Influenza, hepatitis B, and tetanus vaccination coverage among health care personnel in the United States

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Background: Health care personnel (HCP) are at risk for exposure to and possible transmission of vaccine-preventable diseases. Maintenance of immunity is an essential prevention practice for HCP. We assessed the recent influenza, hepatitis B, and tetanus vaccination coverage among HCP in the United States.

Methods: We analyzed data from the 2007 National Immunization Survey-Adult restricted to survey respondents aged 18 to 64 years. Influenza, hepatitis B, and tetanus vaccination coverage levels among HCP were assessed. Multivariable logistic regression was conducted to assess factors independently associated with receipt of vaccination among HCP.

Results: Among HCP aged 18 to 64 years, 46.7% (95% confidence interval [CI]: 39.6%-53.8%) had received influenza vaccination for the 2006-2007 season, and 70.4% (95% CI: 63.9%-76.1%) received tetanus vaccination in the past 10 years; 61.7% (95% CI: 52.5%-70.2%) had received 3 or more doses of hepatitis B vaccination among HCP aged 18 to 49 years. Multiple logistic regression analysis showed that being married was associated with influenza vaccination coverage, higher education level was associated with hepatitis B vaccination coverage, and younger age was significantly associated with tetanus vaccination among HCP. Among those HCP who did not receive influenza vaccination, the most common reason reported was respondent concerns about vaccine safety and adverse effects.

Conclusion: By 2007, influenza and hepatitis B vaccination coverage among HCP remained well below the Healthy People 2010 objectives. Tetanus vaccination level was 70%, and this study provided a baseline data for tetanus vaccination among HCP. Innovative strategies are needed to further increase vaccination coverage among HCP.

Key Words: Influenza; hepatitis B; tetanus; vaccination coverage; health-care personnel.

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Health care personnel (HCP) may have frequent contact with infectious patients or infective material from patients. HCP, which includes physicians, nurses, emergency medical personnel, dental professionals and students, medical and nursing students, laboratory technicians, hospital volunteers, and administration staff, are at high risk for exposure to and possible spread of vaccine-preventable diseases.[1] HCP can acquire infectious diseases from patients and transmit infectious diseases to other patients and staff. Ensuring that HCP are immune to vaccine-preventable diseases is an essential part of successful employee health programs.[1,2]

Achieving and sustaining high vaccination coverage levels among HCP are important for reducing the transmission of infectious diseases among HCP and patients. Optimal use of vaccines cannot only reduce disease burden but can also eliminate unnecessary work restriction.[1-3] Prevention of illness through comprehensive personnel vaccination programs is far more cost-effective than case management and outbreak control.[1]

The Advisory Committee on Immunization Practices (ACIP) and the Hospital Infection Control Practices Advisory Committee have made recommendations regarding the use of certain immunizing agents in HCP.[2] These recommendations can help hospital administrators, infection control professionals, employee health physicians, and HCP optimize infection prevention and control programs. Decisions about which vaccines to be included in immunization programs have been made by primarily considering the likelihood of HCP exposure to vaccine-preventable diseases and the potential consequences of not vaccinating personnel. Immunization of HCP before they enter high-risk situations is the most efficient and effective use of vaccines in health care settings. The diseases for which

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vaccination is recommended are grouped into 3 categories: (1) those for which active immunization is strongly recommended because of special risks for HCP, (2) those for which vaccination is or may be indicated in certain circumstances, and (3) those for which vaccination of all adults is recommended. Influenza and hepatitis B vaccinations are strongly recommended for all HCP. Tetanus vaccination is recommended for all adults including HCP.[2] In addition, a new Tdap vaccine (tetanus-diphtheria-acellular pertussis vaccine) was licensed in 2005 in the United States, and a single dose of this vaccine was recommended by the ACIP for HCP aged < 65 years.[4]

Healthy People 2010 objectives included increasing influenza vaccination levels to at least 60% among HCP. The objectives also called for raising hepatitis B vaccination coverage among HCP to over 90%.[5] Using data from the 2007 National Immunization Survey of adults, we examined the following questions: (1) What are the recent national influenza and hepatitis B vaccination coverage levels among HCP? (2) What is the baseline tetanus vaccination coverage among HCP? (3) How do influenza and hepatitis B vaccination coverage among HCP compare with the Healthy People 2010 objectives? (4) What demographic and access to care factors significantly affect vaccination coverage among HCP? (5) What are the major reasons reported by HCP for not receiving influenza vaccination?

