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Occupational Exposure to HIV: Frequency and Rates of Underreporting of Percutaneous and Mucocutaneous Exposures by Medical Housestaff

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PURPOSE: To study the frequency of work-related exposures to human immunodeficiency virus (HIV)-infected blood and reporting of exposures among medical housestaff.

SETTINGS: Three teaching hospitals where HIV infection is prevalent among patients.

SUBJECTS: Internal medicine interns and residents in training in 1988–1989.

METHODS: In a cross-sectional survey, house officers were asked to complete anonymously a questionnaire reviewing their past percutaneous and mucocutaneous exposure to blood products.

RESULTS: Nineteen percent of the respondents (16 of 86) recalled accidental exposure to HIV-infected blood, and 36% (31 of 86) recalled exposure to blood from patients at high risk for having HIV infection. Of the exposures recalled in the 12 months prior to the survey, 81% (47 of 58) of all needlestick injuries and all (nine of nine) needlestick injuries from HIV-infected blood occurred in postgraduate year 1 or 2 trainees.

Only 30% (31 of 103) of the needlestick injuries recalled by subjects were reported. The principal reasons for not reporting were time constraints, perception that the percutaneous injury did not represent a significant exposure, lack of knowledge about the reporting mechanism, and concern about confidentiality and professional discrimination.

CONCLUSIONS: Medical housestaff are at substantial risk for occupational infection with HIV. A large proportion of internal medicine housestaff recall accidental exposure to blood during medical school and residency, and the majority of exposures were not reported. Hospitals may be able to increase rates of reporting of percutaneous exposures to HIV by developing programs that are easy to access, efficient, and strictly confidential.

A ccidental inoculation is a recognized mode of transmitting many bloodborne diseases to health care workers [1–9]. Since the first report describing transmission of the human immunodeficiency virus (HIV) by needlestick injury in 1984, the potential hazards from percutaneous and mucocutaneous exposure have prompted concern about occupational infection with HIV and dramatic changes in the principles and practice of infection control [8,10]. Nevertheless, accidental exposures continue to occur, and the absolute number of occupationally acquired HIV infections is increasing [11].

The risk of HIV infection from a discreet needlestick exposure is estimated to be 1 in 250 [11]. However, the cumulative risk is dependent not only on the event risk, but also on the total number of exposures sustained. Early studies of the frequency of occupational exposures used employee health records of reported percutaneous accidents or needlestick injuries to estimate the prevalence of nosocomial exposure to infectious agents [12–16]. Most of these studies suggest that health care workers in general, and physicians in particular, either do not report their percutaneous exposures or seldom experience exposures. However, estimates of the prevalence of antibody to hepatitis B virus (HBV) among physicians in the pre-vaccine era range from 12% to 40% [17–22]. This high rate of HBV infection suggests that accidental exposures often are not reported.

Underreporting is important to detect, because it leads to an underestimation of the overall occupational risk of acquiring HIV and other bloodborne pathogens and because optimal post-exposure medical care cannot be provided unless exposures are reported in a timely manner.

TABLE I

Demographics of the Respondents Compared to All Members of the Residency Program

	Respondents	All Members
Mean age (years)	29.0	29.4
Male (%)	65	61
PGY1* (%)	37	38
PGY2† (%)	31	30
PGY3‡ or PGY4§ (%)	32	32
Total number	86	119

* PGY1: Postgraduate year 1 or intern.
† PGY2: Postgraduate year 2 or junior resident.
‡ PGY3: Postgraduate year 3 or senior resident.
§ PGY4: Postgraduate year 4 or chief resident.

We studied the frequency of percutaneous and mucosal exposures to HIV-infected blood and to blood from patients at high risk for HIV infection among internal medicine housestaff who work in an urban area where 15% to 20% of their patients are HIV-infected. Our goal was to determine whether these exposures were underreported, and if so, to identify the main reasons for failing to report. As a corollary, we studied the circumstances resulting in occupational exposure to HIV.

SUBJECTS AND METHODS

The Settings

The study was conducted between January and March of 1989 at three teaching hospitals: Moffitt-Long Hospital, San Francisco General Hospital, and the San Francisco Veterans Adminstration Hospital. Moffitt-Long Hospital is a university hospital with about 100 internal medicine beds where, based on logs of admissions, approximately 10% to 15% of the patients admitted to the medical service are infected with HIV. San Francisco General has about 100 internal medicine beds and approximately 20% of the patients admitted to the medical service are infected with HIV. The San Francisco Veterans Administration Hospital has about 100 internal medicine beds, and approximately 10% of the medical patients are infected with HIV.

