Predictors and Prevention of Nonfatal Overdose Among Street-Recruited Injection Heroin Users in the San Francisco Bay Area, 1998–1999

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Heroin overdoses have been increasing dramatically in the United States.[1] From 1990 to 1995, heroin-related emergency department visits doubled from 33 884 to 70 838,[1] and deaths from overdose more than doubled in the last decade in 2 counties in Oregon and Washington states.[2,3] Increasing purity of heroin, coupled with declining street prices, has been cited as the reason for parallel increases in consumption and overdose.[4] In 1999, in San Francisco, Calif, 3074 emergency department visits for heroin overdose were made.[1] Moreover, from July 1998 through June 1999, in San Francisco, 148 heroin overdose deaths occurred,[5] rendering overdose the third leading cause of years of potential life lost in that city.[6] If heroin overdose is detected and treated in time, it can be reversed within minutes with naloxone,[7] an injectable opiate antagonist.

Several studies have identified factors associated with overdose.[8–11] Overdose is more prevalent after a period of abstinence, when tolerance is lowered, such as following release from jail or drug treatment programs.[8,9] The risk of overdose is greater when heroin is injected while other central nervous system depressants, such as alcohol or sedatives, are being used.[8,10,12–14] Moreover, the potency of heroin varies widely, and overdoses have occurred when users altered their source.[10,15,16]

Those who report a nonfatal overdose in the past are more likely to experience another, potentially fatal overdose in the future.[13] Here we report on the prevalence of recent nonfatal overdose among a sample of street-recruited heroin injectors in the San Francisco Bay Area and quantify associated risk factors. Based on our findings, we propose several practical prevention strategies to stem the increasing number of unnecessary heroin overdose deaths.

Objectives. This study sought to determine prevalence of and risk factors for nonfatal recent overdose among street-recruited injection heroin users.

Methods. From August 1998 through July 1999, 1427 heroin injectors were recruited from 6 inner-city neighborhoods in the San Francisco Bay Area, Calif, and interviewed. Factors hypothesized to be associated with recent overdose were analyzed with logistic regression.

Results. Of the 1427 participants, 684 (48%) had had an overdose, 466 (33%) had experienced 2 or more overdose events, and 182 (13%) had had a recent overdose. In multiple logistic regression, being younger (adjusted odds ratio [OR] for each year of increasing age = 0.95; 95% confidence interval [CI] = 0.94, 0.97), having been arrested 3 or more times in the past year (adjusted OR = 2.50; 95% CI = 1.61, 3.87), drinking 4 or more alcoholic drinks per day (adjusted OR = 2.05; 95% CI = 1.37, 3.05), and having participated in methadone detoxification during the past year (adjusted OR = 1.47; 95% CI = 1.03, 2.09) were independently associated with recent overdose. Being homeless; identifying as gay, lesbian, bisexual, or transgender; having spent 5 or more years in prison or jail; and having engaged in sex work also were associated with recent overdose.

Conclusions. Targeted interventions that decrease risk for overdose are urgently needed. (*Am J Public Health.* 2001;91:1842–1846)

METHODS

Since 1986, the Urban Health Study has conducted semiannual surveys of injection drug users (IDUs) to carry out HIV and hepatitis surveillance and provide risk reduction counseling.[17,18] Participants are recruited from street settings by experienced ethnographers and indigenous outreach workers and by word of mouth with targeted sampling methods.[19,20] Eligibility for the study is based on reporting recent injection drug use (past 30 days) or having participated in previous cross-sections of data collection. New study participants are examined for evidence of venipuncture (tracks) or subcutaneous injection.

From August 1998 through July 1999, 1622 IDUs were recruited from 6 inner-city communities in the San Francisco Bay Area. Participants were interviewed by trained counselors about demographics and sexual and injection risk behavior, including over-

dosing, and were paid a small stipend ($15–$20) for their contribution to the study. The study was approved by the University of California, San Francisco, Committee on Human Research, and each participant gave informed consent.

For this analysis, we restricted our sample to the 1427 participants who reported injecting heroin or "speedballs" (a cocaine and heroin mixture) in the past 6 months. In a subsequent wave of data collection (October 1999–February 2000), a similar population of street-recruited IDUs classified 307 (94%) of 327 overdoses as heroin overdoses. In a smaller follow-up study, 96% defined overdose as "not breathing" and "turning blue" and as potentially leading to death, all features of heroin overdose. Thus, we assume that the vast majority of overdoses reported here represented heroin overdoses.

