

## COMMENTARY

## Open Access



# How to improve influenza vaccine coverage of healthcare personnel

David J. Weber<sup>1,2\*</sup>, Walter Orenstein<sup>3</sup> and William A. Rutala<sup>1,2</sup>

## Abstract

Influenza causes substantial morbidity and mortality worldwide each year. Healthcare-associated influenza is a frequent event. Health care personnel (HCP) may be the source for infecting patients and may propagate nosocomial outbreaks. All HCP should receive a dose of influenza vaccine each year to protect themselves and others. This commentary will discuss the study recently published in the *IJHPR* by Nutman and Yoeli which assessed the beliefs and attitudes of HCP in an Israel hospital regarding influenza and the influenza vaccine. Unfortunately, as noted by Nutman and Yoeli in this issue many HCP in Israel choose not to receive influenza immunization and many harbor misconceptions regarding their risk for influenza as well as the benefits of influenza vaccine. We also discuss proven methods to increase acceptance by HCP for receiving an annual influenza vaccine.

**Keywords:** Occupational health, Healthcare personnel, Vaccines, Influenza

## Background

Protecting healthcare personnel (HCP) and patients from acquiring an infectious disease via person-to-person spread requires strict adherence to key infection prevention and occupational health recommendations [1]. First, hand hygiene before and after every patient contact and at other appropriate times [2]. Second, use of Standard Precautions by HCP when providing care for all patients (i.e., use of appropriate personal protective equipment to prevent contact with infectious body fluids or aerosols) [3]. Third, rapid evaluation of patients with a known or suspected communicable disease and institution of appropriate isolation precautions (i.e., Contact, Droplet and/or Airborne) [3]. Finally, immunizations of all HCP to prevent vaccine preventable diseases [1, 4–8]. In developed countries this would include: mumps-measles-rubella, varicella, tetanus-diphtheria-acellular pertussis, hepatitis B (HCP who have potential exposure to contaminated blood or body fluids), *Neisseria meningitidis* (microbiologists), and influenza. Additional vaccines (e.g., polio, hepatitis A, *Bacillus Calmette-Guerin*) may

be recommended in specific countries and for relief workers [6–8].

Influenza occurs globally with an annual attack rate estimated at 5% to 10% in adults and 20% to 30% in children [9]. Infection may result in hospitalization and death, especially among high-risk groups (e.g., the very young, older adults, chronically ill, and/or immunocompromised). The World Health Organization (WHO) estimates that these annual epidemics result in 3 to 5 million cases of severe illness, and about 250,000 to 500,000 deaths [9]. It is important to remember several aspects of influenza epidemiology: influenza is easily spread from person-to-person; it can affect anybody in any age group; seasonal influenza is a serious public health problem that causes severe illness and death in high risk populations; prior influenza disease does not assure immunity because the virus frequently mutates from year-to-year (antigenic drift; although antiviral drugs are available for treatment, influenza viruses can develop resistance to drugs; and, influenza vaccination is the most effective way to prevent influenza [9].

Healthcare-associated influenza is a major worldwide problem for several reasons [10–12]. First, hospitals provide care to persons at high-risk for morbidity and mortality if they acquire influenza including healthcare-associated infection including neonates, older persons, those with chronic illnesses (e.g., diabetes, heart disease,

\* Correspondence: [dweber@unch.unc.edu](mailto:dweber@unch.unc.edu)

<sup>1</sup>Department of Hospital Epidemiology, University of North Carolina Health Care, 2163 Bioinformatics, CB #7030, Chapel Hill, NC 27599-7030, USA

<sup>2</sup>Division of Infectious Diseases, UNC School of Medicine, Chapel Hill, NC, USA

Full list of author information is available at the end of the article



asthma, lung disease) and immunocompromised persons. Second, nosocomial outbreaks are frequent and their control remains challenging. Third, the diagnosis of influenza is commonly missed because many infected and infectious persons are asymptomatic or mildly symptomatic and the clinical signs and symptoms of influenza can be confused with similar illnesses caused by a variety of other pathogens. Further, persons with influenza may be infectious prior to the onset of symptoms. Fourth, molecular analyses have revealed transmission between patients and HCP, and HCP and patients. HCP have served both as sources of nosocomial outbreaks and propagators of healthcare-associated outbreaks. Fifth, immunization of HCP (4 cluster randomized trials and 4 observational studies) conducted in long-term care or hospital settings has demonstrated that immunization of HCP demonstrates a ‘significant protective association for influenza-like illness and laboratory-confirmed influenza’ [13].

