Hepatitis B vaccination in correctional health care workers

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Background: Data on bloodborne pathogen risk among health care workers (HCWs) employed in the correctional setting are sparse, even though the prevalence of bloodborne infections, including hepatitis B virus (HBV), among inmates is high. To address this, we determined prevalence and correlates of hepatitis B virus vaccination status in correctional health care workers (CHCWs) employed in 3 state correctional health care facilities.
Methods: A confidential, self-administered cross-sectional survey was performed.
Results: Four hundred eleven (69.8%) of 588 eligible participants completed the survey. Of these, 264 (64.2%) reported receiving a primary hepatitis B (HB) vaccine series. Vaccination rates varied by state and by job category. Parenteral exposures were not uncommon; 8.6% (n = 24) of clinical CHCWs and 2.0% (n = 7) of nonclinical CHCWs reported one or more needlesticks in the 6-month period prior to the study. Among clinical staff, vaccination correlated with licensure (RN or MD) and race (white) and in nonclinical staff with history of close contact with HBV infected inmates and with needlestick injury.
Conclusion: Although the HB vaccination rate among CHCWs was generally high, given their potential risk of exposure to HBV, universal vaccination should be encouraged and should include those nonclinicians with job duties that may involve potential exposure to blood/body fluids. (Am J Infect Control 2005;33:510-8.)

Percutaneous and permucosal exposures to blood and body fluids place health care workers (HCWs) at risk for bloodborne infection.[1-5] Historically, hepatitis B virus (HBV) was the most common bloodborne pathogen posing an occupational risk to HCWs, with the incidence of infection following a needlestick contaminated with HBV ranging from 6% to 30%.[6,7] High prevalences of HBV infection were found in certain groups of HCWs with particularly frequent exposure to blood, even in the absence of overt exposures.[8,9] Although HB vaccine became available in the United States in 1982 and was recommended for HCWs whose activities frequently exposed them to blood,[10] by 1990, it was estimated that less than half of all hospital-based HCWs had received the vaccine.[11] However, not long after the Occupational Safety and Health Administration (OSHA) published the Bloodborne Pathogen Standard, which required that employers offer the HB vaccine at no cost to any HCW with reasonably anticipated exposure to blood, the rate of HB vaccination increased to 66% for hospital-based HCWs.[12,13] For HCWs with frequent blood exposure, the vaccination rate was even higher, with rates as high as 75% reported. For certain groups of physicians, HB vaccination rates over 90% have been published.[14]

Much less is known about HB vaccination rates in the nonhospital setting, although we might suspect that they would be lower because hospitals are more likely to have established employee health and infection control programs, thereby simplifying both the process of exposure management as well as the development and implementation of vaccination programs. In comparison, nonhospital health care settings, which are generally smaller, tend to have fewer infection control and employee health resources, potentially placing them at a disadvantage in terms of their ability to actively promote vaccination programs among eligible employees.

In particular, the correctional health care setting is of special interest, not only because bloodborne infection rates are so high among inmates, but because security concerns may result in constraints on certain infection control practices (eg, readily accessible

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sharps containers).[15-18] Besides high inmate prevalence rates and the inherent ''custody vs. care'' tension in correctional health care, there are other factors that may place CHCWs at increased risk of exposure, including subpar levels of compliance with universal precautions/standard precautions (UP/SP) and poor safety climate.[17,19,20] Importantly, the level of acuity of inmate-patient care is increasing.[21] However, data on risk in CHCWs are sparse, and there is only one published report on HB vaccination rates among CHCWs; a 1997 survey in Maryland found that 79% of CHCWs (n = 216) received at least 1 dose of the HB vaccine.[17]

The issue of vaccination also raises an important question: Does receiving the vaccine create a perception among workers that they may be at less risk of infection, thereby leading to less concern about exposures and universal precautions? The issue of whether potent treatments or vaccines could result in a more cavalier approach to risky behaviors has been the topic of recent research in other areas (gay men).[22] Whether HB vaccine relaxes protective behaviors in HCWs remains an open question.

