Scientific Research Publishing

Advances in Infectious Diseases, 2017, 7, 55-69
http://www.scirp.org/journal/aid
ISSN Online: 2164-2656
ISSN Print: 2164-2648

Prevalence, Clinical Features and Outcome of Neonatal Malaria in Two Major Hospitals in Jos, North-Central Nigeria

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How to cite this paper: Diala, U.M., Onyedibe, K.I., Ofakunrin, A.O.D., Diala, O.O., Toma, B., Egah, D. and Oguche, S. (2017) Prevalence, Clinical Features and Outcome of Neonatal Malaria in Two Major Hospitals in Jos, North-Central Nigeria. *Advances in Infectious Diseases*, **7**, 55-69.
https://doi.org/10.4236/aid.2017.73007

Received: July 28, 2017
Accepted: August 27, 2017
Published: August 30, 2017

Abstract

Malaria was thought to be rare in neonates. However, recent studies report increasing prevalence in neonates. Clinical features of neonatal malaria have also not been adequately reported. This study was undertaken to assess the prevalence, clinical features and outcome of malaria in neonates admitted into two tertiary hospitals in Jos, Plateau State. All consecutive neonates aged 0 - 28 days admitted into the neonatal units of Jos University Teaching Hospital and Bingham University Teaching Hospital, Jos were recruited into the study. Giemsa stained blood films of the neonates were examined by trained microscopists. Neonates with malaria had presenting clinical features recorded and treated with amodiaquine (1st line) and quinine (2nd line). Clinical features and parasitaemia were monitored for 14 days for outcome. Of the 301 neonates enrolled, 16 had malaria parasitaemia giving a prevalence of 5.3%. Congenital malaria accounted for 87.5% of cases of neonatal malaria. *Plasmodium falciparum* mono-infection was responsible for all the cases of malaria. ITN use in pregnancy offered some protection against neonatal malaria (CI = 0.2 - 0.7). The median parasite density was 255 (72, 385) parasites/μl. Fever was significantly present in 10 (66.7%) of the cases (p = 0.03). Fifteen of the 16 neonates had clinical and parasitological cure on treatment with amodiaquine. One treatment failure had cure after retreatment with quinine. There was no mortality in all 16 neonates treated for malaria. Malaria is not rare in neonates on admission in Jos. Fever is the commonest clinical feature of neonatal malaria. Amodiaquine provided effective treatment of malaria in neonates in Jos.

Keywords

Neonatal, Malaria, Prevalence, Amodiaquine, Bed Nets

1. Introduction

Malaria remains a major health problem with forty one percent of the world's population living in malaria endemic areas [1]. There were 207 million malaria infections and about 606 thousand deaths from malaria in 2012 [2]. About ninety percent of the malaria burden occurs in sub-Saharan Africa [3]. It is estimated that malaria contributes to 3% - 8% of all infant deaths [3]. Most of these deaths are due to prematurity and low birth weight associated with maternal anaemia and placental malaria [3].

Neonatal malaria was thought to be rare due to the protective barrier of the placenta, transfer of maternal antibodies and the protective effect of foetal haemoglobin (HbF) [4] [5]. However, several studies over the past two decades, especially in Nigeria have shown that the prevalence of malaria in neonates appears to be increasing with values as high as 25% [6] [7]. This increase in the prevalence of neonatal malaria is believed to be associated with drug-resistance of *Plasmodium falciparum* and increased virulence of malaria parasite resulting from altered antigenic determinants [7]. Other factors that contribute to the higher prevalence of malaria in neonates include: increased reporting, poor attitude towards sleeping under insecticide treated net (ITN), poor uptake of intermittent malaria prophylaxis (IT-SP), change in climatic conditions in favour of mosquito breeding and high prevalence of HIV infection in pregnancy [7] [8] [9] [10].

The clinical presentation of malaria in neonates has not been adequately studied mainly due to the fact that it was thought to be rare and most studies aimed at describing prevalence, leaving a gap in knowledge. However, a few studies showed a high percentage of asymptomatic infections [11]. Those with symptoms present with pyrexia, feeding difficulty, vomiting, jaundice, hepatosplenomegaly and anaemia which are also features seen in neonatal sepsis [6] [7]. Pyrexia remains the commonest presenting feature, seen in up to 85% of symptomatic cases [6]. It is, therefore, possible that malaria may be contributing significantly to the high disease burden and mortality attributed to neonatal sepsis [12].

