

## Excluding blood donors at high risk of HIV infection in a west African city

Richard Schutz, Dominique Savarit, Jean-Claude Kadjo, Veronique Batter, N'Valy Kone, Guy La Ruche, Alain Bondurand, Kevin M De Cock

### Abstract

**Objective**—To examine the potential impact of deferral of blood donors at high risk of HIV infection in a west African city where blood is screened for HIV antibodies but no other special measures are taken to protect the blood supply.

**Design**—Cross sectional study.

**Setting**—National Blood Transfusion Centre and Project RETRO-CI, an international collaborative AIDS research project, Abidjan, Côte d'Ivoire.

**Subjects**—1257 male first time blood donors.

**Interventions**—Blood donors were interviewed about demographic and behavioural characteristics and tested for HIV antibodies by enzyme immunoassay and, if positive, synthetic peptide based tests.

**Main outcome measures**—HIV antibody status in relation to presence of behavioural risk factors; calculation of sensitivity, specificity, and predictive values of specific criteria for excluding HIV infected donors.

**Results**—The overall prevalence of HIV infection was 11.4%. The most important risk factors for HIV positivity were prostitute contact and being aged 30-39 years. For identifying seropositive donors individual criteria had sensitivity, specificity, and positive predictive values ranging from 15% to 98%, 38% to 91%, and 17% to 30% respectively. Prostitute contact in the past five years would have excluded 31% of all donors and 73% of HIV infected donors. 27% of those excluded would have been HIV positive.

**Conclusions**—The widespread assumption that donor deferral is not feasible in sub-Saharan Africa needs reassessment. In Abidjan this approach was well accepted and potentially effective. Donor deferral requires evaluation as a strategy for improving blood safety in resource poor areas with high rates of HIV infection.

### Introduction

Prevention of transfusion transmitted HIV infection in industrialised countries has been achieved by reducing unnecessary transfusions, using only voluntary donors, excluding donors with specific risks for HIV infection, and systematic screening of all donated blood for HIV antibodies.<sup>1,2</sup> By contrast, in many developing countries none of these interventions is applied uniformly and the risk of HIV infection as a result of blood transfusion remains high.<sup>3,5</sup> Though considerable investment has been made in increasing access to blood screening,<sup>6</sup> not all transfused blood can be tested.<sup>7,8</sup> Moreover, the high incidence and prevalence of HIV infection in blood donors in many African countries means that some infected units will escape laboratory detection through error or because the infected donor has not yet seroconverted.<sup>9</sup>

Although there has been little systematic study, it has been assumed that excluding high risk donors in Africa is not possible because rates of HIV infection in the general population are high (N Nzila, R L Colebunders, J M Mann, H Francis, K Nseka, and J W Curran, paper presented at third international conference on AIDS, Washington, 1987 (abstract W4.6)).<sup>10</sup> We assessed whether excluding donors likely to be infected with HIV was feasible in a large west African city and what the impact might be on the blood transfusion service in terms of availability of blood.

### Subjects and methods

Abidjan, the largest city in Côte d'Ivoire, has a population of around 2 million. Blood for the city and the surrounding area is provided by the Centre National de Transfusion Sanguine, which in 1990 collected 30 165 units. The study was conducted between February and November 1991 and was restricted to first time donors. These made up 42% of the donor pool, the rest being repeat donors (52%) or family members or acquaintances of patients in hospital (6%). Because only 13% of donors were women, this report concerns only men. Blood donation is voluntary.

**Interviews with donors**—Donors participating in the study were a sample of convenience recruited in a non-selective, arbitrary manner depending on availability of staff. Donors were asked to respond to a verbal questionnaire administered by one of three male clerks who volunteered. The questionnaires concerned basic descriptive and demographic information as well as sexual behaviour, including sex with prostitutes. Having multiple sex partners was defined as having more than one sex partner in the previous 12 months. Having sex with a prostitute was defined as exchanging money or goods for sexual intercourse.

**HIV serology**—Donated blood was screened for antibodies to HIV-1 and HIV-2 by means of an enzyme immunoassay from one of several manufacturers (Boehringer Mannheim; Diagnostics Pasteur, Paris; Abbott Laboratories, Frankfurt). Samples reactive on screening were tested by one of the other enzyme immunoassays. Repeatedly reactive specimens were further tested by a synthetic peptide based assay (Pepti LAV 1-2, Diagnostics Pasteur).<sup>11</sup> All units of blood reactive in the first assay were discarded.

