Sero-epidemiology of transfusion-transmissible infectious diseases among blood donors in Osogbo, south-west Nigeria

Fiekumo Igbida Buseri[1], Musa Abidemi Muhibi[2], Zaccheaus Awortu Jeremiah[1]

[1] *Department of Medical Laboratory Science, Niger Delta University, Wilberforce Island, Bayelsa State*
[2] *Ladoke Akintola University of Technology Teaching Hospital, Osogbo, Nigeria*

Background: Transfusion-transmissible infectious agents such as hepatitis B virus (HBV), human immunodeficiency virus (HIV), hepatitis C virus (HCV) and syphilis are among the greatest threats to blood safety for transfusion recipients and pose a serious public health problem. This cross-sectional study was undertaken with the aim of determining the seroprevalence of HIV, HCV, hepatitis B surface antigen (HBsAg) and syphilis and correlates the findings with sex and age to ascertain the associations, if any, in the occurrence of the pathogens.

Materials and Methods: HBsAg, antibodies to *Treponema pallidum* and HCV were determined using Clinotech test strips. Antibodies to HIV types 1 and 2 were screened with Determine and Immunocomb. All the reactive samples were confirmed using enzyme-linked immunosorbent assays. Antibodies to *Treponema pallidum* were confirmed with a *Treponema pallidum* haemagglutination test.

Results: A total of 1,410 apparently healthy prospective blood donors aged between 18 and 64 years (mean±SD, 32.58 ± 10.24 years) who presented for blood donation at the Ladoke Akintola University of Technology Teaching Hospital Blood Bank, Osogbo were studied. The male:female ratio was 6:1. Of the prospective blood donors, 406 (28.8%) had serological evidence of infection with at least one infectious marker and 36 (2.6%) had dual infections. The overall seroprevalence of HBsAg, HIV, HCV and syphilis was found to be 18.6%, 3.1%, 6.0% and 1.1%, respectively. The highest prevalences of HBsAg, HIV, HCV and syphilis infections occurred among commercial blood donors and those aged 18 to 47 years old, the most sexually active age group. There were no significant associations between pathogens except for syphilis and HIV ($p > 0.001$).

Conclusion: The high seroprevalence of blood-borne pathogens among prospective blood donors in Osogbo, Nigeria calls for mandatory routine screening of blood donors for HBV, HIV, HCV and syphilis.

Key words: Transfusion-transmissible disease markers, prevalence, blood donors, Osogbo, Nigeria.

Introduction

An unsafe blood transfusion is very costly from both human and economic points of view. Morbidity and mortality resulting from the transfusion of infected blood have far-reaching consequences, not only for the recipients themselves, but also for their families, their communities and the wider society[1,2]. Since a person can transmit an infection during its asymptomatic phase, transfusions can contribute to an ever-widening pool of infection in the population. The economic costs of the failure to control the transmission of infection include increased

requirement for medical care, higher levels of dependency and the loss of productive labour force, placing heavy burdens on already overstretched health and social services and on the national economy[1,3].

Factors contributing to transfusion-related transmissions in sub-Saharan Africa include: high rates of transfusion in some groups of patients (particularly women and children); a high prevalence of human immunodeficiency virus (HIV) in the general and blood donor populations; inadequate screening facilities; and lack of infrastructure and capacity to ensure sustainable operations[4,5]. It should, therefore, be mandatory that blood is screened for transfusion-transmissible infectious disease markers such as antibodies to HIV, hepatitis B virus (HBV), hepatitis C virus (HCV) and syphilis, and hepatitis B surface antigenaemia[6,8].

This study was conducted to establish the prevalence of transfusion-transmissible infections in the south-west region of Nigeria to provide the data base for eventual implementation of National Blood Service strategies.

Materials and Methods

Study subjects

A total of 1,410 apparently healthy prospective blood donors aged between 18 and 64 years (mean ± SD, 32.58 ± 10.24 years) who presented for blood donation at the Ladoke Akintola University of Technology Teaching Hospital Blood Bank, Osogbo between September 2007 and January 2008 were studied. Osogbo is situated in the tropical rain forest of the south-western part of Nigeria, 500 km away from Abuja, the Federal Capital City of Nigeria.

