HHS Public Access

Author manuscript

Am J Prev Med. Author manuscript; available in PMC 2020 June 01.

Published in final edited form as:

Am J Prev Med. 2019 June ; 56(6): e177–e183. doi:10.1016/j.amepre.2019.01.011.

Association of State Laws With Influenza Vaccination of Hospital Personnel

Megan C. Lindley, MPH[1], **Yi Mu, PhD**[2], **Aila Hoss, JD**[3], **Dawn Pepin, JD, MPH**[4], **Elizabeth J. Kalayil, MPH**[1,5], **Katharina L. van Santen, MSPH**[2,6], **Jonathan R. Edwards, MStat, MPH**[2], and **Daniel A. Pollock, MD**[2]

[1]Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia;

[2]Division of Healthcare Quality Promotion, National Center for Emerging Infectious and Zoonotic Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia;

[3]Indiana University Robert H. McKinney School of Law, Indianapolis, Indiana;

[4]Public Health Law Program, Office for State, Tribal, Local, and Territorial Support, Centers for Disease Control and Prevention, Atlanta, Georgia;

[5]Carter Consulting, Incorporated, Atlanta, Georgia;

[6]CACI International, Inc., Arlington, Virginia

Abstract

Introduction: Healthcare personnel influenza vaccination can reduce influenza illness and patient mortality. State laws are one tool promoting healthcare personnel influenza vaccination.

Methods: A 2016 legal assessment in 50 states and Washington DC identified (1) assessment laws: mandating hospitals assess healthcare personnel influenza vaccination status; (2) offer laws: mandating hospitals offer influenza vaccination to healthcare personnel; (3) ensure laws: mandating hospitals require healthcare personnel to demonstrate proof of influenza vaccination; and (4) surgical masking laws: mandating unvaccinated healthcare personnel to wear surgical masks during influenza season. Influenza vaccination was calculated using data reported in 2016 by short-stay acute care hospitals (n=4,370) to the National Healthcare Safety Network. Hierarchical linear modeling in 2018 examined associations between reported vaccination and

Address correspondence to: Megan C. Lindley, MPH, Immunization Services Division, 1600 Clifton Road N.E., Mailstop A-19, Atlanta GA 30329. cvx9@cdc.gov.

Author responsibilities were as follows: conceived and designed the study (MCL), assisted in the creation of the analytic plan (KLvS), assisted in the acquisition of the influenza vaccination data (JRE), conducted the legal assessment (AH, DP), conducted all statistical analyses (YM), assisted in the interpretation of results (MCL, YM, AH, DP, EJK, KLvS, DAP), drafted the manuscript (MCL), and revised the article for important intellectual content (YM, AH, DP, EJK, KLvS, JRE, DAP). All authors read and approved the final version of the submitted manuscript.

Partial results were previously presented at the 2016 Academy Health Annual Research Meeting (Boston, Massachusetts), 2016 National Immunization Conference (Atlanta, Georgia), and 2016 Public Health Law Conference (Washington DC). These presentations contained preliminary data on state healthcare personnel influenza vaccination laws; the findings of this report have never been publicly presented.

All authors report no conflicts of interest. No financial disclosures were reported by the authors of this paper.

assessment, offer, or ensure laws at the level of facilities nested within states, among employee and non-employee healthcare personnel and among employees only.

Results: Eighteen states had one or more healthcare personnel influenza vaccination-related laws. In the absence of any state laws, facility vaccination mandates were associated with an 11–12 percentage point increase in mean vaccination coverage ($p<0.0001$). Facility-level mandates were estimated to increase mean influenza vaccination coverage among all healthcare personnel by 4.2 percentage points in states with assessment laws, 6.6 percentage points in states with offer laws, and 3.1 percentage points in states with ensure laws. Results were similar in analyses restricted only to employees although percentage point increases were slightly larger.

Conclusions: State laws moderate the effect of facility-level vaccination mandates and may help increase healthcare personnel influenza vaccination coverage in facilities with or without vaccination requirements.

