

# A Seven Year Review of the Seroprevalence of Transfusion Transmitted Infections in a Hospital Based Blood Bank in Ibadan, Nigeria

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**Abstract:** Africa has the highest prevalence of transfusion transmitted infections. The World Health Organization recommends universal and quality-controlled screening of blood donations for the major transfusion-transmissible infections (TTIs): human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV) and syphilis. Therefore a retrospective study was conducted to assess the effect of strategies in our blood bank to improve blood safety on the seroprevalence of HIV, HCV, HBV and syphilis infections among the donors over a seven year period. Existing data in the blood bank was used to determine number of the blood donors who were infected with HIV, HCV, HBV and syphilis. The test methods used to screen the donors were identified. The trend of prevalence of the transfusion transmitted infections among the blood donors from 2009 to 2015 was also determine. A total of 41,445 blood donors were screened. Voluntary blood donors constituted 11.1% of the donor population. The overall seroprevalence rate for the TTI was 12.3%. The prevalence was highest for HBV (8.5%) followed by HIV (1.8%), HCV (1.4%) and least for syphilis (0.5%) respectively. The infections showed significant inter-year variation ( $p < .001$ ). A decreasing trend was observed for HBV among the blood donors while increase in prevalence of HIV, HCV and syphilis was observed from 2012 to 2014 and decreased in 2015. The prevalence of syphilis has risen from 0% in 2009 to 0.9% in 2015. The seroprevalence for TTI is high but is less compared to report from a previous study in same blood bank. The increasing infection rate for syphilis and sporadic surges in rates for HIV, HCV may suggest that the selection criteria is not effectively eliminating blood donors with risky lifestyle. There is need to educate the blood donors on avoiding risky lifestyle while also intensifying voluntary blood donor motivation strategy and increase community surveillance of the infections.

**Keywords:** Hepatitis B Virus, Hepatitis C Virus, Human Immunodeficiency Virus, Syphilis

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## 1. Introduction

A transfusion transmissible infection (TTI) could be a virus, bacteria, parasite, or other potential pathogen that can be transmitted through blood transfusion into a recipient. The range of infectious agents known to be transmitted through blood transfusion are numerous. In vitro screening for all the organisms is not practicable. Transfusion transmitted infection is a major challenge to the transfusion services all over the world. World health organization recommends a

mandatory screening of all blood donors and units for human immunodeficiency virus (HIV), hepatitis C virus (HCV), hepatitis B virus (HBV) and syphilis infections. The problem of TTI is directly proportionate to the prevalence of the infection in the blood donor community. The magnitude of the problem varies from country to country.

Standard procedures ensure that no donated blood is released for issue until all the required laboratory tests declare the blood negative for TTI. Donor screening can be broadly divided into two main categories: mandatory and

discretionary. The mandatory tests include antigen/antibody (Ag/Ab) for human immunodeficiency viruses (HIV) 1 + 2, anti-HCV for hepatitis C virus (HCV) for HCV, hepatitis B surface antigen (HBsAg) for hepatitis B virus (HBV), anti-treponemal antibody for syphilis. The inclusion of anti-HTLV I/II is considered good practice but not necessarily mandatory. Genomic screening for HIV, HCV and HBV is not mandatory but can be performed on the original donor sample as an alternative to quarantine and follow-up serological testing.

In developed countries, combination of serological tests and viral detection are carried out to screen blood for HBV infection. HBV infection in donations varies between 3.6 and 8.5 per million in the USA and Canada and 0.91 – 13.9 per million in Europe. For the detection of HCV, direct detection of virus is carried out with a yield 0.93 per million in Europe and 3.92 per million donations in North America [1]. The risk of transmitting HIV through blood transfusion in the developed country is 0.14 to 1.1 per million donations<sup>1</sup>. Report from Burkino Faso, a country in Africa gave a seroprevalence of 13.4% and 6.3% for HBV and HCV respectively [2].