The estimated population is 465,000. The biodata of all donors were obtained by careful interview. Care was also taken to make sure that no donor was used more than once and those who had a history of recent ill health, had received a blood transfusion or who had donated blood within the 3 months prior to this study were excluded.

All the blood donors were offered pre- and post-test counselling and informed consent was obtained. Criteria for exclusion of donors included age less than 17 years or more than 65 years, body weight less than 50 kg, haemoglobin value less than 12.5 g/dL, history of jaundice, sickle cell disease, hypertension or current fever. The donors were predominantly Yoruba.

Sample collection

Three millilitres of venous blood were collected from each subject by clean venipuncture, dispensed into a clean dry glass test-tube and allowed to clot naturally at room temperature. The clotted blood samples were then spun in a centrifuge at 2500 rpm for 5 minutes to separate the serum which was used for the analyses. Part of the clot in the test tube was dislodged using normal saline to obtain red cells for the cell grouping.

Serological analyses

Hepatitis B surface antigen (HBsAg), antibodies to *Treponema pallidum* and HCV were detected using Clinotech test strips (Clinotech Diagnostics, Canada). Antibodies to HIV types 1 and 2 were screened with Determine HIV 1/2 test kits (Abbott Japan Co., Ltd., Germany) and Immunocomb (Orgenics, Israel). All the reactive samples were confirmed using Clinotech diagnostic enzyme-linked immunosorbent assay (ELISA) kits. Antibodies to *Treponema pallidum* were confirmed with Treponema pallidum haemagglutination test (TPHA, Lorne Laboratories Ltd., UK). A result was considered positive if both the first and second tests were positive and vice versa. The study was a cross-sectional survey so follow-up samples were not obtained from reactive donors for retesting. The manufacturers' standard operating procedures were strictly followed for the performance of all the tests.

Statistical methods

The data generated were coded, entered, validated and analysed using Statistical Package for Social Science (SPSS) version 12.0. The seroprevalences of HBsAg, HCV, HIV and syphilis were expressed for the entire study group and by age, sex and blood group. Values below 0.05 were considered statistically significant.

Results

Table I shows that 1,200 (85.1%) of the 1,410 blood donors were male and 210 (14.9%) were female, giving a male:female ratio of 6:1. The highest number of male blood donors (n=608; 50.7%) was found to be within the 28-37 year-old age group, whereas the highest number of female blood donors (n=96; 45.7%) was within the 18-27 year-old age group.

Table II shows that the seroprevalences of HBsAg,

HCV, HIV and syphilis were 18.6%, 6.0%, 3.1%, and 1.1%, respectively. All 44 donors who tested positive for HIV had HIV type 1. Figure 1 shows the predominance of HBsAg, HCV, HIV and syphilis infections in the 18-47 year-old age range while Figure 2 shows the predominance of seroprevalence for transfusion-transmissible infections among commercial donors (75.9%).

Table I - Distribution of donors according to gender within different age groups

Age (years)	Male Number	Percent	Female Number	Percent
18–27	262	21.8	96	45.7
28–37	608	50.7	54	25.7
38–47	202	16.8	32	15.2
48–57	90	7.5	28	13.3
58 –67	38	3.2	0	0
Total	1,200	100.0	210	100.0

Table II - Prevalence of seropositivity for markers of transfusion-transmissible infections in the study population

Marker	Number (%)
HBsAg	262 (18.6%)
HCV	84 (6.0%)
HIV	44 (3.1%)
Syphilis	16 (1.1%)
Total	406 (28.8%)

