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Original Paper

Malaria Infection Among Blood Donors in Onitsha Urban, Southeast Nigeria

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ABSTRACT

Blood safety is a major issue of global concern in transfusion medicine especially in developing countries, where national blood transfusion policies and services as well as financial resources are lacking or inadequate. Transfusion-transmitted malaria is a potential health hazard but is often neglected in many malarious areas. Malaria infection among blood donors in Onitsha urban, Southeast Nigeria was studied between August and October 2008. Venous blood of donors was screened for malaria parasites using Giemsa-stained thick and thin blood films. The ABO and Rhesus phenotypes were classified using a haemaglutination standard test and demographic data of donors documented. Of the 410 blood donors analysed, 304 (74.1%) were infected. *Plasmodium falciparium* was identified in all positive cases and mixed infection with *P. malariae* was seen in 5(1.6%) cases. Infection significantly varied with age and not with sex and occupation (p<0.05). People with blood group O^+ showed significantly higher rate of infection (p<0.05). Since there is scarcity of voluntary donors in Nigeria, donor deferral done in non-malarial endemic regions cannot be practiced in Nigeria. The high prevalence of asymptomatic malaria in this area, suggests the need for careful screening of blood samples for malaria parasites. Positive samples should be indicated on the blood packs and transfusion of malaria positive blood requires the administration of curative dose of antimalarials to the patient. Commercial donors should be freely given mosquito treated bed nets and be encouraged to sleep under them.

Keywords: Blood donors, Commercial donors, Nigeria, Transfusion-transmitted malaria

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INTRODUCTION

Malaria is one of the world's deadliest diseases that are placing more than half of the world's population at risk. In the vast majority of tropical and sub-tropical regions of the world, malaria remains the most complex and overwhelming health problem facing humanity, with 300 to 500 million cases and 2 to 3 million deaths per year (World Health Organisation, 2010). About 90% of all malaria deaths in the world today occur in Africa south of the Sahara. The majority of infections in the region are caused by *Plasmodium falciparium*, the most dangerous of the five human malaria parasites (Bronner *et al*., 2009; van Hellemond *et al*., 2009; Daneshvar *et al*., 2010). The most effective malaria vector - the mosquito *Anopheles gambiae* and the most difficult to control is also widespread in this region (World Health Organisation, 2003). This has serious implication as it leads to loss of man hours and decrease in national productivity.

Transfusion therapy is a form of treatment based on the use of blood and its product on human. Although this therapy helps to save lives, blood can nonetheless be a vehicle for transmission of infections including parasitic diseases. Among them is a malaria fever, caused by *Plasmodium* species (Okocha *et al.*, 2005). The malaria parasite is intraerythrocytic, hence can be transmitted by transfusion of any blood component containing infected cells. Transfusion Transmitted Malaria (TTM), compared to natural infection often has a short incubation period because there is no pre-erythrocytic development and depends on the species of parasite introduced which varies from 10 days in *P. falciparium* to 40 days or longer in *P.*

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malariae (Bruce-Chwatt, 1974; Mohareb, 1995). Malaria parasites of all species can remain viable in stored blood for at least one week and can even survive longer in frozen blood (Kark, 1982). For instance, *P. falciparium* has been transmitted through blood stored for 19 days (Desilva *et al.*, 1988).

The World Health Organisation and the International Society of Blood Transfusion encourage voluntary donation of blood in all circumstances. Unfortunately, there is scarcity of voluntary donors in Nigeria while commercial donors abound (WHO, 1984). Such commercial donors are poor low income groups and whose motive for blood donation is purely financial. Under the current policy in the United States of America, individuals who have had malaria are deferred for three years after becoming asymptomatic. Travelers from non – endemic countries with no previous history of malaria are deferred for one year period, after departing from endemic areas. Prior residents of malaria endemic countries are deferred for a three-year period after each departure from an endemic country (FDA, 2006). In Nigeria, screening for malaria parasite is neither routinely done in blood banks, nor stipulated in the current National Blood Transfusion Guidelines. This is because transmission of malaria through blood transfusion is generally not regarded as a serious problem in adult and adolescent whose level of immunity is thought to be sufficiently effective in combating post transfusion malaria in an endemic area like Nigeria (Federal Ministry of Health Nigeria, 1991; Attah, 2000]. In Nigeria , as in other tropical developing countries, the high level of occurrence of blood-demanding health conditions due to increase in road traffic accidents, pregnancy-related haemorrhage, armed robbery attacks, and violent events, amplify the possibility of the transmission of blood-borne diseases (Uneke *et al.*, 2006).