To further our knowledge regarding bloodborne pathogen risk in this group, we collected data on HB vaccination status and the factors associated with vaccination in 1999-2000 from CHCWs recruited from 3 state systems, Rhode Island, Texas, and Maryland, representing low, medium, and high inmate infectious disease risk, respectively. Based on reports of HCW noncompliance with safe work practices and considering the unique characteristics of health care delivery within the correctional setting,[4,17,20,23] we hypothesized that CHCW vaccination status would not only be related to prison HBV prevalence rates but to other factors as well, such as exposure history, adherence to safe work practices, workplace safety climate and job satisfaction. We therefore explored the relationship between vaccination and these other organizational and psychosocial constructs (such as work-related stress) that might indirectly affect workers' vaccination compliance. This risk assessment information may be useful in tailoring risk reduction programs to the needs of CHCWs, an estimated 100,000 workers.[24]

METHODS

Study populations and study sites

The three participating state correctional systems (Rhode Island, Texas, and Maryland) were chosen initially because they represented different levels of risk based on inmate infectious disease status. Within each state correctional system, specific regional health care facilities were designated as ''test sites.'' These sites were chosen to facilitate the participation of as many CHCWs from within each region as possible. Personal letters of invitation to participate in the study were mailed to all CHCWs in each participating state system. The letters included information regarding the study as well as the regional test site locations and testing dates. CHCWs were defined as employees of a prison health care department, and although inmates sometimes perform duties in prison health care units (eg, housekeeping, transport, etc), they were not eligible for inclusion in this study. The Johns Hopkins University Committee on Human Volunteers, the Columbia University Human Subjects Committee, the Centers for Disease Control/National Institute of Safety and Health Institutional Review Board, and each state's correctional system's institutional review boards approved all aspects of this study.

Risk assessment questionnaire development

The study questionnaire was based on a number of well-defined and previously validated instruments and further refined though qualitative research (ie, in-depth interviews and focus groups), followed by extensive pre- and pilot testing and psychometric analyses. (Please contact the corresponding author for copies of the questionnaire, coding information, and psychometric data). The following variables were measured:

Demographics. Sex, age, race, occupation, tenure, education, place of birth, etc.

Vaccination history. Number of doses received, reasons for declining vaccination, year of last dose, whether postvaccination testing was performed and the result of any postvaccination testing.

Community risk factors. Employees were asked to report on a number of variables designed to assess community-acquired risk of HBV infection because this information might influence their acceptance of HB vaccination. Sensitive risk assessment questions, such as those regarding male-to-male sex and illicit injection drug use, were addressed in a composite ''risk'' question that incorporated less sensitive items (eg, transfusion history).

Occupational exposure. Data were collected from employees on any known percutaneous, permucosal, or nonintact skin exposure to blood or body fluids in the 6 months prior to the study, as well as *any* needlestick injury that occurred during their tenure as a CHCW and workplace contact with blood and frequency of handling contaminated needles.

Compliance with universal/standard precautions. To ascertain the relationship between vaccination

status and safe work practices, employees were asked to report their practices with respect to universal/standard precautions using a well-defined (Cronbach's alpha = 0.84) 15-item compliance scale.[4]

Safety climate. A 25-item safety climate scale adapted from a preexisting instrument (Cronbach's $\alpha = 0.88$) was constructed to measure employees' perceptions of their work site safety program (ie, safety climate).[17]

Work stress. Because work stress has been shown to be related to workplace exposures and injuries, as well as safe work behaviors, we included this 18-item (Cronbach's $\alpha = 0.80$), previously validated measure.[17]

Job satisfaction. To evaluate the hypothesis that workers who were less satisfied with their jobs might also be less inclined to adhere to administrative recommendations regarding vaccination, we included a 15-item scale adapted from a National Institute of Occupational Safety and Health (NIOSH) job satisfaction instrument.[25]

Workplace irritations and interpersonal conflict at work. This variable was measured with a scale that consisted of 29 items addressing 2 domains: environmental irritations (eg, noise, temperature) and interpersonal conflict (eg, verbal and sexual harassment and physical abuse from inmates, coworkers, and correctional officers).[17] We hypothesized that these factors, which have been associated with both work stress and job dissatisfaction, could indirectly affect compliance with administrative recommendations, such as vaccination program protocols.

The resulting 267-item, 7-page questionnaire was designed at a 10th grade reading level to facilitate its rapid completion and generally required 30 to 40 minutes to complete.

