New approaches for influenza vaccination of healthcare workers

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Purpose of review

Vaccination of healthcare workers (HCWs) against influenza is an important component of infection control in healthcare settings but HCW vaccination rates remain low. Here we review current and emerging strategies for influenza vaccination of HCWs.

Recent findings

Professional organizations have recommended annual influenza vaccination for HCWs since 1984, but HCW vaccination rates have improved minimally. Recent studies indicate that comprehensive influenza vaccination programs have failed to achieve adequate influenza vaccination rates for HCWs in spite of allocating substantial resources to HCW vaccination programs. Mandatory HCW influenza vaccination programs have been introduced and clearly outperform traditional comprehensive vaccination programs. Some argue that mandatory vaccination programs infringe on HCW autonomy, and introduction of mandatory vaccination programs can be controversial. Public reporting of institutional HCW influenza vaccination rates is another strategy to achieve high vaccination rates, as HCW influenza vaccination may be used in the future as a quality and safety metric.

Summary

HCW influenza vaccination in the setting of a comprehensive infection control program is a core patient-safety practice. Mandatory HCW influenza vaccination and public reporting of HCW vaccination rates will complement one another in achieving substantial gains for HCW influenza vaccination programs.

Keywords

healthcare workers, influenza, public reporting, vaccination

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Introduction

Influenza infection is a leading cause of preventable morbidity and mortality in the United States and is associated with a significantly increased risk of hospitalization and death in vulnerable populations [1,2]. Person-to-person transmission in the healthcare setting occurs through infected patients, visitors, and healthcare workers (HCWs), some of whom are asymptomatic [3]. HCWs often work with symptoms of influenza-like illness (ILI), further increasing the risk of transmission to vulnerable hospitalized patients [4•,5•]. Vaccination of HCWs against influenza is an important component of infection control in healthcare settings [6•]. Numerous professional organizations have recommended annual HCW influenza vaccination as a core patient-safety practice. Despite these recommendations, HCW vaccination rates remain disappointingly low [7,8]. In response to sustained low vaccination rates, many institutions have opted to require influenza vaccination as a condition of employment [9••,10,11••,12••,13,14••,15••]. Mandatory HCW influenza vaccination is now recommended by leading professional societies [6•,16•] and may be used in the future as a healthcare quality and safety measure. The following are the professional organizations recommending and opposing mandatory HCW influenza vaccination:

(1) Recommending mandatory HCW influenza vaccination:
   (a) American Academy of Pediatrics (AAP).
   (b) American College of Physicians (ACP).
   (c) Association for Professionals in Infection Control and Epidemiology (APIC).
   (d) Infectious Diseases Society of America (IDSA).
   (e) National Foundation for Infectious Diseases (NFID).
   (f) National Patient Safety Foundation (NPSF).
   (g) Society for Healthcare Epidemology of America (SHEA).
   (h) United States Department of Defence.
(2) Opposing mandatory HCW influenza vaccination:
   (a) American Nurses Association (ANA).

(b) American College of Occupational and Enviromental Medicine (ACOEM).
(c) New York State Nurses Association (NYSNA).
(d) Service Employees International Union (SEIU).
(e) Washington State Nurses Association (WSNA).

In this article, we will review current strategies to increase HCW influenza vaccination coverage, address criticisms of HCW influenza vaccination, and consider the use of HCW influenza vaccination as a quality and patient-safety measure.

Key points

- Healthcare worker (HCW) influenza vaccination in the setting of a comprehensive infection control program is a core patient-safety practice.
- Mandatory HCW influenza vaccination programs are the most effective means to achieve high HCW vaccination rates.
- Public reporting of HCW influenza vaccination rates has the potential to improve HCW vaccination rates, but standardization and validation of reporting methodology are essential prior to implementation of this strategy.