**Statistical analysis**—Data were analysed by computer software packages for epidemiological and statistical studies (EPI-INFO 5.1; SAS 6.04; BMDP (1990)). For analysis no distinction was made between HIV-1, HIV-2, or dual serological reactivity, subjects being grouped as HIV positive or HIV negative. Variables associated with HIV positivity on univariate analysis were assessed in a multivariate analysis by using logistic regression.

Centre National de  
Transfusion Sanguine,  
Abidjan, Côte d'Ivoire  
Richard Schutz, medical  
officer

Dominique Savarit,  
laboratory scientist  
N'Valy Kone, medical officer  
Alain Bondurand, director

Projet Santé Abidjan,  
Abidjan, Côte d'Ivoire  
Guy La Ruche, medical  
officer

Projet RETRO-CI,  
Abidjan, Côte d'Ivoire  
Jean-Claude Kadjo, computer  
operator  
Kevin M De Cock, director

Division of HIV/AIDS,  
National Center for  
Infectious Diseases,  
Centers for Disease  
Control and Prevention,  
Atlanta, Georgia, USA  
Veronique Batter, statistician

Correspondence to:  
Dr Kevin M De Cock,  
Department of Clinical  
Sciences, London School  
of Hygiene and Tropical  
Medicine, London  
WC1E 7HT.

BMJ 1993;307:1517-9

## Results

All men invited to participate agreed. Of the 1257 donors interviewed and tested, 143 (11.4%) were HIV positive. Characteristics of the study population are shown in table I. Most of the donors were born in Côte d'Ivoire, were aged 20-29, and had at least secondary education.

Table II lists the risk factors for HIV infection on univariate analysis. Sixty six (5%) of the men reported only one sex partner in the previous 12 months and 360 (29%) no sex partner. The two thirds (831/1257) of men with more than one sex partner in the previous year accounted for 140 (98%) of the 143 HIV infections. HIV seroprevalence rates in men with no sex partner, one partner, or multiple partners in the previous year were nil, 1%, and 17% respectively ( $p < 0.001$ ).

Risk factors significantly associated with HIV infection included multiple sex partners, a history of sex with prostitutes, a history of sexually transmitted diseases, age 20 or older, and being illiterate. Being celibate protected against HIV infection ( $p < 0.01$ ).

In the multivariate analysis sex with prostitutes in the past five years without regular use of condoms was the strongest risk factor for HIV infection (odds ratio 10.0; 95% confidence interval 6.6 to 15.0). Once this factor was included in the model, being aged 30-39 remained the only variable significantly associated (odds ratio 6.9; 2.6 to 18.0). Prostitute contact in the past five years (irrespective of condom use) was almost as strong a risk factor in the multivariate model (odds ratio 8.4; 5.6 to 12.6) as prostitute contact without regular condom use.

Table III gives the sensitivity, specificity, and positive and negative predictive values for individual criteria for determining whether a donor was infected with HIV and the proportion of all donors who would have been excluded. Individual criteria had sensitivity values ranging from 15% to 98% for identifying seropositive donors, specificity ranging from 38% to 91%. Positive predictive value—that is, the proportion

of donors responding positively to a criterion and who were infected with HIV—ranged from 17% to 30%. Prostitute contact in the past five years without regular condom use was associated with a sensitivity of 72% and the highest positive predictive value recorded (30%). Rates of sensitivity and positive predictive value for prostitute contact in the past five years irrespective of condom use were 73% and 27% respectively. Either criterion would have excluded fewer than one third of all donors.

## Discussion

In Zaire Nzila *et al* (third international conference on AIDS, Washington, 1987 (abstract W4.6)) found no clinical differences between HIV positive and HIV negative donors, leading to the widespread assumption that excluding donors at high risk of HIV infection was unfeasible in Africa.<sup>10</sup> Though HIV testing of donated blood is the rule in most major African cities, deferral of high risk donors has not been adopted to any significant degree. This study is one of the first attempts to examine systematically the potential impact of such an intervention.