In Nigeria, hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) infections are important causes of concern. Hepatitis B and C infections are prevalent in Nigeria with a carrier rate of about 10–20% and 0.5–6%, respectively among blood donors [3, 4, 5]. Exceptionally high seroprevalence has been reported in Benin – city Nigeria<sup>6</sup> Post transfusion hepatitis has been reported to be as high as 12.5% in Nigeria, though this was before the advent of screening for hepatitis C virus (HCV) [7]. Over the last decade many blood banks in the country have included screening for hepatitis C. The seroprevalence rate for HIV among blood donors is different in various parts of the country. It ranges from 1.0 to 5.8% [4, 8, 10]. A previous study showed fluctuating high seroprevalence rates among our blood donors<sup>11</sup>. In one study from Ibadan, a few infected blood units was reported to have escaped the serological screening process [12]. This further raises concern to frequently monitor blood safety. During the study that showed fluctuating high seroprevalence rates, pre-donation screening for HbsAg and anti –HIV rapid test were performed for all the prospective blood donors. The blood donors who were reactive were permanently deferred while the non-reactive blood donors were bled and the donated blood units were further subjected to automated ELIZA screening for HIV and HCV only. During that period, our blood bank was not screening for *Treponema pallidum* (*T. pallidum*), the causative agent of syphilis. Syphilis was reported to be as high as 2.6% among blood donors in a study from Nigeria [13].

Over the years, new test methods have emerged to improve the detection levels of the transfusion transmitted microbial agent. In the European Union, two selection strategies are employed to determine the qualification of newly-registered blood donors: a single-visit selection called the standard selection procedure (SSP), and a two-stage selection named pre-donation and donation screening (PDS) [14].

Monitoring the trends in the incidence of transmissible

infectious agents in the blood donations has motivated the introduction of new screening techniques to improved early detection of infected individuals. In 2008, the screening algorithm to improve blood safety in our blood bank was changed to include predonation HCV and HIV screening in addition to the predonation HbsAg test being carried out in the previous years and donated blood units are again screened for HIV, HCV, HBV and *T. pallidum*. This study was carried out to determine the seroprevalence rate of HIV, HBV, HCV and *T. pallidum* infection among blood donors during the last seven [7] years and also determine the value of the new screening algorithm (double test algorithm) to offer opportunity to improve blood safety.

## 2. Materials and Method

A retrospective study on existing data of all blood donors in our hospital blood bank from January to December over seven years was conducted. This included all donors aged between 18 and 64 years who intended to donate and eventually donated blood in the years 2009, 2010, 2011, 2012, 2013, 2014, and 2015. The blood bank is situated in a tertiary center that has 850 beds. The blood bank is involved in blood collection, storage, screening for TTI, fractionation of blood into fresh frozen plasma, cryoprecipitate, and platelet concentrate and issue to patients. For the purpose of this study, the definition of a prospective donor is a donor who states his/her wish to give blood and undergoes the selection criteria. The algorithm of blood donation include screening of all prospective blood donors with questions on health status and lifestyle and copper sulphate test (CuSO<sub>4</sub>) to rule out anaemia. Before a donor was allowed to donate blood, rapid tests to screen for anti-HIV 1 and 2, anti- HCV and HBsAg were performed to detect HIV, HCV and HBV respectively, after a pretest counselling on the infections. Two rapid tests were performed for HIV while one each was carried out for HCV and HBV. During the pretest counselling blood donors were given the opportunity to self -defer. Post test counselling was carried out after the rapid tests. Blood donors who were negative for the viruses were allowed to donate. The donated blood units were quarantined until results of the conventional semi-automated Enzyme linked immunosorbent assay (ELISA) to detect HIV, HCV, HBV and syphilis were available.

The rapid tests used to test for HIV were Determine and Unigold. Alere Determine (Alere Medical Co. Ltd, Japan) is an immunochromatographic test for the qualitative detection of antibodies to HIV-1 and HIV-2. It has a 97.96% specificity and 100% sensitivity while Unigold (by Trinity Biotech Plc, Ireland) is a single reagent assay for the detection of antibodies to HIV-1 and 2 in serum, plasma or whole blood with 99.7% specificity and 100% sensitivity. The rapid tests used for HCV and HBV were Rapid Test Strip respectively from First view Lab ACON (ACON Laboratories, Inc, San Diego, USA), rapid immunoassay for the detection of antibodies to HCV and HBsAg in whole blood, serum or plasma. It uses visual interpretation of colour

development. The sensitivity of the tests were 99.8 % and specificity 99.9 to 100%.