We defined *recent nonfatal overdose* as a self-reported overdose that occurred in

1998 or 1999. We limited our analysis to recent overdose, because participants would have more accurate recall of the overdose events and self-reported demographic and risk behavior would be concurrent. The follow-up interval from January 1998 to the day of the interview varied from 7 months for persons interviewed in August 1998 to 18 months for participants interviewed in July 1999.

We used logistic regression modeling to examine demographic and injection and sex risk variables individually for their association with recent nonfatal overdose. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. *Methadone detoxification* refers to treatment for a 21-day period during which the methadone dose is tapered and then discontinued; in *methadone maintenance,* the client is maintained indefinitely at a prescribed dose.

To determine independent predictors of recent nonfatal overdose, we constructed a multivariate model that used stepwise logistic regression and included variables that were associated ($P<.1$) with recent overdose in bivariate analysis (see Table 3) and that we hypothesized might be causally associated with overdose. We also included calendar time in the model to adjust for duration of the follow-up interval for recent overdose. To validate this approach, we performed an interval-censored survival analysis (SAS LIFEREG procedure[21]). The hazard ratios in this model were not significantly different from the odds ratios in the logistic model.

Four participant characteristics that were associated with overdose in bivariate analysis attracted our interest, because although no biological or epidemiologic explanation was evident for any of the associations with overdose, each factor seemed to imply a degree of social marginalization or stigmatization. The 4 characteristics were (1) being currently homeless; (2) having spent 5 or more years in jail or prison; (3) identifying as lesbian, gay, bisexual, or transgender; and (4) having engaged in sex work for money or drugs in the past 6 months. Because previous research suggests that these characteristics may increase vulnerability to adverse health outcomes by increasing social marginalization,[22–29] we sought to determine whether

these factors would remain associated with overdose in multivariate analysis when we controlled for the other predictive factors in our logistic regression model. To do so, we created a 4-point "social marginalization" score by assigning participants 1 point for each of these 4 characteristics that they reported, and we entered that score as an additional independent variable in the logistic regression model.

RESULTS

The median age of study participants was 44 years (interquartile range=38–49 years); 31% were female; 51% self-identified as African American, 35% as White, 7% as Latino, and 7% as Asian or Pacific Islander, mixed, or "other" race/ethnicity. The median duration of injection drug use was 24 years (interquartile range=15–31 years). Of the 1427 participants, 684 (48%) reported an overdose event ever, 466 (33%) had experienced 2 or more overdose events, and 182 (13%) reported a recent overdose (in 1998 or 1999).

In bivariate analysis, identifying as White or "other" race/ethnicity, being younger, identifying as bisexual, being homeless, and having been arrested 3 or more times in the past year were significantly associated with increased odds of recent overdose (Table 1), as was having engaged in sex work in the past 6 months (Table 2). Having participated in methadone maintenance was associated with a decreased odds of recent overdose, whereas having undergone methadone detoxification was associated with an increased odds (Table 1). Also, in bivariate analysis, having a shorter injection career, reporting 4 or more alcoholic drinks per day, injecting heroin more frequently, and using sedatives were each associated with greater odds of recent overdose (Table 2). For each additional characteristic a participant reported that was included in the "social marginalization" score, from 0 to 3 or more characteristics, the odds of recent overdose concomitantly increased in a stepwise fashion ($P<.001$, χ^2 test for trend) (Table 2).

In a multivariate model adjusted for calendar time, 4 variables were independently associated with recent overdose: (1) being younger (adjusted OR for each year of in-

creasing age=0.95; 95% CI=0.94, 0.97), (2) having been arrested 3 or more times in the past year (adjusted OR=2.50; 95% CI=1.61, 3.87), (3) drinking 4 or more alcoholic drinks per day (adjusted OR=2.05; 95% CI=1.37, 3.05), and (4) having participated in methadone detoxification in the past year (adjusted OR=1.47; 95% CI=1.03, 2.09) (Table 3). Identifying as White, reporting sedative use, participating in methadone maintenance, injection frequency and duration, and theoretically grounded interactions between main effects were not independently associated with recent overdose. Of note, when the "social marginalization" score was added to the final multivariate model, for each characteristic a participant reported (from 0 to 3 or more characteristics), the odds of recent overdose independently increased (adjusted OR=1.48 per characteristic; 95% CI=1.21, 1.80), and all other covariates remained significantly associated with recent overdose.