The goal of this study was, therefore, to determine the prevalence, clinical features and outcome of malaria in neonates admitted into two major hospitals in Jos, North-central Nigeria.

2. Materials and Methods

2.1. Study Locations

The study was carried out in Jos University Teaching Hospital (JUTH) and Bingham University Teaching Hospital (BhUTH) which are the two tertiary hospitals in Jos and account for the highest number of neonatal admissions in Jos. JUTH is a 500 bed-space hospital with three wards designated for neonatal care—the Special Care Baby Unit (SCBU) and two lying-in wards (Postnatal wards 1 and 2). The SCBU has 30 bed spaces while the postnatal wards have 32 bed spaces each. There were a total of 670 neonatal admissions in 2012. BhUTH

is a 150 bed hospital. It has a 10 bed space SCBU with 177 neonatal admissions in 2012.

Jos Plateau metropolis is a tropical highland located near the geographical centre of Nigeria. Jos has an area of 7800 km^2 [13]. It lies at a general altitude of 1300 m above sea level, reaching its highest peak at the Shere Hills where it stands at 1766 m above sea level. It is characterised by a mean annual rainfall of about 1260 mm (1050 - 1400 mm), reaching its peak between July and August while the mean annual temperature is about 22˚C [13]. Malaria transmission in Jos is unique as it has two described patterns—an endemic perennial pattern and a seasonal epidemic pattern [14]. Malaria transmission is perennial in most parts of Jos due to presence of factors such as residence near mining ponds and poor housing and drainage that encourage the bionomics of the mosquito vector all year round. The seasonal pattern of transmission is noticed in some areas of southern part of Jos Plateau due to the predominant high altitude and cold climate—factors which have been observed to discourage malaria transmission [11].

2.2. Study Design and Recruitment of Neonates

The study had a prospective hospital based longitudinal descriptive study design and was carried out between 2nd January and 4th July, 2013. All consecutive neonates (aged between 0 and 28 days) admitted into the selected hospitals were recruited within 24 hours of admission if they met the inclusion and exclusion criteria.

Inclusion Criteria

1) All babies aged between 0 - 28 days on admission with duly signed written informed consent form from parents/guardians.

Exclusion Criteria

2) Any newborn with major congenital anomalies;

3) Babies who received antimalarial medications within two weeks prior to recruitment.

The flowchart below (**Figure 1**) illustrates the recruitment process for the study.

2.3. Data Collection

Using a case record form, maternal demographic and obstetric history as well as the neonate's presenting symptoms and examination findings were documented. Gestational age was calculated from mother's last menstrual period for all babies and/or Ballard score for babies presenting within 7 days. Newborns with gestational age less than 37 weeks, 37 - 42 weeks, and over 42 weeks were classified as preterm, term and post term respectively.

Each baby was weighed using a precalibrated beam balance (SECA infant weighing scale, model 725, precision 0.005 kg, range 0.5 - 16 kg). For infants admitted aged less than 24 hours, weight on admission was considered as birth weight and for older infants, birth weight was obtained from birth records where available. Axillary temperature values were measured using a digital thermome-

