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RESEARCH ARTICLE

Uncomplicated Malaria in Children under 6 Months or Less than 5 Kg; How Prescribers in Ghana Manage it in the Absence of a National Policy

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Abstract

Background: Malaria caused by various species of Plasmodium had brought untold socio-economic burden to poor and developing countries of the world. Most malaria associated deaths occur in children below 5 years. The suggestion that antibodies and toxic nature of fetal hemoglobin provide immunity against malaria in children less than 6 months had been disproven. With Ghana having no treatment guideline on the management of uncomplicated malaria in this age group, this study ascertained how Ghanaian prescribers manage malaria in this special risk group.

Method: Using a de novo semi-structured questionnaire in a cross-sectional study, data was collected from 100 prescribers made up of physicians, nurse practitioners, medical assistants and physician assistants working in five hospitals in Tamale, a city in northern Ghana. Data was analyzed using Microsoft excel, Statistical Package for the Social Sciences Version 20 (IBM SPSS) and GraphPad Prims 5.01 (GraphPad Software Inc., San Diego CA). Association between variables was measured using appropriate statistical tests. Statistical significance was assumed at $p < 0.05$ with a confidence interval of 95%.

Results: Within the previous 12 months, 75% of the prescribers of which 67.0% were medical doctors had managed at least a case of malaria in a child less than 6 months or 5 kg. Majority, (88.8%) of prescribers correctly ordered WHO recommended artemisinin based combination medicines with Artesunate-amodiaquine being the most preferred (41.4%). Only 17% were able to indicate the appropriate dosage regimen for this age group. Ability to prescribe the most appropriate antimalarial drug at the correct dosage regimen was not associated with any sociodemographic characteristic of the prescribers.

Conclusion: Although majority of prescribers ordered the WHO recommended antimalarial medicines, it was only less than a fifth who correctly indicated the appropriate dosage regimen for the management of malaria in children under 6 months or less than 5 kg. Trainee physicians should be taught management of malaria in all age groups while practicing prescribers need in-service training on how to manage malaria in this special risk group.

Keywords

Malaria, Prescribers, Children, Six months, Tamale, Ghana

Introduction

One disease that had brought untold socio-economic burden to poor and developing countries especially in Africa and South Asia is malaria; Making it an infectious disease of great public health concern [1]. According to the latest WHO estimates, there were 214 million new cases of malaria in 2015 with 438,000 deaths [2]. About 80% of these malaria related deaths occur in children under 5 years implying that about 800 of such children die every day with most of the death occurring in sub-Saharan Africa [3]. The burden of malaria is huge not only for children under five years but also pregnant women; with these two risk groups accounting for nine out of ten malaria cases [4-6]. In addition to loss of lives, malaria places an economic burden on African nations as it is estimated that it costs Africa US$12 billion per

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year in direct costs and reduces GDP growth by 1.3 percent annually [7]. Occurrence of malaria in infants less than 6 months had been a debatable issue. Demonstration of *in-vitro* malaria parasite growth inhibitory characteristics of lactoferrin and immunoglobin A (IgA) found in breast milk as well as maternal and infant sera has led others to hypothesize that infants are protected from malaria [8,9]. The assumption of infant's immunity against malaria was further boosted by studies that showed that high hemoglobin F concentration at birth inhibits malaria parasite's development in the first few months of human life [10,11]. This assumption of a six-month period of protection in a newborn in contradicted by other studies which found no relationship between presence of maternal antibodies and their protection against malaria in African infants [11,12]. Several other studies undertaken in health facilities and communities in some sub-Saharan countries showed a higher burden of disease in infants under 6 months than what is generally assumed and even if the antibodies provide some protection, it is shorter than the widely quoted six months [13,14]. Although malaria can be transmitted to infants after bites from mosquitoes, several studies across Africa have found malaria parasites present in the cord blood of 7-10% of newborns [15]. In Cameroun, the prevalence of malaria parasitemia between four and six months of age was higher among infants born to women with malaria infected placentas than in those born to women without placental infection [16]. National Malaria Indicator surveys in some African countries such as Nigeria, Malawi, Uganda, Kenya, Guinea, the Gambia and Benin found malaria prevalence rate in children aged less than six months to be between 3.7% and 27% [13,17-19]. Effect of assumption of absence of malaria in children under 6 months had led to limited research and policy guidelines on the treatment of this condition in this age group and are therefore generally excluded from the regulatory trials of anti-malarial drugs during drug development [14,20]. The World Health Organization provided treatment guidelines for children weighting above 5 kg and generally over five months, without specific treatment guidelines for the younger infants but recommended that children weighing less than 5 kg should be given ACT at the same mg/kg body weight as children weighing 5 kg [2]. In Ghana, treatment of malaria involves the use of the artemisinin-based combination therapy namely Artesunate-amodiaquine, Artemether-lumefantrine and Dihydroartemisinin-piperazine but the Standard Treatment Guideline of Ghana provided the dosage regimen for children older than 6 months or weighing more than 5 kg. With the incidence of malaria in the under 6-months-old infants no more in doubt, and with the national treatment guideline not providing information on how to manage this special group, there is the need to ascertain how prescribers in Ghanaian hospitals manage children of this age category and this is what this study had set out to do.