METHODS

The National Immunization Survey (NIS)-Adult (NIS-Adult) is a national telephone survey conducted for the Centers for Disease Control and Prevention (CDC) by the National Opinion Research Center at the University of Chicago. One of the primary objectives of the survey is to provide timely, detailed information regarding adult vaccination coverage among persons aged ≥ 18 years for vaccines recommended by the ACIP, including influenza, hepatitis B, tetanus-diphtheria, hepatitis B, pneumococcal, tetanus-diphtheria-acellular pertussis, human papillomavirus, and herpes zoster vaccines. Factors associated with vaccination also are collected by the NIS-Adult. For the current analysis, we used data collected from May through August 2007. The 2007 NIS-Adult sample of telephone numbers was obtained from 2 lists of telephone numbers: the National Health Interview Survey (NHIS) list included 2006 and the first quarter of 2007 telephone numbers of survey respondents who said they would accept another call to collect additional information that included race/ethnicity and age. The second list was prepared by Survey Sampling International and was selected based on specific age categories. All telephone numbers from the NHIS list with nonmissing age and race/ethnicity information were included in the NIS-Adult survey sampling frame. However, the NHIS list was not large enough to meet the required sample size for the NIS-Adult survey, so additional telephone numbers were selected from the Survey Sampling International list with equal probability of selection. One adult was randomly selected from each household, and interviews were conducted in English or Spanish.

Regarding immunizations, respondents were asked the following questions: ''Since this past September (2006), have you had a flu vaccination?'' and ''Have you ever had a hepatitis B vaccination?'' An affirmative answer to the hepatitis B vaccination question prompted a second question concerning how many doses respondents received, ''How many hepatitis B shots did you receive?'' As recommended by the ACIP, we used receipt of at least 3 doses of hepatitis B vaccine as the outcome measures for hepatitis B. For the tetanus vaccination, respondents were asked ''Have you ever received a tetanus shot?'' and ''Approximately how many years ago did you receive your most recent tetanus shot?'' We used receipt of vaccination within the past 10 years as the outcome measure for tetanus vaccination. Regarding Tdap vaccine (tetanus-diphtheria-acellular pertussis vaccine), respondents were asked ''Did the doctor tell you your most recent tetanus vaccination included the pertussis vaccine?'' Respondents were asked ''Do you currently work in a health care facility?'' Respondents who answered yes to this question were considered to be HCP. For the 2007 NIS-Adult survey, the telephone number resolution rate was 64.4%, the screening completion rate was 63.9%, and the interview completion rate was 74.2%, for a CASRO (Council of American Survey and Research Organization) rate of 31%.[6,7]

For the analysis, demographic and access to care variables included age group (18-34, 35-49, 50-64 years), sex (male, female), race/ethnicity (non-Hispanic white, all others), education (high school education or less, some college education or more), marital status (married, not married), household income (<$35,000, $35,000 or more), and medical insurance status (insured, uninsured).