INTRODUCTION

Influenza vaccination of healthcare personnel (HCP) can reduce influenza illness and patient mortality.[1,2] For more than three decades, the Advisory Committee on Immunization Practices has recommended all HCP and individuals preparing for work in healthcare facilities receive influenza vaccination annually.[3,4] However, influenza outbreaks at hospitals are common and may have severe consequences: patients with laboratory-confirmed nosocomial influenza had mortality rates up to 13% in one review.[5] Nosocomial influenza outbreaks can also impede patient care, create staff shortages, and lead to substantial unplanned costs.[6] For the 2015–2016 influenza season, HCP influenza vaccination coverage reached 79%,[7] below the *Healthy People 2020* target of 90%.[8]

State laws, such as those establishing legal requirements related to HCP vaccination, are one tool used in efforts to safeguard against influenza transmission and outbreaks in healthcare facilities. For example, in 2007, California started requiring employees of acute care hospitals to either receive or formally decline influenza vaccination; facilities must offer influenza vaccination at no cost and provide vaccination-related education to employees. An evaluation of this law did not find increased influenza vaccination rates, but the authors noted that the mandate provided an impetus for data systems used to track influenza vaccination.[9] Influenza vaccination coverage among HCP in Rhode Island increased after the state mandated in 2012 that personnel either receive influenza vaccine or use a mask when working directly with patients during a period of widespread influenza.[10]

In 2016, the Centers for Disease Control and Prevention (CDC) Public Health Law Program (PHLP), in collaboration with the Immunization Services Division and the Division of Healthcare Quality Promotion, conducted a legal epidemiology study on state influenza vaccination laws for hospital-based HCP. Legal epidemiology studies law “as a factor in the cause, distribution, and prevention of disease and injury.”[11] This study’s purpose is to examine state laws related to influenza vaccination of HCP working in hospitals to determine whether these laws correlated with HCP influenza vaccination uptake reported to the National Healthcare Safety Network (NHSN), a national web-based surveillance system used to track healthcare-associated infection and important healthcare process measures.

METHODS

The study used the findings of a legal assessment and facility-reported HCP influenza vaccination data to assess the impact of state laws on vaccination uptake. Details on data sources and statistical analysis are presented below. This study was determined to be research not involving human subjects by the human subjects advisor in CDC's National Center for Immunization and Respiratory Diseases.

Study Sample

Legal assessments are cross-sectional studies that collect and analyze legal provisions across jurisdictions.[12] PHLP's legal assessment collected laws in the statutory and regulatory codes of all 50 states and the District of Columbia (hereinafter, state laws) from March 24 to March 29, 2016, using WestlawNext, a subscription-only online legal research database. PHLP used two broad search strings[a] to collect relevant state laws, developed based on background and preliminary research on influenza vaccination laws. PHLP attorneys analyzed relevant laws and coded them based on characteristics of the provisions therein. Laws were categorized as establishing four types of requirements, based in part on a previous legal assessment[13]: (1) assessment laws: requiring hospitals to assess HCP influenza vaccination status; (2) offer laws: requiring hospitals to offer the influenza vaccine to HCP; (3) ensure laws: requiring hospitals to require HCP to demonstrate proof of influenza vaccination; and (4) surgical masking laws: requiring HCP not vaccinated against influenza to wear surgical masks during the influenza season. Laws not in effect during the 2015–2016 influenza season were not included.

Measures

HCP influenza vaccination uptake in each state was calculated using data reported by short-stay acute care hospitals to CDC's NHSN. Acute care hospitals that participate in the Centers for Medicare & Medicaid Services' (CMS) Inpatient Quality Reporting program are required by CMS to report HCP influenza vaccination data to NHSN. Specifications for the HCP influenza vaccination measure have been described previously.[14–16] Briefly, facilities reported data on influenza vaccination received at the facility and outside the facility for three mutually exclusive groups of HCP who physically worked in the facility for ≥1 day during the influenza vaccination reporting period (October 1 through March 31): employees, non-employee licensed independent practitioners, and non-employee adult students, trainees, and volunteers. Data for the 2015–2016 influenza season covering HCP working in reporting facilities from October 1, 2015 through March 31, 2016 were analyzed in this study.

