HEALTH POLICY AND PLANNING; 16(1): 41–46

Prevalence of HIV infection among former commercial plasma donors in rural eastern China

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Background: Sporadic reports of HIV-1 infection among commercial plasma donors in China between 1994 and 1995.

Objectives: (1) To determine the prevalence of HIV infection among repeat plasma donors; (2) to identify factors associated with HIV infection; and (3) to describe characteristics associated with secondary transmission.

Methods: Plasma/blood donors who had a history of donating plasma/blood before March 1, 1995, their spouses, and their children under 5 years were recruited for a cross-sectional study. A questionnaire and an HIV test were collected anonymously. Information collected included demographic characteristics, sexual behaviour, recreational drug use and history of medical care and blood/plasma donation. HIV antibody was identified by the Hema-Strip rapid test and confirmed by Western blot. The prevalence of HIV infection was calculated and risk factors associated with infection determined by univariate analyses followed by multivariate modelling.

Results: A total of 1517 individuals were interviewed and tested, of whom 1043 adults admitted to donating plasma. The prevalence of HIV infection among plasma donors was 12.5% and among their non-donor spouses was 2.1%. Prevalence was inversely related to educational level and was higher in married participants, but was not associated with medical care, drug abuse or multiple sexual partners. A higher frequency of plasma donation was directly associated with a higher risk of HIV infection. Multivariate analyses demonstrated that being HIV-positive was associated with being 30 to 49 years old [odds ratio (OR) = 1.9], donating both plasma and blood (OR = 2.5), and the frequency of plasma donation (OR = 14 for >10 donations per month).

Conclusion: The study demonstrated that the prevalence of HIV infection in the commercial plasma donor population was alarmingly high. Many married individuals and those getting married in the future will transmit the virus to their spouses and future children. Plasma donors need to be alerted to the risk of being infected with HIV and of transmitting HIV to their families and others. Other countries can benefit from the experience of China in reducing the risk of HIV transmission from plasma donating.

Introduction

The human immunodeficiency virus type 1 (HIV-1) has spread rapidly in Asia since 1989.[1–3] Many of these countries have insufficient funds to test all blood and plasma donors, and several do not inform donors who are found to be HIV-1 antibody-positive that they are infected. HIV infection through plasma donation has been reported in a few developing countries, including China.[4–6]

Thousands of commercial plasma collection centres were established in counties, townships, and villages in China between 1990 and 1994, the majority in rural areas. Donating plasma for money was an easy way for rural farmers to augment their income. The majority of paid plasma donors were adults aged 20–50 years. The shortest interval allowed between each donation was 15 days for plasma and 3 months for whole blood, according to the national regulation for plasma and blood donations. This regulation was followed by most commercial plasma collection centres operated by local government health institutions. Private commercial plasma collection centres, however, often did not follow the regulation.

According to the staff of the private plasma collection centres, a donor would receive 50 yuan (approximate US$6) for each plasma donation and 200 yuan (approximate US$25) for each donation of whole blood. The average monthly

income from farming is US$9–12. Plasma donation was much more popular than whole blood donation because of the commercial demand for plasma. To generate more money, donors often patronized several plasma collection centres and sometimes used false names to avoid the requirement for at least a 15-day interval between plasma donations. The actual frequency of most donations varied from twice a week to twice a month, although some individuals donated as often as every other day.

A physical examination and testing for antibodies against hepatitis B and C was required for each donation. If a donor had antibody against hepatitis B or C, she/he would be disqualified. However, the HIV-1 antibody test was not required before 1995, and thus was not performed at any of the local plasma collection centres.

Usually 800 milliliters of peripheral blood was drawn for each plasma donation. After the plasma was separated from the whole blood, the red blood cells were re-injected back into the donor intravenously. Contamination of red blood cells during the process of obtaining plasma was strongly suggested by the high prevalence of hepatitis C antibody among repeat plasma donors – about 91% in old plasma donors, compared with 3% in new plasma donors.[7,8] Sporadic reports of HIV infection among commercial plasma donors from different geographic areas suggested that outbreaks of HIV infection among this population were occurring among donors as early as 1994 to 1995.

As soon as the problem became apparent, the government of China took strong action to prevent further spread of HIV infection through blood/plasma by temporarily closing all commercial plasma collection centres and issuing new regulations for blood/plasma donation. The extent of the HIV epidemic among commercial plasma donors, however, has not been previously assessed. This study determined the prevalence of HIV-1 infection in repeat plasma donors and factors associated with HIV infection in three counties located in eastern China. The information from the study will be relevant to other countries that have not regulated plasma donations and which, therefore, may have reservoirs of infected plasma donors who are transmitting HIV to others.