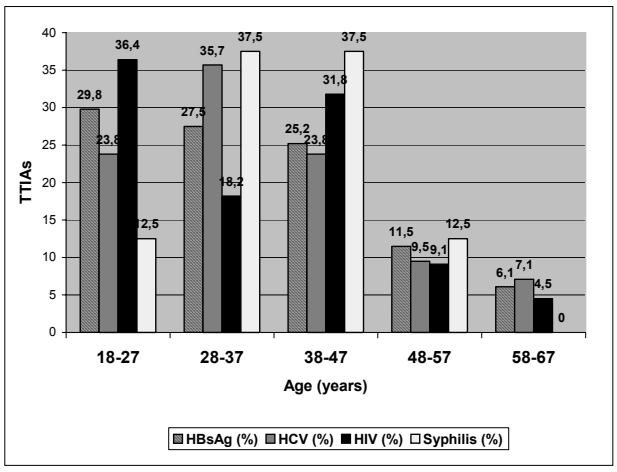

Figure 1 - Distribution and seroprevalence of TTIAs according to age groups

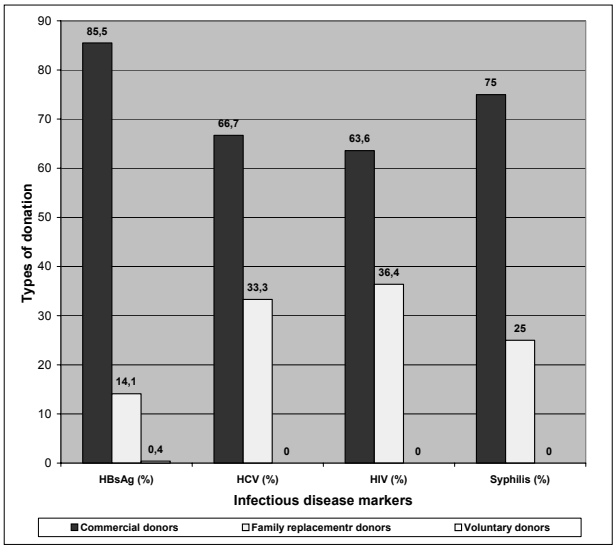

Figure 2 - Distribution of infectious disease markers based on types of donation

Table III shows that 13 (36.1%) of the donors had dual infections with HIV and syphilis while 12 (33.3%) of the donors had HBsAg and HIV dual infections. Chi-square tests for the various infection markers revealed that only syphilis was statistically significantly related to HIV in terms of seroprevalences ($c^2 = 12.813$, df = 1, $p<0.001$).

Table III - Prevalence of dual infections among donors

Type of dual infection	N. positive	Frequency (%)
HBsAg and HIV	12	33.3
HBsAg and HCV	4	11.1
HBsAg and syphilis	2	5.6
HCV and HIV	4	11.1
HCV and syphilis	1	2.8
HIV and syphilis	13	36.1
Total	36	100.0

Discussion

This study shows a high prevalence of transfusion-transmissible infectious agents (HBsAg 18.6%, HCV 6.0%, HIV 3.1% and syphilis 1.1%) in south-west Nigeria. These findings partly agree with those by Chukwurah and Nneli[9] in Enugu, who reported prevalences of 3.5% for HIV and 1.7% for syphilis, but differ with regards to HBsAg and HCV for which

higher prevalences were observed in the current study. The 18.6% seroprevalence of HBsAg found in this study is higher than the 14.0% previously reported by Baba *et al.*[10] in Maiduguri, the 10.4% reported by Mustapha *et al.*[11] in Gombe, Nigeria, the 15.0% reported by Ampofo *et al.*[12] in Ghana and the 10.4% reported by Glynn *et al.*[13] in the United States. It is important to note that HBsAg seropositivity indicates a carrier state or an active infection.

Although all the blood donors were apparently healthy, the 18.6% seroprevalence of HBsAg found in this study indicates that some donors may go on to develop chronic hepatitis, cirrhosis, and some may even progress to develop hepatocellular carcinoma, given the reports that HBV causes acute and chronic hepatitis with a high tendency to progression to cirrhosis and hepatocellular carcinoma[14]. Early treatment of these apparently healthy seropositive individuals is, therefore, encouraged.