Current strategies to improve healthcare worker influenza vaccination

Influenza vaccination is a key component of a comprehensive institutional infection control program aimed at reducing healthcare-associated respiratory infection. In addition to vaccination, rapid detection of infected patients, source control with isolation and/or masking as recommended, patient cohorting, HCW adherence to hand hygiene and respiratory etiquette, work restriction for ill HCWs, policies discouraging presenteeism, visitation restrictions for those with respiratory illness, and antiviral prophylaxis as indicated are important [6•,8,17–19]. Thus, HCW influenza vaccination is viewed as a subset of an institution's infection control program and not a replacement for it. Specific institutional approaches for improving HCW influenza vaccination rates were outlined in a 2005 Society for Healthcare Epidemiology in America (SHEA) position paper [7]. The key elements of such a program include annual vaccination, administrative support and leadership, targeted education campaigns, provision of vaccine at no cost, easy access to vaccine, declination statements, and system-wide surveillance [7].

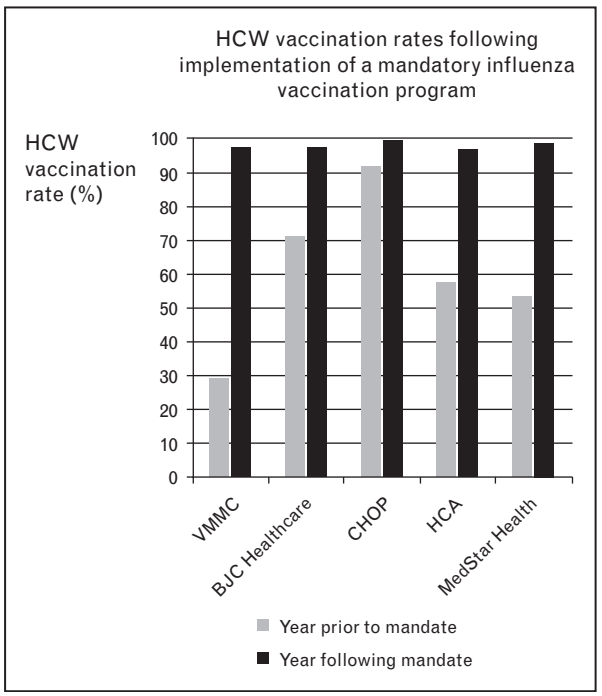
All of the above elements remain important in promoting HCW influenza vaccination, yet comprehensive campaigns have met with limited success. A 2009 review showed the relative and somewhat modest improvement in HCW vaccination rate with various interventions, including declination statements [20]. Published reports of the effectiveness of voluntary comprehensive HCW vaccination programs rarely exceed rates above 75%. Ajenjo *et al.* [21••] reviewed the 10-year HCW vaccination experience of BJC Healthcare in St. Louis, Missouri, USA. From 1997 to 2007, multiple interventions were attempted to improve HCW vaccination, and vaccination rates improved from 45 to 72% during that time [21••]. Notable interventions during the decade experience included peer-to-peer quality comparisons, intrahospital competitions, senior leadership support, and declination statements [21••]. Although this study could be used to tout the success of comprehensive HCW vaccination programs, it also reflects a common and frustrating experience among healthcare organizations throughout the United States: substantial institutional resources were allocated and improvements were made, but three out of every 10 HCWs remained unvaccinated.

Mandatory vaccination programs

Virginia Mason Medical Center in Seattle, Washington, USA altered the traditional paradigm of HCW influenza vaccination. In 2005, they became the first healthcare system in the United States to require influenza vaccination as a condition of employment [9••,22]. Since that time, several healthcare facilities have implemented mandatory vaccination programs with dramatic success, routinely achieving vaccination rates greater than 95% [10,11••,12••,13,14••,15••,23]. Figure 1 illustrates the improvement in HCW vaccination rates achieved by mandatory influenza vaccination programs in large health systems. An updated list of mandatory HCW influenza vaccination programs is available at www.immunize.org [23]. Given the success of these programs, mandatory HCW influenza vaccination as part of a comprehensive vaccination and infection control program appears to be the most effective means to achieve an acceptable HCW vaccination rate and reduce healthcare-associated influenza infections.

