# The risk of transfusion-transmitted viral infections at the Gabonese National Blood Transfusion Centre

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**Background.** Blood transfusions carry the risk of transmitting blood-borne infections. In contrast to the situation in the developed world, there is a limited number of studies examining this problem in sub-Saharan Africa. In this study we aimed to calculate the risks of acquiring human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) infection from units of blood issued by the Gabonese Blood Transfusion Centre between 2009 and 2011.

**Materials and methods.** All the donations were tested for infectious diseases and the seroconversion incidence rates of HIV, HBV and HCV were calculated. The residual risk of transfusion-associated transmission for each virus was calculated by multiplying the seroconversion rates by the window period expressed in fractions of a year.

**Results.** The risks of becoming infected with HIV, HCV, and HBV in subjects receiving units of blood from the Gabonese Blood Transfusion Centre were 64.7, 207.94 and 534.53 per million donations, respectively.

**Conclusions.** This study, which is the first to quantify the true risks of transfusion-transmitted infections in Gabon, reveals and confirms the need to reinforce preventative and screening strategies to improve transfusion safety in sub-Saharan Africa.

**Keywords:** HIV, HBV, HCV, transfusion-transmitted infections, risk.



## Introduction

The blood-transmissible character of viruses such as human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) has heightened public concern about the safety of blood transfusions. This is all the more the case in in developing countries in which blood transfusion is still challenging considering the high prevalence of blood-borne pathogens and the difficulties in ensuring a safe blood supply[1-5].In Gabon the seroprevalence of HIV, HBV and HCV in the general population is 5.2%[6], 11.1%[7] and 11.2%[8], respectively.

Monitoring the trends in the residual risks of transfusion-transmitted infections or the incidence of transmissible infectious agents in blood donations provides a way not only of evaluate the safety of the blood supply[9,10], but also of motivating the introduction of new sensitive screening techniques that will improved early detection of infected individuals[11-18].

The National Blood Transfusion Centre (CNTS) of Gabon currently selects blood donors on the basis of a health check questionnaire and serological screening for HIV, HCV and HBV antibodies and surface antigen, a method, which is less sensitive than nucleic acid screening tests (NAT).

Here we present the prevalence of HIV, HCV, and HBV among Gabonese blood donors and the incidence rates of seroconversion among blood donors for these major blood-borne viruses for the period 2009-2011.

## Materials and methods

Data analysed and reported here are based on the 2009-2011 CNTS records of blood donors containing donors' information and the results of the serological screening. All candidate blood donors sign a consent form giving the CNTS the right to use data associated with their donation for epidemiological research studies. The institutional review board at the CNTS approved this study protocol. The routine procedure for selecting donors includes: (i) a physical examination (body-mass index and blood pressure), (ii) a screening questionnaire (donor medical history) and (iii) blood tests for blood-borne pathogens. At the time of the study, screening for transfusion-transmissible infections relied on the use of fourth-generation tests that combine antibody/antigen detection, as recommended by the World Health Organization guidelines[11]. Briefly, HIV status was assessed using Genscreen ultra HIV Ag-Ab from Bio-rad (Marnes-la-Coquette, France); HCV was assessed using Monolisa HCV Ag-Ab ultra from Bio-rad, and HBV

was tested using HbsAg ultra from Bio-rad. If the first test was reactive, to confirm the infection the donor was called back and a supplemental test was done on a newly collected sample. If the result of the supplemental test was discrepant with the initial preliminary positive result, for HIV a western blot was used to rule out a false positive result using Inno-Lia™ HIV I/II Score (Innogenetics, Ghent, Belgium).

Prevalence and incidence rates were calculated for each infection. Prevalence rates were calculated as the number of reactive donations divided by the number of new donors, whereas incidence rates were calculated as the number of seroconverting donors divided by the total number of person-years at risk[19,20]. Seroconverting donors were donors who, within the study period, initially made a non-reactive donation and thereafter made a reactive donation confirmed to be positive for a transfusion-transmissible infection. The total number of person-years was calculated as described in the relevant literature[19,20]. HBV adjusted incidence rate were calculated using a method described by Schreiber *et al*.[19].

The residual risk or the probability that a seroconverting donor gave an infected blood unit that went undetected as seropositive during the window period was calculated by multiplying the incidences of seroconversion by the window periods, expressed in fractions of a year. The serological window periods used were 22 days for HIV[19,21], 59 days for HBV[19,21] and 66 days for HCV[22].

## Results

During the 3-year study period (2009-2011), 46,018 people were candidates for blood donation, 41,001 donated blood (Table I) and 23,396 made more than one donation.

### Prevalence of viral infections among blood donors

Between 2009 and 2011, the prevalence of HCV among donors increased by a factor of 5, from 1.19% to 6.04%, while the prevalence of HBV decreased from 8.84% to 6.2%. The prevalence of HIV ranged between 2.54% and 3.09% (Table II).