Methods

Study population

The region selected for study was in eastern China and included 10 counties with a population of 70 million. Agriculture was the major local occupation. The average income in the region was below the average for China. Thus, many young people temporally migrated to cities looking for jobs during the farming off-season. We have previously reported three HIV-1 infected donors from this region.[8]

Donating plasma for money was very popular in the region from 1992 to 1995. Almost every county had a plasma collection centre. Most donors were farmers from rural villages. Often donors were organized by a plasma 'pimp' to donate plasma. Each commercial plasma collection centre usually had one coordinator assisted by three to five 'pimps'.

The selection of the counties to be studied was based on three criteria: (1) plasma donation was common between 1992 and 1995; (2) the prevalence of hepatitis C among donors had been documented to be high; and (3) the local health department was willing to cooperate.[7,8] Based on these criteria, three counties were selected.

In the spring of 1995 all commercial plasma collection centres were closed. Most centres destroyed their records of donors in order to avoid potential problems. We asked former coordinators and their 'pimps' to generate a list of villages from which many commercial plasma donors had been recruited. On this basis, six villages were selected from county 1, five from county 2 and seven from county 3.

In each of the selected villages, families were identified who had members who had donated plasma/blood before March 1, 1995. Donors, their spouses, if they were married, and their children under 5 years old were included as study subjects.

Collection of information

A questionnaire and a blood specimen for HIV testing were collected anonymously by interviewers separately for plasma donors and their spouses. Information collected included: (1) age, gender, marital status, education, religion, area of residence and occupation; (2) number of sexual partners in lifetime, condom use and contraceptive methods; (3) history of recreational drug use, drug injecting experience, sharing of equipment and number of sharing partners; (4) history of dental care, surgery, blood transfusions, prior testing for hepatitis and HIV; and (5) year first donated plasma, the number of years donated, the type of donation and the frequency of donation.

HIV testing

The Hema-Strip rapid test was used for screening for HIV antibody using finger stick blood. A venous specimen was collected from those donors and their family members who were positive to the Hema-Strip test for confirmation of their HIV positivity. The Western blot assay (Genelabs Diagnostics Pet Ltd.) was used for confirmation of the Hema-Strip positive test. The Western blots were performed at the laboratory of the National Center for AIDS Prevention and Control, Chinese Academy of Preventive Medicine.

Data analysis

HIV infection was the outcome variable. Demographic variables, sexual behaviour, drug use, medical care, and plasma donation variables were treated as independent variables to identify factors associated with HIV infection. Univariate analyses were done first, followed by multivariate modelling. The logistic model was used for multivariate analyses. The Pearson Chi-squared test was used to evaluate differences of prevalence between groups in the univariate analyses. Odds ratios (ORs) with 95% confidence intervals (95% CI) were

used to determine whether a variable was associated with HIV infection.

Results

Of the 1517 individuals interviewed and tested for HIV antibody, 1043 adults admitted to donating plasma. One hundred and twenty-one of the 130 children less than 19 years old came from county 1. Because of sensitivity about numbers of children (China has a mandatory one-child policy) and preference for male children, we could not enumerate children in counties 2 and 3. The demographic characteristics of participants are presented in Table 1. The ratio of male to female participants was 0.96. Ninety percent were married and 77% were aged 20–49. Ninety-eight percent were farmers and 46% were illiterate. Thirty-three percent reported a history of invasive medical care in the 3 years before the survey and 6% reported having had extramarital sex in their lifetime. Of the 1043 blood/plasma donors, 179 (17%) reported having been rejected for donation of either blood or plasma at least once.

The prevalence of HIV infection by demographic characteristics is also given in Table 1. The overall prevalence of HIV infection was 8.9%. The prevalence varied from 6.8 to 10.4% among the three counties. The difference between counties was not statistically significant. The prevalence of HIV was similar among males and females in counties 2 and 3, but was 2.3 times higher in females in county 1 ($p = 0.003$). The prevalence was inversely related to educational level ($p = 0.001$). The prevalence of infection was highest among 40–49 year olds (12.9%) and was over 6.2% in those of marriageable age (20–29 years).