The post donation screening of the blood units used semi-automated conventional ELISA Tests. The kit used for HIV screening was Genscreen ultra HIV Ag-Ab (Bio-Rad, Raymond Poincare 92430, Marnes La Coquette, France). It is an enzyme immunoassay for the detection of antibodies to HIV 1 and 2 HIV. It detects p24 antigen and antibodies to HIV-1 (groups M and O) and HIV-2 in humans serum or plasma. Monolisa HBs Ag Ultra (Bio-Rad, France) was used in the detection of HBSAg to identify donors who have Hepatitis B virus. The procedure is a qualitative one-step enzyme immunoassay based on the principle of "sandwich" type using monoclonal antibodies and polyclonal antibodies selected for their ability to bind themselves to the various subtypes of HBsAg now recognized by the WHO and the most part of variant HBV strains. HCV Ab version 4.0 Enzyme immunoassay (DIA.PRO Diagnostic Bioprobes Srl Via G. Carducci n° 27 20099 Sesto San Giovanni Milano, Italy) was used for the detection of HCV antibodies (IgG and IgM are detected). The microplates used for the immunoassay were coated with HCV-specific antigens derived from "core" and "ns" regions encoding for conservative and immunodominant antigenic determinants (Core peptide, recombinant NS4 and NS5 peptides). The Enzyme Immunoassay (ELISA) used for syphilis test was Syphilis Ab version Ultra. It uses Treponema pallidum synthetic antigens (p15, p17 and p47) for the determination

of antibodies (IgG, IgM and IgA) to Treponema Pallidum. The test kit has a diagnostic sensitivity and specificity of 100% respectively. Blood units found to be reactive to the tests for identifying any of TTIs were assumed positive for the respective viruses and discarded while the non-reactive were assumed to be seronegative blood units which are safe to be released for blood transfusion.

### 3. Data Analysis

Data were cleaned and prevalence generated with Microsoft Excel for all the TTIs as the number of donors who were positive per 100 donations. The rates were computed yearly from 2009 to 2015. The 95% confidence interval and chi-square for trend was computed using WINPEPI (PEPI-for-Windows): computer programs for epidemiologists. Data was presented using tables and figure.

### 4. Results

A retrospective analysis covering the period between January 2009 and December 2015, showed that 42,729 prospective allogeneic and 64 autologous blood donors were attended to. Three percent of the blood donors failed the CuSO<sub>4</sub> test used to assessment for anaemia. A total of 41,445 who passed the CuSO<sub>4</sub> test were screened with rapid tests for HIV, HCV and HBV.

**Table 1.** Yearly distribution of voluntary blood donations and transfusion transmitted infections from 2009 to 2015.

Years	Total No of blood Donors	Voluntary blood donors		Blood donors with TTI	
		Voluntary donors n(%)	95% Confidence Interval (Lower-Upper)	Blood donors with TTI n (%)	95% Confidence Interval (Lower-Upper)
2009	5355	490 (8.1)	7.4-8.8	617 (11.5)	10.7-12.4
2010	8161	809 (8.6)	8.1-9.2	1,183 (14.5)	13.8-15.3
2011	7887	986 (12.5)	11.8-13.3	718 (9.1)	8.5-9.8
2012	7087	751(10.6)	9.9-11.3	808 (11.4)	10.7-12.2
2013	5018	1,009(20.1)	19.0-21.2	683 (13.6)	12.7-14.6
2014	4204	561(13.3)	12.3-14.6	646 (15.4)	14.3-16.5
2015	3733	199(5.3)	4.6-6.1	445 (11.9)	10.9-13.0
Total	41,445	4,805 (11.1)	10.8-11.4	5,100 (12.3)	12.0-12.6

