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Research Article

An Audit of Neonates Admitted to the Paediatric General Ward in a Tertiary Hospital, in South Africa

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Abstract

South Africa is one of the countries in which neonatal mortality has remained the same or decreased slowly over the past 20 years. Many newborns are discharged after birth and readmitted within a few days. The Integrated management of childhood and neonate illness (IMCNI) guidelines uses seven danger signs to identify sick young infants.

Aim: The aim of the study was to determine the profile and outcome of neonates admitted to the general paediatric wards at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methodology: Audit of all newborns (<28days) admitted to the general wards from 1 January 2011 to 30 April 2011.

Results: A total of 75 neonates were admitted with a mean weight of 3.2 kg (SD 0.65). The majority of neonates 41/75 (54.6%) were male and 21/75 (28%) were Human Immunodeficiency Virus (HIV)-exposed. In the HIV-exposed group only 16/21 (76%) were on HIV prophylaxis. The most important clinical signs were tachypnoea (RR>60) 34 (46.6%) and jaundice 30 (41.1%). Most neonates, 45 (61%) were referred from the local clinic. The most common diagnoses were bronchopneumonia (BRPN) 22 (29.3%), neonatal sepsis (NNS) 27 (36%) and jaundice 20 (26.7%). Two patients died (2.7%) from NNS and BRPN.

Conclusions: A proportion of the neonates are admitted from home to the general paediatric ward with mostly NNS,

BRPN and jaundice. Although the mortality is low, admission to a neonatal ward may be more appropriate. IMCNI guidelines remain the most sensitive indicator of the need for admission, and "routine" investigations are often a non-contributor.

Keywords: LMIC; Neonates; IMCNI

1. Introduction

Childhood mortality in South Africa is decreasing, but neonatal mortality is increasing or stagnant [1]. Globally neonatal mortality comprises 41% of the mortality rate for children below 5 years of age [2]. The most important causes were infection (29%), complications of prematurity (29%) and birth asphyxia (23%) [3, 4]. To reduce neonatal mortality the burden and the spectrum of disease needs to be analyzed. Most neonates in South African emergency departments (EDs) are routinely subjected to a complete septic work-up irrespective of the presenting complaints. Neonates are highly susceptible to infectious diseases because of their immature immune systems and poorly developed skin barrier. According to the World Health Organization (WHO), only 68% of women in developing countries receive some form of antenatal care and only 35% of mothers in the least developed countries have access to skilled health personnel at delivery [4]. At the same time, beneficial practices to reduce infection rates in neonates, such as the use of colostrum and exclusive breastfeeding are often ignored or discouraged. Population-based studies from developing countries have reported clinical sepsis rates from 49 to 170 per 1000 live births [5]. Knowledge of the organisms responsible for sepsis in developing countries is essential for targeted empiric therapy when cultures are awaited or not available. A comprehensive review conducted by Ganatra et al. showed that Gram-negative organisms were the main pathogens and *Staphylococcus aureus, Escherichia coli* and *Klebsiella spp* caused 44% of all sepsis worldwide [6]. However, in Africa there was an overall dominance of Gram-positive organisms especially Group B *streptococci*. The review went on to highlight that blood cultures remain the gold standard for the diagnosis of neonatal sepsis (NNS). However, most district and community hospitals do not possess the necessary laboratory services and the diagnosis of NNS is determined clinically.

Simple symptoms and signs that reliably indicate the presence of severe illness that would indicate the need for urgent hospital admission are therefore of major importance. South Africa uses the WHO Integrated Management of Childhood and Neonatal Illnesses (IMCNI) guideline with the following danger signs: is the child able to drink or breastfeed, does the child vomit everything, has the child had convulsions during this illness and is the child lethargic or unconscious is used to recognize sick young infants. Jeena et al. found that the simple features of feeding difficulties, pyrexia, tachypnoea and lower chest in-drawings are useful predictors of severity of illness as well as effective and safe tools for triaging of young infants for urgent hospital management at primary care centers [7]. They also found that neonatal hyper-bilirubinaemia, pneumonia and NNS were the most common conditions for which young infant's required urgent admission. Importantly, that the same study reported that the addition of laboratory testing only marginally improved the prediction of serious bacterial infection (SBI), hence rendering it non-feasible in a resource-poor setting. However, the basic principles recommending cultures to guide appropriate

antibiotic treatment cannot be ignored.