Data analysis

After determining vaccination rates for the entire sample, we determined rates by job category and by state. Rates of reported exposure to blood/body fluids were determined for various types of exposures. We next examined the associations between vaccination status and demographic, personal, workplace, and psychosocial factors, using univariate odds ratios with their 95% confidence intervals (CI). For the purpose of these analyses, we collapsed vaccination groups as following: vaccinated = all 3 doses or reported history of infection (immunity), and nonvaccinated = less than 3 doses, declinations, could not remember, or left blank.

All variables significant ($P < .05$) in the univariate analyses were entered into logistic regression procedures for the dichotomous (eg, vaccination [full series] vs nonvaccination) outcome. Because respondents might differ from nonrespondents, characteristics of respondents were compared with those of nonrespondents on available parameters (eg, age, sex, occupation) from aggregated prison employee records. We also compared respondent demographics from each of the 3 participating states to be able to justify combining the 3 groups into 1 group of CHCWs.

RESULTS

Of 588 individuals available to participate in the study, 411 (69.8%) provided written consent and returned a completed questionnaire. The response rate did not differ significantly by state (Rhode Island, 76.0%; Texas, 74.0%; and Maryland, 65.0%).

Demographics

Most of the CHCWs were female (75.0%), middle aged (mean age, 45 years), and white (64.0%) and had more than 12 years of education (89.0%). The demographic data from each test site were similar to the state's CHCW population as a whole (data not shown) and statistically similar across the 3 states sampled.

Most of the 411 respondents (n = 280, 68%) worked as clinical staff or technicians and had patient and/or patient specimen contact. Nonclinical workers (n = 131, 32%) were employed as clerks, pharmacy technicians, record keepers, and administrators. Demographic characteristics of the sample are shown in Table 1.

Vaccination status

Of the 411 CHCWs, 264 (64%) reported receiving all 3 doses of the vaccine, 18 (4%) declined the vaccine because they were HBV seropositive from infection, 35 (8.5%) received only 1 or 2 doses, 34 (8%) declined the vaccine for a variety of other reasons, and 60 (15%) did not know their status. The vaccination rate differed significantly by state: Rhode Island participants reported a higher vaccination rate (90.5%) compared with Maryland (73.7%) and Texas (70.7%) ($\chi^2 = 9.18$, $P < .01$).

In the subgroup of 280 clinical CHCWs, 203 (73%) had received all 3 doses of the vaccine, 11 (4%) did not receive the vaccine because of a history of HBV infection, 29 (10%) received only 1 or 2 doses, 14 (5%) declined the vaccine for other reasons (inconvenience, lack of time, concerns about safety, and pregnancy), 5 (1.8%) could not remember their vaccine history, and 18 (6.4%) left the question blank.

Of the vaccinated clinical CHCWs, 62% received their last dose more than 5 years prior to the study. Approximately 38% of clinical staff who received all 3 doses had postvaccination testing for serologic response; of these, 63% reported an adequate response,

22% reported a negative response, and 15% said that they could not remember or did not know their titer. We did not determine whether the individuals who reported nonresponse actually received additional vaccine doses. The rate of vaccination among clinical staff also varied significantly by state, with Rhode Island clinical staff more likely to report vaccination than clinical staff in Maryland or Texas ($P < .05$).

In the subgroup of 131 nonclinical staff, 61 (46.5%) reported receiving all 3 doses of vaccination, 7 (5.3%) reported that they had declined because they were seropositive from natural infection, 6 (4.6%) received only 1 or 2 doses, 20 (15.3%) declined for other reasons (not offered for free, inconvenience, and safety concerns), and 37 (28.2%) could not remember or did not know their status. Again, Rhode Island vaccination rates were significantly higher than those in the other 2 states. Only 13 nonclinical vaccinees had postvaccination testing; of these, 8 (62%) reported a protective response.

Community risk factors

Of the clinical CHCWs, 10.4% (n = 28) reported they had at least 1 community risk factor (eg, history of blood transfusion prior to 1990, injection of street drugs, male-to-male sexual contact). In addition, 4.3% (n = 9) reported an HBV-infected sex partner or household contact, and 72% (n = 84) reported close contact with an HBV-infected person; however, all of these contacts were with inmate-patients infected with HBV.