Methods

Study design and setting

Prescribers made up of 67 physicians, 17 nurse practitioners, 2 medical assistants and 14 physician assistants participated in a cross-sectional study which assessed how they manage malaria among children less than 6 months or weigh less than 5 kg. Five hospitals in the Tamale metropolis namely Tamale Teaching Hospital, Tamale West Hospital, Tamale Central Hospital, Seventh Day Adventist Hospital and a private facility Kabsad Scientific Hospital were the study sites. These hospitals are among the top most patronized health facilities in Tamale, a city in northern Ghana which according to the Ghana Statistical Service (GSS)'s 2010 population and housing census has a total population of 223,252.

Data collection techniques

The study was conducted in April, 2016 using a de novo semi-structured questionnaire. The questionnaire was pretested among 10 prescribers, which ensured correction of ambiguous and inconsistent questions before it was administered for the actual data collection. The authors reviewed the questionnaire to ensure face validity of the data collecting tool. The questionnaires were enclosed in envelopes. To assure confidentiality, respondents returned the questionnaires in the envelopes with the word, 'confidential' written across the sealed end. Persistent reminders in the form of telephone calls and text messages were employed to ensure retrieval of most of the completed questionnaires. A convenient sampling design was adopted hence only prescribers who were easy to reach and readily available were selected.

Study sample size determination

Required sample size was calculated using the Cochran's (1977) formula used for definite populations: $\mathrm{n} = \frac{N}{1+N(e)^2}$ where; n = sample size, N is the estimated total population of prescribers in Tamale = 150, e is the margin of error allowed which is 5% or 0.05 therefore $n = \frac{150}{1+150(0.05)^2} = 109$.

The sample size was distributed among the various categories of prescribers; physicians, nurse practitioners; physician assistants and medical assistants in the ratio 70:20:15:4. The ratio is based on estimated number of the various categories in the study area.

Statistical analysis

Data obtained from the questionnaire was entered and analyzed partly using Microsoft excel. Descriptive data was presented as percentages, frequencies and bar charts. Association between variables was obtained using Statistical Package for the Social Sciences Version 20 (IBM SPSS). Charts were obtained using GraphPad Prims 5.01 (GraphPad Software Inc., San Diego CA). Binary lo-

Table 1: Socio-demographic characteristics of prescribers.

Variable	Subgroup	Number of prescribers	Percentage
Sex	Male	71	71.0
	Female	29	29.0
Age (years) (n = 83)	21-30	45	54.2
	31-40	29	34.9
	Above 40	9	10.8
Years of practice	Less than a year	23	23.0
	1-5	59	59.0
	6-10	13	13.0
	11-15	2	2.0
	Above 15	3	3.0
Years at facility (n = 95)	Less than a year	41	43.2
	1-5	48	50.5
	6-10	6	6.3
Ever worked in a pediatric facility? (n = 99)	Yes	86	86.9
	No	13	13.1
Category of prescriber	Physician	67	67.0
	Nurse practitioner	17	17.0
	Medical assistant	2	2.0
	Physician assistant	14	14.0

Table 2: Familiarity, known cause and management history of malaria in infants under six months by prescribers.

