Published in final edited form as:

AIDS Care. 2009 January ; 21(1): 7–16. doi:10.1080/09540120802017610.

Risks for HIV, HBV, and HCV infections among male injection drug users in northern Vietnam: A case-control study

Vu Minh Quan^a, Vivian F. Go^a, Le Van Nam^b, Anna Bergenstrom^a, Nguyen Phuong Thuoc^b, Jonathan Zenilman^c, Carl Latkin^a, and David D. Celentano^a

^a Johns Hopkins University Bloomberg School of Public Health, Baltimore, Maryland 21205

^b Bac Ninh Department of Health, Vietnam

^c Johns Hopkins University School of Medicine, Baltimore, Maryland 21205

Abstract

Injection drug use (IDU) and HIV infection are important public health problems in Vietnam. The IDU population increased 70% from 2000 to 2004 and is disproportionately affected by HIV and AIDS--the country's second leading cause of death. Hepatitis B virus (HBV) and hepatitis C virus (HCV) share transmission routes with HIV and cause serious medical consequences. This study aimed to determine risk factors for acquisition of HIV, HBV, and HCV infections among IDUs in a northern province. We conducted a matched case-control study among active IDUs aged 18–45 who participated in a community-based survey (30-minute interview and serologic testing). Each HIV-infected IDU (case) was matched with one HIV-uninfected IDU (control) by age, sex (males only), and study site (128 pairs). Similar procedures were used for HBV infection (50 pairs) and HCV infection (65 pairs). Conditional logistic regression models were fit to identify risk factors for each infection. Among 309 surveyed IDUs, the HIV, HBV, and HCV prevalence was 42.4%, 80.9%, and 74.1%, respectively. Only 11.0% reported having been vaccinated against hepatitis B. While 13.3% of the IDUs reported sharing needles (past 6 months), 63.8% engaged in indirect sharing practices (past 6 months), including sharing drug solutions, containers, rinse water, and frontloading drugs. In multivariable models, sharing drugs through frontloading was significantly associated with HIV infection (odds ratio [OR] = 2.8), HBV infection (OR = 3.8), and HCV infection (OR = 4.6). We report an unrecognized association between sharing drugs through frontloading and higher rates of HIV, HBV and HCV infections among male IDUs in Vietnam. This finding may have important implications for bloodborne viral prevention for IDUs in Vietnam.

Keywords

HIV; hepatitis B virus; hepatitis C virus; Vietnam; substance abuse

INTRODUCTION

HIV infection and AIDS are important public health problems in Vietnam. Since HIV was reported in 1990, 113,000 cases have been enumerated nationwide by mid-2006 (Ministry of Health, 2006), and AIDS became the second leading cause of death in 2003 (Ministry of Health, 2004). The principal risk for HIV infections in Vietnam has been injection drug use (IDU), which accounts for 88% of all cases for which risk has been reported or can be inferred (Quan,

Correspondence should be addressed to: Vu Minh Quan, M.D., Johns Hopkins University Bloomberg School of Public Health, Infectious Diseases Program, Department of Epidemiology, 615 North Wolfe Street, Suite E-6546, Baltimore, Maryland 21205, USA, Tel: (66) 81 023 2320 (Thailand), Fax: (66) 53 892 298 (Thailand), vquan@jhsph.edu.

Chung, Long, & Dondero, 2000). Drug use was recognized as a major social problem since the 1990s, following the expansion of market-oriented economic policies known as “*doi moi*”. Vietnam has been an attractive drug transit route for heroin produced in the Golden Triangle, increasing heroin availability and producing new populations of drug users (Beyrer et al., 2000; U.S. Department of State, 2001). Heroin injection replaced opium smoking as the primary route of drug administration (72%) due to decreased availability of opium and easy access to injectable heroin at a relatively low price (approximately US\$ 2 per injection). The number of drug users known to governmental authorities increased 70%, from 101,000 in 2000 to 170,000 in 2004 (United Nations Office on Drugs and Crime, 2005), representing a growing population exposed to bloodborne viral infections, including HIV, hepatitis C virus (HCV), and hepatitis B virus (HBV).

HCV and HBV infections share routes of viral transmission with HIV, and are becoming leading causes of death among HIV-infected persons worldwide (Alter, 2006; Weber et al., 2006). HCV and HBV coinfections are also associated with increased incidence of hepatocellular carcinoma and with hepatotoxic effects among persons receiving HIV antiretroviral drugs (Benhamou, 2004; Powderly, 2004). In Vietnam, the prevalence of HCV and HBV infections and preventable risks among IDUs remain unknown. Not surprisingly, few programs have been designed for preventing these viral infections among IDUs.