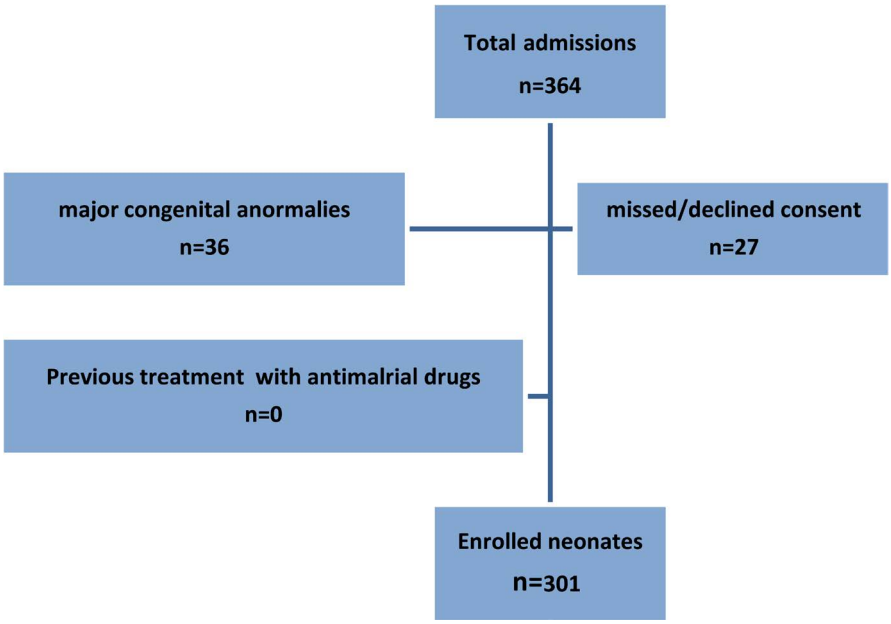

Figure 1. Flowchart of neonates recruited into this study.

ter (UMEC-DT-01A, Range 32˚C - 42˚C, Accuracy ± 0.1˚C) inserted into the axilla until it beeped (usually after about 2 - 3 minutes).

2.4. Sample Collection and Laboratory Procedures

All blood samples were collected following standard aseptic procedures. Thick and thin blood films were prepared using clean grease-free unsilicated glass slides from each baby using heel pricks within 24 hours of admission. The films were air dried without convection, and stained with 10% freshly prepared Giemsa stain maintained at a PH of 7.2. Thin blood films were fixed with 100% methanol prior to staining. The stained blood films were viewed under a light microscope at x1000 magnification (X100 oil immersion lens). The diagnosis of malaria was based on the identification of asexual stages of *Plasmodium* on the thick blood smears, while thin blood smears were used to identify species of *Plasmodium*. *Plasmodium* parasite density was determined by counting the number of asexual parasites against 200 leucocytes on the thick blood film and converted to parasites per microlitre using an assumed total white blood cell (WBC) count of 8000/microlitre (µl). Blood films were declared negative if no parasite was seen after viewing 500 WBC. Each slide was read independently by two trained microscopists in Jos University Teaching Hospital. In the event of discordant results (either positive/negative discordance or greater than twofold density difference above 400 parasites/µl) the slide was examined by a third microscopist. The mean of the values obtained was used for parasite density. Also, Haematocrit was obtained for each of them at admission.

Subjects admitted with a diagnosis of probable sepsis (based on WHO guideline) [15] or considered at risk for sepsis had sepsis work up carried out. A neonate was considered to be at risk for sepsis if one of the following was present: a

history of prolonged rupture of membranes for >24 hours, history of maternal malodorous vaginal discharge, maternal painful micturition, fever in mother within 2 weeks prior to delivery, prematurity, vigorous resuscitation at birth, and delivery outside a hospital. All subjects who had malaria parasitaemia demonstrated in their blood films also had sepsis work up done to exclude neonatal sepsis. Sepsis work up included a Complete Blood Count and Blood Culture. Cerebrospinal fluid (CSF) was also collected for microscopy culture and sensitivity when meningitis was suspected.

2.5. Management and Follow Up for Outcomes

Subjects were managed afterwards in line with the pre-existing standard of care for malaria and neonatal sepsis as obtained in the study sites as outlined below:

1) Subjects who had malaria parasitaemia in their blood film were given amodiaquine syrup at a dose of 10 mg/kg given as a daily dose for 3 days. Subjects with treatment failure (persistence of malaria parasitaemia on thick blood film within 14 days of treatment) were given syrup Quinine at a dose of 10 mg/kg/dose 8 hourly for seven days. Clinical features were reviewed daily and thick blood film repeated on days 3, 7 and 14 to determine outcome of treatment. Outcomes evaluated were clinical cure (absence of clinical features by day 3 of treatment), parasitological cure (persistent absence of parasitaemia by day 14 of treatment with stated antimalarial drug), and treatment failure (presence of parasitaemia within 14 days of treatment with antimalarial drug).

2) Subjects with a diagnosis of probable sepsis were commenced on broad spectrum intravenous antibiotics on admission (ampicillin and gentamycin or ceftazidime and gentamycin) while awaiting blood culture results.