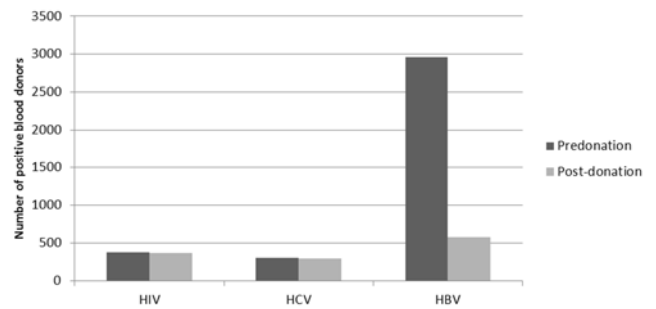
Table 1 displays the frequency of recruitment of voluntary donors during the 7 year- period in comparison to the total blood donors for each year. Voluntary blood donors constituted 11.1% of the total donor population. The voluntary donors were students, hospital workers, walk – in donors, religious organizations and donor drive to companies and educational institutions. Replacement blood donors

constituted 88.9%. The voluntary blood donor population vary from year to year. There was a gradual increase in the number of voluntary blood donors from 2009 to 2013 without a proportionate decrease the number of blood donors who were positive for TTIs. Of the 41,445 blood donors screened, 5,100 (12.3%) donors were positive for TTIs. A surge in the prevalence rates was observed in 2010 and 2014

**Table 2.** Pre-donation and post donation test results for transfusion transmitted infections from 2009 to 2015.

Year	Total No. of blood Donors	Donors positive with pre-donation n (%)	Total No. of blood units screened by ELISA	No. of blood Units positive by ELISA n (%)
2009	5355	472 (8.8)	4883	145 (3.0)
2010	8161	946 (11.6)	7215	237(3.3)
2011	7887	539 (6.8)	7348	179 (2.4)
2012	7087	647 (9.1)	6440	161 (2.5)
2013	5018	519 (10.3)	4499	164 (3.7)
2014	4204	362 (8.6)	3842	284 (7.4)
2015	3733	153 (4.1)	3580	292 (8.2)
Total	41,445	3,638 (8.8%)	37,807	1,462 (3.9)

Table 2 shows that of the 41,445 who were accepted as blood donors 3,638 (8.8%) blood donors were positive for either of the viruses therefore 37,807 donors donated blood. Of the blood units donated, 3.9% were positive to either HIV, HCV, HBV, or syphilis using the automated ELISA technique. There was a gradual decrease in the number of blood donors from 8161 in 2010 to 3733 in 2015 and a steady increase in the number of blood donors detected with the post donation test from 2011 to 2015. The year 2015 had the least number of voluntary donors. The number of blood donors positive for TTI during same period using the postdonation (ELISA) test was twice the number detected during the pre-donation (rapid) test (Table 1 & 2). The total positivity for TTI in the pre- donations test using the rapid kit was 8.8% which constitute 71.3% of the infected blood donors. Until 2014, most of the infected donors were identified during the pre-donation test while there was no striking observed difference in predonation and post donations test results in 2014 and 2015.



**Figure 1.** Detection frequency of HIV, HCV and HBV with predonation and postdonation screening test.

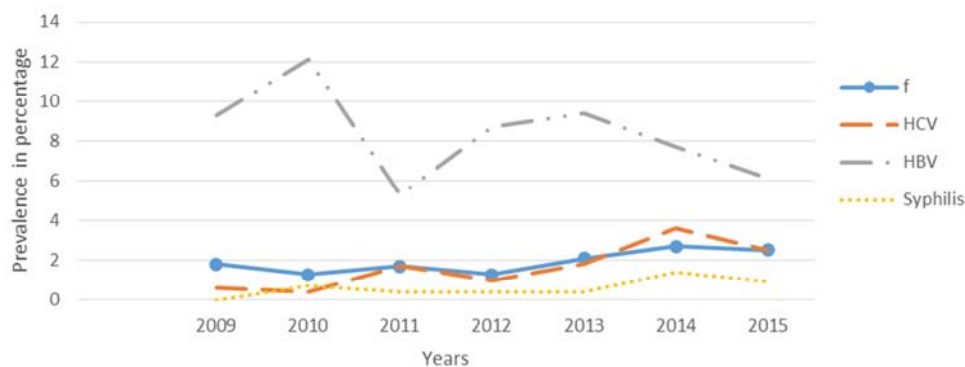
Of the 3540 HBV positive blood donors only 578 (16.3%) were detected in the post- donation tests while 49.3% and 49.4% of blood infected with HIV and HCV respectively were identified during the ELISA post donation test. (Figure 1).