With regards to the age distribution, in our study the highest rate of HBsAg positivity (29.8%) was in the 18-27 year-old age group. This is in contrast to the findings of Mustapha and Jibribn[11], who noted that the highest rate of HBsAg seropositivity (41.6%) was in the 40-49 year-old age group. However, we observed that HBsAg positivity was not limited to any particular age group but was more common among the 18-47 year-old age group, which also constituted the bulk of the blood donors. This suggests that HBV infection is endemic in this environment.

Of the 1,410 blood donors screened, 44 (3.1%) tested positive for HIV-1. None tested positive for HIV-2 or had dual HIV-1 and HIV-2 co-infection. The highest infectious burden occurred in the 18-47 year-old age group. More males were seropositive for HIV (n=36; 81.8%) than females (n=8; 18.2%). Commercially remunerated donors showed the highest prevalence 28/44 (63.6%), followed by family replacement donors 16/44 (36.4%). No voluntary donor tested positive for HIV. The 3.1% seroprevalence of HIV in this study agrees with the 3.8% seroprevalence level found in Ghana[12] and the 2.92% reported by Glynn *et al.*[13] in the United States. However, it is lower than the 5.5% previously reported in Maiduguri,[10] in Cameroon (4.55%)[15] and the 10.6% reported by Amadi *et al.*[16] in Aba, Nigeria.

It was observed in this study that 1.1% of the prospective blood donors had syphilis infection. This 1.1% seroprevalence of syphilis in our study is lower than the 3.6% sero-reactivity reported in Maiduguri[17], the 7.5% seroprevalence reported in Ghana[18] and the 12.4% reactivity reported in Ilorin, Nigeria[8], but is higher than the 0.1% reported by Ejele *et al.*[19] in Port Harcourt. In Ethiopia, the seroprevalence of antibody to syphilis among blood donors was 12.8%[20]. A similar prevalence rate (12.7%) of syphilis antibodies has been reported in blood donors from Dar es Salaam, Tanzania[21]. It has been reported that testing donor samples can identify early syphilis infection[22]. The reason(s) for the relatively lower rate of seroprevalence, compared with the 12.7%[21] and 12.8%[20] rates among Tanzania and Ethiopia blood donors, respectively, cannot be discerned in this study. However, it is conceivable that some individuals may have a higher than normal risk of contracting syphilis. It is also possible that improvements in technology might have made current screening reagents more specific and reliable. Finally, there could be true geographical differences in prevalence. Transfusion syphilis being a nosocomial infection, can easily be acquired in centres where blood is not screened for syphilis or stored before use as in the case of fresh whole blood transfusion[8]. Despite the fact that *Treponema pallidum* cannot survive in properly stored blood and the inescapable cost implications of syphilis testing of blood donors particularly in resource-poor settings, it must be noted that the emphasis of blood transfusion should be on two fundamental objectives – safety and protection of human lives [23]. Syphilis screening of donated blood, no matter what the incidence is in the donor population, has been considered to have value as a 'lifestyle' indicator, as individuals exposed to syphilis may also have been exposed to other sexually transmitted diseases and, therefore, should not donate[3,22,24]. Thus, one of the greatest values of this test at present is as a surrogate marker for lifestyles known to be associated with a high risk of transmitting HIV and hepatitis. In other words, it is not the transmission of syphilis that is so worrisome, but being a sexually transmitted disease, its presence points toward donors' indulgence in high-risk behaviours and consequently higher risk of exposure to infections such as HIV and hepatitis viruses[25]. Since syphilis is a major public health problem worldwide[22], there is the need to screen all blood donors for circulating antibodies to syphilis infection, at least as a surrogate marker.