Among the strategies recommended for preventing HIV infections among IDUs are pharmacotherapy substitution, sterile syringe and needle access, and outreach and behavioral interventions (Institute of Medicine, 2006). Treatment for opiate dependence in Vietnam primarily relies on 83 drug treatment centers nationwide, which are capable of providing treatment to between 50,000 and 60,000 patients annually. Treatment consists of 1–2 week management of withdrawal symptoms, followed by 6–24 months of in-patient psychosocial support. The short-term relapse rate after the treatment has been high (80–90%) (N. M. Tuan, 2004). Methadone or buprenorphine substitution has not been utilized as either a treatment option for opiate dependence or a public health measure for HIV prevention. Distribution of syringes and needles increased from pilot-scale in the 1990s to 1.9 million syringes distributed in 2006 (Ministry of Health, 2007). However, the limited coverage of syringe distribution relative to the demand (estimated at least 90 millions syringes) suggests that major scale-up of distribution is needed. Education for behavioral change is among the few socially and politically acceptable HIV prevention measures which have been widely disseminated in Vietnam. In this context, sound evidence of transmission risks that can be used to guide interventions for preventing HIV and other bloodborne viral infections carries substantial public health importance. This case-control study aimed to determine risk factors for acquisition of HIV infection, HCV infection, and HBV infection among out-of-treatment IDUs who participated in a community-based survey in a province in northern Vietnam—a region with emerging HIV infections among IDUs in recent years (T. H. Nguyen, Nguyen, & Trinh, 2004).

METHODS

Study population and data collection

In 2003, we conducted a community-based survey of IDUs in the semi-rural province of Bac Ninh, which is located 30 kilometers northeast of Hanoi. The province has 960,000 population with a per capita income of US\$ 380 in 2001 (Luan, 2002). Among the eight districts of Bac Ninh province, the highest rate of drug use was in Bac Ninh town (590 per 100,000 population) and one rural district -- Tu Son (140 per 100,000). The two districts are 10 kilometers apart and on the main highway connecting Hanoi to the northeastern border with China. IDUs were recruited through snowball sampling using peer recruiters, who were current or ex-drug injectors. IDUs who were 18 to 45 years old and who reported having injected drugs in the

prior six months were eligible for study enrollment. Risk assessment was based on 30-minute face-to-face interviews using a structured questionnaire. Beside questions on demographics, sexual behaviors, and medical history, the questionnaire asked detailed questions on behaviors occurring during the process of preparing and injecting drugs, including use of containers, rinse water, filters, mixing drugs, sharing drug solution through frontloading (i.e., using a syringe and needle to transfer drugs to another syringe's barrel when the plunger is withdrawn from the distal end), and reuse of other's syringes or needles (direct sharing). After pretest counseling, blood and urine specimens were collected for testing for HIV, HBV, HCV infections, and selected sexually transmitted infections (STI). Participants who completed the survey were compensated Vietnamese Dong 45,000 (equivalent of US\$ 3) for their time. One week after testing, participants (54%) returned to the study site for post-test counseling and test results (Bergenstrom et al., 2007). Participants who were diagnosed with STIs were provided treatment on-site, and those participants who were diagnosed with HIV or viral hepatitis infections were referred to health care facilities in Bac Ninh province.

Laboratory methods

HIV antibody testing was performed on serum specimens using an HIV enzyme-linked immunosorbent assay (EIA) (Abbott Murex Biotech Ltd, Kent, England). Reactive specimens were repeated with the second EIA Genscreen HIV 1/2 (BioRad Laboratories, Marnes-la-Coquette, France) and confirmed by Western blot analysis (BioRad). Serum specimens were tested for hepatitis B surface antigen (HBsAg), hepatitis B core antibody (anti-HBc) and hepatitis B surface antibody (anti-HBs) using EIAs (BioRad). Antibody to hepatitis C virus (anti-HCV) was detected using a third-generation EIA (Abbott Diagnostics, Abbott Park, IL). Serum and urine specimens were also tested for *herpes simplex virus* type 2 (HSV-2), syphilis serology, *Neisseria gonorrhea* and *Chlamydia trachomatis*, on which data were published elsewhere (Go, Frangakis et al., 2006). In this report, data on *C. trachomatis* infection (using Amplicor CT polymerase chain reaction; Roche, Totowa, NJ) and HSV-2 infection (using HerpSelect 2 EIA, Focus Technologies, Los Angeles, CA) were used to examine potential sexual risks of HIV, HCV, and HBV infections.

Matched case-control

Among study participants, 3% were female, consistent with local government's statistics. Data on these participants are presented in descriptive statistics but are excluded from multivariable analyses due to insufficient numbers. Older age was correlated ($p < .001$) with greater number of years injecting drugs, representing cumulative exposure to bloodborne viral infections. The two study sites, may represent geographical variability in injection habits, as suggested by the difference in HIV prevalence by site ($p = 0.01$). To control for potential confounders, we utilized matched case-control analyses with 1:1 ratio to examine risks for viral infections among male IDUs. An HIV infection case was defined as being positive for HIV antibody. An HBV infection case was defined as anti-HBc positivity, and an HCV infection case was defined as anti-HCV positivity. Matching data and analyses were performed separately for each of the outcome measures as follows. We matched each HIV-infected male IDU (case) with one HIV-uninfected, male IDU (control) by study site and age at interview, allowing for a difference of ± 1 year. When multiple controls were possible for a given case, one control was randomly selected. The analysis of HIV infection consisted of 128 pairs matched by age, sex (males only), and geographical site. Procedures used to generate 1:1 matched case-control data sets for HCV infection (65 matched pairs) and HBV infection (50 matched pairs) were similar, but controls were identified first and then were matched with the cases since the prevalence rates of HCV infection and HBV infection were greater than 50%.