Of nonclinical staff, 11.5% (n = 14) reported at least 1 community risk factor, and 7.4% (n = 2) reported sexual or household contact with an HBV-infected person. Fifty-six percent reported contact with an HBV-infected person, and, as with clinicians, all of these contacts were with inmate-patients.

Occupational exposures

Nearly all (93%) of the clinical staff reported frequent or occasional occupational contact with blood or body fluids. A large percentage (90%) reported that they routinely handled contaminated needles as part of their job, and needlesticks were not uncommon. Over one third (31.6%) had experienced at least 1 contaminated needlestick or other percutaneous injury during their tenure in corrections, and 24 (8.6%) clinical staff reported a total of 36 needlesticks in the 6-month period prior to the study. Of these, 23 (63.8%) were brought to the attention of infection control practitioners or health service administrators, resulting in an underreporting rate of 36.2%. Additionally, for the same 6 months, clinical respondents reported other types of exposures, including 22 splashes to the eyes or mouth, 112 blood/body fluid contacts with open wounds, 15 cuts with contaminated objects, and 91 instances of blood/body fluid contact with intact skin. Underreporting of these other types of incidents ranged from 77% to nearly 88%. Overall, 76.2% of all reportable exposure incidents went unreported.

Nonclinical staff reported potentially serious exposures as well. Twenty (15.3%) experienced at least 1 needlestick during their careers in corrections, and, for the 6-month period prior to the study, nonclinicians reported 3 needlesticks, 14 blood/body fluid contacts with nonintact skin, 5 cuts with sharp objects, and 1 splash. The nonclinicians also reported 23 blood/body fluid contacts with intact skin. Underreporting was also common, with 74% of all exposures unreported to administration.

Table 1. Demographic characteristic of correctional health care workers (N = 411)*

Variable	N*	%
Gender		
Male	103	25
Female	308	75
Mean age, yr	44	
SD	10.57	
Range	20-77	
Marital status		
Married	242	59
Not married	167	41
Race/ethnicity		
White	261	64
Non-white	135	33
Place of birth		
United States	359	88
Other	51	12
History of living outside of United States		
Yes	86	21
No	323	79
Job duties		
Clinical	280	68
Nonclinical	131	32
Tenure, mean, yr	6.84 (range, 1-33)	

*Column numbers may not add because of missing values.

Compliance with universal precautions/ standard precautions

Nonclinical staff, for the most part, indicated that the compliance scale items were ''not-applicable'' to them; therefore, only clinical staff data are presented for this construct. Self-reported compliance was generally high, with a mean scale score of 4.27; SD, .49 (maximum score, 5.0; α coefficient = 0.76). High scores (ie, ''always'' complying when indicated) were reported for red bag waste disposal (89.2%) and glove use (87.1%), and low scores were reported for proper handling of contaminated needles (38.8%), wearing

Table 2. Blood/body fluid exposure and vaccination status in CHCWs by job category

	Clinical staff (N = 280)			Nonclinical staff (N = 131)		
Exposure type	**Reporting exposures** %	**Vaccinated*** **(n = 214)** %	**Nonvaccinated (n = 66)** %	**Reporting exposures** %	**Vaccinated*** **(n = 68)** %	**Nonvaccinated (n = 63)** %
(a) Any exposure[†]	18.2	20.7[‡]	11.3	7.0	5.9	8.2
(b) Needlestick	8.6	9.4	6.5	2.3	0	4.9
(c) Splashes to eyes and mouth	5.8	6.6	3.2	0.8	0	1.6
(d) Contact with open wounds	6.2	6.6	4.8	2.3	4.4	0
(e) Cuts with sharp objects	3.3	2.8	34.8	1.6	1.5	1.6
(f) Blood or body fluid on intact skin	15.1	14.7	16.1	6.1	9.3	3.3
(g) History of any needlestick while working in corrections[§]	41.6	41.8	41.1	17.5	29.6[§]	6.7

*Includes those with all 3 doses plus all immune persons (ie, known to be HBV infected).
[†]Defined as any percutaneous/mucocutaneous exposure (groups b-e) in prior 6 months.
[‡]$P = .067$.
[§]$P = .001$.

eye protection (45.0%), and proper disposal of sharps (64.0%). Compliance scores did not vary significantly by state.