In addition to reporting influenza vaccination to NHSN, hospitals may complete an optional survey describing their seasonal influenza vaccination program practices (www.cdc.gov/nhsn/forms/57–215-Seasonal-Survey-form.pdf). Questions include which HCP groups are covered by the facility's influenza vaccination program, whether and how much different HCP groups are charged for facility-provided influenza vaccination, methods used to make

a Search strings included *adv: SD((vaccin! or immun! or inoculat!)* and (*afluria or agriflu or FluMist or laiv or flu! or influenza*)) and *adv: SD(flu shot!)*.

influenza vaccine available to HCP, strategies used to promote influenza vaccination to HCP, documentation requirements for offsite vaccination and vaccine refusal, and whether the facility requires unvaccinated HCP to wear masks or other personal protective equipment during influenza season.

Vaccination promotion strategies assessed included 11 items: vaccination reminders, vaccine education, vaccination campaigns, vaccination coordinated with other annual programs, vaccination requirements for credentialing or employment, unit- or department-based vaccination tracking, feedback on vaccination rates to administrators, incentives for vaccination, vaccination tracking for targeting, and other. Several of these are identified by the Community Preventive Services Task Force[17] as evidence-based methods to increase vaccination uptake.[18]

Statistical Analysis

The main outcome of interest was the proportion of HCP reported vaccinated by each facility, comprising vaccination among employees, licensed independent practitioners, and adult students, trainees, and volunteers combined. Because previous work indicated greater ease of tracking and reporting vaccination among employees versus non-employees,[15,19] secondary analyses limited to proportion of employees vaccinated (i.e., excluding non-employees) were also conducted. The unit of analysis was the individual hospital, nested within the state. The primary variables of interest (main effects) were the presence of each type of state HCP influenza vaccination law—assessment, offer, or ensure—as a yes/no variable. (The independent effect of surgical masking laws could not be calculated because of the small number of states with this type of law; see results.) Hierarchical linear modeling was used to account for cluster effects at the state level. Variables thought potentially to confound the association of laws and HCP influenza vaccination uptake were also considered: number of beds (transformed into a categorical variable based on significant cutpoints), facility teaching status (yes/no), whether various HCP groups were charged a fee for facility-provided influenza vaccination (yes/no), and number of methods used to deliver vaccine to HCP (range zero to eight).

Number of vaccination promotion strategies used was also included in models; however, use of vaccination requirements as a condition of employment or credentialing was analyzed separately because facility-level mandates are known to produce high vaccination coverage[20,21] and could alter the observed effects of state laws. Therefore, the value of promotion strategies ranged from zero to nine. Analyses conducted only among employees included a yes/no variable for whether the facility reported requiring vaccination as a condition of employment, and analyses among all HCP included a yes/no variable for whether the facility reported either requirement (vaccination required as a condition of employment or credentialing, or both). Also, an “other law” variable was constructed to account for states with one or more types of HCP influenza vaccination laws. This variable indicated number of laws in a state in addition to the primary covariate of interest for a given model (e.g., in the assessment model, other law counts offer, ensure, or surgical masking laws in the state). Because four types of law were examined, the value of other law ranges from zero to three.

Some law types were highly correlated, precluding use of a single model; six models are presented to examine each of three types of state HCP influenza vaccination laws among all HCP and among employees only. Analyses were conducted in 2018 using SAS, version 9.3. Significance was set at $p<0.05$. Nonsignificant covariates were removed, and parsimonious models examined. Removal did not notably alter main effects estimates so final models include only the main effect variable and significant covariates with adjustment for other law types.

