

RISK FACTORS FOR TRICHOMONIASIS AMONG WOMEN WITH HUMAN IMMUNODEFICIENCY VIRUS (HIV) INFECTION AT A PUBLIC CLINIC IN LOS ANGELES COUNTY, CALIFORNIA: IMPLICATIONS FOR HIV PREVENTION

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Abstract. Persons with human immunodeficiency virus (HIV) infection who subsequently develop an acute sexually transmitted disease have an increased probability of transmitting HIV. Therefore, characterizing such persons can help direct prevention efforts to a group who are likely to be continuing sources of HIV transmission. We assessed the incidence and factors associated with trichomoniasis in a cohort of HIV-infected women receiving care at a public clinic in Los Angeles County, California from 1992 through 1995. Demographic, clinical, and behavioral data were available from medical records and from patient interviews. *Trichomonas* infection was the most frequently identified sexually transmitted disease and was found in 37 (17.4%) of 212 women representing a crude incidence rate of 14.1 per 100 person-years experience. The crude rate of trichomoniasis was highest in black women (69.0 per 100 person-years), women with a history of trading sex for drugs or money (51.0 per 100 person-years), those using crack or cocaine (35.5 per 100 person-years), women with four or more sex partners (43.0 per 100 person years), and those born in the United States (23.3 per 100 person-years). Among women with severe immunosuppression (CD4+ count < 200), 18.4% (18 of 98) were diagnosed with trichomoniasis. After multivariate analysis using a Cox proportional hazards approach, black race (adjusted rate ratio [RR] = 5.6, 95% confidence interval [CI] = 2.3, 13.3) continued to be strongly associated with *Trichomonas* infection. Trading sex for money or drugs (adjusted RR = 25.2, 95% CI = 4.3, 148.6) and single marital status (adjusted RR = 3.7, 95% CI = 1.1, 13.0) were independent risk factors for trichomoniasis in nonblack women but not among black women. Data from this study indicate that *Trichomonas* may be a frequently acquired infection in HIV-positive women. Our findings suggest that HIV-infected women who are black, and nonblack women who trade sex for money or drugs or are unmarried, are at increased risk of trichomoniasis and therefore may be more likely to transmit HIV infection. Local HIV prevention strategies should target such women for intervention efforts.

Aggressive human immunodeficiency virus (HIV) infection prevention efforts must involve many different methods of interrupting disease transmission.¹ One such approach is the identification and targeting of persons who may be more likely to transmit HIV infection. Persons with recognized HIV infection who subsequently develop a sexually transmitted disease (STD) are one such group. The occurrence of an acute STD provides direct evidence of the practice of unprotected sex. Moreover, concurrent STDs, both ulcerative and nonulcerative, in an HIV-infected person may increase the risk of HIV transmission to an uninfected partner.^{2–8} Therefore, characterizing persons with HIV infection who subsequently develop an STD can help in the targeting of educational efforts to a group with a higher probability of transmitting HIV.

One common STD, particularly affecting women, is infection with *Trichomonas vaginalis*. *Trichomonas* infection can induce both lesions and infiltration of leukocytes in the genital area. Such pathology may amplify the risk of HIV transmission by both increasing the portal of entry for HIV in an uninfected person or by expanding the portal of exit for the virus in an HIV-infected individual. Two cross-sectional studies in Africa have demonstrated an association between *Trichomonas* and HIV infection in women,^{7,8} and a single prospective study implicated *Trichomonas* as a risk factor for subsequent HIV infection among women in Kinshasa, Zaire.⁶ Despite the possible importance of *Trichomonas* in the transmission dynamics of HIV, there is a pau-

city of information on the prevalence and incidence of *Trichomonas* infection, especially in areas heavily affected by HIV and few data exist on the occurrence of infection with this important agent among women after they have become HIV-infected. We assessed the incidence and risk factors for trichomoniasis in a cohort of HIV-infected women receiving care at a public outpatient clinic in Los Angeles County, California.

