Occupational Human Immunodeficiency Virus Exposure Among Residents and Medical Students

An Analysis of 5-Year Follow-up Data

Stephen Radecki, PhD; Allan Abbott, MD; Lynne Eloi, MD

Background: Findings of a needlestick survey at our institution yielded an estimate that 1 case of occupationally acquired human immunodeficiency virus (HIV) among the approximately 1100 residents and third- and fourth-year medical students would potentially occur every 2 to 3 years, and also revealed types of exposures, circumstances, rates of reporting, and reasons for not reporting.

Objective: The present study is a 5-year follow-up study to investigate changes in these parameters.

Methods: A self-administered, anonymous 2-page questionnaire covering occupational exposures and other risk factors was distributed to medical students in classes, and to residents in grand rounds and required conferences. The response rate was 71%.

Results: The incidence of needlestick accidents dropped dramatically over 5 years (1994-1995 vs 1989-1990), especially for surgical residents. Because the proportion of known sources positive for HIV increased over the same period, estimates of occupational HIV risk remain essentially the same, with a projection that 1 student or resident would be expected to experience an occupationally acquired HIV infection approximately every 2 years. The nonoccupational risk for this population, in contrast, seems to be lower than in their age group as a whole.

Conclusions: While the decrease in overall occupational exposures (especially for surgical residents) coupled with slight increases in rates of exposure documentation and use of universal precautions constitute positive findings, the increased proportion of exposure sources who are HIV positive leads to an unchanged estimate of occupational HIV risk for residents and students. Study findings therefore support the continued need for educational efforts aimed at prevention, along with timely dissemination of advances in approaches to postexposure prophylaxis.

Arch Intern Med. 2000;160:3107-3111
SUBJECTS, MATERIALS, AND METHODS

This study measured needlestick accidents and other exposures by means of a self-administered questionnaire (N=442) distributed to residents and third- and fourth-year medical students training at Los Angeles County–University of Southern California Medical Center. The questionnaire consisted of a 28-item form approved by the medical center’s institutional review board committee prior to distribution. The survey was anonymous; potentially identifying characteristics such as age and sex were not included. The survey requested participants to respond to questions regarding occupational exposures to patients’ bodily fluids during the 1994 to 1995 training year. Subjects identified their level of training and their specialties, and provided an estimate of the number of sharp-object and/or bodily-fluid exposures from patients that occurred during the just-completed training year. Estimates of the number of exposures from known HIV-positive persons were elicited, and (when appropriate) respondents were asked why exposures were not reported. The location and reason for accidents were determined. Finally, subjects were asked if they had ever taken prophylactic zidovudine after potential exposure to HIV from an infected patient. With some modifications based on analytic experience, these questions basically replicated our 1989-1990 needlestick/exposure survey of the same institution.1

An additional section, not included in the 1989-1990 questionnaire, consisted of questions regarding exposures outside of patient care, and about certain HIV-risk behaviors. Subjects were asked to describe their most recent sexual encounter, whether protection for sexually transmitted diseases was used, and whether they knew the HIV status of their partner. They were also asked the number of different sexual partners they had had over the last 12 months. Subjects also reported how often protection was used at the time of intercourse over the last 12 months, whether they’d used alcohol prior to or during sexual encounters, and if they felt they were at greater risk drawing blood vs engaging in unprotected sex with a partner of unknown HIV status. Respondents were also asked if they have ever been tested for HIV.

SAMPLING PROCEDURES

All surveys were distributed to participants accompanied by an opaque return envelope. Completed surveys were sealed by respondents and placed in a designated box for collection. House staff were accessed by means of noon conferences, grand rounds, and evening conferences where attendance was required. Third- and forth-year medical students were sampled during a required classroom course; additional surveys were mailed to all students who were “on campus” but not in attendance during these lectures. Response rate calculations were based on the number of medical students and residents who were scheduled to be present at the medical school or medical center at the time the survey was conducted. All questionnaires were completed at the end of the 1994 to 1995 training year. The response rate for residents based on this design was 67.7%; for medical students, 76.8%. The overall (combined) response rate was 71.1%. Although the anonymous nature of the survey does not permit a response/nonresponse analysis, the investigators who were on site during survey distribution sessions observed no systematic differences between those who returned the envelopes and those who did not. There was, however, negative feedback on some of the forms regarding the inclusion of questions assessing nonoccupational risk factors for HIV acquisition, accompanied by an approximate 6% reduction in responses to items in this portion of the questionnaire.

