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Potential Work-Related Exposures to Bloodborne Pathogens by Industry and Occupation in the United States Part II: A Telephone Interview Study

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Background *The companion surveillance portion of this study [Chen and Jenkins, 2007] reported the frequency and rate of potential work-related exposures to bloodborne pathogens (BBP) treated in emergency departments (EDs) by industry and occupation, but it lacks details on the circumstances of the exposure and other relevant issues such as BBP safety training, use of personal protective equipment (PPE) or safety needles, or reasons for seeking treatment in a hospital ED.*

Methods *Telephone interviews were conducted with workers who had been treated in EDs for potential work-related exposures to BBP in 2000–2002. Respondents were drawn from the National Electronic Injury Surveillance System.*

Results *Of the 593 interviews, 382 were from hospitals, 51 were from emergency medical service/firefighting (EMS/FF), 86 were from non-hospital healthcare settings (e.g., nursing homes, doctors' offices, home healthcare providers, etc.), 22 were from law enforcement (including police and correctional facilities), and 52 were from other non-healthcare settings (i.e., schools, hotels, and restaurants). Needlestick/sharps injuries were the primary source of exposure in hospitals and non-hospital healthcare settings. Skin and mucous membrane was the primary route of exposure in EMS/FF. Human bites accounted for a significant portion of the exposures in law enforcement and other non-healthcare settings. In general, workers from non-hospital settings were less likely to use PPE, to have BBP safety training, to be aware of the BBP standards and exposure treatment procedures, and to report or seek treatment for a work-related exposure compared to hospital workers.*

Conclusions *This study suggests that each industry group has unique needs that should be addressed.* Am. J. Ind. Med. 50:285–292, 2007. *Published 2007 Wiley-Liss, Inc.*†

KEY WORDS: bloodborne pathogens; occupational exposure; needlestick injuries; sharps injuries; emergency departments

BACKGROUND

The companion surveillance portion of this study (Chen and Jenkins, also in this issue) reported the frequency and rate of potential work-related exposures to bloodborne pathogens (BBP) that were treated in hospital emergency departments (EDs) by industry and occupation. The surveillance data, however, lack details on the circumstances of the exposure and other relevant issues such as BBP training, use of

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safety needles or personal protective equipment (PPE), hepatitis B vaccination status, exposure treatment procedures, or reasons for seeking treatment in a hospital ED. To collect more detailed data, telephone interviews were conducted with workers who had been treated in EDs for potential work-related exposures to BBP in 2000–2002.

METHODS

In this study, potential work-related exposures to BBP include needlestick/sharps injuries, skin/mucous membrane exposures to blood or other body fluids, and human bites. The study population was workers who were treated in EDs for a potential work-related exposure to BBP. The interviewees were drawn from the National Electronic Injury Surveillance System (NEISS). Information regarding NEISS was provided in the companion study [Chen and Jenkins, 2007] and will not be repeated here.

In the initial phase of this study, consent letters were sent to the all NEISS hospitals that report work-related injuries. Due to the sensitivity of the subject matter, only 42 hospital EDs agreed to participate in the telephone survey. In the second phase, surveillance data from the participating hospitals were reviewed to identify workers with potential BBP exposures. A consent letter was mailed to these workers, informing them of how they were selected for the study, the goals of the study, the types of the questions that would be asked, the right to refuse all or part of the questions, the estimated time to complete the survey, and the confidentiality of their responses. A toll-free number was also provided in the letter so that potential respondents could contact the Consumer Product Safety Commission (CPSC) should they have any questions or concerns about the survey.

Seven contract interviewers conducted the survey under the supervision of CPSC. The investigators provided training to the interviewers. For each case, up to six phone calls were made to reach the interviewee. An average interview lasted approximately 20 min. Fifty percent of the interviews were conducted within 45 days of the ED visit and 75% were conducted within 57 days of the ED visit.

Initially, all of the exposures treated in the 42 hospital EDs from April 2000 to March 2001 were identified for interview. It was subsequently decided to extend the treatment period until February 2002 for workers in non-hospital settings only, in order to collect a larger sample of these workers.