PATIENTS AND METHODS

Patients. Data were available from review of the medical records of HIV-infected women ≥ 13 years of age receiving medical care at the largest HIV outpatient clinic in Los Angeles County as part of the Centers for Disease Control and Prevention (CDC) Adult/Adolescent Spectrum of Disease Study.⁹ This site, which provides routine care to HIV-infected patients, is the largest HIV outpatient clinic in the county and reports approximately 21% of all local cases of acquired immunodeficiency syndrome (AIDS) in women. The population in the geographic catchment area for this clinic is predominantly minority with Latinos comprising 64%, blacks 6%, Asian and other groups 11%, and whites 9%. The facility provides comprehensive care and serves as a primary care provider. Beginning in January 1992, all HIV-infected women were enrolled from this facility. Women were targeted at this site as a way of increasing the representation of women in both the local and national (CDC-

sponsored) sample. Trained medical records technicians review medical records for basic demographic data, HIV-exposure category, AIDS-defining conditions, CD4+ lymphocyte count, and the occurrence of other infections and conditions including trichomoniasis. Routine screening for *Trichomonas* infection is not performed. The medical record is re-reviewed at six-month intervals. Trichomoniasis was defined as *T. vaginalis* infection confirmed through direct microscopy or cytology (Pap smear). Culture for *Trichomonas* is not routinely performed at this facility.

After approval of the primary care provider, all women are asked to complete a standardized 45-min interview as part of the CDC Supplement to HIV-AIDS Surveillance Project.¹⁰ The questionnaire is administered by trained interviewers and includes information on demographics, drug use, sexual behavior, and access to medical and social services. Participants are interviewed a single time.

Human Subject Protection Committee approval was obtained from a federally assured Institutional Review Board. Informed consent, including consent to link medical record information with data from patient interview, was obtained from each participant. Racial identification was based on self-report.

Statistical analysis. Data from the medical record review were linked to data obtained from patient interview. Risk factors assessed included CD4+ lymphocyte count/ μl (< 100, 100–300, and > 300), age group (13–24, 25–34, 35–44, and > 44 years), and HIV risk group (heterosexual contact, injection drug use, transfusion, or none identified) from the medical record and race/ethnicity (white, black, Latino, or other), country of origin (United States or foreign born), marital status, education (< 12 years, 12 years, or > 12 years), income (< \$10,000 or \geq \$10,000), drug use (crack or cocaine, other drugs, or none), exchanging sex for money or drugs, and number of sex partners (in the previous five-year period) from the interview. The denominator for calculation of rates was person-years. The amount of person-time contributed by each patient was determined from time of study entry to first occurrence of *Trichomonas* infection or, for women without trichomoniasis, date of last contact with the facility or date of death.

Assessment of factors associated with trichomoniasis was completed for those women for whom data were also available from an interview. Initial bivariate analysis was conducted for the available demographic and behavioral factors. The chi-square test, Mantel-Haenszel chi-square test, and Mantel-Haenszel chi-square test for trend were used to assess apparent differences. Multivariate analysis used a Cox proportional hazards approach to control for potential confounding variables and to assess interactions. Separate models were created for each independent variable. The software program EGRET (Statistics and Epidemiology Research Corporation, Seattle, WA) was used for all multivariate analyses. Variable selection for the final Cox model was based on the change in estimate criterion.¹¹ Specifically, if addition of a covariate altered the rate ratio by greater than 10%, it was then included in the model. Interaction terms were added to the model based on biologic plausibility and a score test P value < 0.20. Adjusted rate ratios (RRs), 95% confidence intervals (CIs), limits, and P values were calculated. Attributable fractions or the proportion of trichomoniasis at-

tributable to each exposure were computed. To evaluate the adequacy of the Cox model, both residual and influence measures were assessed and results from the Cox analyses were compared with those obtained using stratified analysis.¹²

RESULTS

Through the study period medical record review had been completed for 379 HIV-infected women and interviews had been conducted with 212 (54%) women who contributed 262 person-years experience. A pending backlog of interviews, the inability to access women because of illness or death, patient refusal to participate, and difficulty in locating patients reduced interview completion rates. The female population obtaining care at this clinic is diverse, with minority women (black and Latino) accounting for 89%; 33 (15%) reported injection drug use. Women who were interviewed did not differ significantly in demographic and risk characteristics from those who were not interviewed.