2.6. Data Analysis

Data was entered into the computer using Microsoft Excel 2007 software and analysed using Epi Info 3.5.3 soft-ware. Chi square was used to test for determine differences between groups. Student's t test was used to test for differences between means. Fischer's exact test was used to obtain p values for cross-tables with cells containing <5 subjects. A p value of <0.05 was considered as statistically significant.

2.7. Ethical Issues

Ethical clearance certificates were obtained from JUTH and BhUTH ethical committees. Also, a written informed consent was obtained from a parent/guardian of each neonate after due explanation of the nature, benefits and possible risks of the study to the neonate.

3. Results

3.1. Baseline Characteristics

A total of 301 subjects (240 and 61 from JUTH and BhUTH respectively) were

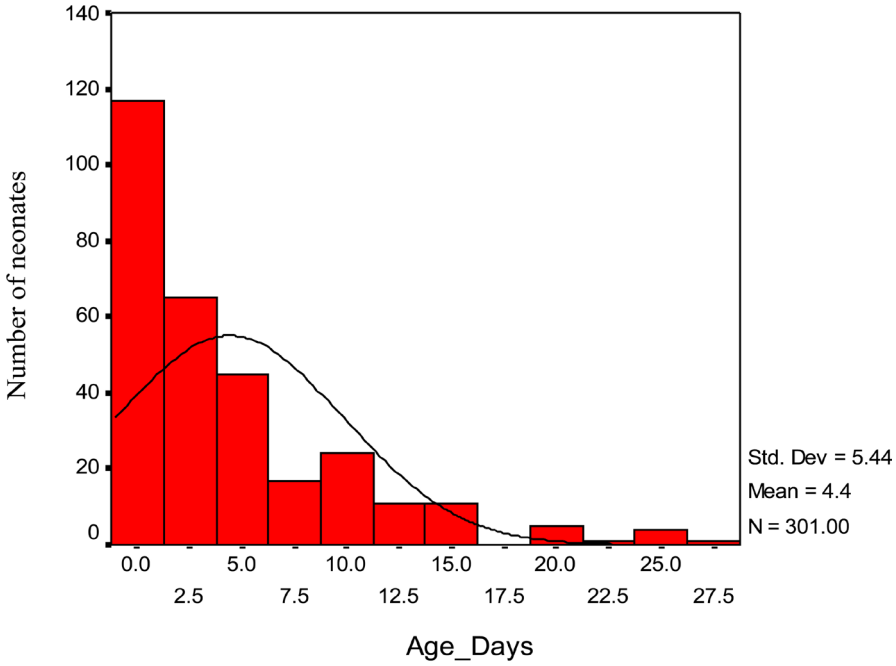

Figure 2. Histogram with a skewed normal distribution curve of ages of studied neonates.

recruited into the study. One hundred and ninety three (64.1%) were males and 108 (35.9%) were females. The median age of the subjects was 2 days (inter-quartile range 0.6 days) (Figure 2). Two hundred and thirty six (78.4%) were neonates aged ≤7 days. The mean birth weight was 2848.8 ± 924.6 grams. Table 1 summarizes the socio-demographic characteristics of the neonates. The socio-demographic characteristics of the neonates in the two hospitals were similar except their mean birth weight. The neonates in BhUTH had a statistically significant higher birth weight than those in JUTH (t = 2.197, p = 0.029).

3.2. Prevalence of Malaria

Malaria parasitaemia was present in 16 out of the 301 neonates with a prevalence rate of 5.3%. Malaria parasitaemia was demonstrated in 11 and 5 subjects in JUTH and BhUTH respectively (p = 0.261, Table I). Congenital malaria was seen in 14 out of the 236 neonates age ≤7 days with a prevalence rate of 5.9%. Congenital malaria represents 87.5% of those with neonatal malaria. Acquired neonatal malaria (malaria parasitaemia in neonates aged 8 - 28 days) was present in 2 out of the 65 neonates aged 8 - 28 days with a prevalence rate of 3.1% (Table 2). Table 3 summarizes the sociodemographic risk factors of malaria in the studied neonates. The consistent use of ITNs was associated with protection against neonatal malaria (p = 0.025). The odds of malaria in neonates of mothers who always slept under an ITN during pregnancy was 0.3.