**Table 3.** Year-wise seroprevalence of HIV, HCV, HBV and syphilis from 2009 to 2015.

Year	Total No of Donors	HIV n (%)	HCV n (%)	HBV n (%)	Syphilis n (%)	Total with TTI n (%)
2009	5355	98 (1.8)	23 (0.6)	496 (9.3)	0 (0)	617 (11.5)
2010	8161	106 (1.3)	32 (0.4)	987 (12.1)	58 (0.7)	1,183 (14.5)
2011	7887	135 (1.7)	136 (1.7)	417 (5.3)	30 (0.4)	718 (9.1)
2012	7087	91 (1.3)	70 (1.0)	619 (8.7)	28 (0.4)	808 (11.4)
2013	5018	104 (2.1)	90 (1.8)	470 (9.4)	19 (0.4)	683 (13.6)
2014	4204	114 (2.7)	151 (3.6)	324 (7.7)	57 (1.4)	646 (15.4)
2015	3733	92 (2.5)	93 (2.5)	227 (6.1)	33 (0.9)	445 (11.9)
Total	41,445	740 (1.8)	595 (1.4)	3,540 (8.5)	225 (0.5)	5,100 (12.3)
p-value	ND	<0.001	<0.001	<0.001	<0.001	<0.001

Table 3: The overall seroprevalence rate for the TTI was 12.3%. Hepatitis B virus had the highest prevalence (8.5 %) followed by HIV (1.8%), HCV (1.4%) and the least prevalent was syphilis (0.5%). The infections showed significant inter-year variation ( $p < .001$ ). The highest seroprevalence for TTIs

was in 2014 during which highest seroprevalence was observed for each infection except HBV. None of the blood donors had syphilis in 2009. The highest prevalence for syphilis was in 2014 with 57 (1.4%) of the donor population ( $n=4204$ ) who tested positive and dropped in 2015 to 0.9%.



**Figure 2.** Trend of Seroprevalence of transfusion transmitted infection among blood donors from 2009 to 2015.

The prevalence of HBV fluctuated significantly over the 7 year period but with a declining trend (Figure 2) while the trend of infection rates for HIV, HCV and syphilis were almost similar but opposite to that of HBV (figure 2). The fluctuation of the rates observed for HIV and HCV among the blood donors were less than 2% during the study period until 2012 for HIV and 2013 for HCV when a surge to 2.7%

and 3.6% respectively in 2014 was observed. Similar to HIV and HCV, the upsurge in seroprevalence for syphilis was in 2014.

## 5. Discussion

The overall prevalence of the TTI observed in this study is

higher than the reported rate in a study carried out in a tertiary hospital blood bank in the same region [13]. Comparison of prevalence rates within Nigeria is flawed by the different blood donation algorithm and test methods used. The reported rate from the study on blood donors in Ife was based on rapid test. When the 8.8% obtained using rapid kit (predonation screening) tests, similar test methods were considered, the prevalence is comparable. The higher prevalence in our study may be due to a better detection rate. Additional 3.9% of the infected blood units were detected by a second screening method that shortened the window period detection time and increasing the range of strains for the organisms. The similar total TTI rate but different predonation and post donation test results obtained in 2010 and 2014 underscores the importance of test methods in determining infection rates. Higher prevalence rate was obtained in a study from Ilorin, Nigeria using the predonation tests [9]. The sensitivity of rapid screening test has been reported to be suboptimal therefore the need for second ELISA screening for all donated blood units to improve blood safety [15-16]. The overall prevalence for the TTIs over the 7 years is higher than that reported from a study carried out over a 4 year period during same time in Ethiopia but lower than another study carried out in same town in Ethiopia over 5 years with larger population [17, 18]. Higher rates have been reported from Mozambique and Ghana [19, 20] while lower seroprevalence rate has been reported from Turkey where unlike aforementioned countries had a replacement blood donor of less than 30% [21]. Studies outside African consistently reported less overall seroprevalence irrespective of the duration of the studies [22, 23] the infections showed significant inter-year variation.