Data collected through the interviews included the circumstances of the exposure, use of PPE, reasons for being treated in ED, BBP safety training, awareness of the OSHA BBP standards, use of safety needles, hepatitis B vaccination status, and other job-related information. Industries were divided into five groups: (1) hospitals; (2) emergency medical service and firefighting (EMS/FF); (3) non-hospital healthcare settings—for example, nursing homes, doctors' offices, home healthcare providers, etc.; (4) law enforcement—including police and correctional facilities; and (5) other non-healthcare business settings—for example, schools, hotels, restaurants, etc.

Descriptive analyses and Chi-square tests were used to compare differences among the industry groups. For those tables with 20% or more cells containing expected counts less than five, Fisher exact tests were used. Differences were considered significant at $\alpha = 0.05$ level. In this manuscript, numbers are not reported for cells which represent approximately 2% or less of the completed cases.

RESULTS

One thousand two hundred thirty-eight injured workers were identified for interview. Of these identified workers, 168 (14%) could not be contacted because the hospitals did not provide a phone number or the phone numbers were not correct or not working. Two cases were ultimately identified as duplicates, leaving 1,067 cases who could be interviewed by telephone. Of the 1,067 identified workers, 650 completed the interview and 417 refused to participate, yielding a response rate of 61%. The 650 interviewed cases were compared with the 417 cases that refused to participate, using data from the surveillance. The mean age of the two groups was the same, 37 years old. Women had a higher response rate than men, 66% for women versus 58% for men. Hospital workers had a higher response rate than non-hospital workers, 67% for hospital workers versus 54% for non-hospital workers. Of the 650 completed interviews, 593 cases were confirmed to be work-related exposures to blood or other body fluids. The remaining 57 cases were not potential BBP exposures and excluded from further analyses. Of the 593 potential work-related BBP exposure cases, 382 (64%) were workers employed in hospitals, 86 (15%) in non-hospital healthcare settings, 51 (9%) in EMS/FF, 22 (4%) in law enforcement, and 52 (9%) in non-healthcare settings. In the group of non-healthcare settings, schools, hotels, biotech research companies, city transit authorities, welfare centers, gas stations, bars and restaurants, recycling centers, and retail stores are workplaces in which exposures occurred.

Exposure Circumstances

Of the 593 interviewed potential work-related BBP exposure cases, needlesticks accounted for 69%, skin/mucous membrane exposures accounted for 21%, and human bites accounted for 10%. The distribution of type of exposures varied significantly by industry group ($P < 0.001$). Needlestick/sharps injuries were the primary source of exposure in hospitals (79%) and non-hospital healthcare settings (73%). Skin and mucous membrane was the primary route of exposures in EMS/FF (61%). Human bites and skin and mucous membrane were two major sources

of exposures in law enforcement (45%, respectively). Needlestick/sharp injuries and human bites accounted for significant portions of the exposures in non-healthcare settings (44% and 36%, respectively). Needles that were being used by the injured worker caused the majority of the needlestick/sharps injuries in hospitals (65%) and non-hospital healthcare settings (54%). Eighty-four percent of the needlestick/sharps injuries in non-hospital healthcare settings involved used needles or sharps compared to 55% in hospitals. Most needlestick/sharps injuries in EMS/FF (53%) and other non-healthcare settings (65%) were caused by needles that were not used by the injured worker but present in the workplace. The difference is statistically significant ($P < 0.001$). Of the 364 needlesticks in hospitals and non-hospital healthcare settings, 23% were related to safety needles. More than 70% of the respondents from EMS/FF and law enforcement reported that the exposure occurred while they were performing an emergency task (Fig. 1).

By reviewing the section of injury description, scenarios of exposures in other non-healthcare settings include: (1) exposures occurred when police or correctional officers were assaulted by suspects or inmates; (2) police officers were stuck by needles when searching or restraining suspects; (3) security guards in retail stores were assaulted by shoplifters; (4) teachers were exposed to blood while helping bleeding students or were bitten by a student; (5) social workers, bus drivers, or bus attendants were assaulted by their clients or customers; and (6) housekeepers in hotels, restaurants, and attendants in gas stations were stuck by used syringes while picking up garbage or cleaning up a car, etc.

Exposure Treatment Practice

Most of the injured workers in hospitals, EMS/FF, law enforcement, and non-hospital healthcare settings reported that they were treated in EDs as a result of their employer's policy to do so. Other reasons for being treated in an ED were supervisor's instruction and self-decision. A large percentage (40%) of injured workers in non-healthcare settings reported that they were treated in EDs as a result of self-decision (Table I).