The long standing concern about transfusion-transmitted hepatitis and Human Immunodeficiency Virus (HIV) infection has overshadowed the fact that other diseases, particularly malaria could be spread by transfusion of blood components (Kaur and Basu, 2005). Blood safety, therefore, remains an issue of major concern in transfusion medicine in developing countries, where national blood transfusion policies and services, appropriate infrastructure, trained personnel and financial resources are lacking or inadequate. It is against this background that this study aims to determine the prevalence of malaria parasitaemia among blood donors, in Onitsha urban, Anambra State of Eastern Nigeria, a holoendemic area. This is with the view of determining the possible risk of transmission of malaria parasites to recipients of donated bloods, and to providing scientific evidence required for the formulation of effective blood-donation policy in resource-constrained settings in the tropics.

MATERIALS AND METHODS

Study Area

The study was carried out in three government approved medical laboratories with blood banks in Onitsha urban. Onitsha is located in Onitsha South Local Government Area, within latitude 6^0 05/ N and longitude 7^0 05/ E. The climate is tropical with an average yearly rainfall of 2000mm, a mean air temperature of 27.6^{0}C and an annual relative humidity of 75%. Onitsha is located along the banks of River Niger, from which the name Nigeria was coined and it is a vast city with the largest market (Onitsha Main Market) in West Africa. Majority of the inhabitants of the city are traders. Some parts of the city like Okpoko, can be described as slums. Overcrowding and unsanitary conditions in some parts of Onitsha urban have led to all season breeding of Anopheline mosquitoes like *Anopheles gambiae*, *A. funestus, A. nili* and *A. pharoensis*.

Consent

Informed consent was obtained from the directors of the medical laboratories where the study was conducted. All donors presenting at the laboratories for blood donation were verbally notified about the study prior to sample collection and they readily gave their consent. The blood samples used for this study were taken from the donated blood.

Study Population, Techniques and Analysis

The study was carried out between August and October, 2008. The three prominent medical laboratories chosen for the study were Gem Medical Laboratory, SDO Medical Laboratory and Resurrection Medical Laboratory. The choice of the three laboratories was because most blood donors patronise them and hospitals refer patients to buy blood from these laboratories. The subjects were apparently healthy individuals who did not show any common signs of malaria, such as fever either in the cold or sweating stage, headache and physically detected anaemia, shivering, pain at body joints, weakness and vomiting. The donors were also

screened for HIV-1 and Hepatitis B virus and confirmed negative for these infection. Thus, every person who came to donate blood and was confirmed fit was involved in the study. The blood samples were collected daily throughout the study period. The blood donors included, 364 commercial (were paid by the medical laboratories for donating blood), 29 relation (were those that donated blood for sick people who are related to them) and 17 volunteer donors (donated blood voluntarily). Both relation and volunteer donors do not receive any form of financial reward.

Venous blood containing ethylenediamine tetra acetic acid (EDTA) routinely collected for haematological analysis was used. To ensure anonymity of the donors, numbers, not names were used. Giemsa-stained thick and thin blood films were performed within an hour of blood collection, to identify individuals infected with the malaria parasite as previously described by (Cheesbrough, 1998). Parasite count was determined using the plus system (WHO, 2002). Parasitological analysis was confirmed by independent experienced microscopists who were unaware of each result according to the World Health Organisation recommended procedures. The ABO/Rhesus phenotypes were performed for all subjects using the slide method (Ibhanesebho *et al.*, 1996), with commercially available reagents (Murex. Inc. Dartford. UK).

Data on age, gender, haemoglobin (Hb) level and occupation of each donor were also documented during blood collection. Minitab for windows 11 was used for data storage and statistical analyses. Proportions and categorical data were compared by the Chi-square test. The adopted significance level for statistical inference was $p< 0.05$.