Statistical methods

We implemented conditional logistic regression models for matched pairs to identify risk factors. To compute conditional likelihood estimates and estimated standard errors of the coefficients, each pair was transformed to a single observation with explanatory variables having values equal to the differences between the corresponding values for the case and the control, where the outcome variable has the value set to 1 for all paired observations. Conditional multivariable logistic regression models were fit to the newly created covariates and response, without an intercept (Hosmer & Lemeshow, 2000). Variables potentially associated with response in univariable analyses ($p < 0.25$) were considered for multivariable models. There were no significant interactions among any variables included in each of the final models. All statistical procedures were performed using SAS version 8 (SAS Institute, Inc., Cary, NC).

The study protocol, procedures and informed consents were reviewed and approved by the Bac Ninh Department of Health, and institutional review boards of Johns Hopkins University and the National AIDS Standing Bureau of Vietnam.

RESULTS

Characteristics of injection drug users

IDUs were young (median age = 27) and the majority (72.2%) initiated drug injection within 5 years of interview, at a median age of 23. Only 3.4% of the IDUs were women and almost all (99.0%) injected heroin (Table 1). No IDUs reported injecting cocaine or amphetamines in the previous 6 months.

Most IDUs were frequent injectors, with 65.7% injected drugs at least 4 days a week in the past 6 months. While 13.3% of the IDUs reported directly reusing other IDU's syringes at least once in the past 6 months, almost two-thirds (63.8%) engaged in practices which may inadvertently serve as transmission routes, including sharing drug solutions, drawing drugs from a shared container, sharing rinse water, and frontloading drugs (Table 1).

Among all IDUs, 12.3% had never had sexual intercourse. Among sexually active male IDUs, the median number of sexual partners in the previous 12 months was 1. However, 42.2% visited female sex workers at least once in the same period. Only half (50.6%) of the male IDUs reported using a condom at their last sexual intercourse. In the past 12 months, one male IDU (0.4%) reported having had male-male sexual intercourse and none reported having received money for sex. Among sexually active female IDUs, the number of sexual partners was somewhat higher (median = 3), but not statistically significant ($p = 0.08$).

The prevalence of HIV infection, HCV infection, and HBV infection among participants were 42.4%, 74.1%, and 80.9%, respectively. Almost all (98.5%) HIV-infected IDUs were also co-infected with HCV or HBV (89.3%). Among 41 IDUs who initiated drug injection less than one year prior to the survey, 11 (26.8%) were HIV-positive and 26 (63.4%) were HCV-positive, suggesting recent and high infection rates soon after the initiation of drug injection. There were no significant differences in HIV and HCV prevalence by sexually transmitted infections (Table 1). Forty-four IDUs (14.2%) had serologic evidence of HBV antigenemia, suggestive of chronic hepatitis B infection. Only 34 IDUs (11.0%) reported having been vaccinated against hepatitis B; of these 24 (70.6%) received all three doses of the vaccine.

Risks for HIV infection

In univariable analyses, sharing water for mixing drugs or for cleaning works, and sharing drugs through frontloading were associated with higher HIV prevalence (Table 2). Sexual

behaviors were inversely associated with HIV infection, though insignificantly. In the multivariable conditional logistic regression model, the only factor significantly associated with higher HIV prevalence was sharing drugs through frontloading at last injection (odds ratio [OR] = 2.75).

Risks for HCV infection

Univariable analyses of HCV infection (Table 3) showed a similar risk profile as seen in HIV infection, in which injection behaviors were associated with increased HCV prevalence, while the effects of sexual behaviors were opposite. In the multivariable model, HCV infection was significantly associated with a greater number of years of drug injection, injecting drugs with needles previously used by another, and sharing drugs through frontloading.

Risks for HBV infection

In univariable analyses (Table 4), HBV infection was associated with length of drug injection and sharing drug solution, but was not associated with sexual behaviors. Since all 10 IDUs with chlamydial infection were HBV-infected, a model could not be fit. A composite variable of chlamydial infection or HSV-2 infection was created. Having been vaccinated for hepatitis B lowered the HBV prevalence but not significantly ($p = 0.37$), however this variable was retained in the multivariable model for its known protective effect. The multivariable model showed that sharing drugs through frontloading was significantly associated with HBV infection.

DISCUSSION

In this study, we report an unrecognized association between sharing drugs through frontloading and higher rates of HIV infection, HCV infection, and HBV infection among Vietnamese male IDUs. The risk factor is independent of age, study site and remains consistently significant across all three blood borne viral infections (OR = 2.8 for HIV infection, 3.8 for HBV infection, and 4.6 for HCV infection). Findings from this case-control study provide additional evidence of frontloading behavior being associated with these bloodborne viral infections, which has been reported only in few cross-sectional studies (Edeh & Spalding, 2000; Samuels, Vlahov, Anthony, Solomon, & Celentano, 1991; Stark, Muller, Bienzle, & Guggenmoos-Holzmam, 1996), and may have important implications for bloodborne viral prevention for IDUs in Vietnam.