We used SUDAAN software, a statistical tool for complex sample survey data (Research Triangle Institute, Research Triangle Park, NC) to calculate point estimates and 95% confidence intervals (CIs) and to account for the complexity of the NIS-Adult sample design. All analyses utilized weighted data to reflect the age and race/ethnicity of the noninstitutionalized civilian US population. Weights were adjusted for unit nonresponse, multiple telephone lines, and noninclusion of nonlandline telephone households. Reasons for not receiving influenza vaccination among HCP were assessed. Data regarding reasons for not receiving

tetanus vaccination were collected, but sample size was too small to report. *T* tests were used to evaluate associations between vaccination status and demographic or other variables, with the statistical significance level set at $P < .05$. Multivariable logistic regression modeling was conducted to determine variables independently associated with receipt of influenza, hepatitis B, and tetanus vaccination among HCP. A predictive marginal prevalence is the estimated vaccination coverage adjusted for all the variables in a multivariable logistic model using a direct standardization procedure.[8,9]

RESULTS

A total of 7,055 respondents aged ≥ 18 years was included in the survey. Of these, 3,917 were 18 to 64 years of age. Respondents who reported unknown vaccination status for influenza vaccination (n = 37), for hepatitis B vaccination (n = 189), and for tetanus vaccination (n = 222) were excluded from the vaccination-specific analysis.

Table 1 shows the demographic characteristics of the sample. Among HCP aged 18 to 64 years, most were female (73.5%), white (61.6%), had some college or higher (71.5%), a household income at least $35,000 (72.1%), and medical insurance (90.0%).

Overall in 2007, 46.7% (95% confidence interval [CI]: 39.6%-53.8%) of HCP aged 18 to 64 years reported having had influenza vaccination (Table 2). Among HCP, statistically significant differences in influenza vaccination rates were observed for marital status; those who were married were more likely than others to have been vaccinated (53.9% and 38.1%, respectively).

Hepatitis B vaccination coverage with ≥ 3 doses was 61.7% (95% CI: 52.5%-70.2%) among HCP aged 18 to 49 years. Among HCP, hepatitis B vaccination coverage levels were associated with education, marital status, and income (Table 2). HCP who had higher education, were married, and at higher income levels were more likely to have received the 3-dose series.

In 2007, 70.4% (63.9%-76.1%) of HCP reported having had tetanus vaccination in the past 10 years. Tetanus vaccination coverage among HCP was higher for those aged 18 to 34 years (78.9% [95% CI: 68.3%-86.6%]) than those aged 35 to 49 years (63.4% [95% CI: 52.4%-73.2%]), and those aged 50 to 64 years (62.8% [95% CI: 53.2%-71.5%]) (Table 2). Tdap vaccination coverage among HCP aged 18 to 64 years was 2.6% (95% CI: 1.2%-5.6%).

Controlling for other demographic factors, multiple logistic regression analysis showed that the association between being married and receiving influenza vaccination among HCP held; however, only the association between higher education level and receipt of hepatitis B vaccination remained when other factors were controlled. Age was significantly associated with tetanus vaccination in the logistic regression model after controlling for other demographic factors (Table 3). Adjusted coverage estimates were similar or only slightly different from the crude coverage (Table 3). For each specific vaccination, coverage was significantly higher among HCP compared with that among non-HCP (Coverage among non-HCP was 27.9% for influenza, 17.7% for hepatitis B, and 55.4% for tetanus vaccination, respectively).

Among those HCP who did not receive influenza vaccination, the most common reason reported was respondent concerns about vaccine safety and adverse effects (24.2%). Other reasons included not thinking they could get influenza (18.0%), forgot, did not have chance, was not convenient (12.3%), do not want vaccine (11.1%), vaccine costs too much (9.7%), and doctor did not recommend (5.0%) (Table 4).