DATA PROCESSING AND ANALYSIS

Twelve clinical departments within the hospital were surveyed, accounting for a total of 744 residents in the study year. For analytic purposes these respondents were classified as medical residents (internal medicine, pediatrics, psychiatry, radiology, and pathology) vs surgical residents (anesthesiology, general surgery, neurosurgery, obstetrics/gynecology, orthopedic surgery, and urology). Data for respondents from other specialties, as well as for those who did not indicate their specialty, are not reflected in the medical/surgical breakdowns but are included in aggregate totals. Third- and fourth-year medical students account for an additional 313 individuals in the targeted study population. In the study’s analysis, inferential statistics are used to extrapolate from study respondents (whose response rates are adjusted for the sizeable numbers of residents and third- and fourth-year students on outside rotations or otherwise not present in the medical center at the time the survey was conducted) to a total “at risk” population of 1057 residents and students for the purpose of projecting an aggregate estimate of occupationally acquired HIV infection for this population. Statistical inference from respondents to the total study population includes the use of proportional weights reflecting the differential response noted above for residents vs students. The study analysis uses χ² significance tests for categorical variables, and t tests for numerical variables such as the number of needlestick accidents experienced over the year.

These rates of underreporting range from 64% to 96%.9,11 (The previous survey showed an underreporting rate of 91%).1 It is necessary, therefore, to conduct focused needlestick surveys of the type reported here on a periodic basis (in this case 5 years, 1994-1995 vs 1989-1990) to determine rates of exposure and the impact of contributing or ameliorating factors on occupational exposure risk to medical students and residents.

Inclusion of measures of risk of nonoccupational exposure to HIV among physicians in training has not been typical in existing studies, and direct comparisons of their occupational vs nonoccupational HIV risks and concerns during medical education have been undertaken to only a limited extent.12,13 However, the ascendance of acquired immunodeficiency syndrome (AIDS) as a leading cause of death among young adults in the 1990s14 obliges us to also explore nonoccupational factors in addition to considering occupational HIV risk within this age group.

The goal of the present study is, primarily, to compare needlestick survey data for medical students and residents at our institution with data collected 5 years pre-
viously to determine if (in the interim) there have been changes in the incidence of self-reported needlesticks, circumstances under which needlesticks occur, reasons for underreporting, and the use of universal precautions. We also incorporate measures related to nonoccupational HIV risk.

## RESULTS

Survey results (Table) indicate that a total of 562 exposures were self-reported in all specialties, compared with 1196 in year 1989-1990. Dividing these exposures by the number of respondents in each study year shows a significant decline overall (2.19 mean exposures per year in 1989-1990 vs 1.30 in 1994-1995; P<.001), led by surgical residents (6.72 vs 2.31; P<.001), emergency medicine residents (2.32 vs 1.03; P<.001), and medical students (1.09 vs 0.73; P<.05). There was no significant difference for medical students between the 2 study years.

Whereas there were no temporal differences in needlestick accidents among medical residents, there was a highly significant decrease in documented exposures (those reported to the resident/student health center) for medical residents and for surgical residents. In contrast, emergency medicine residents showed an almost-perfect record for documenting exposures in the 1994-1995 survey. The proportion of documented exposures also increased overall from 9% (103/1196) in 1989-1990 to 15% (85/562) in 1994-1995.

Numerically, exposures involving HIV-positive patients (that is, patients known to be HIV positive by hospital staff) remained relatively stable over the 5-year period but (with the decrease in total exposures) accounted for approximately double the proportion of exposures compared with 1989-1990. The relationship between HIV-positive exposures and those documented to the health center differs by respondent group (Table), but overall the latter exceeds the former.

Respondents were asked their reasons for not documenting most of their exposures. There were no significant between-group differences in reasons for not documenting exposures found in the 1994-1995 survey; this contrasts with 1989-1990 findings, which showed several differences among respondent groups. The rank-order of reasons did not change appreciably; the top 3 reasons rank identically in the 2 surveys. The leading reason, “not enough time,” increased significantly over the 5-year period (64% vs 81%; P<.01), whereas the next leading reason, “reporting doesn’t alter outcome of the needlestick exposure,” decreased (38% vs 26%; P<.05), as did the third leading reason, “health center too far away” (27% vs 15%; P<.05).