As noted by the Society for Healthcare Epidemiology of America (SHEA), influenza vaccination of HCP serves several purposes: (1) to prevent transmission to patients, including those with a lower likelihood of vaccination response themselves; (2) to reduce the risk that the HCP will become infected with influenza; (3) to create “herd immunity” that protects both HCP and patients who are unable to receive vaccine or unlikely to respond with a sufficient antibody response; (4) to maintain a critical societal workforce during disease outbreaks; and (5) to set an example concerning the importance of vaccination for every person [11].

For the reasons listed above, influenza immunization annually of all HCP is recommended by the World Health Organization [6], the Centers for Disease Control and Prevention [4, 5, 10], almost all countries in Europe [7, 8], other countries around the world [8], and many professional organizations. Further, the Israel Minister of Health includes coverage rates among its ongoing quality measures for healthcare organizations, and this may be helping increase coverage rates. Nevertheless, influenza immunization of HCP is challenging for two key reasons: (1) the vaccine efficacy varies year-to-year depending on how well the strains in the vaccine match with the circulating strains and (2) the vaccine must be provided each year. Two key issues regarding achieving high influenza vaccine coverage of HCP are discussed below. First, what has been reported in the scientific literature regarding why HCP are willing or not willing to receive influenza vaccine? Second, what methods to improve influenza coverage among HCP have been reported in the peer-reviewed literature?

#### **Assessing why HCP are or are not willing to receive influenza vaccine**

In a recent article published in the *Israel Journal of Health Policy Research*, Nutman and Yoeli reported on

an assessment of the knowledge, perceptions and attitudes concerning influenza vaccination among HCP in a large tertiary care academic hospital in Israel [14]. The authors obtained their information by means of an anonymous survey completed by 468 HCP representing all categories of staff. The overall frequency of influenza immunization among these HCP was 42% (physicians, 56%; nurses, 41%; allied health professionals, 37%; and, administrators and support personnel, 30%). Key findings were as follows: (1) most HCP understood that influenza is widespread and can have severe complications including death; (2) only ~82% agreed that hospital personnel are at an increased risk of contracting influenza because of their job; (3) only ~62% believed that influenza immunization is the only effective way to prevent infection; (4) only about 60% disagreed that vaccine side effects can be more severe than influenza; (5) ~50% believed that influenza vaccine can cause influenza; (6) >10% believed that pregnant women should not be immunized; (7) only ~30% thought that if they were not immunized they would become ill with influenza; (8) less than 50% recommend influenza vaccine to their patients; and (9) ~50% were in favor of mandatory immunization of HCP. In the multivariate analysis, items that were independent predictors of immunization were beliefs that: vaccine effectively prevents influenza, HCP are at increased risk of influenza, contracting influenza is likely in the absence of immunization, and HCP might transmit influenza to their families.

The study by Nutman and Yoeli provided similar information to studies in other developed countries. The influenza vaccine vaccination rate of 42% in their hospital is similar to rates reported from many European countries [8], but well below the 77.3% reported in the US [15]. For both Israel and the US, physicians and nurses reported a higher frequency of influenza immunization than allied health professionals and nonclinical HCP. Other surveys which assessed the knowledge, perceptions and attitudes concerning influenza vaccine by HCP have reported similar results as the study by Nutman and Yoeli [16–19]. Beliefs encouraging influenza immunization have generally included a desire to protect oneself and to a lesser extent to protect patients. Other factors favoring immunization include free and convenient immunization, being previously immunized, and peer-pressure and/or support by senior administration. Beliefs reducing the likelihood of immunization have included fear of adverse events, misconception that influenza vaccine can cause influenza, belief that the person is not at risk, doubt that influenza is a serious disease, concern that the vaccine is ineffective, fear of injections, and that times/locations for immunization were inconvenient. It is highly disturbing that HCP frequently hold misconceptions regarding influenza such as the lack of severity of influenza and risks for

generally healthy HCP, as well as holding misconceptions regarding the vaccine such as the vaccine can cause influenza and that adverse events are common. Space limitations preclude a detailed review of the science debunking these misconceptions. However, by way of example, we can note that in Israel, influenza vaccine has been shown to reduce influenza in HCP [20]. Further, multiple studies which have evaluated the frequency of adverse events following influenza immunization of HCP have reported that they are mild and transient [21–23]. The vast majority of influenza vaccines used around the world are inactivated, many which are split or subviral which cannot possibly cause influenza.