Table 1. Sample characteristics of participants aged 18 to 64 years in the United States, by health personnel status and demographic variables: NIS-Adult 2007

	Health care personnel		Nonhealth care personnel	
Characteristic	**Sample**	**Weighted %**	**Sample**	**Weighted %**
Total	484		3432	
Age, yr				
18-34	103	44.6	637	35.5
35-49	129	30.6	947	36.3
50-64	252	24.8	1803	28.2
Sex				
Male	92	26.5	1398	52.6*
Female	392	73.5	2034	47.4
Race/ethnicity				
Non-Hispanic white	177	61.6	1250	62.6
Others	307	38.4	2182	37.4
Education				
≤High School	124	28.5	1430	46.1*
Some college+	357	71.5	1980	53.9
Married status				
Married	269	53.9	2010	63.9*
Not married	213	46.1	1399	36.1
Income, US $				
<35,000	124	27.9	1128	31.9
35,000+	302	72.1	1825	68.1
Health insurance status				
Yes	429	90.0	2858	83.8*
No	55	10.0	574	16.3

*Significant difference between health care personnel and non health care personnel ($P < .05$).

DISCUSSION

This study reports estimates of influenza, hepatitis B, and tetanus vaccination coverage levels among HCP. Influenza, hepatitis B, and tetanus vaccination

Table 2. Adult vaccination coverage among persons aged 18 to 64 years in the United States, by health care personnel status and demographic variables: NIS-Adult 2007

	Influenza vaccination		Hepatitis B vaccination		Tetanus vaccination	
	Health care personnel	Nonhealth care personnel	Health care personnel	Nonhealth care personnel	Health care personnel	Nonhealth care personnel
Characteristic	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Total	46.7 (39.6-53.8)	27.9 (25.6-30.2)*	61.7 (52.5-70.2)	17.7 (14.9-20.9)*	70.4 (63.9-76.1)	55.4 (52.6-58.2)*
Age, yr						
18-34†	49.4 (36.5-62.3)	18.7 (15.0-23.1)*	60.9 (47.5-72.7)	22.9 (18.3-28.3)*,‡	78.9 (68.3-86.6)	56.9 (51.5-62.2)*
35-49	41.7 (30.8-53.5)	26.3 (22.3-30.7)*,‡	63.0 (51.1-73.5)	12.9 (10.0-16.5)*	63.4 (52.4-73.2)‡	53.1 (48.3-57.9)
50-64	47.7 (38.0-57.6)	41.1 (37.8-44.6)‡	NC§	NC§	62.8 (53.2-71.5)‡	56.5 (53.0-60.0)
Sex						
Male	49.2 (33.9-64.6)	27.1 (23.7-30.8)*	63.7 (44.2-79.6)	15.0 (11.7-19.1)*	76.6 (63.6-86.0)	53.4 (48.2-57.6)*
Female	45.6 (37.9-53.6)	29.1 (26.1-32.3)*	61.2 (50.8-70.6)	20.7 (16.3-25.9)*	68.1 (60.6-74.7)	57.7 (54.2-61.1)*
Race/ethnicity						
Non-Hispanic white	46.7 (37.7-56.0)	30.4 (27.3-33.7)*	65.5 (52.8-76.4)	18.8 (14.8-23.4)*	69.5 (60.7-77.2)	58.4 (54.7-62.0)*,‡
Others	46.3 (36.2-56.8)	24.0 (21.0-27.4)*,‡	56.0 (42.6-68.6)	16.0 (12.6-20.0)*	71.6 (62.1-79.5)	50.3 (46.3-54.3)*
Education						
≤High School	41.3 (27.4-56.8)	25.7 (22.2-29.5)*	29.7 (17.0-46.6)‡	13.8 (9.9-18.9)*,‡	64.5 (49.7-77.0)	51.0 (46.4-55.5)‡
Some college+	48.7 (40.8-56.7)	29.9 (27.0-33.0)*	74.6 (64.4-82.6)	21.1 (17.3-25.5)*	72.8 (65.4-79.1)	59.4 (56.1-62.7)*
Married status						
Married	53.9 (45.4-62.2)‡	30.4 (27.4-33.6)*,‡	71.7 (60.2-80.9)‡	17.2 (13.8-21.2)*	69.0 (61.0-76.0)	57.3 (54.1-60.5)*
Not married	38.1 (27.5-50.1)	23.6 (20.1-27.6)*	51.4 (37.2-65.3)	18.4 (14.0-23.8)*	71.8 (61.3-80.4)	52.1 (47.0-57.2)*
Income, US $						
<35,000	42.7 (29.0-57.7)	30.9 (26.2-36.1)	35.6 (20.3-54.5)‡	18.3 (13.2-24.9)	61.0 (46.6-73.7)	52.9 (47.6-58.2)
35,000+	47.7 (38.9-56.6)	27.5 (24.5-30.7)*	75.9 (65.2-84.1)	18.4 (15.0-22.4)*	74.3 (66.7-80.6)	56.4 (53.0-59.8)*
Health insurance status						
Yes	48.2 (40.5-56.0)	30.4 (27.8-33.0)*,‡	64.2 (54.0-73.3)	19.3 (16.1-22.8)*,‡	72.3 (65.6-78.1)	56.8 (53.8-59.7)*
No	31.8 (15.8-53.7)	16.0 (11.7-21.4)	41.6 (22.0-64.2)	10.6 (5.6-19.3)*	53.1 (34.1-71.3)	48.5 (41.3-55.8)‡