Variable	Subgroup	Number of prescribers	Percentage
Familiarity with infant malaria	Not familiar	2	2
	Less familiar	6	6
	Fairly familiar	32	32
	Very familiar	59	59
	Not stated	1	1
Ever treated infant malaria?	Yes	88	88
	No	12	12
Ever treated in last 12 months? (n = 88)	Yes	66	75
	No	22	25
What is the prevalence rate of malaria in under 6 months children? (n = 88)[#]	Less than 10%	6	6.8
	10-20%	9	10.2
	21-40%	4	4.5
	> 40%	9	10.2
	Don't know	60	68.2
Diagnostic method usually applied[*]	Symptomatic	53	32.9
	Rapid diagnostic test	42	26.1
	Blood film (microscopy)	66	41.0
Main cause of infant malaria	Congenital	8	9.5
	Neonatal	76	90.5
Signs and symptoms of infant malaria[*]	Convulsion	9	3.2
	Diarrhoea	24	8.6
	Fever	83	29.7
	Irritability	22	7.9
	Lethargy	8	2.9
	Poor feeding	51	18.3
	Vomiting	52	18.6
	Others	27	9.7

[#]In Ghana, Wagner, et al. [21] reported malaria infection of 13.6% in newborns and 1.5-9.7% in those aged between 2 and 26 week; [*]Prescribers could state more than one method of diagnosis or signs and symptoms of malaria.

gistic regression was used to assess the association between respondents' socio-demographic characteristics and possibility of prescriber managing malaria in a child under 6 months and ability to select appropriate anti-malarial drug and dosage regimen for this special risk group. Statistical significance was assumed at $p < 0.05$ at a confidence interval of 95%.

Ethical consideration

The Ethics Committee of the School of Medicine and Health Sciences of the University for Development Studies granted approval for this study and the procedures. Participants were only interacted with following granting of permission by the heads of the five-selected hos-

pitals in the study. Data was collected from participants only after they had verbally given a free and informed consent to take part in the study. The introductory section of the questionnaire clearly informed that respondents of having the liberty to opt out and that accepting to complete the questionnaire confirms their consent.

Results

Socio-demographic characteristics of prescribers

The majority of the prescribers were males (71%), between 21-30 years-old (54.2%), practiced for 1-5 years (59%) and ever worked in a pediatric ward (86.9%). Furthermore, the majority of the prescribers in this study were physicians (67%) with the minority being medical assistants (2%). The average age of prescribers was 32.4 ± 7.17 years (n = 83). Table 1 presents information on the socio-demographic characteristics of prescribers. The response rate for this study was 91.7%.

Prescribers' history of management of malaria among children less than 6 months

Table 2 shows prescribers' level of familiarity, the types of malaria common in infants under six months and their history of management of malaria in this special group of patients. Majority of prescribers, (59%) indicated they were very familiar with infant malaria. Although 88% of prescribers had ever treated malaria in a child less than 6-months-old, within the previous 12 months, a lesser number of 75% of them had actually managed malaria in this special age group. Although in most suspected malaria situations, (41.0%) diagnosis was by microscopic examination of blood films, in 32.9% of suspected malaria situations, the prescribers used the signs and symptoms expressed by the child for the diagnosis. Fever, (29.7%) and poor feeding (18.3%) were to the top two common signs and symptoms the prescribers found in children with suspected or confirmed cases of malaria. According to majority of prescribers, (90.5%) neonatal malaria was the most common form of malaria they encountered in children. Majority, (68.2%) did not know the prevalence rate of malaria in children under 6 months in Ghana with a further 14.7% stating rates above 20%.

Antimalarial drugs prescribed and reasons for prescribers' choice of drug

Artesunate-Amodiaquine was the most common (41.4%) antimalarial drug ordered by the prescribers in this study with Dihydroartemisinin-piperaquine being the least prescribed (1.1%). For most prescribers, (36.8%), the antimalarial drug being safe and efficacious is the most important factor they consider in deciding on their first-choice antimalarial drug. Table 3 shows the antimalarial drugs prescribed for the management of malaria in children under 6 months and the reasons for the choices.

Accuracy of choice and dosage of antimalarial prescribed for children under 6 months

Comparing the WHO guideline for the management of uncomplicated malaria in children less than 6 months with the drugs the prescribers had prescribed for malaria in infants, majority (81.8%) chose the appropriate antimalarial for this age group. However, only 17.0% of prescribers were able to state the appropriate WHO recommended dosage regimen for the management of malaria in children under 6 months. Figure 1 shows the accuracy of choice and dosage regimen of antimalarial drugs prescribed for children less than 6 months by prescribers.