Trichomonas infection was the most common STD diagnosed and was identified in 37 (17.4%) women, representing a crude incidence rate of 14.1 per 100 person-years experience. Nearly 40% of black women were found to be infected. In contrast, chlamydial (2.9%) and gonococcal infections (1.6%) were relatively infrequent. Diagnosis of chlamydial infection at this facility during the study period was done using an enzyme immunoassay. Bivariate analysis identified several factors associated with trichomoniasis in this cohort. The rate of *Trichomonas* infection was higher among blacks, never married women, and in women with 12 years of education. (Table 1). Trichomoniasis was also associated with crack or cocaine use, the trading of sex for money or drugs, and multiple sex partners (Table 2). Among women with severe immunosuppression (CD4+ count < 200), 18.4% (18 of 98) were diagnosed with trichomoniasis.

After controlling for other variables through multivariate analysis, black race continued to be strongly associated with *Trichomonas* infection (Table 3). The rate of trichomoniasis was nearly six times as great in black women than other racial/ethnic groups. The proportion of trichomoniasis in this cohort attributable to black race was 46.6%. Trading sex for money or drugs and single marital status were independent risk factors for trichomoniasis in nonblack women but not among black women (Table 3). The rate of trichomoniasis in nonblack women with a history of trading sex was 25 times greater than in nonblack women without such a history. Unmarried nonblack women had a rate of *Trichomonas* infection that was nearly four times higher than married nonblack women. The proportion of trichomoniasis attributable to trading sex and to single marital status was 15.6% and 27.6%, respectively. Women who reported crack or cocaine use (adjusted RR = 1.6, 95% CI = 0.57, 4.31, black women of low income (adjusted RR = 5.6, 95% CI = 0.72, 44.1), and nonblack women reporting four or more sex partners (adjusted RR = 1.8, 95% CI = 0.36, 9.5) had higher adjusted rates of *Trichomonas* infection; however, these differences were not statistically significant.

TABLE 1

Bivariate analysis of selected demographic and clinical factors and trichomoniasis among women with human immunodeficiency virus (HIV) infection at a public clinic in Los Angeles County, California, 1992–1995

Factor*	No.	No. (%) with trichomoniasis	Rate per 100 person-years	P
Race/ethnicity				
White	21	2 (9.5)	6.6	Referent
Black	56	21 (37.5)	69.0	<0.01
Latino	133	14 (10.5)	7.6	1.0
Asian/other	2	0 (0.0)	0.0	0.49
HIV risk group				
Heterosexual	79	10 (12.7)	10.3	0.59†
Transfusion	18	4 (22.2)	13.8	
IDU	33	9 (27.2)	19.9	
None identified	82	14 (17.1)	13.3	
Age group (years)				
13–24	34	6 (17.7)	18.7	0.64†
25–34	90	20 (22.2)	16.5	
35–44	57	6 (10.5)	8.7	
>44	31	5 (16.1)	12.3	
Education				
<12 years	131	20 (15.3)	11.9	
12 years	50	15 (30.0)	29.2	0.04
>12 years	31	2 (6.5)	4.7	0.64
Income				
<\$10,000	165	31 (18.8)	16.5	0.07
≥\$10,000	47	6 (12.8)	8.1	
Marital status				
Yes	84	6 (7.1)	5.7	0.04
No	128	31 (24.2)	19.9	
Country of origin				
United States	93	23 (24.7)	23.3	
Other	119	14 (11.8)	8.6	0.02
CD4 + cell count/μl				
>500	35	6 (17.1)	20.6	0.58†
200–400	79	13 (16.5)	15.1	
100–199	32	7 (21.9)	15.5	
<100	66	11 (16.7)	10.9	

* IDU = intravenous drug user.

† Test for homogeneity.

DISCUSSION

Data from this study suggest that *T. vaginalis* may be a frequently acquired infection in women with recognized HIV infection. Our findings suggest that women who are black, and nonblack women who trade sex for money or drugs or who are unmarried are at increased risk of trichomoniasis. These findings suggest that important race-based differences exist in the dynamics of *Trichomonas* transmission among women with HIV infection in Los Angeles.