Previous studies in Vietnam found that HIV infection among IDUs was associated with sharing needles or syringes (Hammett et al., 2005; Tran, Williams, Truong, & Do, 1998; N. A. Tuan et al., 2007). In our study, after carefully distinguishing behaviors which occur during the process of preparing drugs and injecting drugs, we found that direct sharing of needles or syringes decreased compared to reports in the early years of the HIV epidemic (T. A. Nguyen, Hoang, Pham, & Detels, 2001; Quan, Chung, & Abdul-Quader, 1998; Tran et al., 1998), but indirect sharing behaviors such as sharing of drug solution, rinse water, and drug containers are frequently practiced (63.8%, past 6 months). Our data are consistent with the results of the national behavioral surveillance of IDUs in three other northern provinces (Ministry of Health, 2006) and with a report of sharing drug solution in a northern province (Hammett et al., 2005).

The changes in injection practices likely resulted from a change in type of drugs used --almost all IDUs now inject heroin (99%), a dramatic shift from 10 years ago when a large majority (94%) used opium (Tran et al., 1998). Further, disposable syringes and needles are now available at relatively low cost (approximately US\$ 0.06 per set) and have replaced the higher-cost glass syringes. And lastly, education programs through mass media (roadside billboards,

TV clips, leaflets) and peer outreach for IDUs since the mid-1990s may have successfully decreased direct needle sharing (Khoat, West, Valdiserri, & Phan, 2003). However, many IDUs remain unaware of routes of HIV and bloodborne viral transmission other than sharing of needles (Hammett et al., 2005), and continue to engage in indirect sharing behaviors. As the epidemiology of drug use has changed and HIV continues to spread among IDUs in Vietnam (T. H. Nguyen et al., 2004; Quan et al., 2000), it is critical that indirect sharing behaviors be addressed by HIV prevention programs.

Our study has several limitations. The study was conducted in only one province and risk analyses were performed only among male IDUs. The generalizability of the study's findings, therefore, is limited to male IDUs in Bac Ninh province or in provinces with similar socio-economic status in northern Vietnam. Additionally, because all behavioral data relied on self-report, when answering questions about sensitive behaviors, participants may have given what they perceived to be socially desirable responses, and thus, associations of high risk behavior and disease may be underestimated across risk behaviors. Furthermore, the application of matched case-control analyses while helps control for potential confounders under the changing epidemiology of drug use, reduces the effective sample size, and therefore some risk factors may not be detected with the reduced statistical power.

Among IDUs in this study, no sexual behaviors were associated with HIV infection or HCV infection--similar to reports in neighboring countries (Liu et al., 2006; Vanichseni et al., 2001). HIV infection was not associated with either chlamydial infection or HSV-2 infection, but was significantly associated with HCV, the virus primarily transmitted parenterally as HCV prevalence is low among non-IDUs in northern Vietnam (1% among blood donors) (Song et al., 1994). However, several STIs are common among the IDUs, including *Chlamydia trachomatis* (9%) and HSV-2 (22%) (Go, Frangakis et al., 2006), and half of the IDUs reported that they did not use a condom in their most recent sexual intercourse. These data, along with others' suggest that IDUs pose a substantial risk for HIV and STIs to their female sexual partners, and it is critical to promote condom use among IDUs to prevent further transmission (Go, Frangakis et al., 2006; Go, Quan, Voytek, Celentano, & Nam le, 2006).

Prevention of hepatitis B and C infections among IDUs in Vietnam has been ignored by public health authorities. No surveillance system is in place to monitor infection levels. No program exists to provide IDUs with information on viral hepatitis infections and how to prevent them, nor are intervention programs available to provide necessary skills for avoiding infections. This study's data demonstrate an enormous health burden among the IDU population and highlight the need of interventions for preventing HCV and HBV infections. HCV and HBV have been shown to be transmitted more efficiently than HIV through sharing contaminated needle (CDC, 2001). Standard needle and syringe exchange programs have been shown to be effective in preventing HIV transmission, but findings on these programs' effectiveness in HCV prevention are inconclusive, as HCV can be transmitted via sharing of a range of other injection equipment. Therefore, reducing parenteral transmission of HCV and HBV requires that current prevention messages be revised to alert IDUs to the risks associated with drug-sharing through frontloading and to emphasize the importance of reducing or eliminating all equipment-sharing practices. Consideration should be paid to integrating hepatitis B vaccination for IDUs into large-scale HIV prevention programs such as the President's Emergency Plan for AIDS Relief (PEPFAR).

The IDU population in Vietnam continues to grow and follows the spread of HIV. It is projected that 300,000 Vietnamese are living with HIV and AIDS today, of these at least three-quarters are IDUs (Ministry of Health, 2004). With the ever changing epidemiology of drug use in Vietnam, until a cure for addiction or effective vaccines for HIV and viral hepatitis are found and available, it is critical to monitor these infections among IDUs, to identify their associated

risks, and to intervene in a timely fashion. In addition to education and behavioral interventions currently being conducted in Vietnam, a wider range of prevention measures proven to be effective, including access to sterile injection equipment and pharmacological substitution treatment for opiate dependence, should be considered to reduce the burden of HIV and viral hepatitis infections and their medical consequences.