The detection of a high number of infected blood units during the post- donation ELISA screening is instructive. It suggests that a significant number of TTI positive blood units might have been released to patients when only rapid predonation tests were carried out. The prevalence rate from studies carried out using rapid kit are likely to under-report the true seroprevalence.

In developed countries, HBV infection in donations varies from 1 in 300,000 the USA and 1 in 68, 000 in New Zealand to less than 1 in 2.8 million in the United Kingdom which is significantly less than what is obtained in this study [24]. However similarly to these countries Hepatitis B virus has the highest seroprevalence among the donors. There is marked reduction in the infection rate of the donors when compared with the previous study in same blood bank [11]. This suggests that there has been an improvement in the efforts made to reduce the number of infected donors in the donor population. The incorporation of HBV vaccination in the childhood immunization schedule in the last 15 years and enlightenment on the need for HBV vaccination might have contributed to reduction in the number of infected people in the general population which is being reflected in the donor population. The decline in HBV infection in the blood donor is consistent with the observation in the study at Ile- Ife, Nigeria and India [13, 22]. However, this is in contrast to the

study on Chinese donor population which showed an increasing infection rate [23] and non- directional fluctuation in a six year study from Turkey [21].

An overall seroprevalence of 1.8% for HIV infection among the blood donors is less than 3.4% recorded for the current National seroprevalence and 7.6% for a previous study in the same blood bank [11, 25]. The blood donor HIV rate of 1.3% in 2010 was also less than 4.1% of the general population [25]. These rates are within the estimated values ranging between 1.0 % and 6 % reported from other regions of the country for blood donors [4, 5, 9-10]. Marked differences in the prevalence among regions in Nigeria is due to cultural differences, varying level of education, religion, differing socio-economic structure. The socio-cultural and religious practices implicated in the risk of HIV transmission include multiple and concurrent sex partners, child birth handled by unskilled birth attendant outside health facilities, use of instruments for female genital mutilation, traditional markings and tattoo. A reduction in these practices through aggressive campaign and pretest counselling for blood donors to allow them to self-defer might have contributed to the reduction. The reduction observed compared to previous report from same blood bank is encouraging except for a swinging rising in seroprevalence which peaked in 2014. This finding is in contrast to the declining infection rate observed in another study in Nigeria, Ghana, Iran [19, 26, 27]. Surprisingly, the period of rise occurred at the time more infections were detected with post donation tests compared to the predonation tests. The presence of the 13 -20% voluntary blood donors during the period did not translate to decrease in the trend of the seroprevalence. The inability to determine the prevalence rate of this virus in the voluntary blood donors is a limitation of this retrospective study. Blood units obtained from voluntary blood donors are not separated from that obtained from replacement blood donors. It is important to know the motive of some of the voluntary blood donors. The information on this is not available in our records. Viral testing may be a donation incentives in a way as many first-time donors use donation as a means to access HIV testing [28]. A study from Ghana examined transfusion risk for HIV and HBV; the prevalence of anti – HIV and hepatitis B surface antigen in first-time volunteer vs replacement was comparable [29]. The lack of difference in TTI prevalence between voluntary non remunerated and replacement blood donors has also been shown in Brazil and Mexico [30, 31]. Despite this observation, there is no doubt that voluntary blood donation will provide safe blood for patients. A high percentage of voluntary blood donations may be required to significantly reduce TTI in a population with high seroprevalence rate. Significant fluctuation in the voluntary donor population will suggest a fluctuating donor motivation strategies. Significant inter-professional politics and rivalry caused disruption in the health services between the years 2013 and 2015. This might account for the fluctuation in voluntary blood donation and rising trend of HIV, HCV and syphilis among the blood donors. The inability of any of the professional groups who was on strike to perform their role