RESULTS

The mean age of the donors was 31.45 ± 8.65years, while their mean Hb was 14.4 ± 5.81g/dl. Majority of the donors 364(88.8%) were males while 46(11.2%) were females. Among these were 364(88.8%) commercial, 17(4.1%) volunteer and 29(7.1%) relation blood donors. Of the 410 blood donors, 304(74.1%) were infected with malaria parasite. Among the infected individuals, 176 (57.9%) had 1-10 parasites per 100 thick film fields ('+' or 1-40 parasites per mm^3), while 128 (42.1%) had 11-100 parasites per 100 thick film fields ('++' or 41-400 parasites per mm^3). *Plasmodium falciparium* was identified in all the infected cases, but mixed infections with *P. malariae* were also identified in 5(1.6%) of cases. Infection rates of 77.5%, 48.3% and 47.1% were recorded among commercial, relation and volunteer blood donors respectively. This difference was however not statistically significance ($\chi^2_{cal} = 3.27$, $\chi^2_{tab} = 5.99$, $df =2$, $p> 0.05$). Among the 364 male donors, 274 (75.3%) were infected while among the 46 female donors 30(65.2%) were infected.

Table 1: Malaria Parasitaemia with respect to Age and Sex among Blood Donors in Onitsha, Southeastern, Nigeria

Age Groups (Years)	Males		Females		Total	
	Number Examined	Number Infected/(%)	Number Examined	Number Infected/(%)	Number Examined	Number Infected/(%)
20-24	27	19(70.4)	2	1(50.0)	29	20(69.0)
25-29	139	117(84.2)	25	18(72.0)	164	135(82.3)
30-34	103	81(78.6)	12	8(66.7)	115	89(77.4)
35-39	44	33(72.7)	4	2(50.0)	48	35(72.9)
40-44	34	22(64.7)	3	1(33.3)	37	23(62.2)
45-49	13	2(15.4)	-	-	13	2(15.4)
50-59	4	0(0)	-	-	4	0(0.0)
Total	364	274(75.3)	46	30(65.2)	410	304(74.1)

The age group 25-29 years recorded the highest infection rate of 82.3% after which the infection decreased with age. No female donated blood in the age group 45-49 and 50-54years while no infection was observed in the age group 50- 54years for males (Table 1). A difference in age (χ^2_{cal} = 44.27, χ^2_{tab} = 12.59, *df* =6, $p< 0.05$) but not with sex (χ^2_{cal} = 2.09, χ^2_{tab} = 3.84, *df* =1, $p>0.05$) was shown statistically.

Table 2: Malaria Infection in Relation to Blood Groups and Rhesus Factors among Blood Donors in Onitsha, Southeastern, Nigeria

Blood group and Rhesus factor	No. examined	No. infected	Percentage infected
O^+	226	213	80.1
O^-	46	28	60.9
A^+	52	33	63.5
B^+	43	28	65.1
B^-	3	2	66.7

Table 3: Malaria Infection in Relation to Occupation of Blood Donors in Onitsha, Southeastern, Nigeria

Occupation	No. Examined	No. Infected	% Infected
Motor Park touts	117	90	76.9
Traders	63	50	79.4
Students	27	19	70.4
Bus conductors	34	25	73.5
Medical Lab. Scientists	11	8	72.7
Medical doctors	13	8	76.5
Commercial motorcycle riders	25	18	72.0
Commercial motor drivers	25	17	68.0
Apprentices	60	46	76.7
Painters	15	10	66.7
Mechanics	20	13	65.0

Blood group O^+ was the dominant blood type followed by A^+, O^-, B^+ and B^- in this order (Table 2). No AB blood group was recorded. Of the 266 (O^+), 46(O^-), 52(A^+), 43(B^+) and 3(B^-) individuals blood samples examined, infection rates of 80.1%, 60.9%, 63.5%, 65.1% and 66.7% were recorded respectively. The difference among blood group, with majority of O^+ individuals (80.1%) infected was significant (χ^2_{cal} = 13.99, χ^2_{tab} = 9.48, *df* =4, $p< 0.05$). Excluding O^+ (the very high infected donors) the difference in infection in other observed blood groups (A^+, O^-, B^+ and B^-) was not significant (χ^2_{cal} = 1.07, χ^2_{tab} = 7.815, *df* =3, $p> 0.05$).

Infection was also recorded according to occupation (Table 3). Highest infection rate was seen among traders. However, infection rate seen among the different occupational groups was not significant (χ^2_{cal} = 4.68, χ^2_{tab} = 9.48, *df* =4, $p> 0.05$).

