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## Major Article

## Seroconversion rate among health care workers exposed to HIV-contaminated body fluids: The University of Pittsburgh 13-year experience

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**Background:** The studies enumerating the risk of HIV transmission to health care workers (HCWs) as 0.3% after percutaneous exposure to HIV-positive blood, and 0.09% after a mucous membrane exposure, are weakened by dated literature. Our study aims to demonstrate the seroconversion rate after exposure to HIV-contaminated body fluids in a major academic center in the United States.

**Methods:** A prospectively maintained database of reported occupational injuries occurring between 2002 and 2015 at an academic medical center was analyzed. Data collected included the type of injury, injured body part, type of fluid, contamination of sharps, involvement of resident physicians, use of postexposure prophylaxis, and patients' HIV, hepatitis B virus, and hepatitis C virus status.

**Results:** A total of 266 cases were included in the study. Most exposures were caused by percutaneous injuries (52.6%), followed by 43.2% mucocutaneous injuries. Of the injuries, 52.6% were to the hand and 33.5% to the face and neck. Blood exposure accounted for 64.3% of all cases. Of the patients, 21.1% received postexposure prophylaxis. None of the HCWs exposed to HIV-contaminated body fluids seroconverted (seroconversion rate, 0%).

**Conclusions:** HIV does not seem to be as easily transmitted by needlestick, laceration, or splash injuries as previously surmised. Further large-scale and multicenter studies are needed for a more accurate estimation of the risk of transmission of HIV in U.S. health care workers.

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The global estimate of the number of health care workers (HCWs) exposed to HIV through sharps-related injuries is 327,000, and in the year 2000, there were approximately 1,000 new HIV infections among HCWs.<sup>1</sup> The U.S. Public Health Service published its first recommendations that advocated the use of postexposure prophylaxis (PEP) after occupational exposure to HIV in 1996, with subsequent updates.<sup>2</sup> Following this recommendation, there was a notable drop in the number of reported cases of documented occupationally acquired HIV infections. In addition to the U.S. Public Health Service recommendation, other factors such as an increase

in our understanding of exposure to HIV and HIV transmission, the development of infection control guidelines in health care facilities, improvements in the use of PEP in postexposure management, an increase in the number of patients on antiretroviral therapy with suppressed viral loads, and more availability of safely engineered devices have contributed to reducing high-risk occupational exposures to HIV.<sup>3</sup> However, with the rising number of individuals living with HIV in the United States,<sup>4</sup> there is an increased need to provide both short- and long-term medical care for these individuals. This, in turn, increases the frequency of contact between HCWs and patients infected with HIV. With an estimated 385,000 sharps-related injuries occurring among HCWs in U.S. hospitals,<sup>5</sup> HCWs are at a higher risk of occupational exposure to HIV today, than they were 20 years ago. It has been reported that the average risk of occupational HIV transmission is 0.3% after percutaneous exposure to blood of an HIV-positive source and 0.09% after a mucous membrane exposure.<sup>6</sup> These data were obtained from studies<sup>7,8</sup> that are

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limited by outdated data which do not reflect the changes in health care over the last 20 years, or were conducted in non-U.S. medical centers where universal precautions are underused. Our study aims to determine the seroconversion rate after percutaneous or mucocutaneous exposure to HIV-contaminated body fluid in a major academic medical center in the United States.

## METHODS

### *Definitions and inclusion and exclusion criteria*

Occupational exposure is defined as the exposure of body fluids by health care personnel via percutaneous or mucocutaneous route while performing their work duties. Percutaneous injury refers to a needlestick injury, laceration injury, or any injury that leads to a break in the skin barrier resulting in an exposure to a body fluid, whereas mucocutaneous exposure refers to a splash that results in exposure of mucous membranes or skin to body fluids. Therefore, an exposed HCW is one who has sustained a percutaneous injury or whose mucous membrane or nonintact skin has come in contact with blood, or other infectious body fluids. A seroconverted HCW is defined as a HCW with a documented occupational exposure from an anti-HIV antibody (anti-HIV)-positive source, with no other reported concurrent exposure to HIV, who was anti-HIV negative at the time of exposure and who had evidence of HIV seroconversion within 6 months after exposure. The source patient or patient is defined as the individual to whose body fluid the HCW was exposed. Inclusion criteria included needlestick, laceration, or splash injuries from an HIV antibody-positive source. Exclusion criteria included HIV antibody-negative source, data from HCW found to be HIV or hepatitis C virus (HCV) seropositive at the time of evaluation, HCWs exposed to noninfectious fluids (eg, nonbloody nasal secretions, saliva, urine, vomitus, tears, urine, feces), missing data (because of patient refusal, poor data entry, or being unsure), and nonapplicable occupational type of injury, that is one which does not involve occupational exposure to body fluids.