Sources of information on the treatment of malaria in under 6 months children

Figure 2 shows the sources from which prescribers obtained information on the treatment of malaria

Table 3: Antimalarial drugs ordered for treating infants under 6 months by prescribers.

Variable	Subgroup	Number of prescribers	Percentage
Antimalarial drug used	Artemether-Lumefantrine	33	37.9
	Artesunate-Amodiaquine	30	41.4
	Quinine	10	11.5
	IV artesunate	3	3.4
	Dihydroartemisinin-piperaquine	1	1.1
	IV artesunate + AL	2	2.3
	Quinine + IV artesunate	2	2.3
Reasons for the choice of an antimalarial drug	Availability	5	6.6
	Drug of choice	11	14.5
	First line drug	5	6.6
	Hospital protocol	3	3.9
	Minimal side effects	6	7.9
	NMCP* recommendation	3	3.9
	Safe and efficacious	28	36.8
	STG recommendation	4	5.3
	WHO recommendation	7	9.2
	Others	4	5.3

NB: NMCP: National Malaria Control Programme; AL: Artemether-lumefantrine; IV: Intravenous; STG: Standard Treatment Guideline.

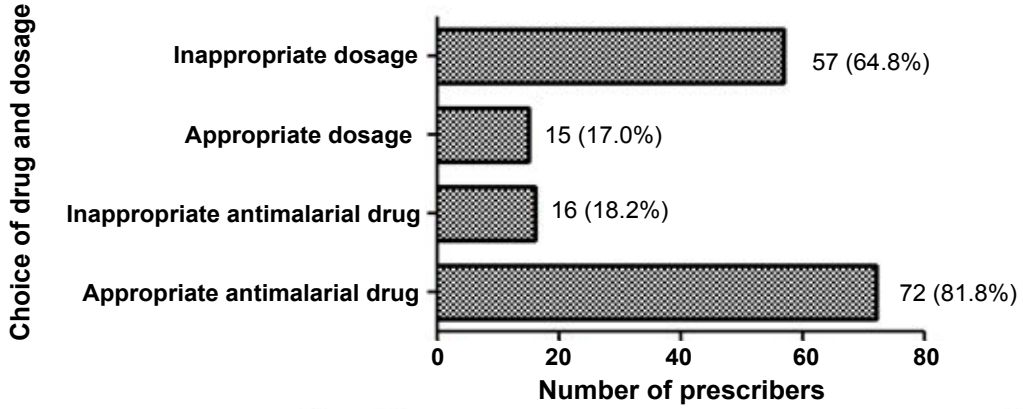

Figure 1: Accuracy of choice and dosage of antimalarial prescribed for children under 6 months.

WHO, (2015) recommended daily dose for the recommended antimalarial for the management of malaria in children under 6 months are AA: 2-10 mg/kg bw (Artesunate) and 7.5-15 mg/kg bw daily (Amodiaquine); AL, 5-24 mg/kg bw (Artemether) and 29-144 mg/kg (Lumefantrine); DAP, 2.5 mg/kg bw (Dihydroartemisinin) and 20 mg/kg bw (Piperaquine) (n = 88).

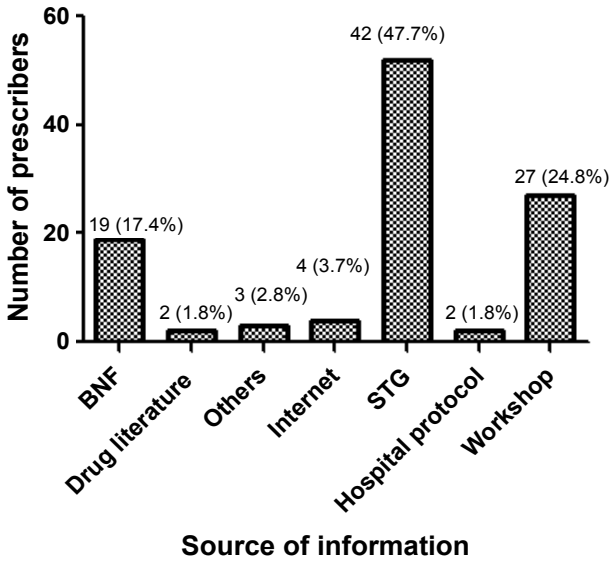

Figure 2: Sources of information on the treatment of malaria in under 6 months children.