Table 2 indicates that the prevalence of HIV infection was not associated with medical care (i.e. surgeries, transfusion, dental care and transplants), drug abuse or having multiple (premarital and extramarital) sexual partners. The prevalence was significantly higher (12.5%) among plasma donors than among those who denied donating (1.3%). The prevalence was higher among those who donated both blood and plasma. Only one of the 362 participants who reported donating only blood was infected. A higher frequency of plasma donation was directly associated with a higher risk of HIV infection. The odds ratio was 27.8 among those who donated more than 31 times compared with those who donated 10 or fewer times. No HIV infections were found among the 124 children under 5 years of age, but all but three of them came

Table 1. The prevalence of HIV infection by demographic characteristics

Variables	County 1		County 2		County 3		Total	
	HIV/N[a]	(%)[b]	HIV/N	(%)	HIV/N	(%)	HIV/N	(%)
HIV-1 infected	53/508	(10.4)	48/507	(9.5)	34/502	(6.8)	135/1517	(8.9)
Gender								
Male	15/243	(6.2)[c]	27/254	(10.6)	16/246	(6.5)	58/743	(7.8)
Female	38/265	(14.3)	21/253	(8.3)	18/256	(7.0)	77/774	(10.0)
Age group (years)								
0–4	0/121	(0)	0/3	(0)	0	(0)	0/124	(0)
15–19	0	(0)	0/5	(0)	0/3	(0)	0/8	(0)
20–29	10/103	(9.7)	8/124	(6.5)	3/112	(2.7)	21/339	(6.2)[d]
30–39	19/149	(12.8)	17/164	(10.4)	16/150	(10.7)	52/463	(11.2)
40–49	17/102	(16.7)	19/140	(13.6)	12/129	(9.3)	48/371	(12.9)
50+	7/33	(21.2)	14/71	(5.6)	3/108	(2.8)	14/212	(6.6)[e]
Education level[f]								
Illiterate	33/223	(14.8)	23/200	(11.5)	17/222	(7.7)	73/645	(11.3)
Primary	14/129	(10.9)	24/237	(10.1)	14/184	(7.6)	52/550	(9.5)
Secondary	6/35	(17.1)	1/67	(1.5)	3/93	(3.2)	10/195	(5.1)[g]
Unknown					0/3	(0)	0/3	(0)
Marital status[f]								
Married	49/371	(13.2)	45/448	(10.0)	33/439	(7.5)	127/1258	(10.1)
Never-married	2/12	(16.7)	2/37	(5.4)	0/36	(0)	4/85	(4.7)
Others	2/4	(50.0)	1/19	(5.3)	1/26	(3.9)	4/49	(8.2)
Unknown					0/1	(0)	0/1	(0)
Occupation[f]								
Farmer	53/382	(13.9)	48/486	(9.9)	33/495	(6.7)	134/1363	(9.8)
Non-farmer	0/5	(0)	0/12	(0)	1/2	(50.0)	1/19	(5.3)
Unknown			0/6	(0)	0/5	(0)	0/11	(0)

[a] HIV/N = number of HIV infections/number of surveyed subjects.
[b] Prevalence of HIV infection.
[c] $p = 0.003$.
[d] 20–29 lower than 30–39 ($p < 0.02$) and 40–49 ($p < 0.003$).
[e] 50+ lower than 30–39 ($p < 0.07$) and 40–49 ($p < 0.02$).
[f] 124 children under 5 years were excluded.
[g] Lower than illiterate ($p = 0.009$) and primary ($p = 0.07$).

Table 2. Potential risk factors for HIV infection (univariate analyses)

Variables	HIV/Subjects[a] (%)	OR[b] (95% CI)	p value
History of invasive medical care			
No	96/1019 (9.4)	1	
Yes	39/498 (7.8)	0.8 (0.6, 1.2)	0.3
History of multiple sexual partners			
No	127/1309 (9.7)	1	
Yes	8/84 (9.5)	0.98 (0.5, 2.1)	0.96
History of blood/plasma donation			
No	4/317 (1.3)	1	
Yes	130/1043 (12.5)	15.6 (5.7, 42.3)	<0.001
Not answered	1/33 (3.0)	3.4 (0.4, 31.5)	0.28
Category of donation			
Whole blood only	2/362 (0.6)	1	
Plasma only	74/472 (15.7)	22.0 (10.1, 48.2)	<0.001
Whole blood and plasma	54/209 (25.8)	41.3 (18.4, 92.4)	<0.001
Frequency of donations per month			
1–2	86/564 (15.3)	1	
3–5	22/79 (27.9)	5.3 (3.1, 9.0)	<0.001
6–9	8/13 (61.5)	22.0 (7.0, 68.4)	<0.001
10+	9/12 (75.0)	41.2 (11.0, 154.5)	<0.001
Average number of donations per year			
1–10	83/876 (9.5)	1	
11–20	15/96 (15.6)	2.6 (1.4, 4.6)	0.002
21–30	14/29 (48.3)	13.0 (6.1, 27.7)	<0.001
31+	14/21 (66.7)	27.8 (11.0, 70.6)	<0.001

[a] Number of HIV infections/number of surveyed subjects.
[b] Odds ratio.

from one village. The prevalence of HIV infection among non-donor spouses of plasma donors was 2.1%.