DISCUSSION

Overdose is highly prevalent among IDUs, and in some countries, overdose surpasses HIV and AIDS as the leading cause of death among IDUs.[30,31] Similarly, in this study of heroin injectors recruited from inner-city streets in the San Francisco Bay Area, overdose was alarmingly prevalent, with nearly half of the sample reporting overdosing at least once and more than a third reporting 2 or more overdoses during their injecting careers. Younger age, frequent arrests, moderate to heavy daily alcohol consumption, and participation in methadone detoxification treatment independently increased the odds of recent overdose.

In our sample, younger age was independently associated with recent overdose. Recent studies have reported that young injectors (younger than 30 years) have a strikingly high prevalence of overdose (55% have overdosed a median of 3 times)[32] and engage in significantly greater injection and sexual risk behavior than their older counterparts[33]; it has also been shown that these higher-risk behaviors are associated with overdose.[32] Thus, health and social service providers who work with young IDUs should emphasize the

TABLE 1—Prevalence of Recent Overdose Among Street-Recruited Injection Drug Users (n = 1427), by Demographic and Drug Treatment Characteristics

Characteristics[a]	No. Reporting Recent Overdose/Total	%	OR (95% CI)
Sex			
Male	134/973	14	1.00
Female	46/444	10	0.72 (0.51, 1.03)
Transgender	2/10	20	1.57 (0.33, 7.45)
Race/ethnicity			
Black	63/732	9	1.00
White	93/502	19	2.41 (1.71, 3.40)
Latino	9/104	9	1.01 (0.48, 2.09)
Other[b]	17/87	20	2.58 (1.43, 4.56)
Age, y			
≥50	20/328	6	1.00
40–49	80/693	12	2.01 (1.21, 3.34)
30–39	50/281	18	3.33 (1.93, 5.75)
<30	32/125	26	5.30 (2.89, 9.70)
Sexual orientation			
Heterosexual	152/1250	12	1.00
Lesbian/gay	10/57	18	1.54 (0.76, 3.11)
Bisexual	19/101	19	1.67 (1.00, 2.84)
Currently homeless[c]			
No	63/781	8	1.00
Yes	119/642	19	2.59 (1.87, 3.59)
Time spent in jail or prison, lifetime			
None	5/76	7	1.00
1–2 wk	19/138	14	2.27 (0.81, 6.34)
≤4 y	82/715	11	1.84 (0.72, 4.69)
≥5 y	70/482	15	2.41 (0.94, 6.19)
Arrested ≥3 times, past y			
No	137/1271	11	1.00
Yes	43/151	28	3.30 (2.22, 4.89)
Drug treatment, past y			
No	90/705	13	1.00
Yes	90/707	13	1.00 (0.73, 1.36)
Methadone detoxification, past y			
No	116/996	12	1.00
Yes	66/423	16	1.40 (1.01, 1.94)
Methadone maintenance, past y			
No	153/1111	14	1.00
Yes	29/312	9	0.64 (0.42, 0.98)

Note. OR = odds ratio; CI = confidence interval.
[a]Some observations (<19) are missing for several of the demographic and drug treatment categories.
[b]Asians, Pacific Islanders, Native Americans, and those of mixed race/ethnicity.
[c]Based on self-classification.

high risk of overdose and provide practical overdose prevention education.

We, as others, found that when IDUs injected heroin after a period of abstinence—when their tolerance was lowered, such as following incarceration or 21-day methadone detoxification—the risk of overdose was higher.[9,10,16] Of note, several groups in Europe, the United Kingdom, and Australia reported that long-term methadone maintenance treatment is protective against heroin overdose.[9,31,34] Our findings highlight the critical importance of including overdose prevention education in prerelease programs in jails and 21-day methadone detoxification clinics.

As others have reported, our data showed that factors contributing to central nervous system depression, such as drinking alcohol while injecting heroin, increased the odds of recent overdose.[9,10,13,35] Autopsy studies have found that in deaths attributed to "heroin" overdose, opiate levels often were no higher than in those who survived and that death rarely occurred in the absence of other substances.[8,36] Thus, prevention education should stress the risk for death when heroin is mixed with central nervous system depressants such as alcohol (and sedatives), because these drugs may promote higher-risk injection behavior and enhance the respiratory depressant effects of heroin.