Acknowledgments

This study was supported by grant No. 1RO1 MH64895 from the National Institute of Mental Health, National Institutes of Health, USA, and by grant No. K24 AI01633, National Institutes of Health, USA. The authors thank Dr. Do Tuan Dat, National Institute of Hygiene and Epidemiology, Hanoi, Vietnam, for his assistance in laboratory quality control.

References

- Alter MJ. Epidemiology of viral hepatitis and HIV co-infection. *Journal of Hepatology* 2006;44(1 Suppl):S6–9. [PubMed: 16352363]
- Benhamou Y. Antiretroviral therapy and HIV/hepatitis B virus coinfection. *Clinical Infectious Diseases* 2004;38(Suppl 2):S98–103. [PubMed: 14986281]
- Bergstrom A, Go V, Nam LV, Thuy BT, Celentano DD, Frangakis C, et al. Return to post-test counselling by out-of-treatment injecting drug users participating in a cross-sectional survey in north Vietnam. *AIDS Care* 2007;19(7):935–939. [PubMed: 17712699]
- Beyrer C, Razak MH, Lisam K, Chen J, Lui W, Yu XF. Overland heroin trafficking routes and HIV-1 spread in south and south-east Asia. *AIDS* 2000;14(1):75–83. [PubMed: 10714570]
- CDC. Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis. *MMWR Recommendations and Reports* 2001;50(RR-11):1–52.
- Edeh J, Spalding P. Screening for HIV, HBV and HCV markers among drug users in treatment in rural south-east England. *Journal of Public Health Medicine* 2000;22:531–539. [PubMed: 11192282]
- Go VF, Frangakis C, Nam le V, Bergstrom A, Sripaipan T, Zenilman JM, et al. High HIV sexual risk behaviors and sexually transmitted disease prevalence among injection drug users in Northern Vietnam: implications for a generalized HIV epidemic. *Journal of Acquired Immune Deficiency Syndromes* 2006;42(1):108–115. [PubMed: 16763499]
- Go VF, Quan VM, Voytek C, Celentano D, Nam le V. Intra-couple communication dynamics of HIV risk behavior among injecting drug users and their sexual partners in Northern Vietnam. *Drug and Alcohol Dependence* 2006;84(1):69–76. [PubMed: 16413145]
- Hammett TM, Johnston P, Kling R, Liu W, Ngu D, Tung ND, et al. Correlates of HIV status among injection drug users in a border region of southern China and northern Vietnam. *Journal of Acquired Immune Deficiency Syndromes* 2005;38(2):228–235. [PubMed: 15671810]
- Hosmer, DW.; Lemeshow, S. Logistic Regression for Matched Case-Control Studies. In: Shewhart, WA.; Wilks, SS., editors. *Applied Logistic Regression*. 2. New York: John Wiley & Sons, Inc; 2000. p. 223–259.
- Institute of Medicine. Preventing HIV infection among injecting drug users in high risk countries. Washington, D.C: The National Academies Press; 2006.
- Khoat DV, West GR, Valdiserri RO, Phan NT. Peer education for HIV prevention in the Socialist Republic of Vietnam: a national assessment. *Journal of Community Health* 2003;28(1):1–17. [PubMed: 12570170]
- Liu W, Chen J, Rodolph M, Beauchamp G, Masse B, Wang S, et al. HIV prevalence among injection drug users in rural Guangxi China. *Addiction* 2006;101(10):1493–1498. [PubMed: 16968351]
- Luan, CV. *Bac Ninh - New Image in the XXIth Century*. Hanoi: National Political Publishing House; 2002.
- Ministry of Health. *Health Statistics Yearbook*. Hanoi: Ministry of Health; 2004.
- Ministry of Health. *Case Reports of HIV and AIDS through June 30, 2006*. Ministry of Health; 2006.