NC, not collected.
*$P < .05$ by *T* test for comparisons between health care personnel and nonhealth care personnel within each level of each characteristic.
†Reference group.
‡$P < .05$ by *T* test for comparisons within each variable.
§NC: Data regarding hepatitis B vaccination were not collected for this age group.

coverage were 47%, 62%, and 70%, respectively. The Healthy People 2010 objectives call for raising influenza vaccination levels to at least 60% and hepatitis B vaccination coverage to over 90% among HCP.[5] Vaccination coverage for influenza and hepatitis B among HCP were well below the Healthy People 2010 objectives. Effective intervention strategies are needed to further increase vaccination coverage and achieve the 2010 objectives among HCP.

Annual influenza vaccination has been recommended for HCP since 1984[10] and is the most effective strategy for preventing influenza among HCP. Influenza outbreaks in hospitals and long-term care settings have been associated with low vaccination coverage among HCP.[3,11,12] Despite obvious reasons for vaccinating and a long-standing recommendation that HCP receive annual influenza vaccination, vaccination coverage is still low (46.7%). Estimates from the 2007 NHIS, a national, in person household survey conducted annually, showed that influenza vaccination coverage among HCP aged 18 to 64 years was 44.4%. Other studies showed that coverage among HCP ranged from < 10% without intervention to as high as 78% following active vaccination campaigns.[13-19] Barriers to acceptance of influenza vaccination among HCP include inconvenience, low awareness of severity of influenza, fear of adverse effects, fear of needles, and beliefs that flu shot causes diseases.[3,20] Major barriers to receiving vaccine from our study included concerns about safety and adverse effects of vaccination and perceptions of low risk of influenza infection. Intervention programs that emphasize the safety record and benefits of influenza vaccination for HCP and for their patients are necessary components. However, the goal of improving influenza vaccination among HCP is a challenging one. Vaccination coverage was higher when HCP could receive influenza vaccination on their unit or floor or if vaccinations were provided free of charge.[20] A combination of intervention strategies such as education to dispel myths, support from administration, convenient access, incentives, heightened awareness of the vaccine campaign, vaccination at no cost, and mass vaccination clinics or fairs have been effective in improving influenza vaccination

Table 3. Multivariable logistic regression and predictive marginal analyses of vaccination among health care workers aged 18 to 64 years in the United States, by demographic variables: NIS-Adult 2007

