Original article

# Screening blood donors for malaria parasite in Sudan

Mohamed Siddig M. Ali[1], A.AI Gader M. Yousif Kadaru[2], Mustafa Salih Mustafa[3]

**Abstract**

**Background**: In countries where malaria is endemic, its transmission is a hazard of blood transfusion and could lead to serious if not fatal complications. To assess the likely importance of transfusion induced malaria in Sudan; a descriptive cross sectional facility based study was carried out.

**Material and Methods**: A total number of 1564 blood donors were screened for malaria parasite by thick and thin blood film using Geimsa' staining technique. All the 397 transfused patients who received the donors' blood during the study period were investigated for malaria before transfusion by the same technique, followed up for four days after transfusion and reinvestigated, if any signs of malaria were present.

**Results**: Results showed that the prevalence of infected donors was 6.5%, the majority of them were between 20 and 40 years old; the required age for donation. The recognized species were predominantly (98.1%) *Plasmodium falciparum* and secondly *Plasmodium vivax* (1.9%). Mainly ring (50.5%) and trophozoite (40.2%) stages were detected, and most of the positive blood films (96.9%) showed densities less than 1000 parasites/µl.

Post transfusion malaria (PTM) was observed in 2.9% of the single transfused and in 4.9% of the multiple transfused patients.

**Conclusion**: It was concluded that the infectivity of asymptomatic donors is considerable. Moreover, the exclusion of this percentage minimizes the risk of transfusion-induced malaria and does not affect donation flow. [*Ethiop.J.Health Dev.* 2004;18(2)70-74]

## Introduction

Blood transfusion is necessary to correct severe anemia, deficiency of plasma clotting factors (1), thrombocytopenia, immunodeficiency states and hypoalbuminaemia (2). However, it accounts for a rather formidable list of illnesses including protozoan, spirochaetal, bacterial and viral diseases in addition to the existence of immunological and toxic effect (3).

Malaria can be transmitted by inoculation of blood from infected donor to patient (4). In certain geographical locations (endemic areas), transmission of malaria by blood transfusion poses a real threat (5). However, in non-endemic areas transmission of malaria by blood transfusion is an uncommon complication of blood transfusion, but because of the delay in diagnosis, it may have a relatively high fatality rate particularly in pregnant women, splenectomized and immuno-compromised patients (6).

Worldwide, different strains of malaria species viz *Plasmodium falciparum, Plasmodium vivax, Plasomdium malriae* and *Plasomdium ovale* are responsible for transfusion-transmitted disease for the capability of plasmodia to survive well in stored blood and even in frozen blood (2).

Manson reported that *P. falciparum* was present in the blood of donors who were exposed to malaria 20 months to three years previously (7). *Plasmodium vivax* has been transmitted by transfusion from donors infected four years previously and *P. malariae* from donors infected 17 years earlier (8). Moreover, McClure and Lam (1945) reported that quartan malaria (*P. malariae*) has been accidentally transmitted in blood previously stored for 5 days (9) and in another case reported by Black (1960), a donor had carried *P. malariae* parasites for 19 years (10).

Screening blood donors for malaria (as recommended by the WHO) is currently not included in the protocols of Sudanese Blood Banks. This risk is worsened by the facts that absence of symptoms even for a long period does not necessarily ensure lack of infectivity and malaria parasites survive well in stored blood.

Further, this route of infection transmits large amounts of parasites whereas most patients in need of blood transfusion are already weakened by severe disease. Malaria thus behaves very aggressively in such patients with a higher risk of complications and fatalities.

As yet, no study has been carried out to determine the size of this problem in Sudan and the authorities do not have sufficient data to allow them to make a firm decision as to whether screening donors is needed or not. Hence, aims of this study were to:

- Measure the prevalence of malaria parasite among blood donors.
- Find out the prevalence of infected donors during the various seasons of the year.
- Measure the incidence of the disease 4 days post transfusion on single (*when one or two pints injected*) and multiple (*when more than two pints injected*) patients transfused with screened blood.

[1]AI Neelain University, Khartoum, Sudan; [2]University of Khartoum, Khartoum, Sudan; [3]Federal Ministry of Health, Khartoum, Sudan

**Material and Methods**

The study design is a descriptive cross-sectional facility based study. This study was conducted in Ahmed Gasim hospital (Khartoum, Sudan) for a total duration of one year (June 2000 to May 2001).

