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ORIGINAL ARTICLE

Neonatal surgical outcomes: a prospective observational study at a Tertiary Academic Hospital in Johannesburg, South Africa

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Abstract

Purpose The neonatal period is the most vulnerable period for a child. There is a paucity of data on the burden of neonatal surgical disease in our setting. The aim of this study was to describe the frequency with which index neonatal surgical conditions are seen within our setting and to document the 30-day outcome of these patients.

Methods This was a single-centre prospective observational study in which all neonates with paediatric surgical pathology referred to the paediatric surgical unit with a corrected gestational age of 28 days were included.

Results Necrotising enterocolitis was the most frequent reason for referral to the paediatric surgical unit ($n=68$, 34.34%). Gastroschisis was the most frequent congenital anomaly referred ($n=20$, 10.10%). The overall morbidity was 57.58%. Surgical complications contributed to 18.51% of morbidities. The development of gram negative nosocomial sepsis was the most frequent cause of morbidity ($n=98$, 50.78%). Mortality at 30 days was 21.74% ($n=40$). Sepsis contributed to mortality in 35 patients (87.5%), 16 of which had gram negative sepsis.

Conclusion Gram-negative sepsis was a major contributing factor in the development of morbidity and mortality in our cohort. Prevention and improvement in infection control are imperative if we are to improve outcomes in our surgical neonates.

Keywords Neonatal outcomes · South Africa · Neonatal surgery · Surgical outcomes

Introduction

The United Nation International Children's Emergency Fund (UNICEF) documented the average global neonatal death rate at 18 per 1000 live births in 2019 [1]. Furthermore, 46% of all deaths in children under the age of 5 years occur in the neonatal period, demonstrating that this is the most vulnerable period for a child [2]. In line with the aim to reduce neonatal mortality, the United Nations (UN) established Sustainable Development Goals (SDGs) in 2015 to promote child health with the aim of reducing neonatal mortality to at least 12 per 1000 live births worldwide which included prioritising the treatment of congenital anomalies and non-communicable diseases [3]. While there have been considerable advances in High-Income Countries (HICs) in improving the mortality of neonates, there is still a significant burden of neonatal mortality in Low-to- Middle-Income Countries (LMICs) where there is significant burden of disease [4, 5]. Worldwide 99% of neonatal mortality occurs in low- and middle-income countries with neonates born in Sub-Saharan Africa at highest risk of death [6–8].

The importance of identifying the burden of paediatric surgical disease has been demonstrated in several studies [4, 9, 10]. Unfortunately, the contribution of paediatric surgical conditions to the neonatal mortality rate is not well established, and consequently, there is a paucity of information on the topic, especially in Low–Middle-Income Countries (LMIC). UNICEF data from South Africa in 2016 show that mortality due to congenital abnormalities is estimated to be 10% of the overall neonatal mortality rate, many of which require surgery in the neonatal period[11]. Unfortunately, this does not provide a complete representation of the

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mortality secondary to surgical pathology in neonates, as acquired conditions such as necrotising enterocolitis (NEC), which are not defined in UNICEF datasets, may contribute to a significant portion of neonatal mortality, and thus the surgical burden of neonatal disease.

The aim of this study is to describe the frequency with which index neonatal surgical conditions are seen within our hospital setting and to document the 30-day morbidity and mortality of neonatal patients with surgical conditions treated at our institution.