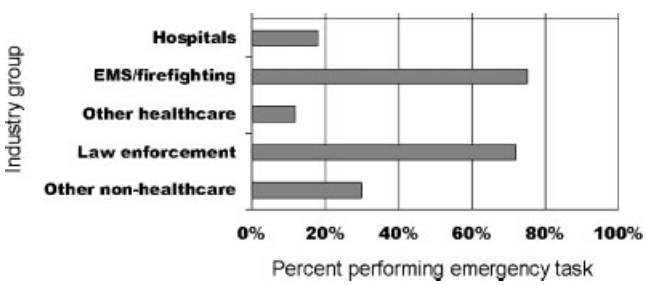

FIGURE 1. Proportion of respondents who reported performing an emergency task at the time of bloodborne pathogen exposure by industry group.

BBP Safety Training and Awareness of the OSHA BBP Standards

Table II delineates the array of BBP safety training and awareness of the OSHA BBP standards by industry group. The availability of BBP safety training was higher but the training tended to be shorter and without lecture in hospitals compared to other industry groups. A large portion of the training in hospitals (33%) and other non-healthcare settings (37%) was delivered in formats other than live lecture, such as, video, written self-study materials, internet lecture, or informal individual instruction on the job, etc. There were a few cases in hospitals and non-hospital healthcare settings where training was available, but the exposed workers had not received the training. There is a positive association between the BBP safety training and awareness of the OSHA BBP standards. Seventy-eight percent of the respondents who had BBP safety training reported awareness of the OSHA BBP standard, compared to 28% among respondents who did not have BBP training ($P < 0.0001$). Ninety-nine percent of the respondents who had BBP safety training felt that it is necessary to wear gloves when helping a person who is bleeding, but whose HIV and hepatitis B status are unknown, compared to 89% among those who did not have the training ($P < 0.0001$).

Job Information and Exposure History

Table III suggests that on average 19% of the exposures occurred within the first year of employment. A large proportion of needlestick/sharps injuries occurred to workers who had never or rarely handled or used medical sharps on the job: 100% in law enforcement, 70% in non-healthcare settings, 26% in non-hospital healthcare settings, 21% in EMS/FF, and 11% in hospitals. The difference among the groups is statistically significant ($P < 0.0001$). Law enforcement had the highest percentage of multiple exposures during the past 12 months, but the lowest percentage of reporting or seeking treatment for the previous exposures. More than half of respondents from law enforcement, EMS/FF, and hospitals reported awareness of coworkers' exposures in the past 12 months.

Preventive Measure Utilization

EMS/FF had the highest percentage of use of PPE, while law enforcement had the lowest percentage at the time of injury (Table IV). PPE listed in this survey included latex or non-latex medical gloves, safety eyeglasses, faceshields, masks, gowns, plastic aprons, or other items. The availability of hepatitis B vaccination is low in other non-healthcare

TABLE I. Reasons for Being Treated in EDs by Industry Group*

Industry group (total number)	Workplace policy (row percent)	Supervisor instruction (row percent)	Personal decision (row percent)
Hospitals (n = 382)	295 (77%)	27 (7%)	60 (16%)
Non-hospital healthcare settings (n = 86)	57 (66%)	13 (15%)	16 (19%)
EMS/FF[a] (n = 51)	36 (71%)	[b]	[b]
Law enforcement (n = 22)	16 (73%)	[b]	[b]
Other non-healthcare settings (n = 52)	20 (38%)	11 (21%)	21 (40%)
Total (n = 593)	424 (72%)	60 (10%)	109 (18%)

*Difference in distribution of this table is statistically significant, Chi-square test: $P < 0.001$.
[a]EMS/FF, emergency medical service/firefighting.
[b]Small cells not reported.

settings. The definition for ''safety needles'' is broad and includes those where the needle retracts into the syringe after use, those that have a protective shield over the needle, and others that do not use needles at all (needleless devices) [NIOSH, 1999]. The availability of safety needles is higher in hospitals and EMS/FF than in non-hospital healthcare settings. Among the 320 respondents who reported the availability of safety needles in their workplaces, 12% reported that they had not used the safety needles. The main reason reported for not using safety needles was that they were not available for all procedures. Other reasons included ''difficult to use'' or ''like conventional needles better.''