Similarly Weber et al. as part of the Young Infant Clinical Signs Study Group conducted a multi-center study of clinical signs in an attempt to identify infants with serious illnesses [8]. In the group from birth to 6 days of age, the commonest diagnoses were severe infection, pre-maturity and birth asphyxia. The use of the following seven symptoms and signs in his study were most predictive of severe illness in the first week of life [8]: temperature >37.4 or <35.5, respiratory rate >60/min, presence of severe chest in drawing, presence of lethargy or unconsciousness, history of feeding difficulty, history of convulsions and movement only when stimulated. Simplifying the algorithm to the above seven signs gave a sensitivity of 85% and specificity of 75% [8]. When applied to the 7 to 59 days old group the algorithm had a sensitivity of 74% and a specificity of 79%. Goswami et al. concluded that the IMCNI algorithm and use of above danger signs appeared to be a "promising, feasible and useful intervention strategy to triage and treat young infants in the 7 days to 2 months age group" [9-10]. They also found the addition of the presence of jaundice would increase the tool's sensitivity. In addition to prompt diagnosis and treatment, preventive strategies are essential to reduce the burden of NNS. There is a need to provide universal antenatal care and education for women in developing countries. During the postnatal period, early and exclusive breast-feeding is perhaps the most important intervention to prevent NNS. Kangaroo mother care (KMC) has also been proven to be an effective intervention to prevent NNS [6] in premature babies.

1.1 Aim

The aim of the study was to determine the profile and outcome of neonates admitted to the general paediatric wards from home.

1.2 Methods

This was a retrospective record review.

1.3 Location

The paediatric department of Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) in Johannesburg, South Africa.

1.4 Inclusion criteria

All neonates (less than 28 days) admitted to the general paediatric wards at CMJAH from the 1st January 2011 to the 30th April 2011 were included. Patients transferred from Primary Health Care Facilities and Secondary Level Hospitals were included.

1.5 Exclusion criteria

Patients transferred from other tertiary hospitals were excluded. Patients with incomplete records were also excluded.

1.6 Ethics

All patient records were treated confidentially and data was stored on a password-protected computer to which only the researcher had access. No patient names, patient numbers or health care provider names were entered into the database, hence ensuring anonymity. The University of Witwatersrand granted ethical clearance

2. Data Collection and Analysis

The study design was a retrospective cohort analysis of data retrieved from the hospital records of all infants <28 days. Data included demographic information, clinical profile laboratory test results and final diagnosis. The selected demographics were age at admission; gender; breastfeeding; HIV (Human immunodeficiency virus) status; antenatal care; current weight. The clinical profile and presenting complaint was based on the IMCNI guidelines and seven danger signs used to identify sick infants. Laboratory investigations included complete blood count (CBC), CRP level, and culture, urine sample analysis and culture, and cerebrospinal fluid sample analysis and culture. Chest radiography was done if respiratory symptoms were present. The diagnosis of SBI, namely, urinary tract infection (UTI), meningitis, bacteremia and bacterial enteritis, was based on the growth of a known pathogen in culture. Blood culture isolates were considered pathogens if the organism was known to cause disease in healthy infants. Urine cultures were obtained by suprapubic aspiration or midstream collection. Sensitivity, specificity and likelihood ratio were calculated using SPSS version 25 (IBM, USA). Normally distributed data (e.g. weight, white cell count) were expressed as mean ± SD; skewed data were expressed as median and interquartile ranges, while categorical variables were reported as frequencies and percentages. Statistical comparisons of neonates with SBI and without SBI were performed using an independent samples t-test and Chi-squared test for all numerical and categorical values, respectively. Significance was set at $p<0.05$. Univariate and multivariate logistic regression models were used to identify variables independently associated with the presence of SBI.

3. Results

Seventy-six neonates fulfilled the inclusion criteria for the study. Only one neonate was excluded from the study because he was referred from a secondary hospital with a congenital cardiac disease. Characteristics of the sample are shown in Table 1.

Baseline characteristics of study group	
Number of Neonates	75
Female Gender	34 (45.3%)
Male Gender	41 (54.6%)
Exclusive Breastfeeding	43 (57.3%)
HIV Exposed	21 (28%)
PMTCT (in HIV exposed group)	16 / 21 (76.2%)
Antenatal Care	56 (74.7%)
Anthropomorphic Measurements	

Weight (kg)	3.2 (± 0.65)

PMTCT-mother to child transmission

Table 1: Characteristics of the study group.