Although mandatory HCW influenza vaccination programs may be implemented differently, they should include the programmatic elements that have been used traditionally in HCW influenza vaccination programs [7]. Mandatory vaccination programs differ primarily in their vaccine exemption policy and treatment of unvaccinated HCWs. Exemption policies can be limited to medical exemptions only, broadened to include religious exemptions [9••,11••,12••,14••], or further broadened to include personal belief exemptions [15••]. For unvaccinated HCWs, a declination statement is useful for surveillance and verification of employee expectations regarding duties during the influenza season [6•]. In published reports of large-scale mandatory programs, unvaccinated HCWs with granted exemptions were often required [9••,13] or

Figure 1 Healthcare worker vaccination rates following implementation of a mandatory influenza vaccination program in five healthcare systems [9••,11••,12••,13,14••]



VMMC, Virginia Mason Medical Center, Seattle, Washington; BJC Healthcare, Barnes-Jewish-Christian Healthcare, St. Louis, Missouri; CHOP, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; HCA, Hospital Corporation of America, Nashville, Tennessee; MedStar Health, Columbia, Maryland.

encouraged [11••] to wear a surgical mask during patient care activities. The evidence behind requiring masks for unvaccinated HCWs is controversial. At the Robert Koch Institute in Germany, a mask-use requirement was temporally associated with a rise in vaccination rate from 33.1 to 51.7% over the course of 10 days following policy implementation [24]. Some healthcare programs allow for re-assignment of unvaccinated HCWs during influenza season, whereas other programs suspend unvaccinated HCWs without pay during outbreaks of influenza or require daily antiviral prophylaxis for unvaccinated HCWs [25,26]. A small percentage of HCWs have had employment terminated for refusal to comply with their hospital's mandatory influenza vaccination policy [9••, 11••,12••,13,14••,15••].

Criticism of mandatory healthcare worker influenza vaccination

Mandatory HCW influenza vaccination programs have been criticized mostly by those who believe that mandatory HCW vaccination infringes on employee autonomy. Yet some criticism of mandatory HCW influenza vaccination blurs the distinction between criticism of HCW policy and criticism of influenza vaccine effectiveness. For example, the American College of Occupational and Environmental Medicine (ACOEM) guidance statement on HCW influenza vaccination states that 'current evidence regarding the benefit of influenza vaccination in HCW as a tool to protect patients is inadequate to override the worker's autonomy to refuse vaccination' [27]. This statement implies a lack of proven effectiveness for HCW influenza vaccine in protecting patients from influenza but it is couched within criticism of mandatory HCW vaccination and not criticism of influenza vaccination. We will address criticism of both mandatory HCW vaccination and influenza vaccination, as overcoming this criticism is important to the success of any HCW influenza vaccination program.

Some have argued that mandatory influenza vaccination is coercive, invasive, and places patient protection above HCW autonomy [6•,27–29]. Although it is important to recognize these arguments, it is also important to place these arguments within the context of a HCW's ethical duty to protect patient safety [6•,30]. This duty consists of acting in a patient's interest, working to protect vulnerable patients and not placing patients at undue risk of harm [6•]. HCWs are already faced with mandatory vaccination (e.g. varicella) and annual invasive procedures (e.g. tuberculin skin testing), and the legal precedent of mandatory vaccination is established [6•,31]. Given the low risk of harm related to influenza vaccination [32], the ethical duty to protect patients supersedes the burden of yearly influenza vaccination. With regard to antagonism between employee and employer, evidence is mixed. Several employee unions have sued healthcare systems to end mandatory HCW influenza vaccination programs, yet surveys in several healthcare systems have shown that a majority of HCWs support mandatory HCW influenza vaccination [12••,33•,34•,35].

Some argue against mandatory HCW influenza vaccination purely on the basis of HCW autonomy, whereas others use a general criticism of influenza vaccine effectiveness. Evaluation of influenza vaccine effectiveness is difficult and is hampered by insufficient diagnostic accuracy and variable vaccine efficacy. First, we will consider these limitations, and then we will address criticism of influenza vaccine effectiveness. The diagnostic criteria for influenza infection are imperfect and the nuances of influenza diagnostic testing allow for criticism of study design and methods. Influenza studies vary in their use of diagnostic criteria, from the sensitive definition of ILI to the specific definition of laboratory-confirmed influenza. Unfortunately, both methods present problems for researchers. The sensitivity of ILI has been questioned by studies showing that laboratory-confirmed influenza cases do not always meet the

definition of ILI [36]. Although PCR for influenza is highly sensitive and specific [37], it is limited by the necessity of ILI as a screening method for diagnostic testing in research protocols. Other methods for diagnostic testing are either labor-intensive (e.g. cell culture, paired serology) or lack sensitivity (e.g. antigen testing) [38]. The efficacy of influenza vaccination is variable and depends upon both the host and the antigenic match between the vaccine and circulating strains. The efficacy of influenza vaccination is of particular concern in hospitalized elderly adults [39]. However, in a season in which influenza vaccine matches circulating influenza strains, HCWs should achieve adequate immune response to influenza vaccination [40,41].