The interns and residents are instructed to follow body substance isolation [23] when handling blood and body fluids from all patients. All housestaff members are instructed to wear gloves at all times when handling blood and body fluids and to avoid recapping needles.

During the study, the three hospitals' policies with regard to reporting needlestick injuries were in transition. All three hospitals recommended that health care workers report occupational exposures that occur after hours to the emergency department. Because the recommendations for the management of occupational risk were changing rapidly and the residents working in the emergency department had varying degrees of expertise in the field of occupational risk, once an exposure was reported to the emergency room, advice was not given strictly according to a uniform protocol.

Data Collection

We invited all members of the internal medicine housestaff during the academic year of 1988–1989 to complete anonymously a questionnaire. The questionnaires were distributed before housestaff conferences and were also mailed to the interns' and residents' homes. Participation was voluntary and anonymous, so that it was impossible for the investigators to identify nonrespondents. The study was approved by the University of California at San Francisco Committee for Human Research.

Because the questionnaires were completed at the midpoint of the training year, exposure rates from the previous 12 months represented 6 months of internship and 6 months of the final year in medical school for most of the interns participating in the study, and represented the second half of internship and first half of the first year of residency for the first-year residents.

The Questionnaire

A needlestick injury was broadly defined as a cutaneous cut, scratch, or puncture from a needle that was contaminated with patient's blood, whether or not the injury drew blood. A mucosal exposure was defined as blood in contact with eyes or oral mucous membranes. A high-risk patient was defined as someone who used intravenous drugs, was a homosexual or bisexual male, had received multiple blood products, or was the sexual partner of any of the aforementioned and whose HIV serology was unknown. Reporting was defined as seeking treatment or advice from an emergency room physician, employee health service worker, or a personal physician. Joining a research study designed to follow health care workers with occupational exposures to HIV was included as reporting.

The questionnaire had three sections. The first section asked about the total number of percutaneous and mucosal exposures experienced from any source since beginning medical school. In addition, we asked the respondents to estimate the number of exposures to blood from HIV-infected patients, high-risk patients, and patients without risk factors during the previous 12 months, and the proportion of those exposures that were reported. The second section collected information on the three most recent recalled exposures, including whether it was from known HIV-infected or high-risk blood, what the mechanism of injury was for each exposure, whether the health care worker was wearing gloves at the time of the injury, whether the injury was reported, and if so, where it was reported. The third

section collected information on the reasons for not reporting exposures. Data were gathered on both structural and psychologic reasons for not reporting the occupational exposure and on whether the housestaff member was tested for antibody against HIV after the exposure.

Statistical Analysis

Descriptive statistics were performed with the SAS PC statistical package. Comparison of proportions was performed by chi-square analysis. All p values were two-tailed.

RESULTS

Study Population

Seventy-two percent (86 of 119) of the eligible housestaff completed and returned the questionnaire; 37% were interns and 63% were residents. The respondents had accumulated 316 person-years of clinical experience in caring for HIV-infected and high-risk patients. The mean age of the participants was 29 years. The age, sex, and year in training of the respondents was similar to those in the programs overall (**Table I**).

Cumulative Frequency of Exposures

Sixty-nine percent (59 of 86) of the respondents recalled at least one needlestick injury during medical school or residency; 19% (16 of 86) recalled a needlestick injury from an HIV-infected patient during this same time interval (**Table II**). Female house officers (9 of 30, 30%) were more likely than male house officers (7 of 56, 13%) to describe needlestick injuries from HIV-infected patients (p <0.05). In addition to the 19% with known percutaneous exposure to HIV-infected blood, 36% (31 of 86) of the respondents also recalled at least one needlestick injury from a patient who was at high risk for HIV infection but whose serologic status was unknown at the time of the injury (Table II). Nineteen percent (16 of 86) of the medical housestaff surveyed recalled a mucosal exposure during medical school or residency from a patient who was known to have HIV infection.