Data on the circumstances surrounding respondents’ most recent exposure indicate that there were between-group differences in the location, HIV status of the patient, and reason for exposure in both study years along with significant 5-year differences in location and reason for exposure. By location, exposures increased both in hospital wards and the operating room, with operating-room exposures doubling for medical students over the 5-year period. Consistent with our previous report, medical residents continued to have the greatest exposure to high-risk or HIV-positive patients. Finally “carelessness” declined as a reason for the exposure (except among medical students), whereas “patient moved” was more likely to be cited by all categories of respondents.

Broken down by type, respondents’ most recent exposures were needlestick accidents, 70%; mucous membrane exposures, 15%; cuts with a sharp object, 12%; and open-wound exposures, 3%. The distribution of exposures by type did not differ by respondent category. Additional data show that 19% of respondents with a potential exposure to HIV had ever taken zidovudine as prophylaxis for the exposure. Finally, a comparison showed a significant increase in use of universal precautions over the 5-year period, with the percentage of respondents reporting use “universally” (100% of the time) increasing from 42% to 52%.

Nonoccupational HIV risk questions incorporated into the 1994-1995 survey can be compared with data from a nationwide sample of age-mates in the 25- to 29-year-old group, into which most of the residents and medical students at our institution fall. The data are derived from the National Health and Social Life Survey (NHSLS), a 1992 survey on sexual behavior.13 The survey used a national probability sample of 3432 respondents ranging in age from 18 to 59 years, 458 of whom fell into the 25- to 29-year age group. The comparison shows that study respondents are less likely to have episodic sex (“less than weekly”), and more likely to have frequent sex or “none.” Differences in numbers of sexual partners are slight, but few study respondents (1.6%) had large numbers of partners. In response to a question about condom use during intercourse within the past 12 months, 21.5% reported consistent use, 49.9% no use at all, and the remainder sporadic use.

Respondents were also asked if they knew the HIV status of their most recent sexual partner (76.5% did), whether drawing blood or having unprotected sex with a partner of unknown HIV status was more risky (86.8%...
chose the latter), and whether they had ever been tested for HIV (69.4% had). The latter finding can be compared with the national survey in which 26.6% of this age group reported having been tested for HIV.

Not having data on the HIV status (or risk group) of our respondents or their sexual partners, we were limited in our ability to designate those individuals at high risk for nonoccupational acquisition of HIV. Nevertheless, we identified a small subset (n=18) of respondents who were notmonogamous, did not use a condom during their most recent sexual encounter, and did not know the HIV status of their partner. Comparisons of occupational and nonoccupational factors between this subgroup and the remaining respondents showed only that they were significantly more likely (P<.001) to consume alcohol prior to or during sex. There were no other findings that would suggest a generalized “risk taking” tendency among this group, nor were there differences in their relative risk assessments (drawing blood vs unsafe sex) or rates of HIV testing.

**COMMENT**

Aggregate figures on the incidence of needlestick accidents and similar exposures to patients’ blood and bodily fluids are strikingly imprecise, estimated to fall somewhere between 100,000 and 1,000,000 injuries annually to US health care workers. A review of findings derived from a variety of institutional studies suggests that physicians in training are at increased risk for exposure, with most of their injuries coming from hollow or suction needles. Furthermore, studies have shown that most exposures are unreported, undermining the value of potentially more comprehensive surveillance data for studying the incidence of exposures, the circumstances associated with their occurrence, the HIV status of the source patient, and (by extension) the occupational HIV risk posed to residents and medical students.

The 5-year differences revealed by this study’s replicated questions on needlestick accidents and other self-reported exposures to patients’ blood and bodily fluids show a significant overall decrease in exposures (attributable to substantial reductions for surgery and emergency medicine) with virtually no change in rates of exposure to known HIV-positive patients. The previously reported more than 6-fold overall disparity between surgical and medical residents was shown to have decreased to less than 2-fold. Estimated rates of seroconversion for the 1989-1990 study year were based on the known (survey-based) HIV-positive rate of 4.3% (52/1196, Table), a more realistic rate of 5% based on published emergency department data, and seroconversion rates following a single percutaneous exposure of 0.42% and 0.29%.