RESULTS

The legal assessment found 18 states with influenza vaccination laws for hospital-based HCP in their statutory or regulatory code in effect during the 2015–2016 influenza season (Table 1). Ten states had assessment laws, 11 had offer laws, eight had ensure laws, and three had surgical masking laws. Eight states had more than one type of HCP influenza vaccination law. Thirty-two states and the District of Columbia had no influenza vaccination laws identified for hospital-based HCP during the 2015–2016 influenza season.

State laws included variations in the types of hospitals or HCP categories to which laws applied and the vaccination exemptions authorized.[22] For example, several state laws specifically applied to general acute care hospitals whereas others applied to all hospitals, including general acute care as well as specialty hospitals. Eleven states expressly permitted medical exemptions, allowing HCP to be exempted from vaccination mandates if the vaccine is medically contraindicated. (Even without an express medical exemption, healthcare facilities would likely not require vaccination in such circumstances.) Four states expressly provided for religious exemptions in cases in which receiving the influenza vaccine would violate the healthcare worker's religious beliefs. Ten states allowed exemptions for philosophical reasons, which in this assessment included any declination for non-medical or non-religious reasons. Six of the 18 states did not expressly outline exemptions to their HCP influenza vaccination laws.

For the 2015–2016 influenza season, 4,370 acute care hospitals in the 50 states and District of Columbia reported HCP influenza vaccination summary data to NHSN and completed the optional influenza vaccination program survey. Of these, 4,194 (96%) were included in the primary analysis; 176 hospitals were excluded due to missing data. Included facilities represent 83% of the 5,049 community and federal short-stay acute care hospitals in the U.S.[23] Mean reported vaccination proportion in 2015–2016 was 84.5% for all HCP (median=86.9%, range, 10.9%–100%) and 87.9% (median=92.9%, range, 12.7%–100%) for employees.

Table 2 shows the multivariate modeling results. Increased number of vaccination promotion strategies and larger hospital bed size (≥500 beds) were significant in all models; increased number of vaccination delivery methods was significant in all models but the ensure law model for all HCP. Presence of other types of HCP influenza vaccination laws in the state beyond the primary law variable of interest was significant only in the assessment law model for all HCP.

By far the most significant covariate in all models was presence of a facility-level vaccination requirement as a condition of employment or credentialing: in the absence of any state laws and controlling for the factors above, such mandates were associated with an 11–12 percentage point increase in mean vaccination coverage ($p<0.0001$). Initial analysis showed facility mandates interacted with state laws, so interaction terms were included—and were statistically significant—in all models. Coefficients for all interaction terms were negative, so estimates of the effect of facility mandates in the presence of state laws were derived by subtracting the value of the interaction term coefficient from the facility mandate coefficient; for example, among employees only, a facility-level vaccination mandate in a state with an ensure law is associated with a coverage increase of 4.6 percentage points (12.8249–8.2749=4.55; Table 2). Facility-level mandates were estimated to increase mean influenza vaccination coverage among all HCP by 4.2 percentage points in states with assessment laws, 6.6 percentage points in states with offer laws, and 3.1 percentage points in states with ensure laws. Among employees only, the estimates were 6.0 percentage points in states with assessment laws, 7.7 percentage points in states with offer laws, and 4.6 percentage points in states with ensure laws.

DISCUSSION

In this analysis of statutory requirements related to HCP influenza vaccination using vaccination data reported by more than 4,000 acute care hospitals, facility-level vaccination requirements were the strongest predictor of higher mean influenza vaccination coverage among HCP. In the absence of state laws, facility vaccination mandates were associated with double-digit increases in mean influenza vaccination coverage compared with facilities with no mandate; in the presence of state laws, these mandates were associated with smaller, although still statistically significant, increases in mean vaccination coverage. The more limited effect of facility mandates in states with HCP vaccination laws provides indirect evidence that state laws related to HCP influenza vaccination may positively influence vaccination uptake.