Methods

This prospective observational study was conducted at Chris Hani Baragwanath Academic Hospital (CHBAH) between 1 January 2019 and 31 December 2019. The Department of Paediatric Surgery at CHBAH is one of the three government hospitals in Johannesburg and accepts patients from the entire province as well as neighbouring provinces. Facilities at CHBAH include a Neonatal Unit which is shared with Paediatric Neonatology and has a Neonatal ICU with 26 ICU beds as well as a transitional care unit which can accommodate up to 60 neonates. There is also a small area dedicated to paediatric surgery patients with 6 beds for patients. All neonates with index surgical pathology and a corrected age (which was defined as the corrected age of the patient according to gestational age) of 28 days or younger admitted by the paediatric surgical unit were included after appropriate informed consent had been obtained. The following conditions were included: oesophageal atresia (OA), congenital diaphragmatic hernia (CDH), intestinal atresia, malrotation with or without midgut volvulus, intestinal duplication, necrotising enterocolitis (NEC), gastroschisis, exomphalos, bladder or cloacal exstrophy, anorectal malformation (ARM), Hirschsprung's disease (HD), and congenital pulmonary lesions. Participants were excluded if they had their primary interventions outside the study period or at a different hospital. Patients whose primary condition was managed by different sub-specialities, including Orthopaedics and Neurosurgery, were excluded. Patients were either admitted to the Neonatal Unit (NU) which is comprised of a Neonatal ICU (NICU) and Transitional Care Unit (TCU) or to the General Paediatric Surgery Ward (PSW). Admissions to the former are typically premature neonates with a weight of less than 2.5 kg and those who require NICU care. Term neonates who do not require NICU are admitted to the general ward which is shared with all other paediatric surgical admissions.

Outcomes were measured by describing development of morbidities and mortality in patients up to 30 days after the initial management. Morbidities were graded according to development of the Clavien–Dindo Scale[12]. Nosocomial sepsis was defined as suspected sepsis based on clinical parameters and included new onset of fever (defined as a temperature above 38.3 degrees Celsius), new-onset tachycardia, changes in respiratory effort, raise in white cell count or C-Reactive Protein, and a positive blood culture. A positive blood culture was a culture that showed the presence of a pathogenic micro-organism, but excluded blood cultures with the same pathogen within 14 days of the original culture to avoid duplication of inclusion of positive blood cultures. Causes for mortality were broadly defined as being due to nosocomial sepsis, respiratory failure, pulmonary heamorrhage, multiple organ failure (MOF) not due to sepsis, disease progression, or where patients were palliated. The presence of sepsis, as defined under morbidities at the time of death, was used to describe nosocomial sepsis as an associated cause of death. Death due to respiratory failure was defined on a clinical basis by attending clinicians and included either acute respiratory failure or patients with chronic respiratory failure after prolonged mechanical ventilation in patients with underlying acquired or congenital conditions. MOF was defined as organ dysfunction of more than 2 organ systems at the time of death. Patients who were palliated were those in whom further management was not deemed to be suitable, and after extensive counselling of caregivers, care was not escalated for these patients.

Ethics clearance was obtained from the Wits Human Research Ethics Committee (M181012). Primary outcome measures were frequency of congenital conditions referred to the unit, management of these conditions, and recording of morbidities and mortality up to 30 days after the initial intervention.

Statistical analysis was conducted using Statistica (Version 13.5.0.17, TIBCO Software Inc.). Continuous non-parametric variables are described using the median and inter-quartile range. Categorical variables are expressed as numbers and percentages. Mann–Whitney *U* tests were performed to measure differences between non-parametric variables, where appropriate. Chi-square tests were used to test for differences between categorical variables. Survival estimates were calculated in Stata (version 15.1, StataCorp LLC) using Kaplan–Meier estimates, and comparison of survival between groups was calculated using log-rank. A p value of less than 0.05 was considered significant.

Results

During the study period, 375 neonates were referred to the Department of Paediatric Surgery with suspected index surgical pathology. Only 274 (73.07%) of these patients were admitted to CHBAH. The remainder were not accepted, and this is due to the recurrent lack of bed availability in NU. Figure 1 depicts the number of surgical neonatal admissions