The frequency of the different signs associated with serious illness is shown in Table 2. None of the infants presented with hypothermia. The most common clinical sign was tachypnea (46.6%), followed by jaundice (41.1%).

Individual signs for prediction of 'serious illness' for neonates	
Pyrexia (temp>37.5 C)	18 (24.7%)
Respiratory Rate > 60	34 (46.6%)
Jaundice	30 (41.1%)
Lethargy	19 (26%)
Poor Feeding	2 (2.7%)
Seizures	1 (1.4%)
Unconsciousness	3 (4.1%)

Table 2: Individual signs.

Most neonates admitted were referred from the local clinic 45 (60.0%), and 21 (28.0%) were self-referred. The common presenting complaints on admission and final discharge diagnosis of neonates less than 7 days and more than 7 days are shown in Table 3.

<7 days					
Presenting complaint			**Discharge diagnosis**		
	n	%		n	%
Jaundice	17	70.83	NNJ	14	58.33
Irritability	4	16.67	NNS	7	29.17
Other	3	12.50	Other	3	12.50
≥ 7 days					
Presenting complaint			**Discharge diagnosis**		
	n	%		n	%
Jaundice	9	17.65	BRPN	22	43.14
URT/LRT	27	52.94	NNS	20	39.22
Irritability	6	11.76	NNJ	6	11.76
Other	9	17.65	Other	3	5.88

NNJ-neonatal jaundice; NNS-neonatal sepsis; BRPN-bronchopneumonia; URT/LRT-upper respiratory tract/lower respiratory tract.

Table 3: Summary of presenting complaint and discharge diagnosis.

The most common initial presentation in the study sample was jaundice 26 (35.6%) and upper or lower respiratory tract (LRT) symptoms 27 (52.94%). Only 9 (12.3%) of the neonates had been previously admitted to hospital. The initial investigation in the ED included a routine glucose (HGT) check 75 (100%), Chest X-Ray (CXR) 41 (54.7%), urine dipstick 27 (36%), lumbar puncture (LP) 33 (44%), full blood count (FBC) 64 (85.3%), C reactive protein (CRP) 64 (85.3%) and blood culture (BC) 64 (85.3%). All babies had their glucose assessed whilst only 27 (36%) had a urine analysis done. The commonest discharge diagnoses for all age groups were bronchopneumonia (BRPN) 22 (29.3%), neonatal sepsis (NNS) 27 (36%) and neonatal jaundice (NNJ) 20 (26.67%). Thirty-three chest x-rays were done. Twenty one patients (28.8%) showed evidence of pneumonia. The mean duration of hospital admission was 7 days (± 5.17). Only two neonates died and died within 24 hours of admission. Their diagnoses were NNS and BRPN. Investigations are shown in Table 4 below.

Investigations	
Blood Cultures (Total-64)	
Negative	54 (84.3%)
Coagulase negative *staphylococcus*	4 (6.3%)
E. coli	1 (1.6%)
E. faecalis	1 (1.6%)
Group B *streptococcus*	2 (3.1%)
Klebsiella spp.	2 (3.1%)
CSF Culture (Total-33)	
Negative	28 (%)
Coagulase negative *staphylococcus*	2 (%)
Group B *streptococcus*	2 (%)
Yeasts	1 (%)
Urine MC&S (Total-27)	
Negative	32 (%)
E. coli	1 (%)
E. faecalis	1 (%)
Yeasts	1 (%)

MC&S-microscopy, culture and sensitivity.

Table 4: Investigations.

Neonates with serious bacterial infection (SBI) and without SBI are compared in Table 5.

Parameter	**Infants with SBI n=15**	**95% Confidence Interval**	**Infants without SBI n=60**	**95% Confidence Interval**	**p-value**
M:F	11:4	-	31:29	-	0.16
Age	15.60	10.87-20.33	13.15	10.78-15.52	0.35

Weight	3.20	2.845-3.555	3.37	3.179-3.57	0.40
White Blood Cell count	11.27	6.886-15.660	10.92	9.395-12.441	0.84
Platelets	363.53	237.37-489.70	286.37	248.31-324.42	0.11
C-reactive protein	<51.73	19.81-83.65	<17.73	9.05-26.42	<0.01
Hb Level	12.63	10.96-14.31	12.48	11.20-13.75	0.90
Prematurity	0	-	4	-	0.31
Low Birth Weight	2	-	3	-	-

Table 5: Patients with SBI vs Without SBI.