### Improving influenza coverage among HCP

As already noted the public health authorities in many countries, as well as many professional organizations, recommend that all HCP should receive a dose of influenza vaccine each year. For example, the Israel Ministry of Public Health includes influenza vaccine coverage among its ongoing quality measures for healthcare organizations which will help increase coverage rates. This public health recommendation is based on sound public health and the peer-reviewed literature. Given this well-founded recommendation, what methods have been demonstrated to improve influenza vaccine coverage among HCP? The 2005, SHEA Guideline listed the following barriers and solutions to HCP influenza immunization [24]: (1) Inconvenient access to vaccine (solution: off-hours clinics, use of mobile vaccination carts, vaccination at staff and department meetings, and provision of adequate staff and resources); (2) Cost (solution: provision of free vaccine); (3) concerns for vaccine adverse events (solution: targeted education including specific information to dispel vaccine myths); and (4) other (solution: strong and viable administrative leadership, visible vaccination of key leaders, active declination of HCP who do not wish or cannot be vaccinated, accurate tracking of individual HCP and unit-based compliance of HCP with vaccination, and surveillance for healthcare-associated influenza). Since this publication, substantial additional research has been published on the effectiveness of different methods to improve influenza vaccine acceptance by HCP (Table 1) [24–35].

Several methods for increasing HCP compliance with influenza immunization deserve further discussion; the use of declination forms, the requirement that HCP who are unable or unwilling to receive influenza vaccine wear a surgical mask while providing patient care or while on a patient unit, and “mandatory” influenza immunization. The 2005 SHEA Guideline on influenza vaccination of HCP recommended as one modality to increase influenza uptake, the use of a declination form to be signed by HCP who were unwilling to accept vaccine [24]. This

**Table 1** Interventions That Improve Influenza Vaccine Coverage for Healthcare Personnel

- 
- Mobile carts
  - Free vaccine
  - Adequate staff resources for vaccine campaign
  - Education on benefits and risks (or lack of risks) for immunization
  - Incentives for immunization
  - Immunizations available on nights and weekends
  - Immunization available at convenient locations (e.g., meetings, common areas)
  - Administrative support including visible vaccination of key personnel
  - Tracing vaccination by individual healthcare providers and hospital units with regular feedback to healthcare providers and administrators
  - Sanctions for failure to be immunized
  - Employment conditional upon receipt of vaccine
- 

declination form described the risk to the HCP and their patients from the HCP refusing immunization. Subsequent research has demonstrated that use of such forms was associated with only a modest increase in vaccine use by HCP, even when combined with other strategies to increase vaccine coverage. Multiple studies demonstrated that the introduction of declination forms continued to lead to vaccine coverage <80% [36–38] and often <70% [39]. The 2010 revised SHEA Guideline on influenza vaccination of HCP included the statement “the use of statements (i.e., declination forms) should not be viewed as the primary method for increasing vaccination rates’ [11].

Another intervention that has been recommended is to require unvaccinated HCP to wear a surgical mask during the influenza season [11]. Several potential issues related to the masking requirement have been raised. First, implementation of such a policy is logistically challenging (i.e., developing methods to identify those HCP required to wear a mask during clinical care). It has proved difficult to develop a simple method to identify such HCP without stigmatizing those HCP who chose not to be vaccinated or were unable to be vaccinated due to vaccine contra-indications. Second, few studies that have assessed the success of this policy have reported on the number of non-compliers and what penalties were assessed for non-compliance.