All those who attended to donate blood and patients without recent history of malaria who received blood from those donors during the study period were recruited for the study. All of them were screened for malaria parasite microscopically before transfusion by Giemsa staining technique. Malaria parasite infected donors were excluded as well as patients with positive blood films before transfusion. Although this research attempts to study the effect of blood transfusion malaria, infected donors' blood (diagnosed by microscopy) was not allowed to be transfused for ethical considerations. However, in exceptional cases presenting with a top emergency, malaria parasite negative blood was not available. Therefore, fresh infected blood was transfused to save these patients' lives.

Blood samples collection, preparation, staining technique, and microscopic identification of *Plasmodium* species were performed as per standard methods (11). The absolute number of parasites (number/µl), was estimated in the thick blood films by counting the parasites against 200 white blood cells according to the following formula:

$$\frac{\text{(No. of parasites "Asexual stage" counted) x (total white blood cells count)}}{\text{No. of leukocytes counted (200)}}$$

Data were analyzed by the computer using the *Statistical Package for Social Sciences* (SPSS) and *Epi-info. Chi-square, Fisher's exact* test and Correlation Coefficient were used for comparison and correlation between proportions. Descriptive statistic was used to summarize the data.

**Results**

The total number of the screened donors who attended to donate blood was 1564 donors, and blood of only 1354 donors was transfused. The other 210 donors were rejected for different reasons such as Hepatitis B (n=91) and HIV viruses (n=31) and malaria parasites (n=88). Concerning the age distribution of the donors, 145 donors (10.7%) were less than 20 years, 1150 (84.9%) between 20 to 40 years, and 59 (4.4%) were more than 40 years. The majority of them, 1065 (78.6%) came from Khartoum State while the other 289 (21.4%) from various states. Most of the donors (98.3%) were males and 71.4% were single.

Altogether, 397 patients who matched the study inclusion criteria received a total of 1354 pints. The diagnosis was anemia in 184 (46.3%), fevers other than malaria in 35 (8.8%), septicemia in 23 (5.8%) and bleeding tendency in 38 (9.6%) patients. Moreover, 83 (20%) of the patients were subjected to open-heart surgery while 34 (8.5%) were subjected to closed heart surgery. Records of the age distribution of the patients showed that 79 (20%) patients were under one year, 98 (24%) under 5 years, 108 (27.2%) between 5 to 14 years and 112 (28.2%) were over 14 years.

Out of 1564 donors who were examined microscopically, only 102 donors (6.5%) showed positive blood films containing asexual stages (ring and trophozoite stage). The monthly distribution of malaria parasite infected donors is shown in figure 1. The higher percentage recognized in June (11.7%) and July while the lower percentage was detected in December (4.0%).

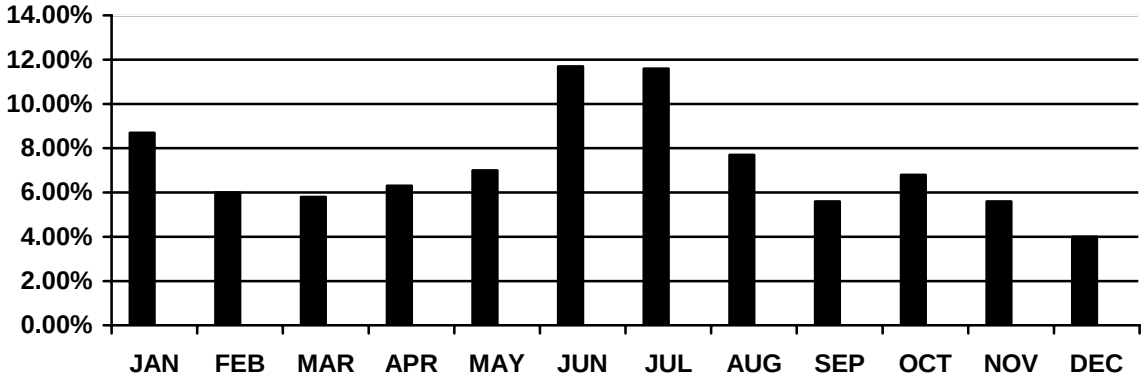


Figure 1: **Monthly Distribution of the Positive Blood Films' Percentage among blood donors during the study period**

The ring stage occurred commonly (57-90%) from April to September followed by trophozoite stage that was recognized abundantly (85-100%) between November and February. The detected species were predominantly *P. falciparum* (98.1%) but only 2 blood films (1.9%) showed *P. vivax* parasite. No other species were detected.