Frequency of Percutaneous and Mucosal Exposures

During the 12 months prior to the study, 58 needlestick injuries were recalled by the 86 respondents. Eighty-one percent (47 of 58) of these were described by current members of the postgraduate year 1 or 2 group (p = 0.0004); all of the nine needlestick injuries contaminated with HIV-infected blood were recalled by the current postgraduate year 1 or 2 trainees (p = 0.05) (**Table III**). In our study, eight needlestick injuries from known HIV-infected blood were recalled among six of 32 medical intern respondents during the 12 months prior

TABLE II

Number of Respondents with Percutaneous Injury Ever by Current Year in Residency

Current Year in Residency	1 or More from HIV-Positive* Source		1 or More from High-Risk† Source		1 or More from Any‡ Source	
	Number	%	Number	%	Number	%
PGY1 (n = 32)	6	19	9	28	23	72
PGY2 (n = 27)	3	11	8	30	18	67
PGY3 (n = 23)	7	30	12	52	15	65
PGY4 (n = 4)	0	0	2	50	3	75
Total (n = 86)§	16	19	31	36	59	69

PGY: postgraduate year.
* HIV-positive = percutaneous injury from a needle contaminated with known HIV-infected blood.
† High-risk = percutaneous injury from a needle contaminated with blood from a patient who uses intravenous drugs, is a male homosexual or bisexual, has had multiple blood products, or is the sexual partner of any of the above and whose HIV serology is unknown.
‡ Any = percutaneous injury from a needle contaminated with blood from *any* patient, regardless of HIV serologic status.
§ The total is 72% of the current internal medicine housestaff.

TABLE III

Frequency of Exposures to HIV-Infected Blood During the Prior 12 Months

	Current Year in Training		
	PGY1 + PGY2 (n = 59)	PGY3 + PGY4 (n = 27)	p Value
All needlestick exposures/person	0.80	0.41	<0.0001*
HIV+ needlestick exposures/person	0.15	0	0.05†
High-risk needlestick exposures/person	0.27	0.11	0.10*
HIV+ mucocutaneous exposures/person	0.20	0.07	0.75†

* Comparison of PGY1 and PGY2 to PGY3 and PGY4 by Mantel-Haenszel test.
† Comparison of PGY1 and PGY2 to PGY3 and PGY4 by Fisher's exact test.
Since the survey was administered at the midpoint of the training year, both PGY1 and PGY2 represent 6 months of internship. These 2 years are at higher risk for percutaneous exposures.

to the survey. Therefore, approximately 25% (95% CI, ± 22%) of interns had potential exposure to HIV.

Nineteen of eighty-six house officers (22%) recalled 28 needlestick exposures from HIV-infected or from high-risk patients during the 1 year prior to the survey. Nine of eighty-six house officers recalled 27 mucosal exposures to HIV-infected blood during the year prior to the survey.

Exposure Circumstances

Overall, 64 of the 86 respondents recalled either one or more needlestick or mucosal exposures during training. When this group was asked about their three most recent exposures, they provided information on 103 needlestick injuries and 21 mucosal splashes. Of the former, 51% (53 of 103) were from HIV-infected or high-risk patients of unknown serologic status. Sixty-seven percent (14 of 21) of the

TABLE IV

Mechanism of Injury for Percutaneous or Mucosal Exposure Among Medical Housestaff (total number of exposures = 124)

Mechanism	Number	%
Disposing of winged needles	16	13
* Recapping injuries	15	12
Filling rubber stopper tubes	15	12
Suturing injuries	14	11
Intravenous stylet punctures	12	10
* Unattended needles on drapes	10	8
Manipulating heparin locks	3	2
* Contaminated needle in pocket	3	2
Other	36	29
Total	124	

* Potentially preventable if compliant with current Centers for Disease Control guidelines.

TABLE V

Rates of Reporting of Needlestick Injuries and Mucocutaneous Splashes by Type of Exposure (n = 124 exposures)

Type of Exposure	Number Reported	% Reported
Needlestick Injuries (n = 103)		
HIV-positive*	6/17	35
High risk†	15/36	42
Other‡	10/50	20
Total	31/103	30
Mucocutaneous splashes (n = 21)		
HIV-positive§	4/9	44
High risk‖	2/5	40
Other¶	2/7	29
Total	8/21	38

* Needlestick injuries from HIV-infected blood.
† Needlestick injuries from high-risk blood.
‡ Needlestick injuries from patients of unknown HIV infection status but without risk factors for infection.
§ Mucocutaneous exposures from HIV-infected blood.
‖ Mucocutaneous exposures from high-risk blood.
¶ Mucocutaneous exposures from patients of unknown HIV infection status but without risk factors for infection.

mucocutaneous exposures were from known HIV-infected or high-risk patients of unknown serologic status. Forty-nine percent of the three most recent needlestick injuries and 50% of the mucocutaneous exposures occurred during the internship year.