Characteristics that imply social marginalization have been associated with several adverse health outcomes in other research.[22–27] In this study, 4 such characteristics—being homeless; having been incarcerated; identifying as lesbian, gay, bisexual, or transgender; and engaging in sex work—were independently associated with recent overdose in an increasing stepwise fashion. These factors may increase levels of social and economic stress and reduce opportunities and resources for self-protective behaviors. Heroin injectors who lack a stable social community, a safe and familiar place to inject, and a steady and known supply of heroin may be more likely to inject alone, to rush injections because of fears of arrest, and to experience fluctuating heroin purity and tolerance, all of which may culminate in a greater tendency toward overdose.[28,29] Of note, a recent study of a cohort of IDUs from Seattle, Wash, published in this Journal found a significant association between overdose death and factors suggesting social marginalization, namely, identifying as bisexual and being homeless.[37]

Harm reduction workers in Europe, recognizing the potential for overdose in everchanging, chaotic injection environments, have developed "safe injection rooms."[38] Although safe injection rooms are not currently

TABLE 2—Prevalence of Recent Overdose Among Street-Recruited Injection Drug Users (n = 1427), by Drug or Alcohol and Sexual Risk Behavior

Risk Behavior[a]	No. Reporting Recent Overdose/Total	%	OR (95% CI)
Duration of injection career, y			
>30	30/360	8	1.00
21–30	67/519	13	1.63 (1.04, 2.57)
11–20	47/300	16	2.04 (1.26, 3.32)
≤10	37/232	16	2.09 (1.25, 3.49)
Frequency of intravenous injections, past 30 d			
None	9/202	4	1.00
1–2/wk	17/190	9	2.11 (0.92, 4.85)
>2/wk–1/d	36/249	14	3.62 (1.70, 7.72)
>1–2/d	36/245	15	3.69 (1.73, 7.87)
>2–3/d	27/197	14	3.41 (1.56, 7.45)
>3/d	55/327	17	4.34 (2.09, 8.98)
≥4 alcoholic drinks/d			
No	124/1141	11	1.00
Yes	43/230	19	1.89 (1.29, 2.76)
Used sedatives, past 30 d			
No	133/1170	11	1.00
Yes	47/255	18	1.76 (1.22, 2.54)
Received money/drugs for sex, past 6 mo			
No	146/1249	12	1.00
Yes	35/162	22	2.08 (1.38, 3.14)
No. of "social marginalization" factors[b]			
0	25/425	6	1.00
1	81/636	13	2.33 (1.46, 3.72)
2	56/296	19	3.73 (2.27, 6.14)
≥3	20/71	28	6.76 (3.45, 13.2)

Note. OR = odds ratio; CI = confidence interval.
[a]Some observations are missing for several of the risk behavior categories.
[b]A 4-point social marginalization score was created by assigning participants 1 point for each of the following variables they reported: (1) being currently homeless; (2) spending ≥5 years in jail; (3) identifying as lesbian, gay, bisexual, or transgender; and (4) engaging in sex work for money or drugs (past 6 months).

TABLE 3—Characteristics and Behaviors Independently Associated With Recent Overdose Among Street-Recruited Injection Drug Users in Multivariate Analysis[a] (n = 1427)

Characteristics or Behaviors	Adjusted Odds Ratio	95% Confidence Interval
Age, y	0.95	(0.94, 0.97)
Arrested ≥3 times, past y	2.50	(1.61, 3.87)
≥4 alcoholic drinks/d	2.05	(1.37, 3.05)
Methadone detoxification, past y	1.47	(1.03, 2.09)

[a]Adjusted for calendar month of interview.

within the scope of US drug policy, IDUs can be strongly advised to (1) inject a small quantity of unfamiliar heroin first, and more slowly than usual, before using a full dose; (2) inject in safe and familiar locations; and (3) avoid injecting alone. More research is required to better explain why and how overdose may result not only from central nervous system depression and lowered tolerance but also indirectly from a constellation of less well understood social, behavioral, and environmental factors.