In this study 84 (6%) of all the blood donors

(n = 1,410) were seropositive for HCV antibodies. This agrees with the findings of Egah *et al.*[26] in Jos, Nigeria who also reported a 6% rate among the 200 blood donors studied. Of the 6% of subjects in our study seropositive for HCV, 5% were male, while 1% were female. This is at variance with the findings in the study by Egah *et al.*[26] in which all the anti-HCV-positive blood donors were male. The 6% seroprevalence observed in this study is also similar to the 5.8% prevalence reported by Mutimer *et al.*[27] among blood donors from southern Nigeria. The seroprevalence rate found in our study is, however, higher than values ranging between 0 and 1.4% reported from USA and Europe[28,29]. The seroprevalence rate found in this study is also higher than the 2.8% found among blood donors in Ghana[30] and the 2.9% among blood donors in Port Harcourt[31], while it is lower than the 12.3% prevalence reported among Nigerian blood donors in Benin city[32] and the 15.8% recorded among Egyptian blood donors[33]. More recently, a prevalence of 5.0% HCV was reported in Port Harcourt, in the south of Nigeria[34].

The finding of a high prevalence of anti-HCV antibodies among apparently healthy blood donors in our study in Osogbo further confirms the presence of hepatitis C infection in Nigeria and highlights the necessity to adopt measures that will ensure safe blood transfusion.

In the current study the highest rates of seroprevalence were found among the 18-47 year-old age group. This finding is in agreement with previous results reported by Baba *et al.*[10] and Ejele *et al.*[19] in which higher prevalences were observed among youths. This observation is worrisome since the most productive and economically viable age group of the population is the worst hit. There is the urgent need for renewed intensification of prevention programmes aimed at changing high-risk behaviours.

This study has also revealed a significant prevalence of HIV, HBV, HCV and syphilis dual or co-infections among blood donors. However, none of the donors showed the presence of all three viral markers. There is a paucity of published data on co-infection by these three viruses among blood donors. Of the 406 individuals with infectious disease markers, 36 (8.9%) of the donors had dual infections. This finding differs from the 19% rate of dual infection found in Ghana[12] but further confirms that transfusion-transmissible infectious markers such as HIV, HBV, HCV and syphilis may share common modes of transmission and risk groups. The prevalence of HIV, HBV, and HCV co-infection needs to be studied on a larger scale for a better understanding of the impact on clinical outcome and treatment response[35].

The HIV/HBV co-infection rate of 33.3% observed in this study among the blood donors tested is higher than that observed by Ejele *et al.*[19] in Port Harcourt. A much higher HIV/HBV co-infection rate of 40.0% was reported by Lodenyo *et al.*[36]. The fact that both infections share similar modes of transmission (predominantly blood and high-risk sexual behaviours) and other risk factors have been attributed to the significant association between HBV and HIV[10,11,37]. The 36.1% seroprevalence of HIV/syphilis co-infection and the statistically significant relationship between HIV and syphilis may suggest unprotected sex as a probable risk factor.

The majority of donors tested in this study were commercially remunerated donors (80.9%), rather than family replacement donors (18.3%) or voluntary donors (0.8%). The amount of voluntarily donated blood has continued to fall over the years in Nigeria due to logistics and organisational problems associated with the Nigerian national blood transfusion service. The net result is that commercial blood donation is the order of the day. In this study the prevalence of all the infectious disease markers was higher among the commercial donors than among family and voluntary donors. Commercially remunerated donors accounted for 85.5%. 66.7%, 63% and 75% of the subjects positive for HBV, HCV, HIV and syphilis, respectively, as compared to 14.1%, 33.3%, 36.4% and 25% for family replacement (relative) donors. The prevalence of HBsAg among voluntary donors was 0.4%, while no voluntary donors were positive for HCV, HIV or syphilis. This observation is consistent with the suggestion by the World Health Organization (WHO) that commercially remunerated blood donors and family replacement donors are more likely to transmit transfusion-transmissible infections than are voluntary donors[1]. A person in need of money is more likely to conceal his/her true state of health, and monetary remuneration, which is often offered as a donor-motivating means, might be highly appealing for people who live in desperate straits. They are more likely to give blood more often than recommended and be more at risk of contracting transfusion-transmissible infections from high-risk behaviours

such as multiple sex partners, intravenous drug abuse and unprotected sexual intercourse. Commercial blood donors cannot guarantee blood safety[38].