As shown in other groups in Abidjan<sup>12</sup> and elsewhere in Africa,<sup>13</sup> blood donors with HIV infection had certain well defined risk factors. Selected characteristics strongly associated with HIV seropositivity included contact with women prostitutes, especially without regular condom use, a history of sexually transmitted diseases, and age. Thus even in areas with high rates of HIV infection not everyone is at equal risk. It should therefore be feasible to identify those most likely to be HIV positive and exclude them from donating blood.

A history of contact with prostitutes in the past five years identified 73% of infected donors (104/143; sensitivity 73%) and was absent in 75% of HIV negative donors (834/1114; specificity 75%). Of all donors with this history, 27% (104/384) were HIV infected (positive predictive value 27%). Applying this criterion would have resulted in 31% of all units being discarded (table III). Thus at a cost of less than one third of the total units of blood donated almost three quarters of infected units could have been excluded, and over a quarter of units excluded would have been from donors who were infected with HIV. Using more complicated criteria for donor exclusion—for example, prostitute contact in the past five years or age 30-39, or both—was more sensitive for identifying infected donors but would have resulted in over half the donors being rejected.

There are at least three advantages of excluding high risk donors for blood transfusion services in a developing country. Firstly, less of scarce resources will be spent on supplemental testing or other interventions for HIV positive subjects; donors at high risk of infection could be referred to the appropriate services for testing, counselling, and follow up. Secondly,

TABLE I—Characteristics of study population

|                       | No (%) of subjects |
|-----------------------|--------------------|
| Age (years)*:         |                    |
| 15-19                 | 137 (11)           |
| 20-29                 | 775 (62)           |
| 30-39                 | 234 (19)           |
| ≥ 40                  | 111 (9)            |
| Origin:               |                    |
| Born in Côte d'Ivoire | 1120 (89)          |
| Immigrant             | 137 (11)           |
| Educational level:    |                    |
| Illiterate            | 116 (9)            |
| Primary education     | 347 (28)           |
| Secondary education   | 794 (63)           |
| Total                 | 1257 (100)         |

\*Median age of subjects was 25. Age range was 16-60.

TABLE II—Risk factors for HIV infection in 1257 first time blood donors (univariate analysis)

|  | No (%) of HIV positive subjects | No (%) of HIV negative subjects | Odds ratio (95% confidence interval) |
|--|---------------------------------|---------------------------------|--------------------------------------|
| More than one sex partner in past 12 months                          | 140 (98)                        | 691 (62)                        | 28.6 (9.5 to 140.9)                  |
| Prostitute contact ever  | 120 (84)                        | 497 (45)                        | 6.5 (4.0 to 10.6)                    |
| Prostitute contact in past five years                                | 104 (73)                        | 280 (25)                        | 7.9 (5.3 to 12.0)                    |
| Prostitute contact in past five years without regular use of condoms | 103 (72)                        | 240 (22)                        | 9.4 (6.2 to 14.2)                    |
| Never used condoms   | 95 (66)                         | 677 (61)                        | 1.3 (0.9 to 1.9)                     |
| Sexually transmitted disease in past five years                      | 63 (44)                         | 336 (30)                        | 1.8 (1.3 to 2.6)                     |
| Several sexually transmitted diseases                                | 61 (43)                         | 266 (24)                        | 2.4 (1.6 to 3.5)                     |
| Several sexually transmitted diseases in past five years             | 39 (27)                         | 171 (15)                        | 2.1 (1.4 to 3.2)                     |
| Illiterate   | 21 (15)                         | 95 (9)                          | 1.9 (1.1 to 3.2)                     |
| Immigrant  | 19 (13)                         | 118 (11)                        | 1.3 (0.7 to 2.2)                     |
| Age 20-39  | 128 (90)                        | 881 (79)                        | 2.3 (1.3 to 4.1)                     |
| Total  | 143 (100)                       | 1114 (100)                      |                                      |