**Table I -** Blood donors screened in the years 2009-2011.

| Years | Blood donation candidates[1] | Deferred candidates[2] | Selected donors (*)[3] | Old donors[4] | New donors[5] | Family/ Replacement donors | Benevolent donors[6] | Female | Male |
|---|---|---|---|---|---|---|---|---|---|
| 2009 | 13,123 | 2,113 (16.1%) | 11,010 (83.9%) | 3,440 (31.2%*) | 7,570 (68.8%*) | 6,617 (60.1%*) | 4,393 (39.9%*) | 2,149 (19.5%*) | 8,861 (80.5%*) |
| 2010 | 14,577 | 1,621 (11.1%) | 12,956 (88.9%) | 4,674 (36.1%*) | 8,282 (63.9%*) | 6,177 (47.7%*) | 6,779 (52.3%*) | 2,867 (22.1%*) | 10,089 (77.9%*) |
| 2011 | 18,318 | 1,210 (6.6%) | 17,108 (93.4%) | 7,116 (41.6%*) | 9,992 (58.4%*) | 8,902 (52%*) | 8,206 (48%*) | 4,212 (24.6%*) | 12,896 (75.4%*) |
| 2009-2011 | 46,018 | 4,944 (10.7%) | 41,074 (89.3%) | 15,230 (37.1%*) | 25,844 (62.9%*) | 21,696 (52.8%*) | 19,378 (47.2%*) | 9,228 (22.5%*) | 31,846 (77.5%*) |

[1]All people who presented at the National Blood Centre willing to donate blood; [2]candidates who were not authorised to give blood because of their medical history or physical examination; [3]candidates who were cleared for blood donation after blood donor history questionnaires and physical examination; [4]returning or regular blood donors; [5]first-time blood donors; [6]volunteer donors.
*% calculated on the basis of selected donors, meaning that the number of selected donors was used as denominator.

**Table II -** Prevalence of infectious-disease markers among first-time donors.

| | Reactive donors | All donors | Prevalence rate (%) |
|---|---|---|---|
| *HCV* | | | |
| 2009 | 90 | 7,570 | 1.19 |
| 2010 | 25 | 8,282 | 0.30 |
| 2011 | 604 | 9,992 | 6.04 |
| 2009-2011 | 719 | 25,844 | 2.78 |
| *HBV* | | | |
| 2009 | 669 | 7,570 | 8.84 |
| 2010 | 165 | 8,282 | 1.99 |
| 2011 | 620 | 9,992 | 6.20 |
| 2009-2011 | 1,454 | 25,844 | 5.63 |
| *HIV* | | | |
| 2009 | 192 | 7,570 | 2.54 |
| 2010 | 299 | 8,282 | 3.61 |
| 2011 | 307 | 9,992 | 3.07 |
| 2009-2011 | 798 | 25,844 | 3.09 |

**Incidence of HIV, HCV and HBV seroconversion among blood donors**

The incidence rates of HIV (107.3 per 100,000) and HCV (115 per 100,000) seropositivity were similar and were each approximately two times higher than the crude incidence rate of HBsAg (52 per 100,000) (Table III). After adjusting the incidence rate of HBsAg to derive the incidence of HBV (348.4 per 100,000), the HBV infection rate estimate exceeded each of the other rates by a factor of two or more.

**Estimated risk of infectivity among blood donors**

Table III shows the estimated probability of viraemia at the time of blood donations that went undetected with the use of current serological tests. We established that the current risk of viral exposure per million donations was 64.7 for HIV, 207.94 for HCV and 534.53 for HBV.

## Discussion

Over the period 2009-2011, the risk of HIV transmission was estimated to be 64.7 per 1 million donations (serological screening tests). This risk is very high compared to what is seen in the developed world[20,22]. The high risk of HIV transmission observed in our setting is explained by our high incidence rate of seroconversion. Thus, the prevention of HIV infection in general population and better selection of donors would be important in reducing the risk of transmitting HIV infection via blood transfusions[9].

The prevalences of HIV, HCV and HBV among blood donors were lower than in the general population. Between 2009 and 2011 the prevalence of HCV among blood donors increased by a factor of 5. This increase in HCV prevalence can be explained by a change in the population of donors. Unlike in the preceding years, in 2011, most of the donors were from the HCV high-risk population[8] (donors aged between 25 and 64 years old) (*data not shown*). The risk of HCV transmission between 2009 and 2011 at the Gabonese National Blood Transfusion Centre was estimated to be 207.94 per 1 million donations (serological screening tests). The risk of HBV transmission, which was the highest of the three viruses, was estimated to be 534.53 per 1 million donations. The risk of transfusion-related transmission of HBV has been reported in literature to be higher than that of transmission of HIV and HCV[19,20]. Overall, the risk of transfusion-transmitted HIV, HCV and HBV infections in the setting of the Gabonese National Blood Transfusion Centre is higher than that in the developed world[20, 22-26].