### *Health care personnel exposure protocol*

A protocol is established at the University of Pittsburgh Medical Center (UPMC) for HCWs exposed to body fluids. Employees are instructed to follow a wound site decontamination procedure consisting of applying soap and water, and washing the affected area for 20 minutes. Employees are instructed to report to either occupational health or the emergency department for collection of blood specimen of both the employee and the source patient (including HIV antibodies and polymerase chain reaction [PCR]), as well as details of the occupational injury. A diagnosis of HIV was confirmed by positive HIV antibodies and PCR tests. The employee was also tested 4 weeks, 12 weeks, 6 months, and 12 months (for HCWs exposed to a source patient coinfecting with HIV and HCV) from the time of injury. Standard assays were used at these testing time points for HIV antibody and RNA. Furthermore, a positive hepatitis B surface antigen test was used to determine an infectious hepatitis B virus (HBV)-positive source. An HCV-positive source was determined by a positive HCV antibody test, confirmed by a positive quantitative HCV RNA test using PCR. Prior to February, 2013, the recommended HIV PEP regimen at our institution consisted of a combination of lamivudine-zidovudine and lopinavir-ritonavir. However, in February 2013, the PEP regimen was changed to a combination of emtricitabine-tenofovir disoproxil fumarate and raltegravir.

### *Data collection*

Approval from the Institutional Review Board of UPMC was obtained in September 2015. A longitudinal analysis of a prospectively maintained database of reported occupational injuries occurring from January 2002-September 2015 at all hospitals in the UPMC Health System was performed. Inclusion and exclusion criteria were used to identify health care personnel exposed to a HIV antibody-positive source by means of needlestick, laceration, and splash injuries. Data collected included type of exposure (percutaneous injury or mucocutaneous exposure), body part injured, type of fluid (blood, ascites fluid, blood-tinged intravenous fluid, peritoneal fluid, bloody irrigation fluid, cerebrospinal fluid, dialysis fluid, vaginal secretion, etc), patients' HBV and HCV status, and use of HIV PEP. Data collection over all hospital sites has been supervised for the 13-year duration of the study by one of the authors. Seroconverted personnel were identified within the database and by direct recollection of the supervising practitioner.

### *Review of the literature*

In October 2016, a review of the literature was conducted using PubMed for ((incidence OR needlestick injuries OR occupational exposure OR occupational accident [MeSH]) OR (splash, mucocutaneous)) AND (seroconversion OR conversion)) AND (HIV OR human immunodeficiency virus). No restrictions on language or date of publication were used, and 1,940 articles were found. Studies, or cohorts within studies, were excluded if they did not report documented original estimates of the seroconversion rate among HCWs exposed to HIV-contaminated body fluid, the source patients were not known or proven to be HIV-positive, all HCWs were lost to follow-up, or they included the same data from the same surveillance project as another included study. References of the studies included from the search were also examined.

### *Statistical analysis*

Univariate and bivariate statistical analysis were performed using SPSS statistical software (version 19.0; SPSS, Chicago, IL). The independent variables included percutaneous and mucocutaneous exposures to the blood or infectious body fluid of a HIV-positive patient and the use of PEP. The dependent variable was the seroconversion of the exposed health care personnel from a HIV-negative status to a HIV-positive status. The  $\chi^2$  and Fisher exact tests were used to analyze categorical data with an  $\alpha$  of 0.05. Therefore, a  $P$  value  $<.05$  was considered statistically significant.  $P$  values are mentioned or described only if results are statistically significant. If described as not significant or not mentioned at all, one can assume they are nonstatistically significant. Factorial logistical regression analysis was used to determine the strength of association between the independent and dependent variables.

## RESULTS

A total of 266 cases met the criteria and, over the 13-year period, were included in the study (Fig 1). Most cases (52.6%) were caused by percutaneous injuries, followed by mucocutaneous injuries (43.2%), with the remaining (4.1%) of uncertain etiology. Most of the injuries (52.6%) were to the hand, followed by the face and neck (33.5%), and the arm, foot, leg, or trunk (5.6%). In 8.3% of the cases, the anatomic location in which the exposure occurred was not recorded. Blood exposure accounted for 64.3% of all cases, blood-containing saliva accounted for 5.6%, and others (eg, peritoneal fluid,

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