BNF- British National Formulary

STG- Standard Treatment Guideline (Ghana)

in children under 6-months-old. For most prescribers, (47.7%), Ghana Standard Treatment Guideline booklet was their foremost source of information for the management of malaria in this age group. Other notable sources were workshops (24.8%) and the British National Formulary (17.4%).

Predictors of possibility of prescriber managing malaria in children under 6-months-old

More male prescribers and their female counterparts (91.1% vs. 86.4%); more physician than non-physician prescribers (90.0% vs. 88.5%) and greater number of prescribers who had spent more than a year in a facility than those who did less than a year (95.7 vs. 81.3%), had ever treated malaria in a child under 6 months. The differences between the subgroups of these variables and ever managing malaria in this special risk group were however not significant. Prescribers who had practiced more than a year were significantly 13.2 times more likely to treat malaria in under 6 months than their colleagues who had not practiced up to a year (96.6% vs. 68.4%; p-value = 0.003; cOR = 13.154; 95% C.I. 2.379-72.722). Also, a prescriber who works or ever worked in a pediatric section in a hospital was significantly 16.5 times more likely to have ever managed under 6 months malaria that colleagues who practice in other departments (94.3% vs. 50.0%; p-value = 0.001; cOR = 16.5; 2.971-91.634). When the variables with significant association with the possibility of ever managing malaria in under 6-months-old were adjusted with the other variables, the likelihood of prescribers who had practiced more than a year increased to 34.8 times compared to those who had done only a year but the difference was no more significant. However, there was still a significant association between having ever worked or working in a pediatric facility and the possibility of treating infant malaria although the level of likelihood decreased from 16.5 to 12.8 times (p-value = 0.019; aOR = 12.82; 95% C.I. = 1.510-108.908). Table 4 shows the association between characteristics of the prescribers and the possibility of managing malaria in under 6 months child.

Association between characteristics of prescribers and ability to manage malaria in under 6-month children with appropriate drugs and dosage regimen

A greater number of female prescribers than male counterpart (84.2% vs. 78.4%) and more younger prescribers less than 30 years than those above 30 (84.2% vs. 75.0%) indicated appropriate antimalarial drugs for the under 6 months category but the differences were not significant. More male physicians however indicated correct dosage regimen than their female counterparts (27.5% vs. 18.8%) but younger prescribers again performed better than their older colleagues (28.1% vs. 20.8) although the differences were not significant.

Table 4: Predictors of possibility of prescriber managing malaria in children under 6-months-old.

Characteristics	Subgroups	Ever managed malaria in child less than 6-months-old?		Unadjusted bivariate analysis			Adjusted bivariate analysis		
		Yes (%)	No (%)	p-value	cOR ratio	95% CI	p-value	aOR	95% CI
Sex	Male	51 (91.1)	5 (8.9)	1			1		
	Female	19 (86.4)	3 (13.6)	0.54	0.621	0.135-2.854	0.081	0.097	0.007-1.330
Age (years)	< 30	38 (88.4)	5 (11.6)	1			1		
	> 30	32 (91.4)	3 (8.6)	0.659	1.404	0.311-6.332	0.666	0.566	0.042-7.530
Length of professional practice (years)	< 1	13 (68.4)	6 (31.6)	1			1		
	> 1	57 (96.6)	2 (3.4)	0.003*	13.154	2.379-72.722	0.075	34.772	0.703-1720.656
Length of practice in current facility (years)	< 1	26 (81.3)	6 (11.8)	1			1		
	> 1	44 (95.7)	2 (4.3)	0.057	5.077	0.954-27.027	0.915	1.218	0.033-45.248
Ever worked in a pediatric facility?	No	4 (50.0)	4 (50.0)	1			1		
	Yes	66 (94.3)	4 (5.7)	0.001*	16.5	2.971-91.634	0.019*	12.82	1.510-108.908
Category of prescriber	Non-physician	23 (88.5)	3 (11.5)	1			1		
	Physician	45 (90.0)	5 (10.0)	0.792	1.226	0.269-5.582	0.33	2.897	0.341-24.616

NB: cOR: Crude odd ratio; aOR: Adjusted odd ratio; *statistically significant.

Table 5: Association between characteristics of prescribers and ability to manage malaria in under 6 months children with appropriate drugs and dosage regimen.