The sensitivity and specificity of clinical indicators predicating severity of illness for the two most important causes of disease in neonates admitted to the general ward. Tachypnoea was very sensitive (100%) and relatively specific (76%) for detecting BRPN with a LR of 3.79. The other clinical indicators were neither specific nor sensitive in detecting serious a specific diagnosis.

4. Discussion

This study shows that a considerable number of neonates are admitted to the general paediatric wards within a few days of birth. The most common indication for admission in the early neonatal period was jaundice and in the late neonatal period was BRPN. Most neonates are discharged early from the neonatal unit because of major resource limitations. In the study unit, premature infants were discharged at a weight >1600 grams babies with a birth weight above 1750 grams were not admitted and well term babies were discharged within 6 hours. During the study period there were no routine home visits by nurses; parents must seek medical assistance if their babies are sick. Neonates discharged early are a potential high-risk group because adequate breastfeeding is not established, mothers are often young and there is no screening for neonatal jaundice. If readmission is required, these babies are not admitted to the neonatal wards, but to the general paediatric wards. Premature discharge of this vulnerable group might be hazardous and may potentially increase hospital admission and mortality rates. A study by Mokhachane et al. however, demonstrated that if home circumstances are adequate, it is safe to discharge well ex premature infants at a weight of greater than 1650 g, as compared to greater than 1800 g [11]. Earlier discharge of this group of very low birth weight (VLBW) infants may assist in reducing overcrowding at hospitals with attendant complications and reduced personnel numbers. A longer stay in hospital would also expose these infants to nosocomial infections that increase morbidity and mortality

The most common diagnoses for neonates admitted to the ward were jaundice and infections, including pneumonia and sepsis. Similar results were found in the seventh report on perinatal care in South Africa [12]. It is important to screen early for neonatal jaundice. Ideally newborns should also have a jaundice checkup within 48 hours of birth. This could be easily done with a transcutaneous biligunometer and use of a primary care algorithm prior to

discharge of neonates. The age of an infant is a very important consideration to predict the pattern of clinical diagnoses [10]. In the current study, for infants less than seven days of age, jaundice and infection (including sepsis, pneumonia and meningitis) were the commonest presentations. This was in agreement with previous studies in neonates presenting to the ED [10, 13, 14]. It is very important to detect jaundice early to prevent the devastating outcome of kernicterus. In infants 7-28 days the most common clinical diagnoses were respiratory tract infection and sepsis. This is similar to the findings illustrated by Jeena et al. [7] whereby in the age group 7-27 days pneumonia, sepsis and hyperbilirubinaemia were the most common diagnosis. Given the syndromic overlap between the clinical presentation of NNS and pneumonia, they are often grouped together. The majority of the neonates in this study were referred from local clinics. Clinics and primary health care centers are the first points of care for the sick neonate. It is therefore imperative that primary health care nurses and junior doctors are adequately trained in neonatal care. It is also important that parents are able to identify danger signs, which may suggest when the neonate requires immediate intervention and when the neonate should be taken to the hospital as opposed to a primary health care center. A 2016 Cochrane review found that IMNCI was associated with a 15% reduction in child mortality when activities were implemented in health facilities and communities [15].

In less developed countries, 'disease specific' algorithms may assist unskilled junior doctors and nurses to identify sick neonates and help them refer the patient early for necessary intervention [10]. The present study looked at clinical predictors of severity of illness in neonates less than 28 days. In those infants admitted to the ward, the likelihood of each clinical sign was determined. The most relevant presenting signs in the current study were respiratory distress and jaundice. Respiratory distress showed a likelihood ratio (LR) of 3 compared to other studies where poor feeding was the most important clinical predictor of severity of illness. In another study the clinical sign of significance were cyanosis (an odds ratio range of 1.5-13.7) [16], which are strongly associated with mortality as a result of hypoxemia, this could be more economically and reliably diagnosed using a pulse oximeter. The presence of any danger signs should prompt health care works with basic training to commence further investigation and empiric treatment until reviewed by someone with a higher level of training [11]. Such an approach prioritizes sensitivity (not missing a true illness) at the expense of specificity (restricting treatment of that illness without serious illness) in a population of vulnerable patients [16]. Clinical signs and symptoms in neonates are often subtle and nonspecific. Sick neonates routinely undergo a full "septic work up" including FBC, CRP, B/C, LP and urine dipstix. As shown in this study 67 of 75 (89.3%) patients admitted received FBC, CRP, B/C and LP and urine dipstix (if indicated). A FBC was not helpful in diagnoses of illness because most FBC was normal despite infants being clinically ill. A CRP was statistically significant in making a diagnosis of SBI. This was a similar finding to a study by Nosrathi et al. [17]. However, although most blood cultures were negative, a positive result and organism identification assisted with choice of antibiotic and duration of antibiotic used.