3.3. Clinical Features of Neonatal Malaria

All 301 subjects had at least one clinical feature at presentation (Table 4). Fever and jaundice were the commonest clinical features at presentation. One (6.25%)

Table 1. Comparison of baseline characteristics of neonates studied in JUTH and BhUTH.

Characteristics	Total (301)	JUTH	BhUTH	χ^2	p value
Age (in days)					
0 - 7	236 (78.4)	185 (61.4)	51 (16.9)	2.549	0.466
8 - 14	49 (16.3)	43 (14.3)	6 (2.0)		
15 - 21	11 (3.7)	8 (2.7)	3 (1.0)		
22 - 28	5 (1.7)	4 (1.3)	1 (0.3)		
Sex					
Male	193 (64.1)	152 (50.5)	41 (13.6)	0.318	0.573
Female	108 (35.9)	889 (29.2)	20 (6.7)		
Mean birth weight (x ± SD)					
Gestational age at birth (weeks)	2848.8 ± 924.6	2781.2 ± 901.5	3081.9 ± 972.5	2.197[$]	0.029*
Preterm (28 - 36)	72 (23.9)	58 (19.3)	14 (4.7)	0.0032	0.955
Term (37 - 42)	229 (76.1)	182 (60.5)	47 (15.6)		
Socioeconomic class of parents					
I (upper)	0	0	0	3.018	0.389
II (upper)	9 (3.0)	8 (2.7)	1 (0.3)		
III (upper)	71 (23.6)	57 (19.0)	14 (4.7)		
IV (lower)	131 (43.5)	98 (32.6)	33 (11.0)		
V (lower)	90 (30.0)	77 (25.6)	13 (4.3)		
Malaria parasitaemia					
Present	16 (5.3)	11 (3.7)	5 (1.7)	0.261	0.126
Absent	285 (94.7)	229 (76.1)	56 (18.6)		

*Statistically significant, [$]Student's t test.

Table 2. Prevalence of malaria parasitaemia in the studied hospitalized neonates in Jos between January and July 2013 (n = 301).

Age (days)	Malaria parasitaemia		χ^2	p value
	Present N (%)	Absent N (%)		
≤7 Days (congenital)	14 (5.9%)	222 (94.1%)	0.826	0.289
8 - 28 Days (acquired)	2 (3.1%)	63 (96.9%)		
0 - 28 Days (neonatal)	16 (5.3%)	285 (94.7%)		

of the 16 confirmed subjects with neonatal malaria also had blood culture confirmed neonatal sepsis. Therefore, the subject was excluded from analysis for clinical features attributable to neonatal malaria. Fever (axillary temperature > 37.5˚C) was the commonest clinical feature of confirmed malaria parasitaemia present in 10 (66.7%) of the 15 cases. Other clinical features seen include: jaundice 5 (33.3%), excessive crying 4 (26.7%), refusal to feed 1 (6.7%). Fever was the only statistically significant symptom of malaria (p = 0.031) (Table 5). When

testing for the usefulness of fever in the diagnosis of malaria, values for sensitivity, specificity, positive predictive value and negative predictive value are 68.8%, 61.4%, 9.1% and 97.2% respectively.

3.4. Parasite Species and Density

P. falciparum was the only specie of *Plasmodium* responsible for all the 16 confirmed cases of malaria parasitaemia. The median parasite density was 255 (interquartile range= 72, 380) parasites/µl with modal parasite density class between 101 - 1000 parasites/µl (Figure 3).

Table 3. Sociodemographic risk factors of neonatal malaria.

