that most ultrasound scans at the peripheral health facilities are done by ultrasonographers who may not have the expertise to diagnose or identify some of the congenital anomalies.

Only 25% of participants had blood cultures done that established sepsis in 21% of the participants, and almost half the participants had presumptive diagnosis of probable sepsis. Most neonates who had complications following surgery had wound sepsis, a finding that could partly explain the prolonged hospital stay. This in turn could have led to hospital-acquired infection. Wound sepsis could also be due to a breach in the skin for some conditions like anterior abdominal defects and frequent handling due to daily cleaning and dressing of incision wounds. The presence of intravenous lines and naso-gastric tubes could also predispose to neonatal sepsis. This finding compares to most studies where hospital-acquired sepsis was a leading cause of morbidity and mortality with poor outcomes associated with sepsis (5, 7, 8).

In this study most neonates (51.3%) stayed Nil per Oral for more than 3 days with a range of 1–24 days. These neonates would have benefitted from TPN but it was not available in the unit. Neonates who had respiratory distress were 4 times more likely to die compared with those without respiratory

distress, pointing towards the need to provide better respiratory support for them. Poor outcomes in most developing countries have been attributed to lack of supportive care such as the standard use of TPN and NICU services.

Of the neonates who did not have surgical intervention at MTRH, about a half of them died before surgery or were too sick to withstand surgery. These poor outcomes could be attributed to lack of NICU and proper ventilatory support. This is reflected in the finding of 25% of participants who died before surgery, and the significant number who were too sick to withstand surgery and who eventually died. Low platelet count, respiratory distress requiring CPAP or oxygen use and electrolyte imbalance were all found to be related to poor outcomes, which is comparable to studies done in other centers. Those studies showed that sepsis, multiple organ failure leading to respiratory distress and thrombocytopenia contributed most to mortality (17, 19, 20).

The median length of hospital stay was 14.5 days, which is in contrast to a study done in Nigeria with a median length of hospital stay of 10 days. Most participants in the Nigerian study had isolated anterior abdominal wall defects, mainly omphalocele major, that necessitated primary abdominal closure, hence the shorter hospital stay (11). It is also in contrast to a study done at KNH with a median length of hospital stay at 10.2 days (10). The longer length of hospital stay in this study could be explained by the high number of neonates with gastroschisis who presented late thus had to undergo the staged closure causing delays in recovery with prolonged hospital stay. There was also significant association between time to initiation of oral feeds and the length of hospital stay. This is evidenced by the 50% mortality rate that occurred among the participants who stayed for more than 72 hours without enteral feeds, hence the need to initiate timely feeds post-operatively. The presence of co-morbid conditions like neonatal sepsis and neonatal jaundice could also have contributed to the longer hospital stay, as treatment of confirmed sepsis requires antimicrobial use for a minimum of 10-14 days. Post-operative complications like wound sepsis and burst abdomen may also have necessitated re-operation which may further prolong the duration of hospital stay.

Conclusions

The overall mortality rate of neonates requiring surgical interventions at MTRH was 31.5%, and their median length of hospital stay was 14.5 days. Neonatal sepsis, respiratory distress and electrolyte imbalance were significantly associated with increased odds of mortality.

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