TABLE III—Effects of excluding blood donors according to specific criteria. Results expressed as numbers (%) of subjects

|  | Sensitivity (proportion of HIV positive donors excluded) | Specificity (proportion of HIV negative donors not excluded) | Positive predictive value (proportion of donors excluded who were HIV positive) | Negative predictive value (proportion of donors not excluded who were HIV negative) | All excluded  |
|--|--|--|---|---|---------------|
| More than one sex partner in past 12 months                          | 140/143 (98)   | 423/1114 (38)  | 140/831 (17)  | 423/426 (99)  | 831/1257 (66) |
| Prostitute contact ever  | 120/143 (84)   | 617/1114 (55)  | 120/617 (19)  | 617/640 (96)  | 617/1257 (49) |
| Prostitute contact in past five years                                | 104/143 (73)   | 834/1114 (75)  | 104/384 (27)  | 834/873 (96)  | 384/1257 (31) |
| Prostitute contact in past five years without regular use of condoms | 103/143 (72)   | 874/1114 (78)  | 103/343 (30)  | 874/914 (96)  | 343/1257 (27) |
| Several sexually transmitted diseases in past five years             | 39/143 (27)  | 943/1114 (85)  | 39/210 (19)   | 943/1047 (90)   | 210/1257 (17) |
| Illiterate   | 21/143 (15)  | 1019/1114 (91)   | 21/116 (18)   | 1019/1141 (89)  | 116/1257 (9)  |
| Age 30-39  | 51/143 (36)  | 931/1114 (84)  | 51/234 (22)   | 931/1023 (91)   | 234/1257 (19) |
| Prostitute contact in past five years or aged 30-39                  | 123/143 (86)   | 690/1114 (62)  | 123/547 (22)  | 690/710 (97)  | 547/1257 (44) |

## Clinical implications

- HIV infected blood may still be transfused in Africa because of lack of access to HIV testing, lack of adequate laboratory quality control, and from donors being in the seroconversion period
- Donor deferral has not been thought feasible in Africa because heterosexual transmission accounts for most cases of HIV infection, making risk groups difficult to identify
- Not everyone is at equal risk for HIV infection; in Abidjan, Côte d'Ivoire, important risk factors for HIV infection among male blood donors were prostitute contact and age
- Behavioural characteristics identified a large proportion of donors who were most likely to be HIV infected; a history of prostitute contact in the past five years identified 73% of HIV infected donors while being present in 31% of all donors
- Excluding donors based on behavioural characteristics of those most at risk of HIV infection is feasible in Abidjan. Donor deferral merits evaluation as an intervention to improve blood safety in developing countries

serological testing cannot identify donors in the seroconversion period; exclusion on risk factors may be the only way to deal with what could be a common finding in areas of high incidence of HIV infection.<sup>9</sup> Lastly, laboratory errors are inevitable, and false negative results are less likely when HIV prevalence in the donor pool is low.

The absence of donor exclusion before the introduction of HIV antibody testing may in part explain the greater number of HIV infected transfusion recipients in France than in other European countries.<sup>14</sup> Even with blood screening, the current risk of transfusion transmitted HIV infection in Abidjan—and presumably in other African cities with high HIV infection incidence and prevalence—exceeds that which existed in industrialised countries at the beginning of the HIV epidemic.<sup>9</sup>

Although the priority must remain to extend HIV testing to all units of blood transfused, donor deferral merits investigation in resource poor areas. Exclusion criteria may differ between societies, and this study should be repeated in other developing countries. Additional requirements for improved blood safety in the developing world are country specific guidelines and supervision of transfusion practices and more emphasis on eliminating all but lifesaving transfusions.