These different rates and assumptions produced an estimated occupational seroconversion rate of between 27 and 46 per 100,000 individuals per year. Although additional data collected for the 1989 to 1990 survey showed that just 14% of respondents’ most recent exposures were mucocutaneous exposures, the rates shown above were not adjusted based on this finding because of the limited data available at that time on seroconversion rates for mucocutaneous exposures (subsequently estimated to be 0.09%).

For the 1994-1995 study year, the known HIV-positive rate was 8.2% (46/562, Table). Based on an average 0.3% seroconversion probability rate for percutaneous and other exposures, the study estimate (which is inherently conservative, based solely on known HIV-positive cases) is 32 occupational HIV seroconversions per 100,000 residents and medical students per year. As for 1989-1990, this again leads us to predict an occupationally acquired HIV infection by a resident or medical student approximately every 3 years (at that time, we said every 2-3 years). Once again, however, we must add the caveat that at the time of the first survey, no such cases were known to have occurred to residents or students within our institution. Nevertheless, this remains a “lower-bound” prediction, based only on infection sources known to the respondent to be HIV-positive. If, for example, the patient HIV-positive rate at Los Angeles County–University of Southern California Medical Center (which is not known) is anything like that at San Francisco General Hospital, San Francisco, Calif (23%), the predicted risk using the hospitalwide rate as the basis for probable exposure of residents and students (as was done previously using emergency department figures) would more than double.

By comparison, mortality statistics for 1994 show a 29.3 per 100,000 death rate for HIV in the 25- to 34-year age group, second only to accidents (32.5/100,000 for those aged 23-34 years). Reported AIDS cases over the 1994 to 1995 year were substantially higher than these mortality statistics—approximately 50 per 100,000 for the 25- to 29-year age group. While the prevalence of AIDS continues to increase, death rates in the United States have of course substantially decreased following the mid-1990s introduction of newer combinations of antiretroviral agents.

An increase in documented exposures from 9% in 1989-1990 to 15% in 1994-1995 and a drop in the proportion of nondocumenters who responded that “reporting doesn’t alter [the] outcome of the needlestick/exposure” both coincided with publication in the early 1990s of guidelines on prophylaxis for occupational exposure to HIV. However, only 19% of respondents with a potential occupational exposure to HIV had taken zidovudine as prophylaxis for that exposure. Finally, we found that 100% use of universal precautions had increased by 10% over the 5 years, to just over half.

The probability of infection from a single episode of unprotected intercourse with an HIV-positive partner or single use of contaminated injection drug equipment is similar to that for an occupational exposure to bodily fluids contaminated with HIV. Our exposure and condom use findings reveal that study respondents exhibit very low rates of nonoccupational risk factors, even compared with the (already low) HIV risk for the nation’s population as a whole, 97% of whom were represented by the sexual behavior survey. The medical students and residents reported a lower than average frequency of multiple sexual partners, coupled with higher than average use of condoms, putting this population outside the ranges of risk behaviors that would
make it feasible to calculate mortality-related risk predictions.34,35

While confined to a single (albeit large) medical center and precluded by its anonymous design from the use of a response/nonresponse analysis, this study has been able to identify potential trends in risk factors for HIV acquisition, as well as to validate previously identified areas of unmet need. There was a pronounced decrease in exposure to needlestick injuries over 5 years, coupled with an increase in use of universal precautions. This corresponds to previously observed findings of a reduction in injuries from 1985 through 1991 that coincided with the sustained implementation of universal precautions.36

What has not changed (much) is the documentation of those exposures, which increased from 9% to just 15%, leaving the remaining 85% undocumented—well within the 64% to 96% underreporting range seen previously.9,11,16 Moreover, the estimated risk of acquiring HIV has stayed essentially the same, and just 1 in 5 respondents potentially exposed to HIV had taken prophylactic zidovudine. These findings support the continued need for educational approaches to minimize risks of exposures to students and residents.37 In addition, the latest (1998) recommendations of the Centers for Disease Control and Prevention on postexposure prophylaxis38 and the availability of newer antiretroviral medications can be expected to have a positive impact on reporting exposures and use of postexposure prophylaxis.

Accepted for publication September 5, 1999.

Corresponding author: Stephen Radecki, PhD, 3621 Emanuel Dr, Glendale, CA 90218.

REFERENCES