Characteristic	Adjusted influenza vaccination coverage % (95% CI)	Adjusted OR OR (95% CI)	Adjusted hepatitis B vaccination coverage % (95% CI)	Adjusted OR OR (95% CI)	Adjusted tetanus vaccination coverage % (95% CI)	Adjusted OR OR (95% CI)
Age, yr						
18-34	53.8 (41.4-66.1)	Referent	64.5 (53.2-75.8)	Referent	79.5 (70.5-88.4)	Referent
35-49	37.6 (26.7-48.4)	0.5 (0.3-1.0)	57.9 (45.9-70.0)	0.7 (0.3-1.6)	63.5 (52.5-74.4)*	0.4 (0.2-0.9)†
50-64	45.0 (35.6-54.4)	0.7 (0.4-1.3)	‡	‡	61.4 (51.9-71.0)*	0.4 (0.2-0.8)†
Sex						
Male	46.9 (32.0-61.8)	Referent	54.0 (37.6-70.4)	Referent	75.1 (63.7-86.6)	Referent
Female	46.5 (38.5-54.6)	1.0 (0.5-2.0)	64.1 (54.3-73.9)	1.7 (0.7-4.5)	68.8 (61.9-75.8)	0.7 (0.4-1.5)
Race/ethnicity						
Non-Hispanic white	45.7 (36.6-54.9)	Referent	60.8 (48.6-73.0)	Referent	68.7 (60.5-76.9)	Referent
Others	48.1 (37.7-58.4)	1.1 (0.6-1.9)	63.5 (51.9-75.0)	1.2 (0.6-1.9)	73.1 (65.1-81.1)	1.3 (0.7-2.2)
Education						
≤High School	43.5 (28.1-58.9)	Referent	30.4 (14.4-46.4)*	Referent	64.0 (50.9-77.1)	Referent
Some college+	47.9 (39.9-68.0)	1.2 (0.6-2.5)	74.4 (65.2-83.6)	7.4 (2.8-19.2)	73.0 (66.1-79.7)	1.6 (0.8-3.2)
Married Status						
Married	55.7 (46.9-64.5)*	2.3 (1.3-4.1)†	70.2 (59.6-80.7)	2.4 (1.0-5.9)	70.9 (63.1-78.8)	1.1 (0.6-2.0)
Not married	36.2 (25.9-46.5)	Referent	53.3 (39.1-67.4)	Referent	69.8 (60.2-79.5)	Referent
Health insurance status						
Yes	47.9 (40.1-55.8)	1.8 (0.7-5.1)	63.1 (53.3-72.8)	1.8 (0.6-5.4)	72.1 (65.8-78.4)	2.1 (0.9-5.3)
No	34.3 (13.8-54.9)	Referent	51.8 (31.5-72.2)	Referent	55.7 (35.7-75.6)	Referent

*$P < .05$ by T test for comparisons within each variable.
†$P < .05$ for comparison with referent group.
‡Data regarding hepatitis B vaccination were not collected for this age group.

Table 4. Percentage of main reasons for not receiving influenza vaccination among health care personel aged 18 to 64 years: NIS-Adult 2007

Main reason	Percentage (n = 259)
Concerned about safety and adverse effect	24.2
Not likely to get flu	18.0
Forgot/did not have chance/was not convenient	12.3
Did not want one	11.1
The vaccine costs too much	9.7
Doctor did not recommended	5.0
Afraid of needles	2.8
Allergy to vaccine	2.2
Doctor said not to get the shot	3.7
Sick at time went in for shot	2.0
Others	9.0

coverage among HCP.[20] Our study also found that married HCP were more likely to be vaccinated than those who were not married. Data have shown that married couples may be more frequent users of preventive services because of the improved social supports, easier transportation, and greater likelihood of having previously established a regular source of care.[21] Systems to improve the ease of access to vaccination services of those without social support networks are needed and may help improve vaccination coverage.