- Ministry of Health. Evaluation of AIDS Prevention and Control in 2006 and Plan for 2007. Ministry of Health; 2007.
- Nguyen TA, Hoang LT, Pham VQ, Detels R. Risk factors for HIV-1 seropositivity in drug users under 30 years old in Haiphong, Vietnam. *Addiction* 2001;96(3):405–413. [PubMed: 11255581]
- Nguyen TH, Nguyen TL, Trinh QH. HIV/AIDS epidemics in Vietnam: evolution and responses. *AIDS Education and Prevention* 2004;16(3 Suppl A):137–154. [PubMed: 15262572]
- Powderly WG. Antiretroviral therapy in patients with hepatitis and HIV: weighing risks and benefits. *Clinical Infectious Diseases* 2004;38(Suppl 2):S109–113. [PubMed: 14986283]
- Quan VM, Chung A, Abdul-Quader AS. The feasibility of a syringe-needle-exchange program in Vietnam. *Substance Use and Misuse* 1998;33(5):1055–1067. [PubMed: 9596375]
- Quan VM, Chung A, Long HT, Dondero TJ. HIV in Vietnam: the evolving epidemic and the prevention response, 1996 through 1999. *Journal of Acquired Immune Deficiency Syndromes* 2000;25(4):360–369. [PubMed: 11114837]
- Samuels JF, Vlahov D, Anthony JC, Solomon L, Celentano DD. The practice of ‘frontloading’ among intravenous drug users: association with HIV-antibody. *AIDS* 1991;5:343. [PubMed: 2059379]
- Song P, Duc DD, Hien B, Nakata S, Chosa T, Watanabe J, et al. Markers of hepatitis C and B virus infections among blood donors in Ho Chi Minh City and Hanoi, Vietnam. *Clinical and Diagnostic Laboratory Immunology* 1994;1(4):413–418. [PubMed: 8556478]
- Stark K, Muller R, Bienzle U, Guggenmoos-Holzmänn I. Frontloading: a risk factor for HIV and hepatitis C virus infection among injecting drug users in Berlin. *AIDS* 1996;10:311–317. [PubMed: 8882671]
- Tran SD, Williams AB, Truong HT, Do NH. Risk factors for HIV seropositivity in a sample of drug users in drug treatment in Ho Chi Minh City, Vietnam. *Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology* 1998;17(3):283–287. [PubMed: 9495230]
- Tuan NA, Fylkesnes K, Thang BD, Hien NT, Long NT, Kinh NV, et al. Human immunodeficiency virus (HIV) infection patterns and risk behaviours in different population groups and provinces in Viet Nam. *Bulletin of the World Health Organization* 2007;85(1):35–41. [PubMed: 17242756]
- Tuan, NM., editor. *Heroin Addiction and Treatment*. Hanoi: Publishing House of Medicine; 2004.
- U.S. Department of State. *International Narcotics Control Strategy Reports, 2001, Southeast Asia and the Pacific*. 2001. Retrieved March 28, 2007, from http://www.shaps.hawaii.edu/drugs/incsr2001/incsr_2001_vietnam.html
- United Nations Office on Drugs and Crime. *Vietnam Country Profile 2005*. 2005. Retrieved February 13, 2007, from http://www.unodc.org/vietnam/en/country_profile.html
- Vanichseni S, Kitayaporn D, Mastro TD, Mock PA, Raktham S, Des Jarlais DC, et al. Continued high HIV-1 incidence in a vaccine trial preparatory cohort of injection drug users in Bangkok, Thailand. *AIDS* 2001;15(3):397–405. [PubMed: 11273220]
- Weber R, Sabin CA, Friis-Møller N, Reiss P, El-Sadr WM, Kirk O, et al. Liver-related deaths in persons infected with the human immunodeficiency virus: the D:A:D study. *Archives of Internal Medicine* 2006;166(15):1632–1641. [PubMed: 16908797]

Table 1
Demographic, Behavioral Characteristics and Prevalence of HIV, HCV, and HBV Infections (N = 309).

Characteristic	Overall sample N (%)	HIV infection		HCV infection		HBV infection	
		No. pos (%)	p-val*	No. pos (%)	p-val	No. pos (%)	p-val
Demographics							
Sex							
Male	299 (96.8)	128 (42.8)	0.42	228 (76.3)	<0.001	242 (80.9)	0.94
Female	10 (3.2)	3 (30.0)		1 (10.0)		8 (80.0)	
Age in yrs, median (range)**	27 (18–45)	z = −1.0	0.29	z = −2.2	0.028	z = −4.9	<0.001
Marital status							
Never married	187 (60.5)	84 (44.9)	0.54	141 (75.4)	0.76	143 (76.5)	0.02
Currently married	89 (28.8)	34 (38.2)		65 (73.0)		81 (91.0)	
Separated/divorced/widowed	33 (10.7)	13 (39.4)		23 (69.7)		26 (78.8)	
Education attainment, yrs**							
Median (range)	8 (1–16)	z = −0.9	0.39	z = −1.3	0.18	z = 1.4	0.15
Employment							
Unemployed	87 (28.2)	43 (49.4)	0.12	65 (74.7)	0.88	71 (81.6)	0.84
Employed part-time for full-time	222 (71.8)	88 (39.6)		164 (73.9)		179 (80.6)	
Hepatitis B vaccination, ≥1 dose							
Yes	34 (11.0)	9 (26.5)	0.05	21 (61.8)	0.08	24 (70.6)	0.11
No	275 (89.0)	122 (44.4)		208 (75.6)		226 (82.2)	
Geographical site							
Bac Ninh town	227 (73.5)	106 (46.7)	0.01	169 (74.4)	0.82	184 (81.1)	0.91
Tu Son district	82 (26.5)	25 (30.5)		60 (73.2)		66 (80.5)	
Drug use behaviors							
Age at first drug injection (yrs), median (range)**	23 (14–44)	z = −3.2	0.001	z = −0.1	0.96	z = −3.2	0.01
Length of drug injection (yrs), median (range)**	3 (1–18)	z = 4.6	<0.001	z = −5.2	<0.001	z = −3.1	0.002
Injected heroin, ever							
Yes	306 (99.0)	131 (42.8)	0.14	227 (74.2)	0.77	248 (81.0)	0.53
No	3 (1.0)	0 (0)		2 (66.7)		2 (66.7)	
Injected heroin mixed with benzodiazepine, ever							