Risk factor	Malaria parasitaemia		OR	95% CI	χ^2	p value
	Present N (%)	Absent N (%)				
SEC						
Lower(IV and V)	11 (3.7)	210 (69.8)	0.79	0.27 - 2.35	0.189	0.664
Upper (I-III)	5 (1.6)	75 (24.9)				
Maternal age						
<29 years	6 (2.0)	132 (43.9%)	0.70	0.24 - 2.03	0.474	0.609
≥29 years	10 (3.3)	153 (50.8%)				
Parity						
1	5 (1.7)	123 (40.5)	0.61	0.23 - 1.82	0.830	0.360
>1	11 (3.7)	162 (54.2)				
Sex						
Female	7 (2.3)	101 (33.6)	1.42	0.43 - 4.42	0.455	0.501
Male	9 (3.0)	184 (61.1)				
Gestational age						
Preterm (28 - 36 weeks)	14 (4.7)	218 (72.4)	2.15	0.47 - 19.94		0.540[#]
Term (37 - 42 weeks)	2 (0.7)	67 (22.3)				
IPT-SP						
<2 doses	5 (1.9)	122 (40.5)	0.625	0.22 - 1.89	0.782	0.362
≥2 doses	11 (4.1)	163 (54.2)				
Use of ITN						
Always	4 (1.3)	152 (50.4)	**0.296**	**0.09 - 0.90**		**0.025[#]***
Not always	12 (4.0)	133 (44.2)				
Maternal HIV						
Reactive	1 (0.3)	13 (4.3)	1.39	0.03 - 10.55		0.543[#]
Non reactive	15 (5.2)	272 (90.4)				

[#]Fisher's exact test, *Statistically significant IPT-SP = intermittent preventive treatment of malaria with Sulfadoxine-pyrimethamine. ITN = insecticide-treated bed net.

Table 4. Clinical features at presentation in the studied hospitalized neonates in Jos between January and July 2013 (n = 301).

Clinical features	Frequency (N = 301)	Percentage (in %)
Vomiting	9	3.0
Refusal to feed	68	22.6
Jaundice	121	40.2
Weak cry at birth	35	11.6
Excessive crying	62	20.6
Diarrhoea	3	1.0
Respiratory distress	47	15.6
Eye discharge	11	3.7
Seizures	9	3.0
Umbilical cord discharge	2	0.7
Skin rashes	7	2.3
Prematurity	69	22.9
Fever (Temp > 37.5˚C)	121	40.2
Hypothermia (Temp < 35.5˚C)	43	14.2
Pallor	11	3.7
Impaired consciousness	18	6.0
Cyanosis	8	2.6
Hepatomegaly	11	3.7
Splenomegaly	2	0.7
Oliguria	2	0.7

Table 5. Clinical features of malaria in the studied hospitalized neonates in Jos.

Clinical feature	Malaria parasitaemia		χ^2	p value
	Present	Absent		
Jaundice				
Present	5 (1.7)	115 (38.3)	0.292	0.589
Absent	10 (3.3)	170 (56.7)		
Refusal to feed				
Present	2 (0.7)	66 (22.0)	0.785	0.376#
Absent	13 (4.3)	219 (73.0)		
Excessive crying				
Present	5 (1.7)	57 (19.0)	1.545	0.214
Absent	10 (3.7)	228 (76.0)		
Fever				
Present	10 (3.3)	110 (36.7)	**4.678**	**0.031***
Absent	5 (1.7)	175 (58.1)		
Pallor				
Present	5 (1.7)	98 (32.7)	0.007	0.933
Absent	10 (3.7)	187 (62.3)		
Prematurity				
Yes	2 (0.7)	67 (25.1)	7.860	0.249
No	13 (5.2)	184 (68.9)		

(Total number of neonates with malaria = 16, 1 neonate was excluded due to confirmed neonatal sepsis which was a confounder.) *Statistically significant, #Fisher's exact test.