The substantially elevated rate of trichomoniasis in black women may indicate a high prevalence of *Trichomonas* infection among the sex partners of these women. The finding of a racial association independent of other factors, and the apparent marginal importance of other exposures for black women, would support such a premise. Reliable data are lacking on the prevalence and incidence of community trichomoniasis in Los Angeles County and therefore it is unknown how common *Trichomonas* may be among local black men. However, very high rates (58%) of trichomoni-

TABLE 2

Bivariate analysis of selected behavioral factors and trichomoniasis among women with human immunodeficiency virus infection at a public clinic in Los Angeles County, California, 1992–1995

Factor	No.	No. (%) with trichomoniasis	Rate per 100 person-years	P
Drug use				
None	147	19 (12.9)	10.0	Referent
Crack/cocaine	33	12 (36.4)	35.5	<0.01
Other drugs	32	6 (18.8)	15.7	0.28
No. of sex partners				
<4	181	24 (13.3)	10.4	<0.01
≥4	31	13 (41.9)	43.0	
Trading sex*				
No	189	27 (14.2)	11.1	<0.01
Yes	23	10 (43.5)	51.0	
Prior STD†				
No	142	21 (14.8)	12.3	
1	29	6 (20.7)	14.5	0.56
≥2	41	10 (24.4)	19.8	0.07

* For money or drugs.

† STD = sexually transmitted disease.

asis among young, inner-city, black men have been noted elsewhere.¹³ The association with black race may also reflect decreased use of barrier protection in this population. We did not have reliable information on condom use in this group of women. Alternatively, it is possible that practices, such as douching, which is reportedly more common in black women and can increase susceptibility to infection,^{14–16} could predispose to trichomoniasis and explain the racial association observed. We did not obtain information on the practice of douching in this cohort of women. It is also conceivable that there exists a genetic or racial-based heightened susceptibility to *T. vaginalis* in black women; however, such a phenomenon has not been recognized. Although race is

TABLE 3

Factors independently associated with trichomoniasis among women with human immunodeficiency virus infection, Los Angeles County, California, 1990–1995

Factor	Adjusted rate ratio*	95% CI†	P
Race/ethnicity			
Black	5.6	(2.3, 13.3)	<0.001
Nonblack	Referent		
Trading sex			
Non-black			
Yes	25.2	(4.3, 148.6)	<0.001
No	Referent		
Black			
Yes	0.98	(0.19, 5.1)	0.89
No	Referent		
Single marital status			
Nonblack			
Yes	3.7	(1.1, 13.0)	0.05
No	Referent		
Black			
Yes	0.65	(0.18, 2.3)	0.62
No	Referent		

* Adjusted rate ratio computed using Cox proportional hazards model.

† CI = confidence interval.

not a modifiable factor, such as exchanging sex for money, the identification of race as a risk factor can assist in the targeting of education and other intervention efforts.

Among nonblack women, two factors, single marital status and trading sex for money or drugs, were independently associated with trichomoniasis. These findings may indicate that clients of women who trade sex may be more likely to have *Trichomonas* infection. Data from other studies suggest that paying consorts may also be resistant to using condoms.¹⁷ Such factors could increase the risk of trichomoniasis independent of other factors, including, for example, the number of sex partners. The increased rate of *Trichomonas* infection in unmarried, nonblack women observed could be a result of decreased condom use by these women or may reflect a higher prevalence of *Trichomonas* infection in the partners of such women. Marital status has been found to be significantly associated with the level of STD/HIV preventive practices.¹⁸

Our study did not confirm the findings of a cross-sectional study by Ghys and others, which reported higher rates of *Trichomonas* at lower CD4 cell levels and suggested that *Trichomonas* may be an opportunistic infection among women with HIV.⁷