- 1 Doll LS, Petersen LR, White CR, Ward JW, HIV Blood Donor Study Group. Human immunodeficiency virus type 1 infected blood donors: behavioral characteristics and reasons for donation. *Transfusion* 1991;31:704-9.
- 2 Mann J, Tarantola DJM, Netter TW, eds. Blood safety and blood products. In: *AIDS in the world*. Cambridge, Mass: Harvard University Press, 1992:421-37.
- 3 Chin J, Mann JM. Global surveillance and forecasting of AIDS. *Bull World Health Organ* 1989;67:1-7.
- 4 Greenberg AE, Nguyen-Dinh P, Mann JM, Kabote N, Colebunders RL, Francis H, et al. The association between malaria, blood transfusions and HIV seropositivity in a pediatric population in Kinshasa, Zaire. *JAMA* 1988;259:545-9.
- 5 Lackritz EM, Campbell CC, Ruebush TK II, Hightower AW, Wakube W, Steketee RW, et al. Effect of blood transfusion on survival among children in a Kenyan hospital. *Lancet* 1992;340:524-8.
- 6 Jager H, Jersiid C, Emmanuel JC. Safe blood transfusions in Africa. *AIDS* 1991;5:S163-8.
- 7 N'tita I, Mulanga K, Dulac C, Lusamba D, Rehle H, Korte R, et al. Risk of transfusion-associated HIV infection in Kinshasa, Zaire. *AIDS* 1991;5: 437-41.
- 8 Ryder RW. Difficulties associated with providing an HIV-free blood supply in tropical Africa. *AIDS* 1992;6:1395-7.
- 9 Savarit D, De Cock KM, Schutz R, Konate S, Lackritz E, Bondurand A. Risk of HIV infection from transfusion with blood negative for HIV antibody in a west African city. *BMJ* 1992;305:498-501.
- 10 Piot P, Harris J, Lamptey P. HIV and AIDS epidemiology. In: *The handbook to AIDS prevention in Africa*. Durham, NC: Family Health International, 1990:1-15.
- 11 De Cock KM, Porter A, Kouadio J, Maran M, Gnaore E, Adjorlolo G, et al. Rapid and specific diagnosis of HIV-1 and HIV-2 infections: an evaluation of testing strategies. *AIDS* 1990;4:875-8.
- 12 Diallo MO, Ackah AN, Lafontaine M-F, Doorly R, Roux R, Kanga J-M, et al. HIV-1 and HIV-2 infections in men attending sexually transmitted disease clinics in Abidjan, Côte d'Ivoire. *AIDS* 1992;6:581-5.
- 13 Berkley SF, Widy-Wirski R, Okware SE, Downing R, Linnan MJ, White KE, et al. Risk factors associated with HIV infection in Uganda. *J Infect Dis* 1989;60:22-30.
- 14 Setbon M. Quand punir n'explique rien. *Le Monde* 1993:May 6.

(Accepted 22 September 1993)

## Early growth and death from cardiovascular disease in women

C Osmond, D J P Barker, P D Winter, C H D Fall, S J Simmonds

### Abstract

**Objective**—To determine whether the link suggested between growth in utero and during infancy and death from cardiovascular disease in men is also present in women.

**Design**—Follow up study of women and men whose birth weight and weight at 1 year of age had been recorded.

**Setting**—Hertfordshire, England.

**Subjects**—5585 women and 10141 men born during 1911-30.

**Main outcome measures**—Standardised mortality ratios for cardiovascular disease.

**Results**—Among women and men death rates from cardiovascular disease fell progressively between the low and high birth weights groups ( $\chi^2=4.3$ ,  $p=0.04$  for women,  $\chi^2=8.5$ ,  $p<0.005$  for men). Cardiovascular deaths in men but not women were also strongly related to weight at 1 year, falling progressively between the low and high weight groups ( $\chi^2=27.5$ ,  $p<0.0001$ ). The highest cardiovascular death rates in women were among those with below average birth weight but above average weight at 1 year. In men the highest rates were among those with below average birth weight and below average weight at 1 year.

**Conclusion**—Relations between cardiovascular

disease and birth weight are similar in men and women. In men cardiovascular disease is also related to weight gain in infancy.

### Introduction

The first direct evidence that coronary heart disease may originate in utero and during infancy came from a study of men born in Hertfordshire, England.<sup>1</sup> The birth weight and weight at 1 year of all babies born in the county since 1911 had been recorded. Among 5654 men born during 1911-30, death rates from coronary heart disease fell progressively between those with the lowest and highest weights at 1 year. There were similar, though less strong, trends with birth weight. A study of 1586 men born in Sheffield similarly showed that death rates from cardiovascular disease fell progressively between those who had low and high birth weight.<sup>2</sup> This trend did not depend on differences in the length of gestation and therefore reflected differences in fetal growth rates.

Subsequent studies suggested that growth in utero and during infancy and the method of infant feeding were linked to the main risk factors for cardiovascular disease. Men and women who had had reduced rates of fetal growth or low weights at 1 year had raised prevalences of hypertension and non-insulin dependent

MRC Environmental Epidemiology Unit, University of Southampton, Southampton General Hospital, Southampton SO9 4XY  
C Osmond, *statistician*  
D J P Barker, *director*  
P D Winter, *computing manager*  
C H D Fall, *paediatrician*  
S J Simmonds, *research assistant*

Correspondence to: Professor Barker.

BMJ 1993;307:1519-24