The most frequent mechanism of injury among the participating housestaff members included: disposal of winged steel needles (13%), recapping injuries (12%), filling tubes with rubber stoppers (12%), suturing injuries (11%), intravenous stylet punctures (10%), and contaminated needles left on disposable drapes (8%) (**Table IV**). The medical student or housestaff member was not wearing gloves when 32% of the needlestick injuries and 40% of the mucosal exposures occurred. Twenty-two percent of the needlestick injuries were avoidable if house officers had followed Centers for Disease Control (CDC) recommendations [24], and 13% would have been avoided if winged steel needles had not been used when performing phlebotomy.

Reporting of Needlestick Injuries

Overall, 70% (72 of 103) of the recalled needle-

stick injuries were not reported. When stratified by type of injury, 65% (11 of 17) of the HIV-positive needlesticks, 58% (21 of 36) of the high-risk needlesticks, and 80% (40 of 50) of all other needlesticks were not reported (**Table V**). The highest rates of underreporting were among the senior residents, where none of the 23 needlestick injuries sustained were reported.

The most frequently indicated reasons for not reporting were structural in nature. Thirty-two percent of the respondents "strongly agreed" that they did not have enough time to report the exposure. Twenty-six percent indicated that they did not know the procedure for reporting a needlestick injury or mucosal splash. Twenty-six percent believed that their needlestick injury did not represent a significant occupational exposure. Seventeen percent were concerned about a breach in confidentiality of their test results if they were to be tested for exposure to HIV, and 14% were concerned about discrimination both professionally and personally if they were found to be HIV-seropositive. Of note, 13% "strongly agreed" or "agreed" that they would rather not know their HIV antibody serology. Fear, anger, frustration, and depression about the exposure were reasons stated by a smaller percentage of housestaff members who did not report the exposure (**Table VI**).

COMMENTS

We found that recalled rates of percutaneous exposure to HIV among internal medicine housestaff were considerably higher than would be predicted from published surveys of the frequency of exposures based on employee health records [13,15] and that most exposures were not reported. Lack of time and unfamiliarity with the reporting procedure were the main reasons why housestaff did not report potential exposures to HIV. Approximately one fifth were concerned about a breach in confidentiality of their test results if they were to report. Since it is possible to be tested anonymously at all of the institutions, this may reflect overall societal concerns about the confidentiality of HIV antibody test results, rather than a structural problem at the hospitals where the house officers practiced. A small percentage expressed fear, anger, and depression as reasons for not reporting exposures. However, these individuals may have the most to gain from reporting if they receive counseling about coping with this potentially life-threatening event.

The only other study thus far that has examined recalled rates of exposure to HIV was performed by Link [25], who found that 37% of internal medicine housestaff had sustained needlestick injuries from HIV-infected blood at some time during their training. This exposure rate may have been higher than

the 19% found among the house officers in our three San Francisco hospitals because of possible differences in prevalence of HIV-infected patients in the practice settings, the number of venipunctures performed by housestaff members, or in rates of compliance with infection-control procedures.

In our study, approximately 25% of the interns were exposed to HIV-infected blood during the previous 12 months working in hospitals where approximately 15% of the patients on the medical service were infected with HIV. If the risk of seroconversion once a percutaneous exposure has occurred is 1 in 250 [11], then based on our data we can extrapolate that approximately 1 in 1,000 medical interns will become infected with the AIDS virus.

This calculated 1-year risk is similar to the observed risk of fatality among other public health and safety workers. The annual risk of fatality among California police officers, for example, is estimated to be 1 in 4,000, and the annual risk of death for California fire fighters is estimated at 1 in 10,000 [26]. Thus, house officers' risk of acquiring HIV infection is in a range that should concern occupational safety advisors and public policy makers.

About 22% of the needlestick injuries from HIV-infected and high-risk blood were avoidable if house officers had followed CDC guidelines [24], and 13% would have been avoided if winged steel needles had not been used for phlebotomy. The risk of HIV infection can be reduced by modifying the way health care workers draw blood and handle contaminated equipment. Since 1981, recapping needles and the inappropriate disposal of contaminated sharp objects have been recognized as two important mechanisms of percutaneous injury [15]. Despite the attention paid to this mechanism of injury, 12% of the needlestick injuries in our study occurred while recapping contaminated needles. In Jagger and co-workers' [27] study of rates of needlestick injuries caused by various devices, one third of injuries were related to recapping. Competing hazards, such as carrying a contaminated, uncapped piece of equipment to the disposal area, were cited as reasons for recapping. Thirty-one percent of the exposures in our study may be attributable to problems with equipment design. These include those from winged steel needles, intravenous stylets, and heparin locks. Therefore, our data support Jagger's conclusion that the best way to decrease the exposure rate to health care workers is to redesign blood drawing and intravenous infusion equipment so that health care workers' hands always remain behind the needle.