Psychosocial factors

Safety climate. The overall mean score for the 20-item safety climate scale was relatively high, 3.79; SD, .51 (maximum score, 5.0; α coefficient = 0.87).

Work stress. This scale had a mean scale score of 2.01; SD, .57 (maximum score, 4.0; α coefficient = 0.94).

Workplace irritations. The mean scale score was 2.21; SD, .57 (maximum score, 5.0; α coefficient = 0.92).

Interpersonal conflict at work. Over 11% (11.4%) of respondents reported hostile interpersonal relationships at work, including verbal and physical harassment and physical abuse. The total mean scale score was 2.13; SD, .56 (α coefficient = 0.92).

Job satisfaction. The mean scale score was 3.17; SD, .63 (maximum score, 5.0; α coefficient = .90).

Correlates of vaccination in clinical CHCWs

Vaccinated clinical staff members were more likely to report a history of *any* percutaneous or permucosal exposure compared with unvaccinated clinical staff ($P = .067$), although this did not reach the level of significance. Furthermore, no significant association was found between vaccination status and various types of recent exposure incidents (Table 2). Vaccinated clinical staff members were, however, significantly more likely to have higher levels of education and to have more frequent blood and needle contact than those unvaccinated (Table 3). After controlling for recruitment site, the odds ratios did not vary significantly, indicating that these variables were associated with vaccination, independent of site. No association was observed between vaccination status and personal risk factors, compliance behaviors, safety climate, work stress, workplace irritations, interpersonal conflict, or job satisfaction. All variables significant at the univariate level, as well as history of percutaneous or permucosal exposure, were then entered into a stepwise multivariate model that controlled for site. Only race (white; OR, 2.39; 95% CI: 1.20-4.78) and professional licensure (eg, RN, MD; OR, 4.12; 95% CI: 1.70-10.27) remained significantly associated with vaccination.

Nonclinical workers

Among nonclinical workers, vaccination was most strongly associated with a history of ever having a needlestick injury during their career in corrections ($P = .001$; OR, 5.90; 95% CI: 1.83-19.0) (Tables 2 and 4). It was also strongly associated with the number of hours worked; vaccinated nonclinical workers were more likely to work more than 45 hours per week than nonvaccinees (OR, 5.59; 95% CI: 2.23-14.01) (Table 4). Vaccination also correlated with higher levels of education, race (white), close contact with a known HBV-infected person (inmate-patients; OR, 4.22; 95% CI: 1.09-16.27), and work stress (Table 4). After controlling for recruitment site, all variables, except work stress, remained significant in the adjusted model. These remaining variables were then entered into a stepwise logistic model; after which, only 2 variables remained significantly associated with vaccination: history of ever having experienced a needlestick and history of close contact with an HBV-infected person.

DISCUSSION

Although overall rates of vaccination among CHCWs approximate published rates for hospital HCWs, a substantial proportion of clinical CHCWs remain at risk

Table 3. Factors significantly associated with self-reported HB vaccination among clinical CHCWs (N = 280)

Variables	Vaccinated* (n = 214) %	Nonvaccinated (n = 66) %	Crude odds ratio	95% Confidence interval	Adjusted odds ratio	95% Confidence interval
Race						
White	71.5	41.2	3.6	1.99-6.41	3.0	1.62-5.56
Non-white	28.5	58.7				
Origin of birth						
United States	88.8	77.3	2.3	1.14-4.76	2.3	1.09-4.72
Non-United States	11.2	22.7				
Licensure						
Professional (eg, RN, MD)	91.1	76.6	3.1	1.48-6.59	3.2	1.46-6.91
Other	8.9	23.4				
Education						
>12 yr	96.3	83.3	5.2	1.98-13.51	4.7	1.77-12.5
≤12 yr	3.7	16.7				
Blood contact						
Frequent	95.5	85.2	3.7	1.27-10.69	3.7	1.28-10.89
Infrequent	4.2	14.8				
Needle contact						
Frequent	92.3	81.5	2.7	1.10-6.69	2.7	1.09-6.68
Infrequent	7.3	18.5				

*Includes those with all 3 doses plus all immune persons (ie, known to be HBV infected).

for HBV infection. This is worrisome, given the prevalence of HBV infection among inmates and the reported frequency of exposure incidents.