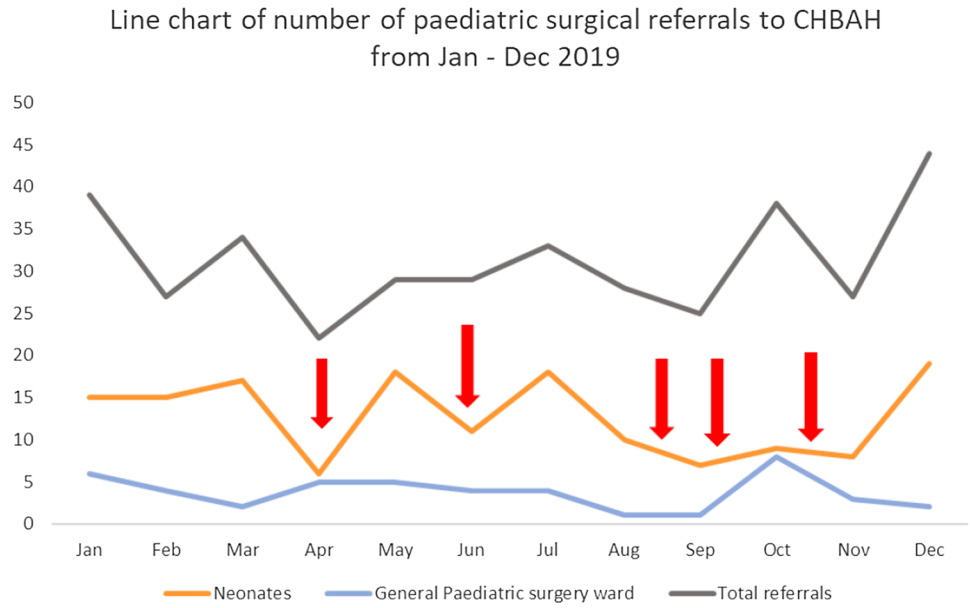

Fig. 1 Line chart of neonatal paediatric surgery referrals and admissions to CHBAH Jan 2019–Dec 2019. Red arrows depict incidents of nosocomial sepsis outbreaks in the neonatal unit. The area was closed to referrals from other hospitals during these periods

per month compared to the total number of referrals. The graph demonstrates a constant shortfall between the total number of referrals and the number of admissions. Of the 274 admissions, 198 participants were included. Reasons for the exclusion of 76 patients were due to refusal of consent to participate in the study ($n=5$), mortality of neonates before consent could be obtained ($n=20$), and inability to contact parents/caregivers to obtain consent ($n=24$). All neonates who died before obtaining consent died withing the first 3 days of referral and were critically ill at arrival. A further 27 participants referred with suspected Hirschsprung's disease, which was excluded on rectal suction biopsy and who were well at 30 days were excluded from analysis. Table 1 provides an overview of the descriptive statistics of the remaining 198 participants. There was an equal proportion of male and female participants in the study and the median gestational age at birth was 34.00 weeks (IQR 31.50–38.00). NEC was the most frequent diagnosis at the time of referral ($n=68$, 34.34%), followed by Gastroschisis ($n=20$, 10.10%). There was a significant difference in the gestational age and birth weight of patients with NEC compared to other patients (p value <0.001) where the median birth weight and gestational age of patients with NEC were 1525 g (IQR 1097.50–2079.50) and 32 weeks (IQR 29.00–35.00), respectively, compared to a median birth weight of 2400.00 g (IQR 1990.00–2900.00) and a gestational age of 36 weeks (IQR 33.00–38.00) in patients who were referred with other pathologies. Table 2 provides a breakdown of the diagnosis and age at referral and the time interval between referral and admission. Of note is that after being accepted for admission to the unit, most patients were transported and admitted on the same day as referral.

During the 30-day follow-up period, 351 morbidities were recorded in 114 patients. The median number of morbidities per patient in these patients was 2.00 (range 1.00—11.00) with a median time to the first recorded morbidity of 4 days (range 0–30 days). There was no significant difference in the development of morbidities between patients who were

Table 1 Descriptive statistics of participant cohort ($n=198$)

	Median	Inter-quartile range
Birth weight (grams)	2183.93	1480–2795
Gestational age (weeks)	34.00	31.50–38
Gender[a]	Male: 95	(48.22)
	Female: 102	(51.78)
Age at referral (days)	4.00	1–14
Days to admission from first referral	0.29	0–10
Outside referrals compared to inborn patients[a]	Inborn: 121	(61.11)
	Referred: 77	(38.89)
Admission ward[a]	Neonates: 153	(77.27)
	General ward: 45	(22.73)

[a]Categorical variable: expressed as number (and percentage)