A 2010 study by Zimmerman and colleagues[24] of the effects of hospital policies and state laws on HCP influenza vaccination found facility vaccination mandates enforced by termination were associated with a 12.8 percentage point increase in vaccination coverage, whereas state vaccination laws were not associated with HCP vaccination coverage or with hospital policies. In the current study, the effect of mandates in the absence of state laws was similar in all models to that found by Zimmerman et al., 11–12 percentage points. However, in contrast to the 2010 study, the current analysis suggests state HCP influenza vaccination laws could be effective in improving HCP influenza vaccination coverage beyond increases spurred by facility vaccination requirements. The observed effect of facility-level mandates is notably lower in the presence of all law types examined—assessment, offer, or ensure laws—and this finding is consistent for all HCP and for employees only. Although this analysis cannot demonstrate causality, it is interesting that the observed effect of facility-level vaccination mandates is lowest in states with the strongest type of vaccination law (i.e., one requiring hospitals to ensure HCP have received or demonstrated proof of influenza vaccination). This suggests the laws themselves could be positively influencing HCP vaccination uptake such that facility mandates result in lesser coverage increases because

there is less room for improvement. It is also possible facility mandates are less strictly enforced in states with vaccination laws, although this would not explain the observed association for relatively weak (i.e., assessment) laws as it is unlikely such laws would be considered by hospitals to adequately replace facility requirements. The current study used a larger sample of facilities than the study by Zimmerman and colleagues and specifically examined the interaction of state laws and institutional policies, which may partially explain differences in findings between the two studies.

Another study, published in 2016, found state laws for hospital-based HCP were associated with a 1.7-fold increase in the odds of influenza vaccination.[25] It is difficult to compare these results directly with the current findings as each study used different measures of HCP vaccination and presence of state laws as well as different analytic techniques. Lin et al.[25] included certain vaccination promotion strategies outlined in state laws (e.g., requirements to educate HCP, document or report HCP vaccination status, or formally document vaccine declinations) in their scoring schema whereas the current study examined vaccination promotion and other activities at the hospital level and independently of state laws. Both studies found generally positive effects of state laws on HCP influenza vaccination uptake; the current study further quantifies these effects by separately examining the impact of different types of laws on HCP influenza vaccination in a much larger dataset of facility-reported vaccination data and accounting for the strong effects of facility-level vaccination requirements for HCP.

Limitations

These findings are subject to several limitations. First, policy mechanisms other than state laws and facility mandates are used to promote HCP vaccination; this study could not fully account for the effects of these mechanisms. For example, the Joint Commission, a nonprofit corporation that accredits U.S. healthcare facilities, requires most healthcare facilities to offer influenza vaccination to HCP as a condition of accreditation.[26] If these mechanisms are more commonly used by facilities in states with HCP influenza vaccination laws, the current analysis would overestimate the effects of state laws on vaccination uptake. In addition, it was not possible to fully isolate the effects of a specific type of law given the presence of multiple vaccination laws in most states, although the other law variable was nonsignificant in most models. Second, the legal assessment did not analyze how state HCP influenza vaccination laws are implemented, including funding and enforcement, which can substantially influence a law's impact. Third, some state laws were unclear in scope so this analysis may have misclassified which laws apply to non-employee HCP. Further, laws may apply only to certain non-employee groups (e.g., students but not volunteers); NHSN does not measure vaccination coverage at this level. Next, NHSN protocol definitions require facilities to report vaccination data for all HCP working in the facility for at least 1 day during the reporting period; HCP working at multiple facilities may be represented more than once in the data. Finally, HCP vaccination data reported to NHSN are not individually validated and may not accurately represent HCP vaccination at reporting facilities. However, prior work validated the HCP vaccination measure used by NHSN,[19] and NHSN data are generally reported by HCP who would be expected to be knowledgeable on this topic, such as occupational health, quality improvement, and infection prevention staff. Strengths of the

current study include the use of a large data set representing up to 8 million U.S. hospital-based HCP, data representing a census of reporting hospitals rather than a sample, and consistency of findings when examined among all HCP and when restricted to employee HCP, who are generally easiest to track and most likely to be covered by institutional vaccination programs.[15,27]

CONCLUSIONS

This study suggests state vaccination laws positively impact influenza vaccination uptake by hospital-based HCP, with additive effects beyond those of institutional vaccination mandates. Additional research could further elucidate relationships between state-level legal requirements, enforcement mechanisms, and institutional strategies and policies for increasing HCP influenza vaccination. Hospitals should continue to implement and amplify institutionally appropriate evidence-based strategies[18,28] to increase influenza vaccination among HCP and protect their staff and patients from the burden of influenza disease.