Out of 102 positive blood films, the parasitaemia of only 97 of them was determined; the other five blood films showed very low (uncountable) number of parasites. Figure 2 illustrates that parasitaemia less than 100-parasites/ µl occurred only from January to February and less than 500

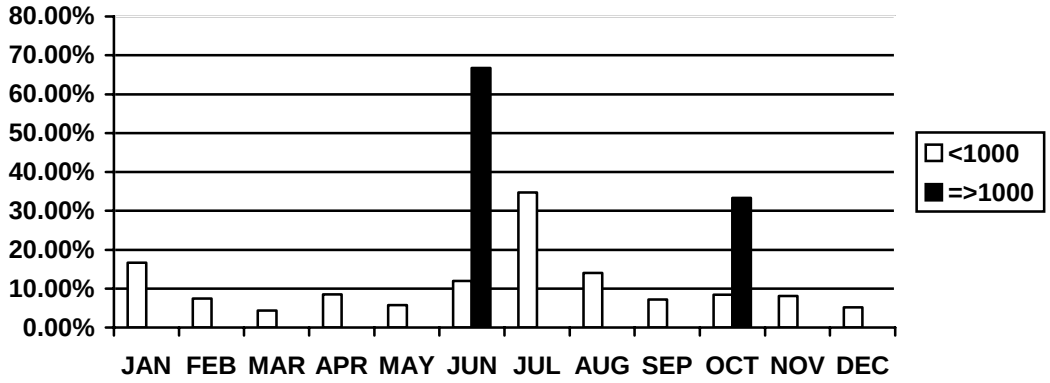


Figure 2: **Distribution of parasite densities of the donors' blood films through months between June 2000 and May 2001**

Parasite/µl between November and March, while parasitaemia more than 1000 parasites /µl was observed in June and October. Fifty-four (55.7%) blood films showed less than 100 parasites /µl; 88 blood films (90.7%) showed less than 500 parasites /µl 6 blood films (6.2%) showed between 500 and 1000 parasite/ µl and only 3 blood films (3.1%) showed more than 1000 parasites / µl. Most of the donors (93.6%) aged 20-40 years had densities of parasites more than 1000 parasites / µl and all donors less than 20 years old and more than 40 years old showed less than 1000 parasites /µl. All females' blood samples showed a parasitaemia less than 100 parasites/ µl.

Parasite stages detected were rings, trophozoites and gametocytes. The ring stage had the greatest percentage (51%), trophozoite (40.6%), combination of rings and trophozoites was observed in 5 (5.2%) donors and that of trophozoites and gametocytes was detected in 3.1% of total blood films.

Blood films containing sexual gametocyte stages only were considered negative; because gamethocytes are not responsible for transfusion-induced malaria.

Table 1 shows the correlation between parasite stages and densities which was found to be significant (p-value=0.001) as the majority of trophozoites (84.6%) counted less than 100 parasites/ µl whereas, 67.3% of ring stages counted more than 100 parasites/ µl.

As shown in table 2, the number of transfused patients who developed malaria within 4 days post transfusion was 14 (3.52%) of the total screened transfused patients. Post transfusion malaria was observed in eight single transfused patients (2.9% of the total single transfused patients) and all of them were transfused with known infected blood. No PTM developed in single transfused patients when no infected blood was injected. Post transfusion malaria was also observed in 6 multiple transfused patients (4.9% of the multiple transfused patients) four of them were transfused with infected blood. There were two multiple transfused patients (1.6% of the total multiple transfused patients) who developed PTM although no parasite was detected in patients' or donors' blood films.