Trichomoniasis is not a reportable condition in most health jurisdictions and prevalence surveys for STDs often do not include attempts to recover *Trichomonas*. Relatively few current data are available on the occurrence of *Trichomonas* infection in the United States. A large, multicenter study of nearly 14,000 pregnant women found an overall *Trichomonas* prevalence of 12.6%.¹⁹ Among black women, 22.8% were infected and black race was strongly associated with trichomoniasis in multivariate analysis. Cigarette smoking, single marital status, lower educational attainment, and increasing numbers of sexual partners were also identified as risk factors for *Trichomonas* infection. A recent report, which documented the occurrence of STDs in 372 sexually active, inner-city women in Brooklyn, New York, found a high prevalence of *Trichomonas* (27%) in a population that was 92% black.²⁰ *Trichomonas* was the most frequently identified STD and infection was associated with crack cocaine use and increasing numbers of sex partners. Another study of 279 women, 96% of whom were black, from a public STD clinic in Baltimore, Maryland found a prevalence of *Trichomonas* infection of 19% and similarly, trichomoniasis was the most commonly found STD.²¹ Small numbers of nonblack women precluded an assessment of race/ethnicity as a risk factor for *Trichomonas* infection in these studies. A larger study of 818 women, evaluated on a monthly basis for a six-month period, found 21% to be infected with *Trichomonas* and estimated a rate of 5.4 per 100 person-months.²² Trichomoniasis was associated with increasing numbers of sex partners, and the use of oral contraceptives was found to be protective. Race was not assessed as a possible risk factor. Older data, however, have noted substantial race-specific differences in the occurrence of trichomoniasis. A large study from the early 1960s that assessed the prevalence of *Trichomonas* in PAP smears from more than 30,000 women working in various Philadelphia, Pennsylvania industries reported finding *Trichomonas* in 30.4% of black women and 10.9% of white women.²³ Though recent data are limited and were obtained among selected groups of women, they suggest that *T. vag-*

inalis is an exceptionally common infection, and often the most frequently identified STD, among poor urban women, particularly those who are black.

The high rate of trichomoniasis observed in women with HIV infection has potential implications for HIV prevention. The occurrence of an acute STD, including trichomoniasis, confirms the practice of unprotected sex and the accompanying potential for the spread of HIV. Moreover, concurrent STDs may amplify the risk of HIV transmission. Such coinfections can increase the level of viral-laden bodily fluids and/or the numbers of lymphocytes and macrophages present in the genital contact area.²⁴ *Trichomonas* typically elicits an aggressive local cellular immune response with inflammation of the vaginal epithelium and exocervix.²⁵ In addition, punctate hemorrhages can be observed colposcopically in 45% of infected women.²⁶ The greater numbers of both free virus and viral-infected white blood cells may increase the probability of HIV exposure and transmission. Therefore, persons with HIV who develop trichomoniasis are likely to be an important source of continuing HIV transmission and characterizing such persons can assist in the targeting of prevention efforts. If *Trichomonas* is as common among HIV-infected women as our findings suggest, it could have a substantial population effect on HIV transmission even if trichomoniasis increases the risk of HIV transmission by only a small or modest amount.

Our data must be interpreted cautiously for several reasons. It is possible that some of the women in this clinic accessed care for STDs at alternative facilities. Therefore, the incidence of trichomoniasis observed may be an underestimate. Moreover, this possible under recognition, or misclassification of disease status, could be differentiated by race, marital status, and trading of sex and consequently our results could be biased by such misclassification. We believe that this potential limitation is mitigated since the clinic provides comprehensive services and is accessed by many of the women as a primary care provider. The use of only moderately sensitive techniques such as direct microscopy and cytology also indicate that the estimate of *Trichomonas* infection is spuriously low. In addition, we did not have data on the proportion of women who were diagnosed with trichomoniasis through PAP smear alone and it is possible that our findings could be a result of PAP screening practices. However, PAP smears were performed on a smaller proportion of black women (25%) than nonblack women (42%) and therefore could not explain the higher rate of *Trichomonas* infection in black women. It is also possible, since *Trichomonas* infection can be chronic in nature, that some of the trichomoniasis identified may not represent acute infection but rather chronic colonization that has been newly recognized. It is unlikely, however, for such a phenomenon to be differentiated by the various factors found to be associated with infection. In addition, it is possible that our results reflect, at least in part, diagnostic bias since clinicians could be more likely to selectively screen for STDs women who are black, unmarried, and report trading sex for money or drugs. Similarly, single women and those who trade sex might present for more screening if they were concerned about acquiring STDs. Another possible bias is that women with other STDs, as might be expected for unmarried women and those who trade sex, may be more likely to be evaluated

for *Trichomonas*. However, the incidence of other STDs was quite low and therefore such a bias, if it exists, is probably small. A further limitation is the generalizability of our findings. This study focused on a selected, relatively small, group of women who are enrolled in health care and are receiving services at a single, albeit large, HIV clinic. Consequently, our findings cannot necessarily be extrapolated to other populations of HIV-infected women. The small sample size of this cohort also limited the statistical power to identify other, possibly important, factors associated with trichomoniasis. Finally, the attributable fractions we provide, which are dependent on the relative frequency of exposure, as well as the level of estimated risk, must be viewed as applying only to this cohort since, for example, the proportion of black women may vary considerably by subpopulation.