Research has revealed that hospitals which include disincentives for HCP refusing influenza vaccine have higher rates of influenza vaccine coverage [39–41]. Examples of disincentives have included requirement to sign a vaccine declination form and a requirement that non-immunized persons wear a surgical mask while on clinical units. The most successful strategy to improve HCP influenza vaccine coverage has been to make receipt of vaccine as a condition of employment (i.e., “mandatory”

immunizations). Hospitals employing this strategy exempt HCP with a contra-indication to immunization and some also exempt HCP with a religious objection. Multiple reports of hospitals that use this strategy have reported vaccine coverage rates >95% [15, 39, 42, 43]. Increasing numbers of hospitals in the US now require receipt of influenza vaccine as a condition of employment (HCP with a contra-indication are usually exempt) [15]. Concern has been raised about the ethics of “mandatory” immunization of HCP. However, multiple professional societies have endorsed that employment as a HCP should be conditional on willingness to receive influenza vaccine, as vaccine protects both the HCP and the patient.

## Conclusions

Influenza causes substantial morbidity and mortality worldwide each year. Healthcare-associated influenza is a frequent event. HCP may be the source for infecting patients and may propagate nosocomial outbreaks. All HCP should receive a dose of influenza vaccine each year to protect themselves and others. Unfortunately, as noted by Nutman and Yoeli in this issue many HCP in Israel choose not to receive influenza immunization and many harbor misconceptions regarding their risk for influenza as well as the benefits of influenza vaccine. Multiple proven methods can be used by healthcare facilities to improve influenza vaccine coverage among HCP (Table 1). The only proven method to reliably achieve a coverage level >95% is to require influenza immunization as a condition of employment.

## Abbreviations

HCP: Healthcare personnel; SHEA: Society for Healthcare Epidemiology of America; WHO: World Health Organization

## Acknowledgement

None

## Funding

No funding was obtained to support this paper.

## Availability of data and materials

No primary data or materials were presented in this commentary.

## Authors' contributions

All authors participated in writing and reviewing this paper. All authors read and approved the final manuscript.

## Authors' information

DJW is a liaison member of the ACIP; WO is a former Assistant Surgeon General of the US Public Health Service and is Associate Director of the Emory Vaccine Center; WAR is Director of Hospital Epidemiology, UNC Health Care.

## Commentary on

Nutman A, Yoeli N. Influenza vaccination motivators among healthcare personnel in a large acute care hospital in Israel. *Israel Journal of Health Policy Research* 2016; 5:52. DOI: 10.1186/s13584-016-0112-5.

## Competing interests

The authors declare that they have no competing interests.

## Consent for publication

All authors approved this paper for publication.

## Ethics approval and consent to participate

Not applicable (not human research).

## Author details

<sup>1</sup>Department of Hospital Epidemiology, University of North Carolina Health Care, 2163 Bioinformatics, CB #7030, Chapel Hill, NC 27599-7030, USA.

<sup>2</sup>Division of Infectious Diseases, UNC School of Medicine, Chapel Hill, NC, USA.

<sup>3</sup>Division of Infectious Diseases, Department of Medicine, Emory University School of Medicine, Atlanta, GA, USA.