Characteristic	Overall sample N (%)		HIV infection		HCV infection		HBV infection	
	No.	pos (%)	p-val*	No.	pos (%)	p-val	No.	pos (%)
Yes	33 (10.7)	14 (42.4)	1.00	30 (90.9)	0.02	28 (84.8)	0.54	
No	276 (89.3)	117 (42.4)		199 (72.1)		222 (80.4)		
<i>Injection behaviors, past 6 months</i>								
Frequency of drug injection								
4–7 days a week	203 (65.7)	87 (42.9)	0.88	153 (75.4)	0.30	166 (81.8)	0.14	
1–3 days a week	87 (28.2)	37 (42.5)		60 (69.0)		66 (75.9)		
Less than once a week	19 (6.1)	7 (36.8)		16 (84.2)		18 (94.7)		
Pooled resource to buy drugs								
Yes	186 (60.2)	82 (44.1)	0.46	132 (71.0)	0.12	149 (80.1)	0.66	
No	123 (39.8)	49 (39.8)		97 (78.9)		101 (82.1)		
Injected drugs with needles previously used by another, past 6 months								
Yes	41 (13.3)	17 (41.5)	0.90	27 (65.9)	0.20	32 (78.0)	0.62	
No	268 (86.7)	114 (42.5)		202 (75.4)		218 (81.3)		
Sharing drug solution								
Yes	178 (57.6)	81 (45.5)	0.20	137 (77.0)	0.18	145 (81.5)	0.77	
No	131 (42.4)	50 (38.2)		92 (70.2)		105 (80.2)		
Drew drugs from a shared container								
Yes	130 (42.1)	53 (40.8)	0.62	97 (74.6)	0.86	100 (76.9)	0.13	
No	179 (57.9)	78 (43.6)		132 (73.7)		150 (83.8)		
Shared water for cleaning works								
Yes	27 (8.7)	13 (48.1)	0.53	18 (66.7)	0.36	23 (85.2)	0.55	
No	282 (91.3)	118 (41.8)		211 (74.8)		227 (80.5)		
Shared drug solution through frontloading								
Yes	149 (48.2)	68 (45.6)	0.27	113 (75.8)	0.50	119 (79.9)	0.65	
No	160 (51.8)	63 (39.4)		116 (72.5)		131 (81.9)		
<i>Injection behaviors, last drug injection</i>								
Drew drugs from a shared container								
Yes	46 (14.9)	17 (37.0)	0.42	32 (69.6)	0.45	34 (73.9)	0.19	
No	263 (85.1)	114 (43.3)		197 (74.9)		216 (82.1)		
Sharing filter								

Characteristic	Overall sample N (%)		HIV infection		HCV infection		HBV infection	
	No.	pos (%)	p-val*	No.	pos (%)	p-val	No.	pos (%)
Yes	6 (1.9)	4 (66.7)	0.23	4 (66.7)	0.23	0.68	5 (83.3)	0.88
No	303 (98.1)	127 (41.9)		225 (74.3)			245 (80.9)	
Sharing water for cleaning works or mixing drugs								
Yes	14 (4.5)	11 (78.6)	0.005	12 (85.7)	0.31		13 (92.9)	0.25
No	295 (95.5)	120 (40.7)		217 (73.6)			237 (80.3)	
Shared drug solution through frontloading								
Yes	60 (19.4)	33 (55.0)	0.028	46 (76.7)	0.62		50 (83.3)	0.60
No	249 (80.6)	98 (39.4)		183 (73.5)			200 (80.3)	
Sexual behaviors								
Ever had sex								
Yes	271 (87.7)	111 (41.1)	0.17	203 (74.9)	0.73		225 (83.0)	0.01
No	38 (12.3)	20 (52.6)		26 (68.4)			25 (65.8)	
No. sex partners, past 12 months, median (range)								
Male IDUs**	1 (0-40)	z = -2.7	0.007	z = 2.4	0.018		z = 0.3	0.74
Female IDUs**	3 (0-50)	z = 0.3	0.73	z = 1.1	0.33		z = 1.7	0.09
Last sex with female sex workers (males only)								
Yes	83 (27.8)	44 (53.0)	0.027	66 (79.5)	0.41		64 (77.1)	0.29
No, or never had sex	216 (72.2)	84 (38.9)		162 (75.0)			178 (82.4)	
Laboratory results								
HIV infection								
Yes	131 (42.4)	--	--	129 (98.5)	<0.001		117 (89.3)	0.001
No	178 (57.6)			100 (56.2)			133 (74.7)	
HCV infection								
Yes	229 (74.1)	129 (56.3)	<0.001	--	--		196 (85.6)	<0.001
No	80 (25.9)	2 (2.5)					54 (67.5)	
HBV infection								
Yes	250 (80.9)	117 (46.8)	0.001	196 (78.4)	<0.001		--	--
No	59 (19.1)	14 (23.7)		33 (55.9)				
<i>Chlamydia trachomatis</i> infection, PCR								
Yes	33 (10.7)	14 (42.4)	1.00	24 (72.7)	0.85		31 (93.9)	0.04