Characteristics	Subgroups	Appropriateness of antimalarial prescribed (n = 70)				Appropriateness of dosage regimen of antimalarial prescribed (n = 56)			
		Yes (%)	No (%)	p-value	OR (95% CI)	Yes (%)	No (%)	p-value	OR (95% CI)
Sex	Male	40 (78.4)	11 (21.6)	1		11 (27.5)	29 (72.5)	1	
	Female	16 (84.2)	3 (15.8)	0.592	1.467 (0.361-5.96)	3 (18.8)	13 (81.3)	0.497	0.608 (0.145-2.554)
Age (years)	< 30	32 (84.2)	6 (15.8)	1		9 (28.1)	23 (71.9)	1	
	> 30	24 (75.0)	8 (25.0)	0.321	0.563 (0.172-1.837)	5 (20.8)	19 (79.2)	0.534	0.673 (0.193-2.349)
Length of professional practice (years)	< 1	12 (92.3)	1 (7.7)	1		3 (25.0)	9 (75.0)	1	
	> 1	44 (77.2)	13 (22.8)	0.245	0.282 (0.033-2.378)	11 (25.0)	33 (75.0)	1.0	1.0 (0.229-4.367)
Length of practice in current facility (years)	< 1	21 (80.8)	5 (19.2)	1		6 (28.6)	15 (71.4)	1	
	> 1	35 (79.5)	9 (20.5)	0.902	0.926 (0.273-3.136)	8 (22.9)	27 (77.1)	0.633	0.741 (0.216-2.540)
Ever worked in a pediatric facility?	No	4 (100.0)	0 (0.0)	1		1 (25.0)	3 (75.0)	1	
	Yes	52 (78.8)	14 (21.2)	0.999	0.0	13 (25.0)	39 (75.0)	1.0	1.0 (0.096-10.471)
Category of prescriber	Non-physician	16 (69.6)	7 (30.4)	1		4 (25.0)	12 (75.0)	1	
	Physician	40 (85.1)	7 (14.9)	0.134	2.5 (0.755-8.278)	10 (25.0)	30 (75.0)	1.0	1.0 (0.262-3.815)

There were no significant differences between prescribers who had longer period of practice or had worked longer in their facility from those who had worked or stayed in their current workplace for less than a year when they were to indicate the appropriate antimalarial drug for this special age group. Whether the prescriber is a physician or a non-physician or have worked in a pediatric facility or not, there was no difference in them stating the dosage regimen correctly although greater number of physicians were able to choose the most appropriate antimalarial drugs. Table 5 shows the association between socio-demographic characteristics of prescriber and their ability to indicate the appropriate medicines and dosage regimen for the management of malaria in a child less than 6-months-old.