Our results should be considered in light of the following limitations. We used targeted sampling techniques to recruit a sample directly from the drug-using population in the San Francisco Bay Area. Nevertheless, this was not a true random sample; therefore, the results cannot be generalized to all heroin injectors. Because of the clandestine nature of drug use, it is not possible to sample drug users at random. Furthermore, there may be inherent biases in self-reported drug use and risk behavior data because of social desirability, recall, and intoxication. Previous research, however, has shown high validity in self-report among drug users recruited outside clinical settings.[39,40] Moreover, we did not specify the type of drug overdose and did not furnish a standard definition of overdose. To address this, we eliminated from the analysis IDUs who had not injected heroin within the past 6 months.

Despite these limitations, we found a strikingly high prevalence of overdose and several modifiable risk factors that suggest several potential lifesaving interventions. We must focus overdose prevention efforts on relatively young injectors and those who are frequently arrested, drink alcohol daily, and participate in 21-day methadone detoxification. Specifically, we should urgently disseminate overdose prevention messages such as avoiding mixing heroin with other central nervous system depressants and exercising caution after periods of abstinence. Finally, in light of the tragic number of unnecessary deaths from overdose, we should seriously consider novel interventions such as "safe injection rooms" and providing resuscitation training and take-home naloxone to injection heroin users. ■

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References

1. Office of Applied Studies. *Year-End Emergency Department Data From the Drug Abuse Warning Network (DAWN).* Rockville, Md: Substance Abuse and Mental Health Services Administration; 1999.

2. Centers for Disease Control and Prevention. Unintentional opiate overdose deaths—King County, Washington, 1990–1999. *MMWR Morb Mortal Wkly Rep.* 2000;49(28):636–640.

3. Centers for Disease Control and Prevention. Heroin overdose deaths—Multnomah County, Oregon, 1993–1999. *MMWR Morb Mortal Wkly Rep.* 2000; 49(28):633–636.

4. Office of National Drug Control Policy. *What America's Users Spend on Illegal Drugs, 1988–1995.* Washington, DC: Executive Office of the President; 1997.

5. *Annual Report, July 1, 1998–June 30, 1999.* San Francisco, Calif: Medical Examiner's Office; 1999:65.

6. *San Francisco—Overview of Health Status, Population Health and Prevention Division.* San Francisco, Calif: Planning Office, Population Health and Prevention, San Francisco Department of Public Health; 2000:28.

7. Sporer KA, Firestone J, Issacs SM. Out of hospital treatment of opioid overdoses in an urban setting. *Acad Emerg Med.* 1996;3:660–667.

8. Darke S, Zador D. Fatal heroin "overdose": a review. *Addiction.* 1996;91:1765–1772.

9. Darke S, Ross J, Hall W. Overdose among heroin users in Sydney, Australia, I: prevalence and correlates of non-fatal overdose. *Addiction.* 1996;91:405–411.

10. Gossop M, Griffiths P, Powis B, Williamson S, Strang J. Frequency of non-fatal heroin overdose: survey of heroin users recruited in non-clinical settings. *BMJ.* 1996;313:402.

11. Zador D, Sunjic S, Darke S. Heroin-related deaths in New South Wales, 1992: toxicological findings and circumstances. *Med J Aust.* 1996;164:204–207.

12. Levine B, Green D, Smialek JE. The role of ethanol in heroin deaths. *J Forensic Sci.* 1995;40:808–810.

13. Powis B, Strang J, Griffiths P, et al. Self-reported overdose among injecting drug users in London: extent and nature of the problem. *Addiction.* 1999;94: 471–478.

14. Taylor A, Frischer M, Goldberg D. Non-fatal overdosing is related to polydrug use in Glasgow [letter; comment]. *BMJ.* 1996;313:1400–1401.

15. Darke S, Hall W, Weatherburn D, Lind B. Fluctuations in heroin purity and the incidence of fatal heroin overdose. *Drug Alcohol Depend.* 1999;54:155–161.

16. Bammer G, Sengoz A. Non-fatal heroin overdoses [letter]. *Med J Aust.* 1994;161:572–573.

17. Watters JK. Trends in risk behavior and HIV seroprevalence among injecting drug users in San Francisco, 1986–1992. *J Acquir Immune Defic Syndr.* 1994; 7:1276–1281.

18. Watters JK, Estilo MJ, Clark C, Lorvick JJ. Syringe and needle exchange as HIV/AIDS prevention for injection drug users. *JAMA.* 1994;271:115–120.

19. Watters JK, Biernacki P. Targeted sampling: options for the study of hidden populations. *Soc Probl.* 1989;36:416–430.