ACKNOWLEDGMENTS

The findings and conclusions of this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention (CDC).

At the time the study was conducted, Ms. Hoss was a contractor in CDC's Public Health Law Program.

REFERENCES

1. Salgado CD, Giannetta ET, Hayden FG, Farr BM. Preventing nosocomial influenza by improving the vaccine acceptance rate of clinicians. Infect Control Hosp Epidemiol. 2004;25(11):923–928. 10.1086/502321. [PubMed: 15566025]
2. Ahmed F, Lindley MC, Allred N, Weinbaum CM, Grohskopf L. Effect of influenza vaccination of health care personnel on morbidity and mortality among patients: systematic review and grading of evidence. Clin Infect Dis. 2014;58(1):50–57. 10.1093/cid/cit580. [PubMed: 24046301]
3. CDC. Recommendations of the Immunization Practices Advisory Committee (ACIP) prevention and control of influenza. MMWR Morb Mortal Wkly Rep. 1986;35(20):317–326, [PubMed: 3010071]
4. CDC. Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2011;60(RR-7):1–45.
5. Voirin N Barret B, Metzger M-H, Vanhems P. Hospital-acquired influenza: a synthesis using the Outbreak Reports and Intervention Studies of Nosocomial Infection (ORION) statement. J Hosp Infect. 2009;71(1):1–14. 10.1016/j.jhin.2008.08.013. [PubMed: 18952319]
6. Sartor C, Zandotti C, Romain F, et al. Disruption of services in an internal medicine unit due to a nosocomial influenza outbreak. Infect Control Hosp Epidemiol. 2002;23(10):615–619. 10.1086/501981. [PubMed: 12400893]
7. Black CL, Yue X, Ball SW, et al. Influenza vaccination coverage among health care personnel – United States, 2015–16 influenza season. MMWR Morb Mortal Wkly Rep. 2016;65(38):1026–1031. 10.15585/mmwr.mm6538a2. [PubMed: 27684642]
8. HHS. Healthy People 2020. Immunization and infectious diseases. www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=23. Accessed April 18, 2018.
9. Khodyakov D, Uscher-Pines L, Lorick SA, Lindley MC, Shier V, Harris K. A qualitative analysis of the impact of healthcare personnel influenza vaccination requirements in California. Vaccine. 2014;32(25):3082–3087. 10.1016/j.vaccine.2013.06.077. [PubMed: 23845810]
10. Kim H, Lindley MC, Dube D, Kalayil EJ, Paiva KA, Raymond P. Evaluation of the impact of the 2012 Rhode Island health care worker influenza vaccination regulations: implementation process

and vaccination coverage. J Public Health Manag Pract. 2015;21(3):E1–E9. 10.1097/PHH.0000000000000128.