Of special concern is the fact that, within a 6-month period, nearly 7% of nonclinical CHCWs had at least 1 potentially serious exposure to blood. As the OSHA Bloodborne Pathogens Standard makes clear in 1910.1030(c)(2)(i),[12] if occupational exposure is a consideration for some employees, the employer must prepare exposure determinations for all employees, and, as recommended by the CDC, the bloodborne pathogen and infection control plans ''should cover all employees (including inmates who are assigned work duties at a correctional facility) who could be reasonably anticipated, as the result of job duties, to be exposed to blood, bodily fluids, or other materials that might contain HBV or HCV.''[26] Therefore, persons responsible for developing and implementing HB vaccine programs for CHCWs need to consider *all* employees of health care units. The OSHA Bloodborne Pathogen Standard requires that employers offer the HB vaccine to all employees with reasonably anticipated exposure to blood. Our results indicate that this criteria should be broadly applied among CHCWs because even nonclinical staff of correctional health care units were exposed. Although our questionnaire did not collect information about the cause of this exposure, anecdotal reports indicate that nonclinician staff members sometimes assist in providing urgent patient care. We know that rates of exposure are higher in settings in which health care delivery is unpredictable and urgent, such as emergency departments. In prisons, unpredictable events might similarly result in situations that inadvertently involve nonclinical staff. A closer analysis of the circumstances surrounding nonclinical staff exposure would help to clarify this and be useful in planning to eliminate this risk.

Although all 3 states comply with OSHA regulations, their vaccination rates differed significantly ($P < .01$). Although we hypothesized that vaccination rates might correlate with inmate prevalence rates, we did not find this. In fact, Rhode Island, with the lowest prevalence of HBV among inmates, had the highest HB vaccination rate. This is probably a reflection of their proactive HB vaccination program and the fact that Rhode Island, unlike the other 2 states, has centralized prison facilities, thereby potentially facilitating mass vaccination programs.

We also did not find a significant correlation between vaccination and compliance behaviors or with any of the psychosocial constructs we assessed, such as work stress. Given the fact that Rhode Island had a significantly higher rate of vaccination in both clinicians and nonclinicians, it may be that organizational factors, such as vaccine accessibility, is much more important than individual-related factors in terms of supporting vaccination. Therefore, correctional systems might consider a mass vaccination approach to aid in universal vaccination of staff.

Compliance rates for universal precautions/standard precautions noted in this study (during 1999-2000) were similar to published rates reported in a Maryland survey of CHCWs (data from 1997).[17] However, CHCWs scores were lower than other HCW rates reported for both hospital-based HCWs and other populations of nonhospital based HCWs during the same time period,

Table 4. Factors significantly associated with self-reported HB vaccination among nonclinical CHCWs (N = 131)

Variables	Vaccinated (n = 68) %	Nonvaccinated (n = 63) %	Crude odds ratio	95% Confidence interval	Adjusted odds ratio	95% Confidence interval
Race						
White	80.0	58.3	2.86	1.29-6.33	2.37	1.01-5.60
Non-white	20.0	41.7				
Education						
>12 yr	91.2	71.4	4.13	1.52-11.23	3.39	1.15-9.90
≤12 yr	8.8	28.6				
Hours workers per week						
>45 hr	58.8	88.9	5.59	2.23-14.01	4.74	1.79-12.66
≤45 hr	41.2	11.1				
Close personal contact with HBV-infected inmates						
Yes	46.5	18.9	3.73	1.35-10.31	2.56	1.11-5.92
No	53.5	81.1				
History of needlestick						
Yes	29.6	6.7	5.90	1.83-19.0	5.66	1.68-19.08
No	70.4	93.3				
Work stress						
High	59.4	36.8	2.51	1.20-5.20	Nonsignificant	
Low	40.6	63.2				

especially for certain specific items (eg, sharps container use).[23]

Our results do not support the concern that vaccination might lead to a perception of immunity, thereby resulting in less careful work practices, although we did note a tendency for vaccinees to have a recent history of a serious exposure compared with nonvaccinated CHCWs. This question merits additional research among HCWs in general.