Nevertheless, our data indicate that trichomoniasis in HIV-infected women may be more common in blacks, and among nonblacks who are unmarried and trade sex. Our findings may be useful for targeting prevention efforts to interrupt HIV transmission since these persons may be more efficient transmitters of HIV. Health care providers and agencies directing HIV prevention funding should consider targeting women with one or more of these characteristics for educational intervention. Such efforts, to target persons with an increased probability of transmitting the virus, may be particularly important for those patients with severe immunosuppression. Aggressive detection and treatment of *Trichomonas* infection in HIV-infected women may help reduce subsequent HIV transmission.

Our data may also provide insight into the emerging patterns of the HIV epidemic in Los Angeles, which is increasingly affecting blacks and women.^{27,28} Part of this trend of HIV transmission may be a result of the amplifying effect of STDs, including trichomoniasis, on the local infection dynamics of HIV. In Los Angeles County, blacks have significantly higher rates of syphilis and gonorrhea than other racial/ethnic groups (STD Report, Los Angeles County Department of Health Services). Further study of the possible role of *Trichomonas* in the dynamics of HIV transmission is warranted.

Physicians should have a heightened index of suspicion for trichomoniasis in women who are black, and nonblack women who trade sex and are unmarried. The occurrence of any acute STD in an HIV-infected patient should prompt aggressive patient counseling at the provider level.

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REFERENCES

1. Choi K-H, Coates TJ, 1994. Prevention of HIV infection. *AIDS* 10: 1371-1389.
2. Wasserheit JN, 1992. Epidemiological synergy, 1992. Interrelationships between human immunodeficiency virus infection and other sexually transmitted diseases. *Sex Transm Dis* 19: 61-77.
3. Aral SO, 1993. Heterosexual transmission of HIV: the role of other sexually transmitted infections and behavior in its epidemiology, prevention and control. *Annu Rev Public Health* 14: 51-67.
4. Clotey C, Dalabetta G, 1993. Sexually transmitted diseases and human immunodeficiency virus, epidemiologic synergy? *Infect Dis Clin North Am* 4: 753-770.
5. Mertens TE, Hayes RJ, Smith PG, 1990. Epidemiological methods to study the interaction between HIV infection and other sexually transmitted diseases. *AIDS* 4: 57-65.
6. Laga M, Manoka A, Kivuvu M, Malele B, Tuliza M, Nzila N, Goeman J, Behets F, Batter V, Alary M, Heyward WL, Ryder RW, Piot P, 1993. Non-ulcerative sexually transmitted diseases as risk factors for HIV-1 transmission in women: results from a cohort study. *AIDS* 7: 95-102.
7. Ghys PD, Diallo MO, Ettienne-Traore V, Yeboue KM, Gnaore E, Loroughon F, Kale K, Van Dyck E, Brattegaard K, Hoyi YM, Whitaker JP, De Cock KM, Greenberg AE, Piot P, Laga M, 1995. *Genital ulcers associated with human immunodeficiency virus-related immunosuppression in female sex workers in Abidjan, Ivory Coast.* *J Infect Dis* 172: 1371-1374.
8. ter Meulen J, Mgamma HN, Chang-Claude J, Luande J, Mtiro H, Mhina M, Kashaija P, Pawlita M, 1992. Risk factors for HIV infection in gynaecological inpatients in Dar Es Salaam. Tanzania, 1988-90. *E Afr Med J* 69: 688-692.
9. Farizo KM, Buehler JW, Chamberland ME, Whyte BM, Froelicher ES, Hopkins SG, Reed CM, Mokotoff ED, Cohn DL, Troxler S, Phelps AF, Berkelman RL, 1992. Spectrum of disease in persons with human immunodeficiency virus infection in the United States. *JAMA* 263: 1798-1805.
10. Diaz T, Chu SY, Byers RH, Hersh BS, Conti L, Rietmeijer CA, Mokotoff E, Fann E, Boyd D, Iglesias L, Checko PJ, Frederick M, Hermann P, Herr M, Samuel MC, 1994. The types of drugs used by HIV-infected injection drug users in a multistate surveillance project: implications for intervention. *Am J Public Health* 84: 1971-1975.
11. Mickey RM, Greenland S, 1989. A study of the impact of confounder-selection criteria on effect estimation. *Am J Epidemiol* 129: 125-137.
12. Greenland S, 1989. Modeling and variable selection in epidemiologic analysis. *Am J Public Health* 79: 340-349.
13. Saxena SB, Jenkins, RR, 1991. Prevalence of *Trichomonas vaginalis* in men at high risk for sexually transmitted diseases. *Sex Transm Dis* 18: 138-142.
14. Scholes D, Daling JR, Stergachis A, Weiss NS, Wang SP, Grayston JT, 1993. Vaginal douching as a risk factor for acute pelvic inflammatory disease. *Obstet Gynecol* 81: 601-606.
15. Joesoef MR, Sumampouw H, Linnan M, Schmid S, Idjadi A, St. Louis M, 1996. Douching and sexually transmitted diseases in pregnant women in Suraaya, Indonesia. *Am J Obstet Gynecol* 174: 115-119.
16. Aral SO, Mosher WD, Gates W Jr, 1992. Vaginal douching among women of reproductive age in the United States: 1988. *Am J Public Health* 82: 210-214.
17. Wong ML, Tan TC, Ho ML, Lim JY, 1992. Factors associated