Very few published data exist on the risk of transfusion-transmitted viral infections in sub-Saharan Africa. Lefrère *et al.*[27] reported findings in Blood Transfusion Centres from the Congo, the Ivory Coast, Mali and Senegal, showing lower (1.6-6 times) residual risk for HIV than what we observed at the Gabonese National Blood Transfusion Centre. Jayaraman *et al*.[28] estimated the median overall risks of becoming infected with HIV, HCV and HBV from a blood transfusion in sub-Saharan Africa as 1,000, 2,500 and 4,300 infections per 1 million units, respectively. These estimates are about 15, 12 and 8 times higher than what we observed for HIV, HCV and HBV respectively. Applied to Gabon, the model of Jayaraman *et al*. estimated HIV, HCV and HBV transfusion transmission risks as 3,030, 5,400 and 9,400 per 1 million units, respectively. These estimates are about 47, 25 and 18 times higher than what we actually observed for HIV, HCV and HBV, respectively. In the absence of real data mathematical models could be useful to quantify transfusion risks, but derived estimates could be lower or even higher than the true risk. In the case of Gabon we found the risks derived from such models were very high compared to the true risk.

Rigorous donor selection and preventive measures such as increasing the coverage of HBV vaccination, adequate disinfection procedures of equipment shared among patients (e.g. in the haemodialysis centre) and all other practices to prevent HIV, HCV and HBV should be taken across sub-Saharan Africa to reduce the risk of transfusion-transmitted viral infections.

Although donor pre-screening and preventive measures to avoid nosocomial infections in the general population have been shown to have a positive impact on the residual risk of transfusion-transmitted infections, the improvement over time of blood screening tests (or diagnostic tools) is an important factor in the reduction of the residual risk of transfusion transmitted infections[15,16].

**Table III** - Seroconversion incidence rates and residual risks of transfusion-transmitted infection in the blood supply associated with window-period donations by converting donors.

| **Incidence rates of seroconversion associated with each of three blood-borne pathogens** | | | | **Residual risks of transfusion-transmitted infection in the blood supply associated with window-period donations by seroconverting donors** | |
|---|---|---|---|---|---|
| *Infection* | *N. of seroconversions* | *N. of person-years* | *Incidence rate per 100,000 person-years* | *Length of window period (days)* | *Estimate of residual risk* |
| HIV | 29 | 27,033 | 107.3 | 21 | 1 in 15,462 |
| HBV | 14 | 27,019 | 348.4 (52*) | 59 | 1 in 1,775.7 |
| HCV | 31 | 27,015 | 115 | 66 | 1 in 4,808 |

*Incidence rate before correcting to account for the transient antigenemia.

## Conclusions

Overall, we believe that stringent donor pre-screening and preventive measures to control infections in the general population must be coupled with new and more sensitive screening tests in order to achieve a significant reduction of the risk of transfusion-transmitted viral infections in Gabon and across sub-Saharan Africa.

## Authorship contributions

Leonard Kounegnigan Rerambiah and Joel F. Djoba Siawaya partecipated equally to this work.