Table 1: **Correlation between parasite densities and parasite stages**

| | Stages | | | | |
|---|---|---|---|---|---|
| Density | Troph | Ring | R&T | R&G | Total |
| <100 count | 33 | 16 | 2 | 2 | 53 (55.2) |
| 100-500 count | 6 | 25 | 2 | 1 | 34 35.4) |
| 501-1000 count | 0 | 6 | 0 | 0 | 6 (6.3) |
| >1000 count | 0 | 2 | 1 | 0 | 3 (3.1) |
| Total count | 39 | 49 | 5 | 3 | 96 (100) |

Corrected chi-square value=30.49 df=9 Asympt. Sig. (2-tailed) 0.001

Missing = 1 R = Ring T = Trophozoite G = Gametocyte

Table 2: **Transfusion – induced malaria in single and multiple transfused patients**

| | Post transfusion malaria | | |
|---|---|---|---|
| | Present | Absent | Total |
| Single transfused patients | 8 (2.9) | 267 | 275 |
| Multiple transfused patients | 6 (4.9) | 116 | 122 |
| | 14 (3.5) | 383 | 397 |

Table 3: **Post transfusion malaria in patients receiving malaria parasite infected and non-infected blood**

| | Post transfusion malaria | | Total |
|---|---|---|---|
| | Present | Absent | |
| Patients received non infected blood | 02 | 340 | 385 |
| Patients received infected blood | 12 | 12 | 12 |
| Total | 14 | 352 | 397 |

Table 3 showed that post transfusion malaria occurred in two (0.52%) of transfused patients who received screened non-infected blood, while it was observed in 12 (100%) transfused patients who received known infected blood. All patients who (100%) received infected blood "blood film with asexual stage" did develop PTM whereas, only 0.52% of the patients developed PTM when transfused with malaria negative screened blood.

Correlation between patients' age and developing malaria post transfusion is insignificant; Pearson correlation: -0.05, 4: 0.3. However, no correlation was recognized between donors' age and post transfusion malaria; Pearson correlation: 0.02, 4: 0.690. Post transfusion malaria cases (PTM) constituted 31.3% of the fever cases (45) that occurred post transfusion. Post transfusion malaria was found to be highly significant ($P< 0.01$ levels of 2-tailed tests when matched with the number of infected donors for the same patient ($P < 0.001$) and when matched with donors' sex and stages of the parasite ($P < 0.05$, 2 tailed). No association was detected between PTM and diagnosis of the patients.

**Discussion**

The health problems posed by transmission of malaria through blood transfusion are immense and are expected to remain a menace, specially, if the screening of the donors' blood for malaria before donation is not initiated.

The prevalence of infected donors (6.5%) seems to be considerable. The exclusion of this portion does not impede donation flow. Moreover, it is very valuable because there were single transfused patients prevented from transfusion malaria by the rejection of 18 (1.1%) infected donors who attended to donate for those 16 patients. On the other hand, there were 43 multiple transfused patients prevented by avoidance of injection of 70 (4.5%) asexual stage infected donors.

The above 88 infected donors who were excluded might have infected 59 very ill patients recruited for this study, regarding that some patients receive more than one pint. If those blood donors were not screened for malaria before donation, the total number of post transfusion malaria cases might have increased to 73 cases instead of 14 cases as all patients who received infected blood in this study (12) developed malaria. Therefore ignoring the screening of blood donors for malaria before donation will lead to serious, if not fatal, complications.

Post transfusion malaria cases constituted 31.3% of the total number of post transfusion fever cases. If infected donors' blood was not injected, post transfusion malaria cases might have constituted only 4.4% of the post transfusion fever cases. These findings when compared with findings of study carried out in Nigeria by Ajao (1978) who found a rate of 48.4% (2) are still very low.

There is a good correlation between the positive blood films percentage and the results of malaria prevalence surveys, which were carried out by the Ministry of Health in Khartoum State during the different seasons every year. In these surveys, asymptomatic individuals were screened for malaria using microscopic identification techniques.

The results of these surveys showed that 55 of asymptomatic individuals had positive blood films in the year 2000 (Ministry of Health – statistical records) compared with 6.5% obtained in the present study. There were similar findings regarding the identified Plasmodium species (predominantly *P. falciparum*) in both studies. However, a big variation in positivity in different seasons and varying geographical distribution is observed.

In the present context, the prevalence of infected donors with *P. falciparum w*as 639%. This finding is almost similar to the finding of a study conducted in Nigeria by Chichwen et al. in 1978 who detected *P. falciparum* in 4.1% of asymptomatic donors (8). However, the prevalence of infected donors in this in this study was much lower than that obtained by Guiguemide et. al. (1992) in Burkina Faso where 14% of donors were found to be infected with *P. falciparum.* Moreover, it is also much lower than obtained by Thi and others in 1991 who studied the prevalence of infected donors in Vietnam and

found that over 43% of asymptomatic individuals were positive for *P. falciparum*(12).