It is important to point out that the results obtained in this study do not reflect the prevalence of markers of transfusion-transmissible infections in the unselected general population because blood donors are a pre-selected group and all of them are within the sexually active age group. Further studies aimed at determining the epidemiology of transfusion-transmissible infections among the general population will be of value in determining the population prevalence.

References

1) World Health Organization (WHO). Blood Safety Strategy for the African Region. Brazzaville, World Health Organization, Regional Office for Africa (WHO AFR /RC51/9 Rev.1). 2002
2) World Health Organization (WHO). Status of blood safety in the WHO African Region: Report of the 2004 Survey WHO Regional Office for Africa, Brazzaville 2007: 1-25.
3) Kitchen AD, Barbara JAJ. Transfusion transmitted infections. In: Murphy MF and Pamphilon DH (Eds): Practical Transfusion Medicine. Blackwell Science, Oxford 2001: 192-210.
4) Holmberg J. Activities Relating to Global Blood Safety at the Department of Health and Human Services. USA. 2006: 1-5.
5) Burnouf T, Radesevich M. Reducing the risk of infection from plasma products: specific preventive strategies. Blood Rev 2000; **14**: 94-110.
6) Choudhury N, Phadke S. Transfusion transmitted diseases. Indian J Paediatr 2001; **68**: 951-8.
7) William A, Nicholas N, Ansah J, et al. Prevalence of blood borne infectious diseases in blood donors in Ghana. J Clin Microbiol 2002; **40**: 3523-5.
8) Nwabuisi C, Aderinola CI, Ibegbulam OG. The sero-prevalence of syphilis in unscreened and unstored blood transfused in Ilorin, Nigeria. Medipharm Med J 2005; **2**:7-9.
9) Chukwurah EF, Nneli RO. Prevalence of transfusion transmissible infectious disease markers among blood donors in a south Eastern state of Nigeria. Niger Biomed Sci J 2005; **1**: 114-7.
10) Baba MM, Hassan AW, Gashau W. Prevalence of hepatitis B antigenaemia and human immunodeficiency virus in blood donors in Maidugiri, Nigeria. Niger J Med 2000; **9**: 10-2.
11) Mustapha SK, Jibrin YB. The prevalence of hepatitis B surface antigenaemia in patients with human immunodeficiency virus (HIV) infection in Gombe, Nigeria. Ann Afr Med 2004; **3**: 10-2.
12) Ampofo W, Nil-Trebi N, Ansah J, et al. Prevalence of blood-borne infectious diseases in blood donors in Ghana. J Clin Microbiol 2002; **40**: 3523-5.
13) Glynn SA, Kleinman SH, Schreiber. Trends in incidence and prevalence of major transfusion transmissible viral infection in the United States. J Am Med Assoc 2000; **284**: 229-35.
14) Szmuness W, Much MI, Prince M, et al. Hepatitis B: evolving epidemiology and implications for control. Semin Liver Dis 1990; **11**: 84-92.
15) Musi SS, Monny L M, Ndjitoyap NEC, et al. Prevalence of transfusion transmitted infectious agents among healthy blood donors in Cameroon. International Conference on AIDS Report. July 11-16; 2004: 15.
16) Amadi AN, Mba LE. Distribution of HIV infection in Abia State, Nigeria. Niger J Med Invest Pract 2001; **2**:38-40.
17) Chikwem JO, Mohammed I, Okara GC, et al. Prevalence of transmissible blood infections among blood donors at the University of Maiduguri Teaching Hospital, Maiduguri, Nigeria. East Afr Med J 1997; **4**: 213-6.
18) Adjei AA, Kudzi W, Armah H, et al. Prevalence of antibodies to syphilis among blood donors in Accra, Ghana. Japanese Infect Dis 2003; **56**:165-7.
19) Ejele OA, Erhabor O, Nwauche CA. Trends in the prevalence of some transfusion-transmissible infections among blood donors in Port Harcourt, Nigeria. Haema 2005*;* **8**: 273-7.
20) Rahlenbeck SI, Yohhanes G, Molla K, et al. Infection with HIV, syphilis and HBV in Ethiopia: a survey in blood donors. Int J STD/AIDS 1997; **8**: 261-4.
21) Matee M, Magesa P, Lyamuya E. Seroprevalence of human immunodeficiency virus, hepatitis B and C viruses and syphilis infections among blood donors at the Muhimbili National Hospital in Dar Es Salaam, Tanzania. BMC Public Health 2006: **6:** 21-4.
22) Gardella C, Anthony A. Richard H, et al. Persons with early syphilis identified through blood or plasma donation screening in the United States. J Infect Dis 2002*;* **185**:545-9.
23) Abbey SD, Erhabor O, Nwoka E, et al. Seroprevalence of Treponema pallidum infection among blood donors in a resource poor setting in the Niger Delta of Nigeria. Niger Biomed Sci J 2006; **2**: 29-31.
24) Zohreh A, Mazyar G, Bashir H, et al. Zero prevalence of syphilis among blood donors in Tehran, Iran. Transfusion Today 2005; **64**: 24.
25) Contreras M, Hewitt PE. Clinical blood transfusion. In: Hoffbrand AV, Lewis SM and Tuddenham (editors): Postgraduate Haematology. Fourth Edition. Arnold, London 2001: 215-34.
26) Egah DZ, Mandong BM, Iya D, et al. Hepatitis C virus antibodies among blood donors in Jos, Nigeria. Ann Afr Med 2004; **3**: 35-7.
27) Mutimer D J, Olomu A, Skidmore S. Viral hepatitis in Nigeria – sickle cell disease and commercial blood donors. Quarterly J Med 1994; **87**: 407-11.
28) Stevens CE, Taylor PE, Pindyck J. Epidemiology of hepatitis C virus. J Am Med Assoc 1997; **263**: 49-53.
29) Sharara AI, Hunt CM , Hamilton JD. Hepatitis C. Ann Intern Med 1996; **125**: 658-68.
30) Wansbrough-Jones MH, Frimpong E, Cant B, et al.