Received: 28 September 2016 Accepted: 28 November 2016

Published online: 16 December 2016

## References

- Weber DJ, Rutala WA, Schaffner W. Lessons learned: protection of healthcare workers from infectious disease risks. *Crit Care Med*. 2010;38(8 Suppl):S306–14.
- Pittet D, Allegranzi B, Boyce J, World Health Organization World Alliance for Patient Safety First Global Patient Safety Challenge Core Group of Experts. The world health organization guidelines on hand hygiene in health care and their consensus recommendations. *Infect Control Hosp Epidemiol*. 2009;30:611–22.
- Siegel JD, Rhinehart E, Marguerite Jackson M, Chiarello L, the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. <http://www.cdc.gov/hicpac/2007IP/2007IsolationPrecautions.html>. Accessed 10 September 2016.
- Centers for Disease Control and Prevention. Immunization of Health-Care Personnel: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Rec Reports*. 2011;60(RR07):1–45.
- Centers for Disease Control and Prevention. Recommended Adult Immunization Schedule - United States - 2016. <https://www.cdc.gov/vaccines/schedules/hcp/adult.html>. Accessed 10 September 2016.
- World Health Organization. WHO recommendations for routine immunization – summary tables. Table 4, vaccination of health care workers. [http://www.who.int/immunization/policy/immunization\\_tables/en/](http://www.who.int/immunization/policy/immunization_tables/en/). Accessed 10 September 2016.
- Maltezou HC, Poland GA. Vaccination policies for health-care workers Europe. *Vaccine*. 2014;32:4876–80.
- Haviari S, Bénet T, Saadatian-Elahi M, André P, Loulergue P, Vanhems P. Vaccination of healthcare workers: a review. *Hum Vaccin Immunother*. 2015; 11:2522–37.
- World Health Organization. Influenza (seasonal). <http://www.who.int/mediacentre/factsheets/fs211/en/>. Accessed 10 September 2016.
- Centers for Disease Control and Prevention. Influenza vaccination of health-care personnel: Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Advisory Committee on Immunization Practices (ACIP). *MMWR Rec Reports*. 2006;55(RR02):1–16.
- Talbot TR, Babcock H, Caplan AL, Cotton D, Maragakis LL, Poland GA, Septimus EJ, Tapper ML, Weber DJ. Revised SHEA position paper: influenza vaccination of healthcare personnel. *Infect Control Hosp Epidemiol*. 2010;31:987–9.
- Vanhems P, Bénet T, Munier-Marion E. Nosocomial influenza: encouraging insights and future challenges. *Curr Opin Infect Dis*. 2016;29:366–72.
- Ahmed F, Lindley MC, Allred N, Weinbaum CM, Grohskopf L. Effect of influenza vaccination of healthcare personnel on morbidity and mortality among patients: systematic review and grading of evidence. *Clin Infect Dis*. 2014;58:50–7.
- Nutman A, Yoeli N. Influenza vaccination motivators among healthcare personnel in a large acute care hospital in Israel. *Israel Journal of Health Policy Research*. 2016;5:52.
- Black CL, Yue X, Ball SW, Donahue SM, Izrael D, de Perio MA, Laney AS, Williams WW, Lindley MC, Graitcer SB, Lu PJ, Bridges CB, DiSogra C, Sokolowski J, Walker DK, Greby SM. Influenza vaccination coverage among health care personnel—united states, 2014–15 influenza season. *MMWR Morb Mortal Wkly Rep*. 2015;64:993–9.
- Hofmann F, Ferracin C, Marsh G, Dumas R. Influenza vaccination of healthcare workers: a literature review of attitudes and beliefs. *Infection*. 2006;34:142–7.