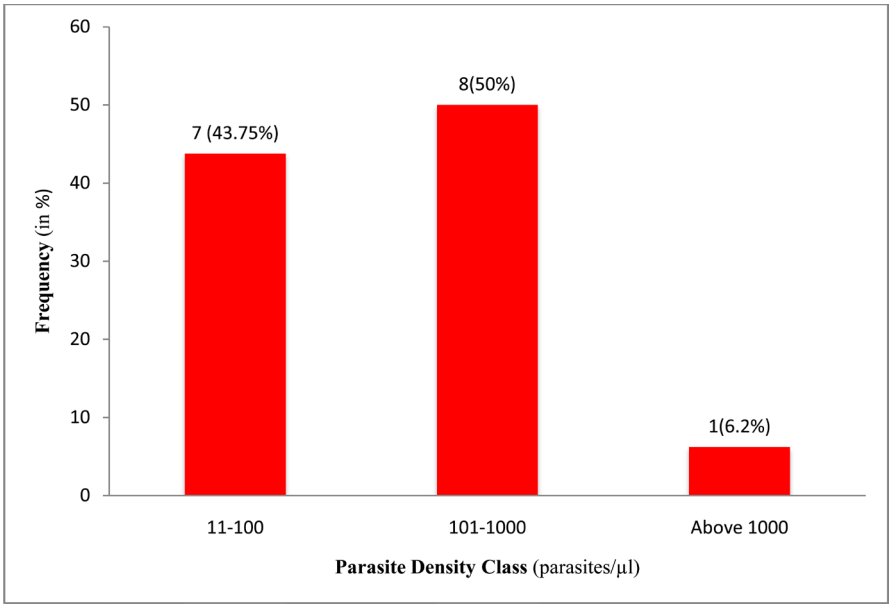

Figure 3. Parasite density distribution in the studied neonates with malaria in Jos.

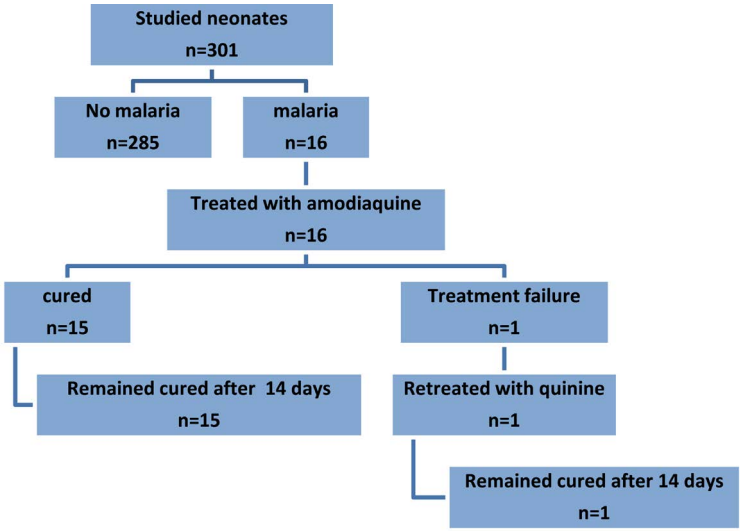

Figure 4. Flowchart of treatment outcomes of neonates with malaria.

3.5. Treatment Outcome

Fifteen out of the sixteen (93.8%) neonates with confirmed malaria infection had clinical and parasitological cure following treatment with amodiaquine. One of the sixteen had both clinical and parasitological treatment failure with amodiaquine and achieved both clinical and parasitological cure on retreatment with quinine. There was no malaria recrudescence recorded in all 16 neonates with malaria after 14 days following treatment. None of the subjects with malaria died (Figure 4).

4. Discussion

The point prevalence of neonatal and congenital malaria in this study were 5.3%

and 5.9% respectively with congenital malaria being the predominant form of malaria. The prevalence was much lower than obtained in a retrospective study on neonatal malaria in Sagamu, where a prevalence of 24.8% was observed [8]. In that study, only 89 (38.7%) of the 230 neonates on admission had light microscopy evidence for malaria. That means that the percentage of positive blood smears was actually 53% which is really high and underscores the fact that retrospective studies are often fraught with pitfalls in methodology. Another retrospective study in Jos also reported a higher prevalence of 31.6% [16]. That study in Jos also demonstrated sampling bias because only subjects suspected to have neonatal malaria based on clinical features, mainly fever were recruited. However, the low prevalence obtained in the index study is similar to findings from studies in Zaria and Calabar where prevalence rates of 8.25% and 7.6% were obtained respectively [17] [18]. Also, a multi-centre study on congenital malaria, involving several regions of Nigeria showed an overall prevalence rate of 5.1% [19]. These studies were prospective studies and used Giemsa stained light microscopy for malaria diagnosis.