DISCUSSION

The high rate of positivity for malaria parasites in the blood of donors in this study is alarming. This strongly suggests a serious risk of transfusion-transmitted malaria in the south-eastern Nigeria. Other similar studies in Nigeria with high malaria prevalence among blood donors abound (Ibhanesebho *et al.,* 1996; Okocha *et al.,* 2005; Uneke *et al.,* 2006). In Onitsha, climate and vegetation are consistent with tropical rainforest. Tthe seasonal rainfall is higher and longer which gives rise to much surface water to support the breeding of vectors. The recorded high rate may be due to this. The period of study which is the rainy season also may have contributed to the high infection rate. High rate of malaria transmission during rainy season has been reported (Uneke *et al.,* 2006). The number of parasites recorded in thick films (+, ++) does not indicate severe infection but then preservation of blood at 4^{o}C does not destroy the parasites and one to two parasites per micro-litre of blood which are undetected on thick or thin blood films are sufficient to transmit the illness (Umeanaeto *et al.,* 2006). This is a major challenge to the problem of clinical and transfusion services all over the world.

Majority of blood donors who are mostly males are commercial donors and they fall within the age range of 25-29 years. Transfusion malaria was described as particularly common in countries where blood donation has become a commercial transaction and where the blood donors come from less affluent social classes (Bruce-Chwatt, 1982; Adewuji, 2001). This feature is recorded in this study, as 88.8% of blood donors donated for money. This has become a dominant trait in the sub-Saharan Africa including Nigeria, where majority of blood donors (commercial donors) are low income earners and live in places where vector transmission of malaria is high. The reason for the low number of female blood donors could be because females are culturally inhibited as far as commercial blood donation is concerned. Additionally, physiological changes such as menstruation, pregnancy, lactation and iron deficiency anaemia often hinder women from donating blood.

Nevertheless, only persons who were confirmed fit were involved in the study (see study population under materials and methods). Although the differences in infection among some blood groups was not significant, findings also showed that people with blood group O^+ are significantly susceptible to malaria infection. Some reports however vary with this (Facer and Brown, 1979; Martin *et al.,* 1979; Montoya *et al*., 1994). A suggestion to researchers in this field is therefore made. However, the high infection rates observed among all blood groups and their rhesus factor suggest that they are all susceptible to malaria. In fact, there is evidence that the ABO histo-blood group is not correlated to the incidence of malaria (Fisher and Boone, 1998), but it has been linked as a co-receptor in parasite and vascular cytoadherence, with higher rosette rates among non-group O compared to group O erythrocytes (Cserti and Dzik , 2007).

All occupational groups are also susceptible to malaria infection whether educated or not, as there was no significant difference recorded among them in this work. This shows that the disease is actually endemic and is a problem in this area. Asymptomatic carriers are generally the source of transfusion-transmitted malaria. Since apparently healthy individuals are selected for blood donation, density of parasites is usually very low, and may be easily missed (Kaur and Basu, 2005). In Sub-Saharan Africa where malaria is hyper-endemic (Uneke *et al.,* 2006), this can pose a serious health hazard to blood recipients.

In as much as blood transfusion is required in severe anaemia due to malaria and other illnesses, safe blood transfusion should be guaranteed. This is because post-transfusional malaria may not only compound the already deplorable health condition of the recipients, but may also be fatal (Kitchen and Chiodini, 2006). Thus the need for effective donor selection guidelines cannot be overstated. In USA, approximately 150,000 donors are differed each year due to a perceived risk of malaria exposure. Contrarily, in Nigeria, especially south eastern Nigeria, such may not be feasible because almost every donor may be excluded due to malaria endemicity in the area. Due to paucity of blood donors in Nigeria, donor deferral cannot also be practiced. Commercial donors predominate in Nigeria and screening for malaria parasites is neither routinely done in Nigerian blood bank nor stipulated in the current National Blood Transfusion Guidelines (Federal Ministry of Health, 1991; Umeanaeto *et al*., 2006). This may be because transmission of malaria through blood transfusion is generally not regarded as a serious problem as the area is holoendemic for malaria.

It is therefore recommended that all blood pints be screened very carefully for malaria parasites and blood packs marked negative or positive as the case may be. In case a patient is transfused with a malaria positive blood, the patient can be given a curative regimen of antimalarials, especially when the patient falls into the malaria vulnerable group (children, pregnant women, immigrants from outside malarious regions). Since most commercial donors are from low income groups, they should be freely given long lasting insecticide treated bed nets and fabrics (door and window blinds). They should be educated to use them appropriately and regularly.

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