17. Corace K, Prematunge C, McCarthy A, Nair RC, Roth V, Hayes T, Suh KN, Balfour L, Garber G. Predicting influenza vaccination uptake among health care workers: what are the key motivators? *Am J Infect Control*. 2013;41:679–84.
18. Hollmeyer HG, Hayden F, Poland G, Buchholz U. Influenza vaccination of health care workers in hospitals—a review of studies on attitudes and predictors. *Vaccine*. 2009;27:3935–44.
19. Prematunge C, Corace K, McCarthy A, Nair RC, Pugsley R, Garber G. Factors influencing pandemic influenza vaccination of healthcare workers—a systematic review. *Vaccine*. 2012;30:4733–43.
20. Atamna Z, Chazan B, Nitzan O, Colodner R, Kfir H, Strauss M, Schwartz N, Markel A. Seasonal influenza vaccination effectiveness and compliance among hospital health care workers. *Isr Med Assoc J*. 2016;18:5–9.
21. Park SW, Lee JH, Kim ES, Kwak YG, Moon CS, Yeom JS, Lee JH, Lee CS. Adverse events associated with the 2009 H1N1 influenza vaccination and the vaccination coverage rate in health care workers. *Am J Infect Control*. 2011;39:69–71.
22. Regan AK, Tracey L, Gibbs R. Post-marketing surveillance of adverse events following immunization with inactivated quadrivalent and trivalent influenza vaccine in health care providers in Western Australia. *Vaccine*. 2015;33:6149–51.
23. McEvoy SP. A retrospective survey of the safety of trivalent influenza vaccine among adults working in healthcare settings in south metropolitan Perth, Western Australia, in 2010. *Vaccine*. 2012;30:2801–4.
24. Talbot TR, Bradley SE, Cosgrove SE, Ruef C, Siegel JD, Weber DJ. Influenza vaccination of healthcare workers and vaccine allocation for healthcare workers during vaccine shortages. *Infect Control Hosp Epidemiol*. 2005;26:882–90.
25. Sartor C, Tissot-Dupont H, Zandotti C, Martin F, Roques P, Drancourt M. Use of a mobile cart influenza program for vaccination of hospital employees. *Infect Control Hosp Epidemiol*. 2004;25:918–22.
26. Salgado CD, Giannetta ET, Hayden FG, Farr BM. Preventing nosocomial influenza by improving the vaccine acceptance rate of clinicians. *Infect Control Hosp Epidemiol*. 2004;25:923–8.
27. Lee HY, Fong YT. On-site influenza vaccination arrangements improved influenza vaccination rate of employees of a tertiary hospital in Singapore. *Am J Infect Control*. 2007;35:481–3.
28. Zimmerman RK, Nowalk MP, Lin CJ, Raymund M, Fox DE, Harper JD, Tanis MD, Willis BC. Factorial design for improving influenza vaccination among employees of a large health system. *Infect Control Hosp Epidemiol*. 2009;30:691–7.
29. Song JY, Park CW, Jeong HW, Cheong HJ, Kim WJ, Kim SR. Effect of a hospital campaign for influenza vaccination of healthcare workers. *Infect Control Hosp Epidemiol*. 2006;27:612–7.
30. Harbarth S, Siegrist CA, Schira JC, Wunderli W, Pittet D. Influenza immunization: improving compliance of healthcare workers. *Infect Control Hosp Epidemiol*. 1998;19:337–4.
31. Talbot TR, Dellit TH, Hebden J, Sama D, Cuny J. Factors associated with increased healthcare worker influenza vaccination rates: results from a national survey of university hospitals and medical centers. *Infect Control Hosp Epidemiol*. 2010;31:456–62.
32. Palmore TN, Vandersluis JP, Morris J, Michelin A, Ruprecht LM, Schmitt JM, Henderson DK. A successful mandatory influenza vaccination campaign using an innovative electronic tracking system. *Infect Control Hosp Epidemiol*. 2009;30:1137–42.
33. Polgreen PM, Chen Y, Beekmann S, Srinivasan A, Neill MA, Gay T, Cavanaugh JE, Infectious Diseases Society of America's Emerging Infections Network. Elements of influenza vaccination programs that predict higher vaccination rates: results of an emerging infections network survey. *Clin Infect Dis*. 2008;46:14–9.
34. 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;50:459–64.
35. Huynh S, Poduska P, Mallozzi T, Culler F. Mandatory influenza vaccination of health care workers: a first-year success implementation by a community health care system. *Am J Infect Control*. 2012;40:771–3.
36. LaVela SL, Hill JN, Smith BM, Evans CT, Goldstein B, Martinello R. Healthcare worker influenza declination form program. *Am J Infect Control*. 2015;43:624–8.
37. Ajenjo MC, Woeltje KF, Babcock HM, Gemeinhart N, Jones M, Fraser VJ. Influenza vaccination among healthcare workers: ten-year experience of a large healthcare organization. *Infect Control Hosp Epidemiol*. 2010;31:233–40.
38. Ribner BS, Hall C, Steinberg JP, Bornstein WA, Chakkalakal R, Emamifar A, Eichel I, Lee PC, Castellano PZ, Grossman GD. Use of a mandatory declination form in a program for influenza vaccination of healthcare workers. *Infect Control Hosp Epidemiol*. 2008;29:302–8.
39. Talbot TR. Do declination statements increase health care worker influenza vaccination rates? *Clin Infect Dis*. 2009;49:773–9.
40. Fricke KL, Gastañaduy MM, Klos R, Bégué RE. Correlates of improved influenza vaccination of healthcare personnel: a survey of hospitals in Louisiana. *Infect Control Hosp Epidemiol*. 2013;34:723–9.
41. Miller BL, Ahmed F, Lindley MC, Wortley PM. Institutional requirements for influenza vaccination of healthcare personnel: results from a nationally representative survey of acute care hospitals—United States, 2011. *Clin Infect Dis*. 2011;53:1051–9.
42. Pitts S, Maruthur NM, Millar KR, Perl TM, Segal J. A systematic review of mandatory influenza vaccination in healthcare personnel. *Am J Prev Med*. 2014;47:330–40.
43. Johnson JG, Talbot TR. New approaches for influenza vaccination of healthcare workers. *Curr Opin Infect Dis*. 2011;24:363–9.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at  
[www.biomedcentral.com/submit](http://www.biomedcentral.com/submit)