20. Bluthenthal RN, Watters JK. Multimethod research: from targeted sampling to HIV risk behaviors. In: Lambert EY, Ashery RS, Needle RH, eds. *Qualitative Methods in the Prevention of Drug Abuse and HIV Research.* Rockville, Md: National Institute on Drug Abuse; 1995:212–230. NIDA Research Monograph 157.

21. Bourgois P, Lettiere M, Quesada J. Social misery and the sanctions of substance abuse: confronting HIV risk among homeless heroin addicts in San Francisco. *Soc Probl.* 1997;44:155–173.

22. Deren S, Estrada A, Stark M, Williams M, Goldstein M. A multisite study of sexual orientation and injection drug use as predictors of HIV serostatus in out-of-treatment male drug users. *J Acquir Immune Defic Syndr Hum Retrovirol.* 1997;15:289–295.

23. Pyett PM, Warr DJ. Vulnerability on the streets: female sex workers and HIV risk. *AIDS Care.* 1997;9: 539–547.

24. Kral AH, Lorvick J, Bluthenthal RN, Watters JK. HIV risk profile of drug-using women who have sex with women in 19 United States cities. *J Acquir Immune Defic Syndr Hum Retrovirol.* 1997;16:211–217.

25. Reindollar RW. Hepatitis C and the correctional population. *Am J Med.* 1999;107(6B):100S–103S.

26. Paone D, Cooper H, Alperen J, Shi Q, Des Jarlais DC. HIV risk behaviors of current sex workers attending syringe exchange: the experiences of women in 5 US cities. *AIDS Care.* 1999;11:269–280.

27. Siegel S. Pavlovian conditioning and drug overdose: when tolerance fails. *Addict Res Theory.* In press.

28. Gutiérrez-Cebollada J, de la Torre R, Ortuño J, Garcés JM, Camí J. Psychotropic drug consumption and other factors associated with heroin overdose. *Drug Alcohol Depend.* 1994;35:169–174.

29. *SAS/STAT User's Guide, Version 6.* 4th ed. Vol 2. Cary, NC: SAS Institute Inc; 1990:997–1025.

30. Frischer M, Bloor M, Goldberg D, Clark J, Green S, McKegany N. Mortality among injection drug users:

a critical reappraisal. *J Epidemiol Community Health.* 1993;47:59–63.

31. Davoli M, Perucci CA, Forastiere F, et al. Risk factors for overdose mortality: a case-control study within a cohort of intravenous drug users. *Int J Epidemiol.* 1993;22:273–277.

32. Ochoa K, Hahn J, Seal K, Moss A. Overdosing among young injection drug users in San Francisco. *Addict Behav.* 2001;25:1–8.

33. Kral AH, Lorvick J, Edlin BR. Sex- and drug-related risk among populations of younger and older injection drug users in adjacent neighborhoods in San Francisco. *J Acquir Immune Defic Syndr Hum Retrovirol.* 2000;24:162–167.

34. van Ameijden EJ, Krol A, Vlahov D, Flynn C, van Haastrecht HJ, Coutinho RA. Pre-AIDS mortality and morbidity among injection drug users in Amsterdam and Baltimore: an ecological comparison. *Subst Use Misuse.* 1999;34:845–865.

35. Stein MD, Bonanno J, O'Sullivan PS, Wachtel TJ. Changes in the pattern of drug overdoses. *J Gen Intern Med.* 1993;8:179–184.

36. Sporer KA. Acute heroin overdose. *Ann Intern Med.* 1999;130:584–590.

37. O'Driscoll PT, McGough J, Hagan H, Thiede H, Critchlow C, Alexander ER. Predictors of accidental fatal drug overdose among a cohort of injection drug users. *Am J Public Health.* 2001;91:984–987.

38. Burki C. Swiss approach to heroin overdose: from safe injection rooms to heroin prescription. Abstract presented at: Preventing Heroin Overdose: Pragmatic Approaches; January 13–14, 2000; Seattle, Wash.

39. Watters J, Needle R, Brown B, Weatherby N, Booth R, Williams M. The self-reporting of cocaine use [letter]. *JAMA.* 1992;268:2374–2375.

40. Dowling-Guyer S, Johnson ME, Fisher DG, et al. Reliability of drug users' self-reported HIV risk behaviors and validity of self-reported recent drug use. *Assessment.* 1994;1:383–392.