The low prevalence may stem from the prevailing climatic conditions in Jos situated on high altitude which discourage breeding of *Anopheles* mosquito and malaria transmission [18]. The low prevalence of neonatal malaria in this study compares favourably with the low prevalence of malaria in pregnancy in women seen in Jos. A previous study in JUTH reported a prevalence rate of malaria in pregnancy of 9 percent [20]. Also, the finding of lower prevalence rates of malaria in neonates in this study as compared to previous studies is in keeping with the global trend of reduced malaria transmission since 2005 [21]. This reduction in malaria transmission stems from increased governmental campaigns and drive towards universal provision of malaria control interventions such as ITNs and IPT-SP [21]. In this study, maternal use of ITN consistently, was associated with protection against malaria in their neonates. However, use of IPT-SP at the recommended 2 doses was not associated with protection.

In this study, congenital malaria was the predominant type accounting for 87.5% of all cases of confirmed malaria. This is consistent with other studies and supports the fact that the transplacental route remains the most important route of transmission of malaria in neonates and interventions for malaria control in neonates should be targeted at reducing transplacental malaria transmission [8] [22]. Transfusion malaria did not contribute to malaria burden in this study. This is probably because no subject received blood transfusion prior to recruitment.

Plasmodium falciparum was the only species responsible for neonatal malaria infection in this study. This may be explained by the fact that *P. falciparum* is the predominant specie of *Plasmodium*, responsible for over 98 percent of all malaria infections in Nigeria [2] [23]. Also, from studies in Nigeria, *P. falciparum* is the main reported parasite responsible for placental malaria which is the route for transmission of congenital malaria infection [17].

The low parasite density observed in neonates with malaria in this study is similar to studies in neonates done elsewhere [17] [19]. This low parasite density characterizing neonatal malaria infection is thought also to be as a result of the protective effect of Hb F, the short half live of neonatal red blood cells and protective effect of maternally derived antibodies [24].

All the neonates with malaria were symptomatic and thus reflects the peculiarity of the study population which were mainly ill neonates. Fever was the only statistically significant clinical feature associated with neonatal malaria infection in this study. Fever also represents the commonest clinical feature of malaria in neonates in most other studies [8] [19]. Fever had a high negative predictive value of 97.2% which means that the absence of fever in a neonate correlates with absence of disease. The usefulness of the presence of fever predicting the presence of malaria in neonates is however limited because the sensitivity and positive predictive values of fever in infected neonates were 68.8% and 9.1% respectively. Other clinical features also documented are jaundice, excessive crying and refusal to feed, but they are non-specific for malaria in this cohort. These features have also been documented in previous studies on malaria in neonates [17] [19] [25]. A study in Abuja demonstrated high positive predictive values and sensitivities for jaundice, pallor, fever and hepatomegaly but did not test for difference between groups [25]. Another study in Zaria showed that fever was the commonest presenting feature seen in 82% (14/17) of the cases. In the study in Zaria, jaundice was also common (7/17) while seizures (2/17), excessive crying (2/17), difficulty in breathing (1/17) and poor suck (1/17) were also reported but no test for association was carried out [17].

Neonatal malaria was not significantly associated with prematurity in the current study. In fact, neonates with malaria tended to be delivered at an older gestational age and had a higher birth weight. However, this was not statistically significant. This finding is similar to those in previous studies [26] [27]. Previous studies report prematurity and intrauterine growth restriction as consequences of malaria in pregnancy [26] [28]. However, findings from the current study are not in support of the fact that either of these conditions increases the risk of malaria in the neonates and may suggest a complex mechanism of transmission of malaria parasites from infected pregnant women to their offspring.

There was no mortality attributable to malaria infection in this study. Ninety four percent of the neonates with malaria responded to amodiaquine. The remaining one patient responded to Quinine. This good outcome of treatment is similar to those in studies in Zaria and reflects the mild course of the disease in neonates with low parasite density and the high sensitivity of the parasite to amodiaquine [16] [17].

5. Conclusion

Our study demonstrated a prevalence rate of malaria of 5.3% in neonates on admission in two tertiary hospitals in Jos. Neonatal malaria was characterized by

low parasite density and a mild disease, with fever as the commonest clinical feature. All the neonates with malaria survived intact. Sleeping under ITNs during pregnancy was associated with protection against neonatal malaria.

Acknowledgements

The authors sincerely appreciate the nurses and doctors in the neonatology units of JUTH and BhUTH for assistance in data collection, Dr Da'am and Mr Mark Terver for laboratory support.

Disclosures and Funding

The authors of this study have no financial disclosures related to this study. This study had no external funding.

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