*The Authors declare no conflicts of interest.*

## References


1) Stokx J, Gillet P, De Weggheleire A, et al. Seroprevalence of transfusion-transmissible infections and evaluation of the pre-donation screening performance at the Provincial Hospital of Tete, Mozambique. BMC Infect Dis 2011; **11**: 141.
2) Osaro E, Charles AT. The challenges of meeting the blood transfusion requirements in Sub-Saharan Africa: the need for the development of alternatives to allogenic blood. J Blood Med 2011; **2**: 7-21.
3) Diarra A, Kouriba B, Baby M, et al. HIV, HCV, HBV and syphilis rate of positive donations among blood donations in Mali: lower rates among volunteer blood donors. Transfus Clin Biol 2009; **16**: 444-7.
4) Fouelifack Ymele F, Keugoung B, Fouedjio JH, et al. High rates of hepatitis B and C and HIV infections among blood donors in Cameroon: a proposed blood screening algorithm for blood donors in resource-limited settings. J Blood Transf 2012; **2012**: 1-7.
5) Ampofo W, Nii-Trebi N, Ansah J, et al. Prevalence of blood-borne infectious diseases in blood donors in Ghana. J Clin Microbiol 2002; **40**: 3523-5.
6) Gabon DGPS. *Rapport National sur la réponse au VIH/SIDA*. Libreville: Ministère de la Santé, 2012.
7) Dazza MC, Trebucq A, Gaudebout C, et al. Population-based study of serum hepatitis B virus DNA in Gabon. Trans R Soc Trop Med Hyg 1993; **87**: 539-40.
8) Njouom R, Caron M, Besson G, et al. Phylogeography, risk factors and genetic history of hepatitis C virus in Gabon, central Africa. PLoS One 2012; **7**: e42002.
9) Polizzotto MN, Wood EM, Ingham H, Keller AJ. Reducing the risk of transfusion-transmissible viral infection through blood donor selection: the Australian experience 2000 through 2006. Transfusion 2008; **48**: 55-63.
10) Glynn SA, Kleinman SH, Schreiber GB, et al. Trends in incidence and prevalence of major transfusion-transmissible viral infections in US blood donors, 1991 to 1996. Retrovirus Epidemiology Donor Study (REDS). JAMA 2000; **284**: 229-35.
11) World Health Organization. *Screening donated blood for transfusion-transmissible infections: recommendations*. Geneva: WHO Press; 2009.
12) Al Shaer L, Abdul Rahman M, John TJ, Al Hashimi A. Trends in prevalence, incidence, and residual risk of major transfusion-transmissible viral infections in United Arab Emirates blood donors: impact of individual-donation nucleic acid testing, 2004 through 2009. Transfusion 2012; **52**: 2300-9.
13) Vrielink H, Reesink HW. Transfusion-transmissible infections. Curr Opin Hematol 1998; **5**: 396-405.
14) Pomper GJ, Wu Y, Snyder EL. Risks of transfusion-transmitted infections: 2003. Curr Opin Hematol 2003; **10**: 412-8.
15) Cable R, Lelie N, Bird A. Reduction of the risk of transfusion-transmitted viral infection by nucleic acid amplification testing in the Western Cape of South Africa: a 5-year review. Vox Sang 2013; **104**: 93-9.
16) Stramer SL, Notari EP, Krysztof DE, Dodd RY. Hepatitis B virus testing by minipool nucleic acid testing: does it improve blood safety? Transfusion 2013; **53** (Suppl 3): 2449-58.
17) Laperche S. Multinational assessment of blood-borne virus testing and transfusion safety on the African continent. Transfusion 2013; **53**: 816-26.
18) Tagny CT, Mbanya D, Leballais L, et al. Reduction of the risk of transfusion-transmitted human immunodeficiency virus (HIV) infection by using an HIV antigen/antibody combination assay in blood donation screening in Cameroon. Transfusion 2011; **51**: 184-90.
19) Schreiber GB, Busch MP, Kleinman SH, Korelitz JJ. The risk of transfusion-transmitted viral infections. The Retrovirus Epidemiology Donor Study. N Engl J Med 1996; **334**: 1685-90.
20) Pillonel J, Laperche S. Trends in residual risk of transfusion-transmitted viral infections (HIV, HCV, HBV) in France between 1992 and 2002 and impact of viral genome screening (Nucleic Acid Testing) [in French]. Transfus Clin Biol 2004; **11**: 81-6.
21) Jackson BR, Busch MP, Stramer SL, AuBuchon JP. The cost-effectiveness of NAT for HIV, HCV, and HBV in whole-blood donations. Transfusion 2003; **43**: 721-9.
22) Chiavetta JA, Escobar M, Newman A, et al. Incidence and estimated rates of residual risk for HIV, hepatitis C, hepatitis B and human T-cell lymphotropic viruses in blood donors in Canada, 1990-2000. CMAJ 2003; **169**: 767-73.
23) Dodd RY, Notari EPt, Stramer SL. Current prevalence and incidence of infectious disease markers and estimated window-period risk in the American Red Cross blood donor population. Transfusion 2002; **42**: 975-9.
24) Tosti ME, Solinas S, Prati D, et al. An estimate of the current risk of transmitting blood-borne infections through blood transfusion in Italy. Br J Haematol 2002; **117**: 215-9.
25) Kim MJ, Park Q, Min HK, Kim HO. Residual risk of transfusion-transmitted infection with human immunodeficiency virus, hepatitis C virus, and hepatitis B virus in Korea from 2000 through 2010. BMC Infect Dis 2012; **12**: 160.
26) Dodd RY. Current safety of the blood supply in the United States. Int J Hematol 2004; **80**: 301-5.
27) Lefrère JJ, Dahourouh H, Dokekias AE, et al. Estimate of the residual risk of transfusion-transmitted human immunodeficiency virus infection in sub-Saharan Africa: a multinational collaborative study. Transfusion 2011; **51**: 486-92.
28) Jayaraman S, Chalabi Z, Perel P, et al. The risk of transfusion-transmitted infections in sub-Saharan Africa. Transfusion 2010; **50**: 433-42.


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