DISCUSSION

Limitations and Strengths

In interpreting the results of this study, it should be kept in mind the limitations associated with the NEISS and the limitations associated with a telephone survey [Knight et al., 1995; Castillo and Rodriquez, 1997]. The limitations associated with NEISS were discussed in the companion surveillance portion of this study [Chen and Jenkins, 2007]. Limitations associated with a telephone survey are recall and non-response biases. In this study, hospital workers had a higher response rate than non-hospital workers. Female workers had a higher response rate than male workers. Implications of differences in response rates on the study results are unknown. A housekeeper in a hotel, a bus attendant in a city transit authority, or a waiter in a restaurant might have little time or private workspace to complete the survey on the job. Information was not available on whether the phone number used in the interview was a home or a work phone number. Because of the sensitivity of the subject matter, the survey did not collect any information on post-exposure evaluation and post-exposure prophylaxis.

There are two approaches for reporting data from NEISS follow-back surveys—reporting either national estimates or actual numbers from the interviews. Both have advantages as well as limitations. Each case in NEISS is assigned a statistical weight that can be used to make national estimates. Castillo and Rodriquez [1997] reported national estimates on their NEISS follow-back study of injuries to older workers. Advantages of reporting national estimates include: (1) it maximizes the benefit of the NEISS probability sample design and allows a national interpretation of the findings; and (2) national injury rates and relative risk can be calculated by using national employment estimates. Using national estimates is more statistically sound in certain situations. For example, in NEISS one case could reflect 100 similar cases (with a weight of 100) while another case might represent 10 similar cases (with a weight of 10). The two cases have different statistical contributions when generating national estimates. But, there is an assumption to be made in order to generate national estimates. The assumption is that the interviewed cases are a random sample of all similar cases captured in NEISS. As well, generating estimates based on a sub-sample of a sample increases the sampling error of the estimates [Cochran, 1997]. The increased sampling error in addition to the relatively small number of interviewed cases results in unstable estimates. For this reason, Knight et al. [1995] reported actual numbers in another NEISS follow-back study. For the present study, only 42 NEISS hospitals participated in the survey and these 42 participating hospitals are not a random-sample of the total number of NEISS hospitals. For this reason, actual numbers from interviewed cases rather than national estimates are reported in this study.

Bias of ED-Based Surveillance

According to the survey, 92% respondents from hospitals, 90% from EMS/FF, 77% from non-hospital healthcare settings, 68% from law enforcement, and 52% from other non-healthcare settings reported that ED is the

TABLE II. Bloodborne Pathogen (BBP) Safety Training and Awareness of the OSHA BBP Standards by Industry Group*

Industry group (total number)	Percent who reported training available ($P < 0.0001$)[a]	Percent who reported training delivered by lecture ($P < 0.002$)	Percent who reported training covered the BBP standard[b] ($P < 0.0001$)	Length of training (median hour)	Percent who reported awareness of the OSHA BBP standard ($P < 0.0001$)
Hospitals (n = 381)	94% (358/381)	67% (234/347)[b]	94% (325/347)	1.00	84% (319/381)
Non-hospital healthcare settings (n = 86)	87% (75/86)	80% (56/70)	89% (62/70)	1.25	67% (58/86)
EMS/FF[c] (n = 51)	90% (46/51)	93% (42/45)	84% (38/45)	2.00	75% (38/51)
Law enforcement (n = 22)	86% (19/22)	79% (15/19)	74% (14/19)	2.00	50% (11/22)
Other non-healthcare settings (n = 52)	46% (24/52)	63% (15/24)	71% (17/24)	1.50	37% (19/52)
Total (n = 592)	88% (522/592)	72% (362/505)	90% (456/505)	1.00	75% (445/592)

*For ease of presentation for a series of no-mutually exclusive questions are presented on this table. Rows may add to more than 100%.
[a]Chi-square test: $P < 0.05$ suggests that at least one industry group is statistically significant different from the other groups.
[b]Denominator in this column is the number of respondents who had the BBP training in each industry group.
[c]EMS/FF, emergency medical service/firefighting.