The effect of HCW influenza vaccination on patient outcomes is controversial. A recent Cochrane review criticized the methodology of studies evaluating the effect of HCW influenza vaccine on elderly patient outcomes [42••]. Three cluster-randomized controlled trials and one prospective cohort study have shown a protective effect of HCW influenza vaccination on all-cause mortality in residents of long-term care facilities, and these studies were combined for meta-analysis in the Cochrane review; an additional cluster-randomized trial which did not show reduced mortality was also included [42••,43–48]. The protective effect of HCW influenza vaccination on all-cause mortality remained significant in the meta-analysis but was not significant for laboratory-confirmed influenza or pneumonia, and the authors criticized the use of all-cause mortality as an outcome metric in HCW influenza vaccine effectiveness studies [42••,47]. The positive and negative aspects of using all-cause mortality in influenza vaccine efficacy studies are outlined in reviews by Simonsen *et al.* [49] and Nichol [50]. Although methodological concerns exist, the combined results of the meta-analysis of HCW influenza vaccination show a reduction in patient mortality and cannot be ignored. Additionally, the biologic plausibility of HCW influenza vaccination in protecting patients is unmistakable as herd immunity to other vaccine-preventable illnesses is an established precedent. Thus, the recommendation for HCW influenza vaccination for patient protection is supported both in concept and in practice.

As available studies have shown a benefit only for patients of long-term care facilities, critics reject extrapolation of these data into acute care settings based on the lack of proven benefit in hospitalized patients. Although there are no randomized studies proving that HCW influenza vaccination reduces mortality in hospitalized patients, more data have emerged which demonstrate the burden and importance of healthcare-associated influenza. The burden of healthcare-associated influenza and its relationship to ILI was evaluated in a prospective study of ILI in a French acute care hospital over three influenza seasons [51••]. In this study, laboratory-confirmed influenza comprised 21.5% of all ILI in French HCWs through 3 years of ILI surveillance, nearly identical to 22.3% of laboratory-confirmed influenza seen in hospitalized patients as a whole and 20.3% of laboratory-confirmed influenza seen in hospitalized patients who did not have ILI on admission [51••]. A striking result to this study was the significant increase in healthcare-associated ILI incidence based on exposure to HCWs or patients with ILI, peaking at an incidence rate ratio of 34.75 in patients exposed to both one patient and one HCW with ILI [51••]. The authors suggested that some transmission to patients did occur among unvaccinated HCWs, but the efficacy of HCW influenza vaccination in preventing laboratory-confirmed influenza could not be evaluated [51••]. This study provides solid evidence for healthcare-associated transmission of ILI, and by extension, influenza, and emphasizes the substantial patient risk associated with ILI exposures. The consistency of laboratory-confirmed influenza in healthcare-associated ILI cases also illustrates that healthcare-associated influenza is a substantial risk to patients [51••].

In response to concerns over mandatory HCW influenza vaccination, some have sought compromise by recommending a combined approach – mandatory vaccination of HCWs only in areas of vulnerable patient populations (ICUs, etc.) while using an opt-out approach for the rest [52•]. Similarly, a recent study by Polgreen *et al.* [53•] used social network analysis to evaluate priority targets for HCW influenza vaccination. In this study, prioritization of HCW vaccination based on the number of expected close contacts outperformed a random vaccination strategy in simulations of influenza attack rates in the healthcare setting [53•]. This strategy would likely be useful in the event of a vaccine shortage but does not appear feasible as a routine vaccination strategy. It is worth noting that all attempted simulations had minimal influenza transmission at high HCW vaccination rates [53•]. Both a combined approach and a prioritization approach present institutional resource utilization and standardization of practice concerns. First, valuable resources are used in determining which HCWs require vaccination or reassignment based on refusal of vaccination. Second, requiring vaccination for only some HCWs could be misinterpreted as inequity by those HCWs for whom vaccination is required. Lastly, a disjointed vaccination strategy could increase the difficulty of tracking and reporting HCW influenza vaccination.