Underreporting of needlestick injuries was recognized as early as 1983 [28]. Failing to report exposures to HIV-infected blood leads to an inaccurate

TABLE VI

Reasons Stated for Not Reporting Needlestick Exposures (n = 72 Unreported Exposures)

Reasons Given	Agree or Strongly Agree (number)
Insufficient time	32% (23/72)
Not perceived as health risk	26% (19/72)
Reporting procedure unknown	26% (19/72)
Too frustrated to report the exposure	19% (14/72)
Concerned about confidentiality	17% (12/72)
Too angry to report the exposure	15% (11/72)
Too embarrassed to report the exposure	14% (10/72)
Concerned about occupational discrimination	14% (10/72)
Would rather not know own HIV serology	13% (9/72)
Too depressed to report the exposure	13% (9/72)
Too fearful of AIDS to report the exposure	10% (7/72)

estimation of prevalence and a subsequent underestimation of the overall occupational risk of acquiring HIV infection. This decreases hospitals' incentives to change venipuncture equipment or to develop confidential, efficient programs for reporting percutaneous exposures. For the health care worker, failing to report forfeits the opportunity for early treatment or evaluation for HBV exposure, advice about reducing the risk of transmission of HIV to sexual partners, and counseling about the psychologic aspects of a potentially life-threatening exposure. More recently, health care workers who do not report exposures may be unwittingly forgoing prophylactic zidovudine treatment for massive percutaneous exposures to HIV [29]. Furthermore, compensation for occupationally acquired HIV infection may require proof of a temporal relationship between exposure and seroconversion.

Frequency of reporting may increase if housestaff perceive that there is more benefit than harm to be derived from reporting potential exposures to HIV. For this to occur, hospitals must design reporting procedures that ensure confidentiality and are time efficient. All health care workers who handle blood products should be required to attend annual infection-control seminars that review universal precautions and the current mechanism for reporting percutaneous exposures. During the reporting procedure, health care workers should receive an evaluation of the severity of the exposure and verification of HBV immunity. At a minimum, needlestick programs should provide information about the risk of seroconversion, a psychologic evaluation, and appropriate advice about protecting sexual contacts, refraining from blood, semen, or organ donation, and delaying pregnancy during the immediate months after an exposure. Institution-sponsored disability insurance for occupationally acquired HIV infection would also increase the benefit derived from reporting potential exposures to HIV. As new prophylactic antiviral therapies be-

come available, it will be imperative that potential exposures to HIV be identified and treated early.

An anonymous questionnaire based on recall of exposures has limitations. In particular, recall may be inaccurate. House officers who had HIV needlestick injuries may have been either more or less likely to respond to the survey. However, we achieved a 72% response rate and nonresponders were similar to the housestaff at large. Even if none of the nonresponders had percutaneous exposures to HIV, the 1-year incidence of exposure to HIV-infected or high-risk blood would be 24%. It is important to note that the 1 in 250 risk of seroconversion once a percutaneous exposure has occurred is based on prospective follow-up of reported exposures of unknown severity and may not be generalizable to recalled exposures in an anonymous questionnaire. We used a broad definition of needlestick injury in our survey, and this may have encouraged respondents to include minor percutaneous exposures that were potentially lower risk than 1 in 250 for infection. Although there are limitations with comparing retrospective estimates of exposure to prospectively gathered mortality rates (which have narrower confidence intervals) collected for other occupations, this comparison can provide a perspective on an estimated 0.1% 1-year risk of HIV infection among medical interns. Finally, these results may not be generalizable to nurses, phlebotomists, or surgeons but are likely to be relevant to other internal medicine training programs in urban centers where HIV-infected patients are common.

In conclusion, our study suggests that the frequency of housestaff exposures to HIV-infected blood is higher than expected and that most of the needlestick injuries from HIV-infected blood are not reported. The reported circumstances of exposure suggest that compliance with current infection-control procedures will not prevent many needlestick injuries and that the design of the current equipment used for venipuncture is inadequate. If this unacceptably high exposure rate is to decrease, equipment will need to be changed. The high rate of underreporting poses additional risks for the house officer and for the hospital. To increase rates of reporting, hospitals need to enlist input from housestaff and other health care workers in the design of confidential, time-efficient programs and need to have a formal mechanism for teaching workers how to use the programs.

ACKNOWLEDGMENT

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