Hepatitis B virus (HBV) infection is the major infectious hazard for HCP. The seroprevalence of HBV among HCP is 2 to 4 times higher than that of blood donor controls.[22] The risk for acquiring HBV infection from occupational exposures is dependent on the frequency of percutaneous or permucosal exposures to blood, which occur in health care settings most often as needlesticks or other sharp device injuries.[20] Occupational exposures to HBV have historically accounted for 4.5% of the acute hepatitis B cases in the United States, and this proportion has dropped to 0.5% in recent years.[23] Since 1982, hepatitis B vaccination has been strongly recommended for HCP by the ACIP.[24] Our study found that hepatitis B vaccination coverage among HCP was 61.7% in 2007, which was well below the Healthy People 2010 objective of achieving over 90% hepatitis B vaccination coverage among HCP.[25] The Healthy People 2010 objective provided a benchmark for decreasing or eliminating occupation-acquired HBV infection in the United States; however, attainment of the Healthy People 2010 goal of over 90% for HCP poses a formidable challenge. Hepatitis B coverage among hospital-based HCP was 51% in 1992, 66.5% in 1995, and 75% in 2003.[26-28] Estimates from the 2007 NHIS showed that hepatitis B vaccination coverage among HCP aged 18 to 49 years was 66.9% (CDC unpublished data).

Hepatitis B vaccination coverage among HCP could also be compared with coverage from other countries. Vaccination coverage among HCP in other countries is generally below 85%, including 65% in Italy, 66% in Thailand, 85% in Belgium, 55.4% in India, 55% in Morocco, and 40% in Sweden.[29-32] In addition, our study found that educational levels were independently associated with hepatitis B vaccination among HCP. This result may be related to occupation type and level of education; in addition, physicians are more likely to have contact with contaminated needles than administration staff working in the hospital. Individuals with an education less than high school may experience more barriers to receiving care because they lack knowledge about preventive services.[33]

Tetanus is an acute, often fatal, disease caused by an exotoxin and transmitted primarily when wounds are contaminated. Tetanus vaccination is recommended for all adults including HCP. The primary series is 3 doses and a booster dose of Td should be given every 10 years.[4,34,35] We found that tetanus vaccination coverage was 70.4% among HCP in 2007. Vaccination coverage for Tdap was low (2.6% for HCP). Tdap vaccine was newly licensed in 2005 in the United States, and a single dose of this vaccine was recommended for all adults aged $<$ 65 years and HCP by ACIP.[4] Tetanus and Tdap vaccination coverage among HCP have not been previously published. This study provided a baseline data for tetanus vaccination among HCP in the United States. Further monitoring tetanus and Tdap vaccination coverage among HCP is necessary to evaluate national and local efforts to increase coverage.

Our study showed that vaccination coverage for the 3 vaccines was in accordance with ACIP recommendations but needs further improvement. Hospitals and other health care institutions should consider providing vaccination at no or minimal cost to their employees and should consider policies to encourage vaccination. HCP must be reminded of the potential consequences of transmitting diseases to their patients and embrace vaccination as a standard of care to protect their patients, and themselves, against vaccine-preventable diseases.

A primary limitation of this study is that the vaccination status was self-reported and may be subject to recall bias and misclassification bias. No studies have evaluated the validity of self-reported adult vaccination among HCP; however, several previous studies have found that self-report of influenza vaccinations were reliable compared with review of medical records.[36-38] Additionally, the standardized CASRO survey response rate was low 31%, which could have resulted in nonresponse bias. However, the basic demographic characteristics by age, sex, and race/ethnicity from the 2007 NIS-Adult were similar to those observed in the 2007 NHIS (data not shown). Finally, NIS-Adult excludes persons without telephones and those with only cellular phones and thus may result in possible selection bias.

Comprehensive strategies are needed to further improve uptake of recommended vaccinations for HCP. Recommended approaches include the following: enhancing legislation and regulatory approaches to improve HCP vaccination; using reminder/recall systems, removing administrative and financial barriers; emphasizing the benefits of HCP vaccination for staff and patients; providing vaccinations in locations that are easily accessible; identifying where vaccination coverage levels are low and targeting interventions there; and implementing catch-up vaccination programs for HCP who are already employed and ensuring that newly hired HCP receive necessary vaccinations.[2,3,39,40]

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