When considering influenza vaccine study methodology and vaccine efficacy, it is important to acknowledge that scientific criticism is useful and will improve future studies of influenza vaccination. However,

infection control policy is informed by more than scientific evidence alone; patient and HCW safety, implementation strategy, practicality, cost, and administrative support are all factors in policy formation. We recommend mandatory HCW influenza vaccination because available evidence suggests that HCW vaccination does prevent influenza-related morbidity and mortality in vulnerable patients, at very low risk of harm to the HCW.

Influenza vaccination as a reported quality measure

Another strategy to improve HCW influenza vaccination coverage focuses on use of vaccination rates as a reported measure of quality and patient safety. Facility-specific HCW influenza vaccination rates are already a publically reported metric in some states [54]. In Iowa, a voluntary reporting system with statewide surveillance was associated with a median vaccination rate of 82% [55]. Recently, the National Quality Forum (NQF) endorsed a proposed measure for HCW influenza vaccination rates for use as a reportable process measure for healthcare-associated infection. This metric is currently being tested in a multistate study. One challenge with public reporting of vaccination rates revolves around how a program measures such coverage, including which HCWs are specifically included in the program. A recent survey of US hospitals showed large variability in the reporting of HCW influenza vaccination rates [56]. Many institutions do not target HCWs who are independently contracted or present as volunteers [56], yet these employees are at no less risk of influenza transmission than other employees. Therefore, clarifying the reporting methodology and validating a standardized metric is essential prior to public reporting of this information.

Conclusion

HCW influenza vaccination rates remain far below recommended targets but new strategies to improve these rates have emerged. The current effectiveness of HCW influenza vaccination merits its use in healthcare settings to protect vulnerable hospitalized patients. Mandatory HCW influenza vaccination in the setting of a comprehensive infection control program is the most effective means to achieve a high HCW vaccination rate. Public reporting of institutional HCW influenza vaccination rates is another strategy, which will highlight the disappointing performance of most healthcare systems and magnify the need for improved HCW vaccination rates. Mandatory HCW influenza vaccination and public reporting of HCW vaccination rates will complement one another in achieving substantial gains for HCW influenza vaccination programs.

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References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 399–400).

1 Thompson WW, Shay DK, Weintraub E, *et al.* Mortality associated with influenza and respiratory syncytial virus in the United States. JAMA 2003; 289:179–186.

2 Salgado CD, Farr BM, Hall KK, Hayden FG. Influenza in the acute hospital setting. Lancet Infect Dis 2002; 2:145–155.

3 Foy HM, Cooney MK, Allan ID, Albrecht JK. Influenza B in households: virus shedding without symptoms or antibody response. Am J Epidemiol 1987; 126:506–515.

4 • Jena AB, Baldwin DC Jr, Daugherty SR, *et al.* Presenteeism among resident physicians. JAMA 2010; 304:1166–1168.
This survey of resident physicians showed high rates of 'presenteeism', or working while sick, in resident physicians.

5 • Widera E, Chang A, Chen HL. Presenteeism: a public health hazard. J Gen Intern Med 2010; 25:1244–1247.
This study describes an outbreak of viral gastroenteritis in a nursing home and the role of presenteeism in propagating spread of the infection.

6 • Talbot TR, Babcock H, Caplan AL, *et al.* Revised SHEA position paper: influenza vaccination of healthcare personnel. Infect Control Hosp Epidemiol 2010; 31:987–995.
This paper revises the influenza vaccination recommendations for healthcare personnel by the Society of Healthcare Epidemiology of America. Mandatory HCW influenza vaccination is now recommended by SHEA.

7 Talbot TR, Bradley SE, Cosgrove SE, *et al.* Influenza vaccination of healthcare workers and vaccine allocation for healthcare workers during vaccine shortages. Infect Control Hosp Epidemiol 2005; 26:882–890.

8 Fiore AE, Uyeki TM, Broder K, *et al.* Prevention and control of influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2010. MMWR Recomm Rep 2010; 59:1–62.