Discussion

Malaria is quite a deadly disease for children under 5 years with even a low malaria parasite density of 1 to 500 parasites/µL easily progressing to death in a malaria-naïve infant [13]. It is therefore imperative that health professionals are able to adequately diagnose and treat malaria with the appropriate medicines and dosages in this special age group. To be able to provide quality service, it is important prescribers are knowledgeable about the disease and ways of managing it. Although up to 91% of prescribers in this study indicated there were fairly or very familiar with malaria in infants, they were not aware of the prevalence rate of malaria in under 6-months-old children in Ghana. According to Fisher, various studies across Africa found that between 7-10% of newborns may have malaria parasites in their cord blood [15]. In Ghana, Wagner, et al. reported malaria infection of 13.6% in newborns and 1.5-9.7% in those aged between 2 and 26 weeks [21]. With almost two-thirds of prescribers having no idea of prevalence rate of malaria in under 6 months children, and about a third diagnosing malaria based on signs and symptoms, most prescribers may possibly be over-diagnosing and inappropriately treating malaria in children less than 6 months. The use of signs and symptoms in diagnosing malaria may not be the most appropriate procedure but it is widely used by many prescribers. A study in Nigeria by Afolabi, et al. found that most clinicians in Nigeria treated persons presenting with fever with antimalarial drugs [13]. For three-fourth of prescribers to have treated malaria in children under 6 months within the previous 12 months when the prevalence rate according to Wagner, et al. to be less than twenty percent, implies the assumption of over prescription of antimalarial drugs in this special risk group is not far from being real [21]. In Uganda, more than half of children under 6 months with suspected malaria cases with fever, were given antimalarial drugs although no diagnostic tests were performed [19]. This study also had fever being the most common sign or symptom that increases the prescriber suspicion of malaria in an infant under 6 months. Length of professional practice and previous experience in a pediatric facility were the only factors that significantly increased the likelihood of a prescriber ever treating malaria in an under 6 months child by 13.2 and 16.5 times respectively. This is understandable since longer periods of practice and working in children section in a hospital invariably will increase the chance of a prescriber ever encountering various forms of diseases including malaria in children under 6 months. With other variables as confounders, the only predictor of a prescriber treating malaria in under 6 months was working or ever worked in a pediatric facility ($p = 0.019$; aOR = 12.8). In treating malaria, it is important that an appropriate antimalarial and dosage regimen must be prescribed and administered to ensure effective clearance of the parasites from the body and also prevent development of resistance to the antimalarial drugs by the malaria parasites. WHO recommended Artemisinin based combination therapies for treatment of malaria in highly endemic areas however, there is limited pharmacokinetic, pharmacodynamics and safety data on ACT in infants less than 5 kg [2,22]. WHO however recommends that infants weighing less than 5 kg with malaria should be treated with ACT at the same mg/kg body weight, target dose as for children weighing 5 kg [2]. It is commendable that about four-fifth of prescribers in this study treated malaria in under 6 months as recommended by WHO with Artesunate-amodiaquine (AA) being the foremost choice for the majority when treating uncomplicated malaria in this special risk group. Attakorah, also found AA to be the first drug of choice for 90.5% prescribers in Ghana's second biggest hospital, the Komfo Anokye Teaching Hospital when treating uncomplicated malaria in under 5 years children [23]. This high preference for AA over antimalarial drugs could be the reliance of prescribers on Ghana's Standard Treatment Guideline which has AA as the first line drug for the treatment of uncomplicated malaria in children weighing more than 4.5 kg and in adults [24]. Prescribers have therefore assumed AA as also the most appropriate drug for children less than 6 months or weighing less than 5 kg. For almost half of the prescribers in this study to list Ghana's Standard Treatment Guideline (STG) and about one-fifth indicating the British National Formulary (BNF) as their sources of information on treatment of malaria in children under 6 months is another area of interest. These reference books do not have guidelines on the treatment of malaria in this special risk group so the prescribers may have extrapolated their knowledge in treating malaria in indicated age or weight groups to the treatment of malaria in children under 6 months or under 5 kg. For more than four-fifth of prescribers in this study not able to accurately state the appropriate dosage regimen of the antimalarial drugs is worrisome and undermines the effective of the management of malaria in this special risk group. Although physicians were 2.5 times more likely to prescribe the appropriate antimalarial drug than non-physicians, the difference was not significant. None of the socio-demographic characteristics of the

respondents had any association with the ability of a prescriber to accurately prescribe antimalarial drugs for children less than 6 months. With most prescribers unable to indicate the appropriate dosage regimen for the treatment of malaria is children under 6 months or less than 5 kg, there is an urgent need for in-service training workshops for all categories of prescribers and other health workers on the correct management of malaria in early stages of human life since the earlier assumption that children under 6 months are immune against malaria had been proven not to be accurate. This study however had some limitations worth noting. Firstly, the study was carried out in Tamale, northern Ghana and therefore the results cannot be used to represent the level of malaria in under 6 months management skills of the entire population of prescribers in Ghana's health system. Secondly, the use of convenience sampling does not eliminate biases but considering the busy schedules of the prescribers, it was the most plausible method to apply. Finally, the questionnaires were not collected on the day of administration, so it is possible some may have referred to some sources to aid them with the answers which may not reflect the actual knowledge levels of respondents. Enclosing the questionnaires into envelopes however provided some assurance of confidentially and should have led to the provision of more sincere answers by the respondents.

Conclusion

In the management of malaria in this special risk group, majority of prescribers in Tamale, Ghana prescribed the WHO recommended ACT notably Artesunate-amodiaquine but there was a deficit in knowledge of prescribing the appropriate dosage regimen. With majority of the prescriber lacking knowledge on the prevalence rate of malaria in children under 6 month and diagnosis being mostly symptomatic by a third of prescribers, there is a possibility of over-prescription of antimalarial drugs. There is the need for more in-service-training workshops for all prescribers on malaria management in this special risk group to reduce mortality due to inappropriate treatment.

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All the authors listed contributed equally to the production of this manuscript.

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