Table 2 Overview of diagnoses and age at referral of conditions of cohort

Category	Number (%)	Median age at referral in days + (IQR)	Median time to admission from time of referral in days + (IQR) + (range)
NEC	68 (34.34)	11.00 (5.00–22.50)	0 (0–1) (0–10)
Gastroschisis	20 (10.10)	0 (0)	0 (0–1) (0–1)
Hirschsprung's disease	17 (8.59)	17 (5–20)	0 (0–1) (0–1)
Malrotation ± midgut volvulus	13 (6.57)	5.00 (3–8)	0 (0) (0–7)
ARM	12 (6.06)	2.00 (1.00–7.50)	0 (0–1) (0–5)
Jejunal/ileal atresia	11 (5.56)	2.00 (0–3)	0 (0–1) (0–1)
Omphalocele	10 (5.05)	0 (0)	0 (0–0) (0–1)
Duodenal atresia	6 (3.03)	2.5 (2–5)	1(0–2) (0–5)
HPS	5 (2.52)	27 (6–29)	0 (0–0) (0–0)
Oesophageal atresia ± TOF	4 (2.02)	5 (2–19)	0 (0–0)
OA + ARM	3 (1.51)	0 (0.00–2.00)	1 (1–1) (1–1)
Meconium cyst/peritonitis	3 (1.51)	2.00 (1–9)	1 (1–1) (1–1)
Gastric perforation	3 (1.51)	2.00 (1.00–2.00)	0
CDH	2 (1.01)	1 (0–2)	0(0)
Other	21 (10.60)	3.00 (2.00–11.00)	0 (0–0) (0–4)

inborn, compared with those referred from other hospitals (p value: 0.987). However, there was a significant difference in the development of morbidities between patients admitted to the general paediatric ward and the neonatal ward ($p < 0.001$) with a relative risk of morbidity in the neonatal area of 4.25 (CI 2.07–8.71). When comparing onset of sepsis in the various diagnoses, there was a significant difference in the time of first onset of morbidity as well as the number of morbidities in patients with NEC. The median time to first episode of morbidity was 2.5 days (IQR 2.0–7.0) in the group with NEC compared to a median time of 4.5 days (IQR 3.0–11.0) in patients with other conditions (p value 0.008). Patients with NEC had a median of 3.0 (IQR 1–5) complications during the 30-day period compared to a median of 2.0 (IQR 1–3) of complications in other patients (p value 0.010).

Nosocomial sepsis, which excluded wound sepsis, was the most frequent morbidity recorded, with 193 episodes in this cohort. The median time to the first episode of sepsis was 7 days (IQR 3–12.5 days). The most frequent causative organisms cultured were Gram-negative bacilli. Of note is that 73.47% ($n = 72$) of these organisms were multi-drug resistant organisms. Candida species were the second most common isolate on blood cultures, causing significant sepsis in 55 instances (28.50%) (Table 3). Of significance is that *Candida auris*, an organism not previously cultured in our neonates, was grown in 14 cases, causing significant morbidity and mortality. Table 4 provides an overview of all morbidities using Clavien–Dindo Classification Grade I–IV (Grade V is discussed separately under mortalities) [12]. Sixty-five instances of surgical morbidity were recorded (18.51% of all morbidities). Management of these surgical complications included 23 relook operations. The most frequent reasons for these relook operations were wound sepsis ($n = 23$ 6.6%), anastomotic leak ($n = 11$, 3.13%), adhesive bowel obstruction ($n = 5$, 1.42%), and intra-abdominal collections ($n = 3$, 0.85%). There were 42 (11.97%) instances of surgical site infection recorded in the patients who developed morbidity, of which wound sepsis was the most frequent SSI.