9 •• Rakita RM, Hagar BA, Crome P, Lammert JK. Mandatory influenza vaccination of healthcare workers: a 5-year study. Infect Control Hosp Epidemiol 2010; 31:881–888.
This article describes the five-year experience of Virginia Mason Medical Center in Seattle, Washington, USA with mandatory HCW influenza vaccination. High vaccination rates were sustained, and workforce disruptions were minimal.

10 Palmore TN, Vandersluis JP, Morris J, *et al.* A successful mandatory influenza vaccination campaign using an innovative electronic tracking system. Infect Control Hosp Epidemiol 2009; 30:1137–1142.

11 •• Babcock HM, Gemeinhart N, Jones M, *et al.* Mandatory influenza vaccination of healthcare workers: translating policy to practice. Clin Infect Dis 2010; 50:459–464.
This article describes the experience of introducing mandatory HCW vaccination at BJC Healthcare in St. Louis, Missouri, USA. High vaccination rates were achieved, and a reduction in declination statements was noted with initation of a mandatory vaccination program.

12 •• Feemster KA, Prasad P, Smith MJ, *et al.* Employee designation and healthcare worker support of an influenza vaccine mandate at a large pediatric tertiary care hospital. Vaccine 2011; 29:1762–1769.
This article describes the experience with mandatory HCW vaccination at Children's Hospital of Philadelphia. The implementation of a mandatory program was first done in targeted employees and then expanded to the entire healthcare system. This study surveyed employees and found that a majority of employees found mandatory vaccination to be coercive, but a majority of employees also felt that mandatory vaccination was important for protecting patients.

13 Cormier SB, Septimus E, Moody JA, *et al.* Implementation of a successful seasonal influenza vaccine strategy in a large healthcare system. In: Program and abstracts of Fifth Decennial International Conference on Healthcare-Associated Infections; 2010; abstract 385.

14 Karanfil LV. Championing patient safety through mandatory influenza vaccination for all healthcare personnel and affiliated physicians. Infect Control Hosp Epidemiol 2011; 32:375–379.
•• This article describes the experience with mandatory influenza vaccination at MedStar Health in Maryland and Washington, District of Columbia, USA. A large number of affiliated physicians (149) had their admitting priviledges suspended during the influenza season due to noncompliance with the mandatory vaccination program.

15 Septimus EJ, Perlin JB, Cormier SB, *et al.* A multifaceted mandatory patient safety program and seasonal influenza vaccination of healthcare workers in community hospitals. JAMA 2011; 305:999–1000.
•• This study describes the experience with implementing mandatory influenza vaccination at Hospital Corporation of America (HCA). HCA is the largest healthcare system to implement mandatory influenza vaccination for employees. Notably, personal exemptions were allowed in addition to medical and religious exemptions, and the vaccination rate achieved was 96%.

16 Bernstein HH, Starke JR. Policy statement: recommendation for mandatory influenza immunization of all healthcare personnel. Pediatrics 2010; 126:809–815.
• This policy statement outlines the position of the AAP on mandatory influenza vaccination of HCWs.

17 Siegel JD, Rhinehart E, Jackson M, Chiarello L. 2007 Guideline for Isolation Precautions: preventing transmission of infectious agents in healthcare settings. Am J Infect Control 2007; 35:S65–S164.

18 Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control/Infectious Diseases Society of America. MMWR Recomm Rep 2002; 51:1–45, quiz CE1–4.

19 Fiore AE, Fry A, Shay D, *et al.* Antiviral agents for the treatment and chemoprophylaxis of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Surveill Summ 2011; 60:1–24.

20 Talbot TR. Do declination statements increase healthcare worker influenza vaccination rates? Clin Infect Dis 2009; 49:773–779.

21 Ajenjo MC, Woeltje KF, Babcock HM, *et al.* Influenza vaccination among healthcare workers: ten-year experience of a large healthcare organization. Infect Control Hosp Epidemiol 2010; 31:233–240.
•• This study evaluates the 10-year influenza vaccination experience of BJC Healthcare in St. Louis, Missouri, USA. Over the decade experience, a number of interventions were attempted in order to boost the HCW vaccination rate, but the highest rate achieved was 72%.

22 Talbot TR, Schaffner W. On being the first: Virginia Mason Medical Center and mandatory influenza vaccination of healthcare workers. Infect Control Hosp Epidemiol 2010; 31:889–892.