TABLE III. Employment and Exposure History by Industry Group*

Industry group (total number)	Percent who worked for less than one year ($P = 0.02$)[a]	Percent who reported multiple exposures in the past 12 months ($P = 0.02$)	Percent who reported or sought treatment for the previous exposure[b] ($P = 0.04$)	Percent who reported co-workers' exposures in the past 12 months ($P = 0.005$)
Hospitals (n = 381)	18% (70/381)	22% (85/381)	69% (57/83)	53% (202/381)
Non-hospital healthcare settings (n = 86)	24% (21/86)	20% (17/68)	[d]	36% (31/86)
EMS/FF[c] (n = 51)	[d]	27% (14/51)	[d]	55% (28/51)
Law enforcement (n = 22)	[d]	[d]	[d]	64% (14/22)
Other non-healthcare settings (n = 52)	33% (17/52)	[d]	[d]	35% (18/52)
Total (n = 592)	19% (115/592)	23% (136/592)	60% (81/134)[a]	49% (293/592)

*For ease of presentation, results for a series of non-mutually exclusive questions are presented on this table. Rows may add to more than 100%.
[a]Chi-square test: $P < 0.05$ suggests at least one industry group is statistically significant different from the other groups.
[b]Denominator in this column is the number of respondents who reported multiple exposures in the past 12 months in each industry group.
[c]EMS/FF, emergency medical service/firefighting.
[d]Small cells not reported.

TABLE IV. Protective Measure Utilization by Industry Group*

Industry group (total number)	Percent who reported use of PPE[a] at the time of exposure ($P < 0.0001$)[b]	Availability of hepatitis B vaccination ($P < 0.0001$)	Availability of safety needles[c] ($P < 0.0001$)
Hospitals (n = 381)	79% (300/381)	84% (320/381)	80% (255/320)
Non-hospital healthcare settings (n = 86)	58% (50/86)	79% (68/86)	61% (32/52)
EMS/FF[d] (n = 51)	86% (44/51)	92% (47/51)	82% (28/34)
Law enforcement (n = 22)	[e]	86% (19/22)	N/A[f]
Other non-healthcare settings (n = 52)	[e]	50% (26/52)	56% (5/9)
Total (n = 592)	70% (416/592)	81% (480/592)	77% (320/415)

*For ease of presentation, results for a series of non-mutually exclusive questions are presented on this table. Rows may add to more than 100%.
[a]PPE, personal protective equipment.
[b]Chi-square test: $P < 0.05$ suggests at least one industry group is statistically significant different from the other groups.
[c]Denominator in this column is the number of respondents who reported use of medical sharps as part of their job in each industry group.
[d]EMS/FF, emergency medical service/firefighting.
[e]Small cells not reported.
[f]Not applicable.

designated place for treatment of potential work-related BBP exposures. Data on the variation of treatment policy and practice by industry supports the hypothesis that occupational injuries occurring in hospitals may be overrepresented because of easy access and hospital policy. It may also be useful in developing an industry-specific weight to correct the bias of overrepresented occupational injuries in hospitals and underrepresented injuries in non-hospital settings.

Exposure Underreporting

Findings from this study also attest to the serious underreporting of potential work-related exposures to BBP. This study suggests that many respondents were either not aware of exposure treatment procedures, or did not report/seek treatment for a previous work-related exposure that occurred in the past 12 months. According to the respondents interviewed, an average 40% of exposures in the past 12 months were unreported or untreated and the percentage varied by industry group (Table III). A number of other studies have also documented significant underreporting of BBP exposures. With specific regard to needlestick injuries, 12 different studies in the U.S. have documented underreporting ranging from a low of 11% among phlebotomists in a six hospital survey to 96% among operating room personnel in a survey of three hospitals [Perry and Jagger, 2003].

The OSHA BBP Standards

The federal standard addressing work-related exposure to BBP is the Occupational Safety and Health Administration BBP standards-29 CFR 1910.1030 [OSHA, 2001], which have been in effect since March 1992. The standards require, but are not limited to the following: (1) annual worker training in preventing occupational exposures to BBP; (2) use of PPE; (3) free hepatitis B vaccinations offered to workers with occupational exposure to BBP; and (4) employers to identify and make use of effective, safer medical devices [OSHA, 2003]. The BBP standards apply to all employers who have employees with reasonable anticipated exposure to blood and other potentially infectious materials but there is debate over how this is defined and interpreted. Findings from this study underscore the challenges and importance of identifying workers at high risk of exposures, who are working in non-healthcare settings, or who do not routinely handle or use medical sharps on the job. This study suggests that on average 18% of needlestick/sharps injuries occurred to workers who never or rarely use medical sharps on the job. Respondents from non-healthcare settings were less likely to have BBP safety training, to be aware of the OSHA BBP standard, and to have hepatitis B vaccinations, compared to respondents from hospitals. Even in hospitals, 6% of respondents reported that they did not know if BBP safety training was available in their workplace.