One hundred and eighty-four participants were followed up for 30 days from the time of initial management. Fourteen of the 198 patients were lost to follow-up. Outcomes of patients followed up for 30 days are shown in Table 5. Overall, 57 (30.98%) patients were discharged, and 78 (42.39%) were not yet discharged due to ongoing treatment for sepsis or nutritional requirements. Forty patients (21.74%) died before the end of the 30-day follow-up period, and 16 (40%) or these mortalities occurred in patients with NEC. Importantly, 30 of the 40 mortalities (75%) occurred within the first 10 days of referral (Fig. 2). Sepsis was the most frequent underlying contributing cause of death in this subset of patients ($n = 35$, 87.5%) with organisms such as *XDR A.baumanii* being most frequently cultured at the time of death ($n = 8$, 25.71%) (Table 6). Of note is that all mortalities occurred in the NU. There was no significant difference in the outcome of patients who were inborn compared to patients who were referred from another hospital (log-rank p value: 0.052) (Fig. 2).

Discussion

This study highlights three important findings on the outcomes of neonates with surgical pathology in our institution. First, it emphasises the burden of disease as shown by the

Table 3 Breakdown of organisms cultured at time of nosocomial sepsis

Organism on blood culture	Organism	Number (%)	Total
Gram-negative bacillus	*XDR Acenitobacter baumannii*	31 (16.06)	98 (50.78)
	ESBL Klebsiella pneumonia	30 (15.54)	
	Acinetobacter baumannii	16 (8.29)	
	Carbapenem Resistant Enterobacteraciae	11 (5.70)	
	Klebsiella oxytoca	2 (1.04)	
	Serratia marcecsens	2 (1.04)	
	Non-ESBL Klebsiella species	2 (1.04)	
	Pseudomonas species	2 (1.04)	
	Proteus species	2 (1.04)	
Gram-positive cocci	*Enterococcus species*	9 (4.66)	22 (11.40)
	Coagulase negative Staphylococcus	6 (3.11)	
	Other Staphylococcus species	3 (1.55)	
	Methicilin Resistant Staphylococcus aureus	2 (1.04)	
	Streptococcus viridans	2 (1.04)	
Gram-positive bacillus	*Clostridium difficile*	2 (1.04)	2 (1.04)
Saccharomycetes	*Candida parapsilosis*	22 (11.40)	55 (28.50)
	Candida auris	14 (7.25)	
	Candida albicans	2 (1.04)	
	Other candida spp	15 (7.77)	
Herpesvirales	*Cytomegalo virus*	3 (1.55)	3 (1.55)
Suspected sepsis B/C result not found		13 (6.74)	13 (6.74)
Total		193	193

27% of neonates referred to our institution were not admitted due to resource constraints. This discrepancy between demand for beds and supply was even more apparent during outbreaks of nosocomial sepsis in the neonatal unit, during which all out-of-hospital referrals were declined. Limited beds in the NU, while not unique to a LMIC setting [13], may have potentially devastating consequences with resultant delays to care contributing to increased rates of morbidity and mortality in neonates reliant on surgical intervention for survival [4]. This study also underscores that nosocomial sepsis, specifically late-onset sepsis, contributes towards a morbidity rate of over 50% and mortality rate of more than 20% of our study population and, third, that there is a high incidence of NEC in our setting, which is associated with significant morbidity and mortality.

Although the mortality of surgical neonates referred to our institution is similar to that of other Sub-Saharan countries, with a recorded mortality rate between 35 and 43% [4, 7, 13–15], this study found that the majority of mortalities occurred within the first 7 days of treatment. This is in contrast to a study from Nigeria in which most mortalities occurred within the first 48 h after admission, which they attributed to the critically ill nature of the neonates on admission[13]. Our late mortality figures are more in keeping with the development of nosocomial sepsis which has been linked to increased late mortality in other studies [16].

The higher overall morbidity in this study compares to morbidity in the order of 33% as quoted in other studies from LMICs [4, 7]. This may be partially explained by delayed referral, as evidenced by the significant increase in the development of morbidities in patients where referral was delayed. This is an important socio-economic barrier that, although not unique to our setting compared with other LMICs, needs urgent attention by improving antenatal and perinatal care, as well as improved access to NICU beds [7]. There were also significantly more morbidities in the NU where patients are more often premature or very low birth weight (VLBW) and require interventions such as mechanical ventilation (MV) and central venous catheterisation (CVC) more frequently and may have a prolonged hospital stay due to underlying congenital anomalies or prematurity, which may further predispose to development of morbidity, especially nosocomial sepsis [17].