23 Immunization Action Coalition. 2011. http://www.immunize.org/honor-roll/. [Accessed 21February 2011]

24 Wicker S. Unvaccinated healthcare workers must wear masks during flu season: a possibility to improve influenza vaccination rates? Vaccine 2009; 27:2631–2632.

25 Vancouver Island Health Authority. Influenza outbreak prevention and control in long term care facilities. 2010. http://www.viha.ca/NR/rdonlyres/3F126B89-8CA7-4B27-A2E0-BD365A2CD940/0/InfluenzaPreventionResourceDocumentFacilities20102011.pdf [accessed 21 February 2011].

26 Yassi A, Lockhart K, Buxton JA, McDonald I. Vaccination of healthcare workers for influenza: promote safety culture, not coercion. Can J Public Health 2010; 101 (Suppl 1):S41–S45.

27 American College of Occupational and Environmental Medicine (ACOEM) guidance statement: seasonal influenza prevention in healthcare workers. 2008. http://www.acoem.org/guidelines.aspx?id=5362 [accessed 21 February 2011].

28 Lugo NR. Will carrots or sticks raise influenza immunization rates of healthcare personnel? Am J Infect Control 2007; 35:1–6.

29 Isaacs D, Leask J. Should influenza immunisation be mandatory for healthcare workers? No. BMJ 2008; 337:a2140.

30 Poland GA. Mandating influenza vaccination for healthcare workers: putting patients and professional ethics over personal preference. Vaccine 2010; 28:5757–5759.

31 Stewart AM. Mandatory vaccination of healthcare workers. N Engl J Med 2009; 361:2015–2017.

32 Vajo Z, Tamas F, Sinka L, Jankovics I. Safety and immunogenicity of a 2009 pandemic influenza A H1N1 vaccine when administered alone or simultaneously with the seasonal influenza vaccine for the 2009–10 influenza season: a multicentre, randomised controlled trial. Lancet 2010; 375:49–55.

33 Douville LE, Myers A, Jackson MA, Lantos JD. Healthcare worker knowledge, attitudes, and beliefs regarding mandatory influenza vaccination. Arch Pediatr Adolesc Med 2010; 164:33–37.
• This study evaluated attitudes of HCWs toward mandatory vaccination at a large tertiary children's hospital. Acceptance of mandatory vaccination of HCWs was high but was not associated with the belief that influenza vaccination protected patients.

34 deSante JE, Caplan A, Shofer F, Behrman AJ. Physician attitudes towards influenza immunization and vaccine mandates. Vaccine 2010; 28:2517–2521.
• This Web-based survey of physicians showed substantial support for mandatory influenza vaccination of healthcare workers.

35 Poland GA, Ofstead CL, Tucker SJ, Beebe TJ. Receptivity to mandatory influenza vaccination policies for healthcare workers among registered nurses working on inpatient units. Infect Control Hosp Epidemiol 2008; 29:170–173.

36 Babcock HM, Merz LR, Fraser VJ. Is influenza an influenza-like illness? Clinical presentation of influenza in hospitalized patients. Infect Control Hosp Epidemiol 2006; 27:266–270.

37 Roa PL, Catalan P, Giannella M, *et al.* Comparison of real-time RT-PCR, shell vial culture, and conventional cell culture for the detection of the pandemic influenza A (H1N1) in hospitalized patients. Diagn Microbiol Infect Dis 2011; 69:428–431.

38 Talbot HK, Falsey AR. The diagnosis of viral respiratory disease in older adults. Clin Infect Dis 2010; 50:747–751.

39 Liu WM, Zeijst BA, Boog CJ, Soethout EC. Aging and impaired immunity to influenza viruses: implications for vaccine development. Hum Vaccin 2011 [Epub ahead of print].

40 Jackson LA, Gaglani MJ, Keyserling HL, *et al.* Safety, efficacy, and immunogenicity of an inactivated influenza vaccine in healthy adults: a randomized, placebo-controlled trial over two influenza seasons. BMC Infect Dis 2010; 10:71.

41 Wilde JA, McMillan JA, Serwint J, *et al.* Effectiveness of influenza vaccine in healthcare professionals: a randomized trial. JAMA 1999; 281:908–913.