Safety Needles Evaluation

OSHA [1999] reported that safety devices were estimated to comprise 65% of the total market for IV line access systems, greater than 40% of the market for winged steel needles, and less than 10% of the markets for vacuum tube blood collection needles and IM/SQ needle/syringes. This study suggests that 23% of needlestick/sharps injuries were related to safety needles. Similar results were found in other studies [Laramie and Letitia, 2002; Perry et al., 2003]. Perry et al. reported 22% of sharps injuries were related to safety needles, of these injuries, the safety mechanism was not activated in 71%. The effectiveness of safety devices needs to be evaluated in order to eliminate those with little effect on reducing the number of needlestick/sharps injuries in actual use.

Safety Training Evaluation

The length, format, and content of BBP safety training varied greatly by industry group according to the workers interviewed. Hospital workers had the highest percent of training availability but the shortest training length compared to other groups of workers. On average, 28% respondents reported that their training was delivered in formats other than live lecture, such as video, written self-study materials, and informal individual on the job instruction. The OSHA BBP standard requires that training programs include an opportunity for interactive question and answer with a trainer. It is unknown how this is accomplished in the video, written self-study material, and internet lecture formats. Twenty-nine percent of the BBP safety training in non-healthcare settings did not cover the OSHA BBP standard. On average, 22% the respondents who had the training were not aware of the BBP standard. These findings suggest that the curriculum and effectiveness of BBP safety training needs to be evaluated in order to identify sufficient training for workers to grasp the minimum elements required by OSHA. Integrated training evaluation measures may need to be developed to help managers, trainers, and other workplace policy makers determine the proper training content and appropriate training formats tailored to the particular needs of their workers. The finding that 19% of the exposures occurred during the first year of employment also has important implications for BBP safety training practices. It underscores the importance of the OSHA BBP standard requirement for training to be delivered at the initial assignment and atleast annually thereafter. This early training might be more important among workers employed in certain non-healthcare settings where the training may be less frequent and the turnover rate might be higher, such as hotel housekeepers. Based on the authors' personal communication with occupational safety practitioners from several organizations where BBP safety training was delivered by live lecture, the training is provided one or two times a year and it is common for there to be a three to six month lag time for a new worker to receive BBP safety training.

CONCLUSION

Beyond counting the numbers, this telephone survey provides detailed information on issues surrounding potential workplace BBP exposures. Data on similarities and differences among different industry groups, in types of exposures, exposure treatment procedures, safety training, attitudes, knowledge, use of safety needles, and hepatitis B vaccinations, are useful in developing tailored prevention efforts that address the specific needs in particular industry and occupation groups.

Findings from this study suggest that efforts to prevent workplace BBP exposures should be emphasized and extended beyond hospitals and beyond healthcare settings. Each industry group has unique needs that should be addressed in the prevention of potential work-related exposures to BBP. For example, using safety needles can be an effective approach to prevent sharps injuries in hospitals and non-hospital healthcare settings, but PPE (such as medical gloves, masks, safety glasses, etc.) is critical in EMS/FF and law enforcement settings to prevent skin/mucus membrane contact with blood or other body fluids. A range of approaches that encompass specific work tasks as well as the general safety environment will be needed within each workplace and across industries. Gershon et al. [2000] found that hospital-based workers who reported high levels of senior management commitment to safety or safety training and feedback experienced half as many potential BBP exposures.

Good housekeeping practices are needed in non-healthcare settings to prevent sharps injuries, for example, while collecting garbage. Improving awareness of the OSHA BBP standards and establishing exposure reporting and treatment procedures would also be an important first step to minimize the adverse consequences of BBP exposures in non-healthcare workplaces. The importance of focusing on prevention is underscored in studies like that of Do et al. [2003] who examined the details of the 57 documented cases of occupationally acquired HIV in the U.S. and found that eight (14%) of the health care workers contracted HIV despite receiving antiretroviral post-exposure prophylaxis. For healthcare workplaces, CDC [2007] has developed a Workbook for Designing, Implementing, and Evaluating a Sharps Injury Prevention Program that provides useful tools for developing a prevention program. Given the risks demonstrated in this article for workers outside healthcare settings, future prevention efforts will need to focus on reducing the risks for BBP exposures in a wide range of work situations.

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