Multivariate analyses based on a logistic model demonstrated that being HIV-positive was associated with being in the 30–49 year old age group (ORs = 1.8, 1.9), donating plasma (OR = 15.5) or both plasma and blood (OR = 24.8), and with the frequency of plasma donation (OR = 14.3 for >10 donations per month) (Table 3). History of invasive medical care in the past 3 years, a history of drug use, and a history of having multiple sexual partners were not associated with HIV infection.

Discussion

This study demonstrates that HIV infection had been introduced into the commercial plasma-donor population in this area and that the prevalence was very high (12.5%). This rate is higher than that reported from sentinel surveillance data in antenatal clinic attenders (0%), sexually transmitted disease clinic attenders (<0.0001%) and among commercial sex workers (0.27%). The results reaffirm the prompt decision made by the Chinese government to close all commercial plasma collection centres in spring 1995 and to issue a new law in 1997 to regulate commercial and non-commercial blood

Table 3. Risk factors for HIV infection among plasma donors (logistic modeling)

Variables	Odds ratio (95% CI)	p value
Age group (years)		
15–29	1	
30–39	1.8 (1.0, 3.1)	0.05
40–49	1.9 (1.1, 3.5)	0.023
50+	1.4 (0.7, 3.0)	0.37
Category of donation		
Whole blood only	1	
Plasma only	15.5 (7.0, 34.2)	<0.001
Whole blood and plasma	24.8 (10.9, 56.8)	<0.001
Frequency of donations per month		
1–2	1	
3–5	2.0 (1.2, 3.5)	0.014
6–9	7.6 (2.4, 24.2)	0.001
10+	14.3 (3.7, 55.0)	<0.001

and plasma donations. It is surprising that the prevalence of HIV in children under 5 was zero, but it is possible that those children who were infected prior to the cessation of plasma donating in 1995 had died by the time we conducted our survey in 1997. It is also possible that their mothers were infected after the children were born. The prevalence in non-donating spouses of donors was 2.1%, which is considerably higher than reported among other risk groups and the general population.[9] Thus, HIV was being transmitted from the plasma donors to their spouses.

The study had several limitations. First, participants were not randomly sampled, therefore they were probably not representative of all plasma donors. Secondly, both drug use and sexual behaviour are sensitive issues; thus, the prevalence of these reported behaviours was in all likelihood underestimated. A recent survey of sexual behaviour in Anhui using a tape recorder and earphones to administer questions yielded a higher prevalence of high-risk behaviour.[10] Thirdly, the frequency of plasma donation was self-reported, so some misclassification was likely. The effect of misclassification of frequency of donating would reduce the relationship between HIV infection and frequency of donation. Therefore, it is possible that the magnitude of the relationship we observed was an underestimate.

According to a study by Liu et al. in the same area, extramarital sex in not uncommon among rural residents, especially among temporary migrants to urban areas and among younger farmers.[9] These activities present additional opportunities for the spread of HIV from plasma donors to other persons in other areas, especially in urban areas. HIV testing in China is still uncommon. Information on the magnitude of the HIV epidemic in the population and identification of HIV status, however, is urgently needed to prevent the further spread of HIV in China from infected plasma donors, underscoring the need to introduce 'risk-free' testing, i.e. testing that does not put the individual at risk of disclosure of their HIV status or their membership in a socially undesirable risk group.

Conclusion

The study demonstrated that the prevalence of HIV infection in the commercial plasma donor population was alarmingly high and that HIV is being transmitted to non-donor family members. Married individuals and those getting married in the future may transmit the virus to their spouses and future children as well as to other sexual partners. Data on the magnitude of the epidemic in the population and the prevalence of HIV in former plasma donors and their sexual contacts is urgently needed to prevent the further spread of HIV. Plasma donors need to be made aware that they may be infected with HIV and may, thus, be transmitting the virus to their family members and others. They should, therefore, be encouraged to get tested.

China has set an example for other countries by rapidly responding to the epidemic by reducing the number of commercial plasma donor centres and by issuing a new law more closely regulating plasma donation centres. Other countries, especially developing countries, need to be aware that unless **all** plasma donations are monitored, there is a possibility of widespread HIV transmission, both among the donors and their families and to recipients of untested plasma and untreated plasma products.

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Acknowledgements

This study was supported by a grant from the University of California Pacific Rim Research Program and a grant from the Fogarty International Center #TW00013.

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