Prevalence and genotype of hepatitis C virus infection in pregnant women and blood donors in Ghana. Trans R Soc Trop Med Hyg 1996; **92**: 496-9.

31) Koate BBD, Buseri FI, Jeremiah ZA. Seroprevalence of hepatitis C virus among blood donors in Rivers State, Nigeria. Transfus Med 2005; **15**: 449-51.

32) Halim NK, Ajayi OI. Risk factors and seroprevalence of hepatitis C antibody in blood donors in Nigeria. East Afr Med J 2000; **77**: 410-12.

33) Rehman K, Khan AA, Haider Z, et al. Prevalence of serological 'markers of HBV and HCV in health care personnel and apparently healthy blood donors. J Pakistani Med Assoc 1996; **46**: 152-4.

34) Jeremiah ZA, Koate B, Buseri F, et al. Prevalence of antibodies to hepatitis C virus in apparently healthy Port Harcourt donors and association with blood groups and other risk indicators. Blood Transfus 2008; **6**: 150-5.

35) Ahsan SM, Mehta PR. HIV, HBV and HCV Co-infection Study. Bombay Hosp J 2002; **3**:5-7.

36) Lodenyo H, Schoub B, Ailly R, et al. Hepatitis B and C virus infection and liver function in AIDS patients at Chris Hani Baragwanath Hospital, Johannesburg. East Afr Med J 2000; **77**: 13-5.

37) Mustapha SK, Kudi AA, Asaka LE. Prevalence of hepatitis B surface antigen (HBsAg) and HIV among blood donors in Gombe. J Life Environ Sci 2002; **4**: 231-5.

38) Busch MP, Glynn SA, Stramer SL, et al. Correlates of hepatitis C virus (HCV) RNA negativity among HCV seropositive blood donors. Transfusion 2006; **46**: 469-75.

Received: 7 November 2008 - Revision accepted: 2 March 2009
Correspondence: Dr Zaccheaus Awortu Jeremiah
P.O Box 1437
Diobu, Port Harcourt 500001
Rivers State, Nigeria
e-mail: zacjerry@yahoo.com