The morbidity rate due to surgical complications in this study, accounting for 18.51% of the total morbidities, was comparable to those from other LMICs [13]. Twenty-three relook surgeries were required (12.12%). Breakdown of previous anastomosis ($n = 11$, 3.13%), mandatory relook after clip-and-drop ($n = 9$, 2.6%) and adhesiolysis for adhesive bowel obstruction ($n = 5$, 1.42%) were the most common reasons for relook laparotomy in our study population. There were 42 (11.97%) instances

Table 4 Overview of morbidities in cohort and management

Clavien–Dindo classification	Morbidity category	Number (%)
Grade I	Wound sepsis	23 (6.55)
	Drip site complications	6 (1.71)
	Increased stoma losses	5 (1.42)
	Electrolyte abnormality	2 (0.57)
	Acute kidney injury	2 (0.57)
Grade II	Nosocomial sepsis	193 (54.99)
	Anaemia requiring transfusion	16 (4.56)
	Seizures	7 (1.99)
	Acute gastro-enteritis	2 (0.57)
Grade IIIa	Pneumothorax	8 (2.28)
	Intra-operative liver injury	2 (0.57)
Grade IIIb	Anastomotic leak	11 (3.13)
	Relook post clip-and-drop	9 (2.56)
	Adhesive bowel obstruction	5 (1.42)
	Intra-abdominal collection	3 (0.85)
	New-onset NEC 3b	2 (0.57)
	Abdominal compartment syndrome	1 (0.28)
	Sheath dehiscence	1(0.28)
	Formal vesicostomy	1 (0.28)
	Serosal injury at previous repair developed with perforation requiring relook	3 (0.85)
	Relook and closure of gastroschisis	1 (0.28)
Grade IV	Accidental/self-extubation	8 (2.28)
	Apnoea requiring CPR	2 (0.57)
	Pulmonary heamorrhage	2 (0.57)
Other		36 (10.26)
Total		351 (100)

Table 5 Outcomes at 30 days of surgical neonates ($n=184$)

Outcome	Number	%
Discharged, without morbidity	36	19.56
Discharged with morbidity requiring follow-up by paediatric surgery	9	4.89
Discharged, awaiting results and/or primary surgery	21	11.41
Not yet discharged	78	42.39
Died	40	21.74

of surgical site infection, with half of these due to superficial wound sepsis. The risk of SSI is reportedly higher in neonates and may presumably be due to underlying co-morbidities, which include prematurity and prolonged requirements for total parenteral nutrition in addition to the immature immune system of neonates [18]. These risks along with factors related to resource constraints, which negatively impact infection control and prevention, may

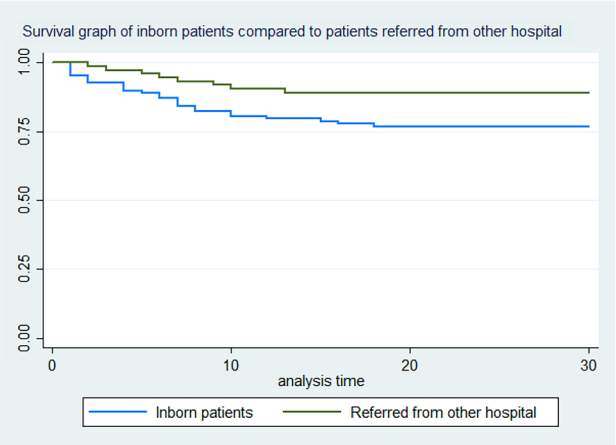

Fig. 2 Kaplan–Meier survival estimates by place of referral

Table 6 Contributing causes of mortality and underlying causative organisms on culture at time of death ($n=40$ patients)

Cause	Number
Sepsis	35 (87.5%)
Respiratory failure	11 (27.5%)
Pulmonary haemorrhage	1 (2.5%)
Multiple organ failure not due to sepsis	7 (17.5%)
Disease progression	11 (27.5%)
Palliated	9 (22.5%)

play important roles in our setting in contributing to the increased SSI rate.