42 Jefferson T, Di Pietrantonj C, Al-Ansary LA, *et al.* Vaccines for preventing influenza in the elderly. Cochrane Database Syst Rev 2010: CD004876.
•• This meta-analysis evaluated four cluster-randomized trials and one prospective study of the effectiveness of HCW influenza vaccination in protecting nursing home residents from influenza. The combined results of the meta-analysis showed a signficant reduction in all-cause mortality for nursing home residents but did not show a protective effect for pneumonia or laboratory-confirmed influenza. The authors of the meta-analysis concluded that current data are insufficient to evaluate the effectiveness of HCW influenza vaccination in protecting patients.

43 Potter J, Stott DJ, Roberts MA, *et al.* Influenza vaccination of healthcare workers in long-term-care hospitals reduces the mortality of elderly patients. J Infect Dis 1997; 175:1–6.

44 Carman WF, Elder AG, Wallace LA, *et al.* Effects of influenza vaccination of health-care workers on mortality of elderly people in long-term care: a randomised controlled trial. Lancet 2000; 355:93–97.

45 Hayward AC, Harling R, Wetten S, *et al.* Effectiveness of an influenza vaccine programme for care home staff to prevent death, morbidity, and health service use among residents: cluster randomised controlled trial. BMJ 2006; 333:1241.

46 Lemaitre M, Meret T, Rothan-Tondeur M, *et al.* Effect of influenza vaccination of nursing home staff on mortality of residents: a cluster-randomized trial. J Am Geriatr Soc 2009; 57:1580–1586.

47 Hayward AC, Watson J. Effectiveness of influenza vaccination of staff on morbidity, and mortality of residents of long-term care facilities for the elderly. Vaccine 2011; 29:2357–2358.

48 Oshitani H, Saito R, Seki N, *et al.* Influenza vaccination levels and influenza-like illness in long-term care facilities for elderly people in Niigata, Japan, during an influenza A (H3N2) epidemic. Infect Control Hosp Epidemiol 2000; 21:728–730.

49 Simonsen L, Taylor RJ, Viboud C, *et al.* Mortality benefits of influenza vaccination in elderly people: an ongoing controversy. Lancet Infect Dis 2007; 7:658–666.

50 Nichol KL. Challenges in evaluating influenza vaccine effectiveness and the mortality benefits controversy. Vaccine 2009; 27:6305–6311.

51 Vanhems P, Voirin N, Roche S, *et al.* Risk of influenza-like illness in an acute
•• healthcare setting during community influenza epidemics in 2004–2005, 2005–2006, and 2006–2007: a prospective study. Arch Intern Med 2011; 171:151–157.

This prospective study evaluated the risk of influenza-like illness through three flu seasons. A substantial burden of healthcare-associated influenza-like illness was shown, of which 20.3% was laboratory-confirmed influenza. The investigators also showed a very convincing exposure-associated risk of influenza-like illness for patients.

52 McLennan S, Wicker S. Reflections on the influenza vaccination of healthcare
• workers. Vaccine 2010; 28:8061–8064.

This editorial commentary advocates for targeted mandatory influenza vaccination of HCWs of vulnerable patients and suggests an opt-out strategy for the remaining HCWs.

53 Polgreen PM, Tassier TL, Pemmaraju SV, Segre AM. Prioritizing healthcare
• worker vaccinations on the basis of social network analysis. Infect Control Hosp Epidemiol 2010; 31:893–900.

This unique study simulates influenza transmission under various scenarios, ranging from high attack-rates to low. A targeted HCW vaccination strategy based on frequency of patient exposures was tested against a random vaccination strategy and performed equally well in the evaluation. All tested strategies performed well a high vaccination rates.

54 Maryland Hospital Performance Evaluation Guide. 2011. http://mhcc.maryland.gov/consumerinfo/hospitalguide/hospital_guide/reports/healthcare_associated_infections/index.asp [accessed 21 March 2011].

55 Polgreen PM, Polgreen LA, Evans T, Helms C. A statewide system for improving influenza vaccination rates in hospital employees. Infect Control Hosp Epidemiol 2009; 30:474–478.

56 Lindley MC, Yonek J, Ahmed F, *et al.* Measurement of influenza vaccination coverage among healthcare personnel in US hospitals. Infect Control Hosp Epidemiol 2009; 30:1150–1157.