The positivity of infected donors in the present study (6.5%), was directly proportional to the number of malaria cases was visited the outpatients' clinic (r=0.7) and the number of malaria cases in casualty patients in Ahmed Gasim Hospital (r=0.6). Also, it was directly proportional to the number of blood films reported to be positive at surrounding peripheral hospital laboratories (r=0.56). It can be explained that the difference in the positivity of infected donors obtained by different studies is due to the variation in environmental conditions prevailing in each area of Sudan. This is because it was found that the prevalence is directly correlated with the density of the flying anopheles in Khartoum State (r=0.68). The present study showed that most (84.9%) of the positive blood films and the highest densities of parasites were recorded from donors in the age range 20-40 years (the preferable donation age). This is in agreement with the study done in Burkina Faso by Guiguemide and others in 1992 who found the higher densities and higher infectivity of malaria parasites in donors under 35 years old (13).

However, this correlation is not significant (P = 0.2), it implies no significant association between donors' infectivity and age. The low densities observed from November to March were significantly associated with trophozoite prevalence. Density increased as ring stages increases and gradually rise up till they reach a peak in July. Simultaneously, trophozoite density decreased gradually as ring stages increased. This exchange may indicate low multiplication traffics of the parasite *invivo* in asymptomatic individuals. This is a significant finding with a P-value < 0.01.

The microscopic identification technique of malaria is the ideal technique that can be applied at the present time till feasibility application of applying an advanced technique is available. The establishment of malaria diagnosis unit in each blood bank is not difficult and blood bankers can perform the tests after being well trained.

**Conclusion**

The prevalence of infected donors is considerable and this necessitates the screening of donors for malaria prior to donation. This procedure will undoubtedly reduce transfusion-induced malaria and does not impede donation flow. The hazard of transmitting malaria through blood transfusion is much greater than the cost of testing donors' blood even if an expensive technique is used. The microscopy of malaria can be easily introduced in each blood bank of the different regions of Sudan.

**Recommendation**

1. Screening blood donors for malaria is mandatory. Infected donors should be treated before being accepted for donation.
2. Blood bank technicians should be properly trained and microscopic examination units should be established in each blood bank.
3. Since this process only minimizes the risk of transfusion induced malaria, further studies are recommended for absolute eradication of this problem.

**Acknowledgement**

I wish to express my sincere gratitude and thanks to Prof. AL Fadhil O. Omer, Dr. Musa M. Khier, Miss Nawal Taj Elsir, and Miss Mona Abbas Babiker for invaluable help.

**References**

1. Kitchen AD, Elnageh M. Transmissible non-Viral Agents. Transfusion Microbiology practices. WHO Regional publications, 1997;16.
2. Talib VH, Khuana SK. Haematology for Students. 1996, 1st ed: 415.
3. Oluwole G. Ajao. Malaria and Postoperative Fever. J Trop Med Hyg. 1978;8:81.
4. Bruece-Chwatt, LJ. A longitudinal Survey of Natural Malaria Infection in a Group of African Adults. West African Med J 1963;12:199-206.
5. Dover AS, Schultz MG. Transfusion Induced Malaria. Transfusion. 1971;11:353-57.
6. Nabarro D, Edward DG. Accidental Transmission of Malaria to Child by Injection of Blood. Lancet. 1940;II:556.
7. Manson Bahr PCC, Bell DR. Manson's Tropical Diseases 1987;19th Edition.
8. Chikwen JO, Mohamed I, Okara GC. Prevalence of transmissible blood infection among blood Donors at the University of Maiduguri Teaching Hospital, Nigeria. E Afr Med J. 1997;24(4):213-6.
9. McMlure RD, Lam CR. Malaria from Bank Blood Transfusion. Surg Ovn Obs. 1993;42;309.
10. Button EL, Shute PG. The Risk of Transmitting Malaria by Blood Transfusion. J Trop Med Hyg. 1993;42:309.
11. Cheesbrough Monica. Medical Laboratory Manual for Tropical Countries. 1987,2nd ed. 602.
12. VU THI Hang, Tran Van Be Phan Ngoc Tran, et al. Screening Donor's Blood for Malaria by PCR. Trans Roy Soc Hyg, 1995;89:44-49.
13. Guiguemide TR, Sanou MA, Ouedraogo JB, Coulibaly N, Gbary AR, Coulibaly SO. Malaria and Transfusion. Version Francaise, 1992;2:9.