- with sexually transmitted diseases among prostitutes in Singapore. *Int J STD AIDS* 3: 332–337.
18. O'Campo P, Deboer M, Faden RR, Kass N, 1992. Prior episode of sexually transmitted disease and subsequent sexual risk-reduction practices. A need for improved risk-reduction interventions. *Sex Transm Dis* 19: 326–330.
 19. Cotch MF, Patorek JG, Nugent RP, Yerg DE, Martin DH, Eschenbach DA, 1991. Demographic and behavioral predictors of *Trichomonas vaginalis* infection among pregnant women. *Obstet Gynecol* 78: 1087–1092.
 20. Dehovitz JA, Kelly P, Feldman J, Sierra MF, Clarke L, Bromberg J, Wan JY, Vermund SH, Landesman S, 1994. Sexually transmitted diseases, sexual behavior, and cocaine use in inner-city women. *Am J Epidemiol* 140: 1125–1134.
 21. Pabst KM, Reichart CA, Knud-Hansen CR, Wasserheit JN, Quinn TC, Shah K, Dallabetta G, Hook EW, 1992. Disease prevalence among women attending a sexually transmitted disease clinic varies with reason for visit. *Sex Transm Dis* 19: 88–91.
 22. Barbone F, Austin H, Louv WC, Alexander WJ, 1990. A follow-up study of methods of contraception, sexual activity, and rates of trichomoniasis, candidiasis, and bacterial vaginosis. *Am J Obstet Gynecol* 163: 510–514.
 23. Ipsen J, Feigl P, 1970. A biomathematical model for prevalence of *Trichomonas vaginalis*. *Am J Epidemiol* 91: 175–184.
 24. Kreiss JK, Coombs R, Plummer F, 1989. Isolation of human immunodeficiency virus from genital ulcers in Nairobi prostitutes. *J Infect Dis* 160: 380–384.
 25. Wolner-Hanssen P, Krieger JN, Stevens CE, 1989. Clinical manifestations of vaginal trichomoniasis. *JAMA* 264: 571–576.
 26. Fouts AC, Kraus SJ, 1980. *Trichomonas vaginalis*: reevaluation of its clinical presentation and laboratory diagnosis. *J Infect Dis* 141: 137–143.
 27. Greenland S, Lieb L, Simon P, Ford W, Kerndt P, 1996. Evidence for recent growth of the HIV epidemic among African-American men and younger male cohorts in Los Angeles County. *J Acquir Immune Defic Syndr* 11: 401–409.
 28. Sorvillo FJ, Kerndt P, Cheng K-J, Beall G, Turner PA, Beer VL, Kovacs A, 1995. Emerging patterns of HIV transmission: the value of alternative surveillance methods. *AIDS* 9: 625–629.