efficiently might have compromised standards and gave room for infected people to present themselves for blood donation. The same reason might explain the drop in total blood donors. An increasing trend has also been observed in other studies from china and Poland [23, 32] and Germany [33]. The rise might also suggests a fatigue in activities and programmes to stem down the spread of HIV. The increase might also suggest a rise in the number of new infections in the general population.

Studies on HCV prevalence in Sub Saharan African showed that blood donors consistently had lower prevalence (1.9 %) than the general population prevalence [34]. A prevalence of 0.8 to 6.0% has been reported among blood donors in Nigeria [4, 5, 8, 9]. A prevalence of 4.4% was reported from a neighbouring country, Ghana and 1.8% for Libya and 0.11% for California, USA [20, 35, 36]. A prevalence rate of 4.14% has been reported for Western Africa where Nigeria falls [34]. Trends of infection among the blood donors for HCV and HIV infection showed a similar pattern of moderate fluctuation. A shared route of transmission of both viruses may account for this. The inability to identify patients with dual or multiple infection is a limitation in this study. Prevalence of anti-HCV showed declining trend in Korea and Germany but has been stable in the last 20 years in Poland [32, 33, 35]. Seroprevalence of HCV and HIV differ over time among different categories of blood donors as declining trend was observed among first time donors while prevalence remain stable among repeat blood donors [36, 37, 38]. A seroprevalence of 0.6 and 0.4% in 2009 and 2010 which peaked to 3.6% in 2014 is alarming and should be viewed seriously. Blood donors are healthier cohort of any community and mirror the seroprevalence in the general population. The increasing trend may be a window to emerging risky behaviour and changing lifestyle. Since early identification of an epidemic is an opportunity to plan and effect intervention measure, a community based study may be relevant to unravel the increase.

The overall seroprevalence for syphilis in this study is lower than 2.1% in Burkina Faso but higher than 0.1 to 0.5% in Ethiopia [2, 17, 18, 41]. A prevalence of 0 to 8% has been reported for Nigeria [4, 14, 39, 40]. The increase in the percentage of blood donors with syphilis infection from 0% in 2009 to 1.4% in 2014 is an undesirable development. Hopefully the decline to 0.9% the following year will be a sustained downward trend in infection rate of the blood donors. The pattern of trend is in contrast to the decrease followed by a stable prevalence rate observed among Iranian blood donors [42]. Increasing trend for syphilis infection has been reported in blood donors in Pakistan [43]. The increase has been attributed to unsafe sexual practice and decline in the use of protective measures. Testing of blood donors for syphilis is used as a surrogate measure of high risk behavior in some developed countries [44]. The poor survival of *Treponema pallidum*, the causative agent of syphilis in refrigerator has been exploited by some blood bank as an excuse to absolve themselves of the responsibility of screening of donated blood or blood donors. This practice is

unacceptable because seroconversion of blood recipients who received blood  $\leq 4$  days has been reported [45]. In blood banks with inadequate blood and high demand, oftentimes blood are released for transfusion before these days required to kill the spirochete. Due to the aforementioned and the high prevalence observed in the later years of the study, transfusion services should screen for syphilis to reduce the incidence of transfusion acquired syphilis. This is further supported by a study from Ghana that observed recent infection of syphilis in 3.5% and 4.5% of the blood donors and blood recipients respectively [45].

## 6. Conclusion

Significant differences in prevalence of all the infections occur during the years under study. Reduction in seroprevalence of HIV, HCV, and HBV compared to previous study in the same center suggests an improvement in donor donor selection strategy. However, blood donor motivation strategies should be intensified to increase voluntary blood donation and reduce the number of blood donors likely to donate during the window period of the infections.

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