Of interest was the finding that less than half of the vaccinees reported postvaccine titers. Both the OSHA Bloodborne Pathogen Standard as well as the CDC guidelines provide clear direction in this matter: Appropriate postvaccination follow-up is essential, and CHCWs must be informed on this as well as postexposure follow-up.[12,26] Exposure reporting, although low, was similar to formal reporting rates in hospital-based HCWs, at least for needlesticks.[3,4] For other types of exposures, CHCWs had lower rates of reporting. This may be a reflection of the difficulty CHCWs face in receiving postexposure care, potentially resulting in reporting of only those exposures that seem especially serious to the individual CHCW. Although correctional health care facilities are increasingly providing postexposure care on-site (vs receiving care at a nearby emergency department), this issue should be reexamined and any remaining barriers to reporting addressed.

Among clinical CHCWs, the factors associated with vaccination status (eg, licensure) and the reasons for declining vaccination were similar to those revealed in studies involving hospital-based HCWs.[27,28] Among nonclinical CHCWs, we noted 2 important associations with vaccination: history of needlestick injury, which could have served as an impetus to be vaccinated, and history of close personal contact with a person known to be HBV infected (most of this contact was with inmate-patients). Perhaps knowledge of the high rates of HBV in inmates served as a motivation for nonclinical staff members to become vaccinated. In any case, the cross-sectional design of this study precludes our ability to state definitively that these risk factors actually led to vaccination (and not vice versa).

Several study limitations should be acknowledged. First, because we tested CHCWs from only 3 state correctional systems, our results may not be generalizable to all CHCWs. Vaccination rates varied significantly by state, and it is likely that rates vary not only across state systems but even within a state system, by facility. This study, however, expands our information on CHCWs vaccination practices, and, because we directed our analyses at potential determinants of vaccination status using relative rather than absolute measures, we are able to generalize at least for these observed associations. We also showed that, even after controlling for state, significant associations with vaccination remain. Another possible bias might have resulted from participants offering socially desirable responses on the most sensitive questions. We tried to counter this by emphasizing the confidentiality of the study and by embedding the most sensitive questions in 1 large ''risk composite'' question.

Inaccurate recall of vaccination history and postvaccination titers could have affected the estimation of

effect of various factors on vaccination status. We tried to prevent this by framing the questions in a way that helped improve recall. For other variables, such as exposure variables, we tried to limit recall bias by restricting our questions, for the most part, to the previous 6 months. Potentially, the most important limitation of this study was its cross-sectional design, which precludes the assignment of temporal associations. However, this cost-effective design provides information that can serve as a basis for future prospective studies of vaccine acceptance or refusal. Prospective studies will help us to understand not only the barriers to vaccination but also the issues underlying these barriers, thus better preparing us for meaningful intervention.

The complexity of performing scientific research with this unique population of HCWs might be a fundamental reason for the scarcity of information on their occupational health risks. Even our limited findings, however, allow us to make a number of recommendations to reduce risk. First, all correctional health systems should review the HB vaccination status of *all* CHCWs, confirming vaccination when possible, and making every effort to encourage vaccination among the unvaccinated. Second, all new employees, *including nonclinical workers*, should be assessed for their vaccination status as well as their potential for exposure, and, again, every effort should be made to attain universal vaccination. As part of this process, the concerns of CHCWs regarding the safety of the vaccine as well as the issue of convenience should be addressed because these were barriers to acceptance for many CHCWs. Third, because vaccination is an important component of bloodborne pathogen exposure prevention programs, annual review and updating of all programmatic elements is essential, and, given the unexpected number of nonclinical staff reporting exposure, these workers should be included in these programs. Risk factors for all exposures should be assessed and addressed, given that CHCWs may be at risk for other bloodborne infections. Because we found that correctional system infection control and employee health programs vary considerably across systems, we encourage the development and implementation of standardized best practices for this overlooked segment of the health care workforce. Finally, the attention to vaccination arises from the observed magnitude of risk in CHCWs, which was considerable, given that as many as 15% of all CHCWs who reported potentially serious exposure incidents were unvaccinated. If this is extrapolated, using the most conservative estimates, as many as 15,000 unvaccinated CHCWs (clinical and nonclinical staff) in the United States are potentially at risk of HBV infection. The recommendation for universal HB vaccine for this work group is therefore warranted.

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