In this study the bacterial pathogens cultured in infants admitted to the ward were coagulase negative *staphylococcus* (CNS), group B *streptococcus* and *Klebsiella pneumoniae*. This was similar to organisms identified in other developing countries by Ganatra et al. [6]. Currently, all neonates admitted with suspected SBI are commenced on empiric ampicillin and gentamycin. Emergence of resistance and virulent strains render common

antibiotic regimes ineffective against *Klebsiella spp* and CNS. Ongoing surveillance of positive cultures and antimicrobial sensitivity patterns will guide empiric therapy in this setting. The mortality rate in this study was surprisingly low. There were two deaths (2.7%) compared to the Seventh Report on Perinatal Care in South Africa, which highlighted a rising in-hospital mortality rate (IHMR) from 5.6/100 admissions in 2005 to 7/100 admissions in 2009 [12]. The observed current low mortality rate may be due to easier access to clinics and hospitals by patients, and the CMJAH is a tertiary institute with well-trained staff in the wards.

Both infants that died in the study, died within 24 hours of admission due to sepsis and pneumonia respectively. This confirms similar issues pointed out by the above-mentioned report that reflects a range of quality of care issues such as late presentation as a result of poor parent education or lack of transport or inappropriate first line assessment and management on admission to hospital. Are we missing a group of neonates that do not present at all to a hospital and die at home? According to data in the Saving Babies Report, almost twice as many neonates than children present as dead on arrival (DOA) [12]. In the current study exclusive breastfeeding rates were 57.3%, but still low. This demonstrates there still needs to be a greater emphasis on promotion of breastfeeding. During the postnatal period, early and exclusive breastfeeding is perhaps the most important intervention to prevent sepsis. The current study showed 28% of babies admitted are HIV exposed. Most HIV exposed 16 of 21 (76.2%) diagnosed received PMTCT (prevent mother to child transmission) prophylaxis.

Although antenatal care (ANC) was received by 74.7% of mothers, this is lower than ANC received by the general population. Lack of ANC could possibly be a risk factor for admission of these neonates. There is definitely a gap in care, where many pregnant women are not tested for HIV. HIV care in South Africa is still significantly suboptimal and requires urgent attention. In this study a third of infants admitted to the general ward are HIV-exposed, but only 76% had received PMTCT. A quarter of these HIV-exposed infants eligible for perinatal anti-retroviral did not receive them. Hopefully this gap in care for pregnant women and HIV-exposed infants can be bridged by implementation of the new PMTCT guidelines. Emphasis should be on ARVs (antiretroviral) for mothers and exclusive breastfeeding for infants. Importantly breastfeeding reduces malnutrition and child death. The new guidelines adopt an approach to infant feeding that maximizes infant survival, not only the avoidance of HIV transmission

5. Conclusion

The findings of the study are in agreement with previous studies on the WHO IMCNI signs that predicts serious neonatal infection with tachypnea and or chest in drawing and jaundice being specific for pneumonia and neonatal jaundice, This study recommends that the revised IMCNI strategy should be implemented as a basic algorithm for initiating referral and empiric treatment especially in facilities staffed by healthcare workers with only basic training.

Limitations

This is a retrospective, single centre analysis. The time frame has been limited to a 4-month period.

Declarations-Ethics Approval

The study was approved by the Human Research Ethics Committee of the University of the Witwatersrand

Consent for Publication

Not applicable

Availability of Data and Material

Authors will make the data available upon reasonable request

Competing Interests

The authors declare no competing interests

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Authors' Contributions

TR conceptualized the study, performed data collection and analysis data and wrote up the various drafts for publication. DB an MM, assisted in the review of the various drafts for publication. All authors have read and approved the final version of this manuscript.

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