In addition to the development of SSI, surgical neonates are known to have a higher risk of developing nosocomial sepsis [17]. The risks are related to similar risks for the development of SSI mentioned above in addition to factors such as prolonged need for mechanical ventilation and prolonged use of central venous access [17]. Combining this with an environment with limited resources and relative overcrowding of the neonatal facility, as seen at our institution, lead to recurrent outbreaks of nosocomial sepsis, which further overburdens the already strained resources and which may explain the increased rate of nosocomial sepsis in this study. A review of South African literature showed that the most frequent organisms cultured in other neonatal ICUs were predominantly *Group B Streptococcus*, *Staphylococcus aureus, Serratia marcescens, Acinetobacter baumani*, *Vancomycin Resistant Enterococcus* (*VRE), Pseodomonas aeruginosa, Escherichia coli, Candida albicans,* and *Klebsiella pneumoniae* [19–21]. Fungal sepsis was only present in 4% of patients in one of these studies [21]. Of particular concern is the high incidence of infection due to Gram-negative Bacilli, found in 50% ($n=95$) of cultures with over 75% of these considered to

be multi-drug resistant organisms, such *as XDR Acinetobacter baumanii, ESBL Klebsiella pneumonia, Carbapenem resistant enterobacteraciae (CRE), Serratia marcecsens,* and *Pseudomonas* species in our cohort. Gram-negative bacilli such as these have been shown to negatively impact survival of neonates [16, 21, 22]. Our rate of fungal infections was higher than reported in the literature and was the second most common cause of sepsis, isolated in 28.5% of cultures, with *Candida parapsilosis* predominating. Of concern was that there was a new outbreak of *Candida auris* not previously cultured in our neonatal population during the course of the year which contributed towards mortality in at least one patient. Findings such as these highlight that improvement in prevention of sepsis and improved infection control are therefore an absolute necessity if we are to improve outcomes in surgical neonates.

In contrast to other LMICs and HICs, we showed a higher proportion of NEC in our patient cohort [7, 13–15, 23]. This, however, is in keeping with the other studies from South Africa which have shown a higher prevalence of surgical NEC [4, 7, 23, 24]. NEC contributed 40% towards the overall mortalities of our patients. There was also a significant difference in the number of morbidities and a shorter time to the first episode of a morbidity in patients with NEC compared to other patients in this study which may be due to the lower birth weight and lower gestational age of these patients compared to other patients in the study. In addition to this, it has been shown in the other studies that NEC is a predictor of morbidity and mortality in surgical neonates [7, 16, 18]. The prevention and improved management of NEC is therefore of importance if we are to improve the burden of disease and outcomes of neonatal patients in our setting. Prevention strategies that have been documented to decrease the incidence of NEC as well as overall mortality in quality improvement studies are improvements in nutritional care and specifically the use of breast milk, controlling use of antibiotics, and controlling the use of antacids [25]. The most important and consistent finding across these quality improvement initiatives as well as that of the consensus statement by Gephart et al. and the ERAS working group was the use of mother's milk over formula [26, 27]. The provision of breastmilk can be either in the form of providing improved settings for mothers to breastfeed by providing support to initiate and maintain breastfeeding or through the provision of human milk through breastmilk banks. This is a current priority in our centre and the construction of a human breast milk bank is underway in an effort to reduce the prevalence of NEC.

Conclusion

This study described that the most common neonatal surgical conditions referred to our institution were NEC (34.34%) and Gastroschisis (10.10%). The overall morbidity of our surgical neonatal population was 57.58%. Surgical complications contributed 18.51% of these, whilst sepsis contributed a further 55% of the morbidities. Mortality in this study was 21.74% with the majority occurring within the first 10 days after admission. Sepsis was a major contributing factor in the development of morbidities and mortalities. Resistant Gram-negative and fungal sepsis pre-dominated in our cohort. Patients with NEC developed morbidities earlier and had more episodes of morbidity compared to neonates with other diagnoses. Prevention and control of infection with a focus on the prevention of NEC are imperative if we are to improve outcomes in our surgical neonates.

Declarations

Conflict of interest None to declare.

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