11. Burris S, Ashe M, Levin D, Penn M, Larkin M. A trans-disciplinary approach to public health law: the emerging practice of legal epidemiology. Annu Rev Public Health. 2016;37:135–148. 10.1146/annurev-publhealth-032315-021841. [PubMed: 26667606]
12. Wagenaar AC, Burris S, eds. Public health law research: Theory and methods. San Francisco, CA: Jossey-Bass; 2013.
13. Lindley MC, Horlick GA, Shefer AM, Shaw FE, Gorji M. Assessing state immunization requirements for healthcare workers and patients. Am J Prev Med. 2007;32(6):459–465. 10.1016/j.amepre.2007.02.009. [PubMed: 17533060]
14. National Quality Forum. Quality Positioning System. Influenza vaccination coverage among healthcare personnel. www.qualityforum.org/QPS/0431. Accessed April 18, 2018.
15. Lindley MC, Lorick SA, Geevarughese A, et al. Evaluating a standardized measure of healthcare personnel influenza vaccination. Am J Prev Med. 2013;45(3):297–303. 10.1016/j.amepre.2013.04.019. [PubMed: 23953356]
16. CDC, National Healthcare Safety Network. Healthcare personnel vaccination module: influenza vaccination summary. www.cdc.gov/nhsn/pdfs/hps-manual/vaccination/hps-flu-vaccine-protocol.pdf. Published 11 2017 Accessed April 18, 2018.
17. Community Preventive Services Task Force. About the Community Guide. Atlanta, GA: CDC www.thecommunityguide.org/about/about-community-guide. Updated 10 19, 2017 Accessed August 8, 2018.
18. Community Preventive Services Task Force. Increasing appropriate vaccination. Atlanta, GA: CDC www.thecommunityguide.org/topic/vaccination. Published 2016 Accessed April 18, 2018.
19. Libby TE, Lindley MC, Lorick SA, et al. Reliability and validity of a standardized measure of influenza vaccination coverage among healthcare personnel. Infect Control Hosp Epidemiol. 2013;34(4):335–345. 10.1086/669859. [PubMed: 23466904]
20. Rakita RM, Hagar BA, Crome P, Lammert JK. Mandatory influenza vaccination of healthcare workers: a 5-year study. Infect Control Hosp Epidemiol. 2010;31(9):881–888. 10.1086/656210. [PubMed: 20653445]
21. Babcock HM, Gemeinhart N, Jones M, Dunagan WC, Woeltje KF. Mandatory influenza vaccination of health care workers: translating policy to practice. Clin Infect Dis. 2010;50(4):459–464. 10.1086/650752. [PubMed: 20064039]
22. CDC. Public Health Law Program. Menu of state hospital influenza vaccination laws. www.cdc.gov/phlp/docs/menu-shfluvacclaws.pdf. Published 2017 Accessed April 17, 2018.
23. American Hospital Association. Fast facts on U.S. hospitals, 2018 www.aha.org/statistics/fast-facts-us-hospitals. Accessed August 7, 2018.
24. Zimmerman RK, Lin CJ, Raymund M, Bialor J, Sweeney PM, Nowalk MP. Hospital policies, state laws, and healthcare worker influenza vaccination rates. Infect Control Hosp Epidemiol. 2013;34(8):854–857. 10.1086/671265. [PubMed: 23838231]
25. Lin CJ, Nowalk MP, Raymund M, Sweeney PM, Zimmerman RK. Association of state laws and healthcare workers' influenza vaccination rates. J Natl Med Assoc. 2016;108(1):99–102. 10.1016/j.jnma.2015.12.013. [PubMed: 26928494]
26. Joint Commission on Accreditation of Healthcare Organizations. New infection control requirement for offering influenza vaccination to staff and licensed independent practitioners. Jt Comm Perspect. 2006;26(6):10–11.
27. Lindley MC, Yonek J, Ahmed F, Perz JF, Williams Torres G. Measurement of influenza vaccination coverage among healthcare personnel in U.S. hospitals. Infect Control Hosp Epidemiol. 2009;30(12):1150–1157. 10.1086/648086. [PubMed: 19848601]
28. Community Preventive Services Task Force. Promoting worksite health. Atlanta, GA: CDC www.thecommunityguide.org/topic/worksite-health. Published 2008 Accessed April 18, 2018.

Table 1.