Characteristic	Overall sample N (%)	HIV infection		HCV infection		HBV infection	
		No. pos (%)	p-val [*]	No. pos (%)	p-val	No. pos (%)	p-val
No	276 (89.3)	117 (42.4)		205 (74.3)		219 (79.3)	
HSV-2 infection							
Yes	65 (21.1)	26 (40.0)	0.69	46 (70.8)	0.50	57 (87.7)	0.12
No	243 (78.9)	104 (42.8)		182 (74.9)		192 (79.0)	

* p-value obtained from chi-square test, unless otherwise indicated;

** Wilcoxon rank sum test; PCR, polymerase chain reaction.

Univariable and Multivariable Logistic Regression Models for 1-1 Match Case-Control to Predict HIV Infection, n = 128 Pairs, Male Injection Drug Users, Bac Ninh Province, Vietnam.

Table 2

Effect	Univariable Models			Multivariable Model*		
	OR	95% CI	p-value	OR	95% CI	p-value
Length of drug injection (yrs) **	1.07	0.98–1.16	0.146	1.06	0.96–1.16	0.267
Age at first drug injection (yrs) **	1.01	0.93–1.09	0.856			
Injecting drugs with needles previously used by another, past 6 months	0.86	0.40–1.85	0.696			
Sharing water for mixing drugs or cleaning works, last injection	10.00	1.28–78.11	0.028	4.63	0.53–40.19	0.164
Sharing drug solution through frontloading, last injection	3.22	1.53–6.81	0.002	2.75	1.17–6.48	0.021
No. of sexual partners, past 12 months	0.92	0.84–1.01	0.094	0.94	0.84–1.05	0.241
Having had sex with a female sex worker, past 12 months	0.68	0.42–1.13	0.137	0.72	0.37–1.43	0.350

OR denotes odds ratio; CI, confidence interval;
* Multivariable model included Length of drug injection, Sharing water for mixing drugs or cleaning works at last injection, Sharing drug solution through frontloading at last injection, Number of sexual partners in the past 12 months, and Having had sex with a female sex worker in the past 12 months;
** Odds ratio for one year increase.

Univariable and Multivariable Logistic Regression Models for 1-1 Match Case-Control to Predict HCV Infection, n = 65 Pairs, Male Injection Drug Users, Bac Ninh Province, Vietnam.

Table 3

Effect	Univariable Models			Multivariable Model *		
	OR	95% CI	p-value	OR	95% CI	p-value
Length of drug injection (yrs) **	1.46	1.15–1.84	0.002	1.47	1.12–1.92	0.006
Injecting heroin mixed with benzodiazepine, ever	3.50	0.73–16.85	0.118	1.70	0.24–11.9	0.591
Injecting drugs with needles previously used by another, past 6 months	2.14	0.87–5.25	0.096	3.21	1.02–10.05	0.046
Sharing drug solution through frontloading, last injection	2.60	0.93–7.29	0.069	4.63	1.24–17.24	0.023
No. of sexual partners, past 12 months	0.89	0.79–0.99	0.036	0.91	0.76–1.10	0.330
Having had sex with a female sex worker, past 12 months	0.55	0.26–1.15	0.111	0.95	0.21–4.25	0.941

OR denotes odds ratio; CI, confidence interval;
* Multivariable model included all variables in the table;
** Odds ratio for one year increase.

Univariable and Multivariable Logistic Regression Models for 1-1 Match Case-Control to Predict HBV Infection, n = 50 Pairs, Male Injection Drug Users, Bac Ninh Province, Vietnam.

Table 4

Effect	Univariable Models			Multivariable Model*		
	OR	95% CI	p-value	OR	95% CI	p-value
Length of drug injection (yrs) **	1.14	0.93–1.41	0.206	1.10	0.88–1.37	0.396
Sharing drug solution through frontloading, last injection	4.33	1.24–15.21	0.022	3.82	1.06–13.80	0.041
No. of sexual partners, past 12 months	1.03	0.96–1.11	0.383			
Having had sex with a female sex worker, past 12 months	1.07	0.52–2.22	0.853			
Having <i>Chlamydia</i> infection (PCR) or HSV-2 infection (EIA)	2.60	0.93–7.29	0.069	2.15	0.69–6.70	0.188
Being vaccinated against hepatitis B, at least one dose	0.57	0.17–1.95	0.372	0.89	0.23–3.46	0.864

OR denotes odds ratio; CI, confidence interval; PCR, polymerase chain reaction; EIA, enzyme-linked immunosorbent assay;

* Multivariable model included Length of drug injection, Sharing drug solution through frontloading at last injection, Having chlamydial infection or HSV-2 infection, and Being vaccinated against hepatitis B;

** Odds ratio for one year increase.