Influenza Vaccination Laws for Hospital-based Healthcare Workers, by State and Type, 2015–2016 Influenza Season

State	Assessment laws[a]	Offer laws[b]	Ensure laws[c]	Surgical masking laws[d]
California	X	X	X	
Colorado	X	X	X	X
Georgia		X		
Illinois		X		
Maine	X	X		
Maryland		X		
Massachusetts			X	
Nebraska		X	X	
Nevada	X			
New Hampshire	X	X	X	
New York	X		X	X
Ohio	X			
Oklahoma		X		
Oregon	X			
Rhode Island	X		X	X
South Carolina		X		
Tennessee		X	X	
Utah	X			
Total	10	11	8	3

Notes: For additional information, see Centers for Disease Control and Prevention, Menu of State Hospital Influenza Vaccination Laws at www.cdc.gov/phlp/docs/menu-shfluvacclaws.pdf.[22] States not included in this table (n=32 and District of Columbia) were determined to have no laws relevant to this analysis.

[a] Assessment laws require hospitals to assess the influenza vaccination status of healthcare personnel.

[b] Offer laws require hospitals to offer the influenza vaccine to healthcare personnel.

[c] Ensure laws require hospitals to require healthcare personnel to demonstrate proof of vaccination against influenza.

[d] Surgical masking laws require healthcare personnel not vaccinated for influenza to wear surgical masks during the influenza season.

Table 2.

Summary Results of Six Models Examining Association of State Laws With Healthcare Personnel Influenza Vaccination, 2015–2016 Influenza Season

Variable	All healthcare personnel		Employee healthcare personnel	
	Parameter estimate[a]	*p*-value	Parameter estimate	*p*-value
Assessment law				
Presence of assessment law in state	1.2385	0.6140	2.1382	0.2931
Number of promotion strategies used	0.5945	**<0.0001**	0.7639	**<0.0001**
Number of delivery methods used	0.3268	**0.0281**	0.4337	**0.0012**
≥500 beds[b]	2.8727	**0.0008**	1.6418	**0.0332**
Presence of other law in state[c]	3.2928	**0.0176**	2.1437	0.0619
Presence of facility-level vaccination requirement	11.3019	**<0.0001**	12.4528	**<0.0001**
Interaction term for state law and facility requirement	−7.0984	**<0.0001**	−6.4029	**<0.0001**
Offer law				
Presence of offer law in state	4.6785	**0.0193**	4.2968	**0.0081**
Number of promotion strategies used	0.5925	**<0.0001**	0.7590	**<0.0001**
Number of delivery methods used	0.3506	**0.0189**	0.4499	**0.0008**
≥500 beds	3.0496	**0.0004**	1.8718	**0.0153**
Presence of other law in state[c]	1.5083	0.1995	1.2450	0.1939
Presence of facility-level vaccination requirement	10.9336	**<0.0001**	12.4483	**<0.0001**
Interaction term for state law and facility requirement	−4.3283	**<0.0001**	−4.7377	**<0.0001**
Ensure law				
Presence of ensure law in state	6.4976	0.0727	5.2937	0.0705
Number of promotion strategies used	0.6547	**<0.0001**	0.7626	**<0.0001**
Number of delivery methods used	–	n/s	0.4123	**0.0020**
≥500 beds	2.8517	**0.0007**	1.6028	**0.0370**
Presence of other law in state[c]	1.3361	0.4827	1.1582	0.4547
Presence of facility-level vaccination requirement	11.1252	**<0.0001**	12.8249	**<0.0001**
Interaction term for state law and facility requirement	−8.0189	**<0.0001**	−8.2749	**<0.0001**

Notes: Boldface indicates statistical significance ($p<0.05$).

[a] Parameter estimates represent the expected percentage point change in mean vaccination coverage at the hospital given the presence of the covariate examined. For vaccination promotion strategies and delivery methods, estimates represent expected percentage point change in mean vaccination coverage at the hospital for each additional strategy or method used. For “other law”, estimates represent expected percentage point change in mean vaccination coverage at the hospital for each additional law in the state.

[b] Referent: Bedsize of <500 beds.

[c] Number of healthcare personnel influenza vaccination laws in a state in addition to the primary covariate of interest for a given model (e.g., in the assessment model, “other law” counts offer, ensure, or surgical masking laws in the state).

n/s, non-significant.