

Review: interventions to increase influenza vaccination among healthcare workers in hospitals

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Included employees who accessed patient care areas or worked within six feet of patients during influenza season.

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Annual influenza vaccination rates among hospital healthcare workers (HCW) are almost universally low despite recommendations from WHO and public health authorities in many countries. To assist in the development of successful vaccination programmes, we reviewed studies where interventions aimed to increase the uptake of influenza vaccination among hospital HCW. We searched PUBMED from 1990 up to December 2011 for publications with predetermined search strategies and of pre-defined criteria for inclusion or exclusion. We evaluated a large number of 'intervention programmes' each employing one or more 'intervention components' or strategies, such as easy access to vaccine or educational activities, with the goal to raise influenza vaccine uptake rates in hospital HCW during one influenza season. Included studies reported results of intervention programmes and compared the uptake with the season prior to the intervention (historical control) or to another intervention programme within the same season that started from the same set of baseline activities. Twenty-five studies performed in eight countries met our selection criteria and described 45

distinct intervention programmes. Most studies used their own facility as historical control and evaluated only one season. The following elements were used in intervention programmes that increased vaccine uptake: provision of free vaccine, easy access to the vaccine (e.g. through mobile carts or on-site vaccination), knowledge and behaviour modification through educational activities and/or reminders and/or incentives, management or organizational changes, such as the assignment of personnel dedicated to the intervention programme, long-term implementation of the strategy, requiring active declination and mandatory immunization policies. The number of these components applied appeared to be proportional to the increase in uptake. If influenza uptake in hospital HCW is to be increased on sustained basis, hospital managers need to be committed to conduct a well-designed long-term intervention programme that includes a variety of co-ordinated managerial and organizational elements.

Keywords Health personnel, influenza vaccine, vaccination rates.

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Introduction

Influenza infections in hospital healthcare workers (HCW) may lead to nosocomial outbreaks,^{1,2} particularly in immunocompromised patients,³ and staff shortages with associated disruption of services.⁴ HCW have been implicated in the transmission of influenza to inpatients.^{5,6} When antigenically well matched, seasonal influenza immunization has been efficacious in HCW.^{7,8} Increased uptake by HCW has also been shown to reduce morbidity and mortality in geriatric long-term-care patients^{9–12} and may have a protective effect for hospitalized patients,^{13,14} making vaccination of HCW particularly important for this group as the efficacy of the vaccine is lower in the

elderly and immunocompromised than in younger healthy adults.^{15,16} Although many national public health institutions and the World Health Organization (WHO) have recommended seasonal influenza vaccination for HCW for many years, low uptake is widespread. In our first review article on influenza vaccine uptake by HCW, we identified two major reasons for non-receipt: lack of convenient access to vaccination and lingering misconceptions or lack of knowledge about influenza and the vaccine.¹⁷ In the current review, we analyse interventions used to increase the uptake of influenza vaccination among HCW, to assist public health policy makers, hospital managers and infection control practitioners in the development of successful vaccination programmes.

Methods

Published articles were identified searching PUBMED computerized database from January 1990 to December 2011 with a combination of keyword and subject heading searches using the following terms: 'influenza', 'health personnel', 'vaccination', 'influenza vaccines', 'hospitals' (see the exact search strategy in Annex 1). We also checked the reference lists of relevant publications, including reviews and meta-analyses of interventions aimed at increasing influenza vaccination rates among HCW. The following selection criteria for inclusion were applied: the study implemented and evaluated a strategy aimed at increasing seasonal influenza vaccination uptake among HCW; the study population included HCW from acute care hospitals; the study compared the effect of the vaccination strategy against a historical or concurrent control; the study described all activities that were carried out before (historical control) and after the start of the vaccination strategy; the publication was published in English, French or German.

For the review of the selected studies, we evaluated the impact of intervention programmes implemented during an influenza season, which we have designated one 'observation season'. Each intervention programme includes a set of individual intervention components, which are specific interventions used to raise influenza vaccine uptake rates in HCW, such as free vaccine, worker education and improved access. Some studies implemented and compared more than one set of intervention components in the same year in different facilities or settings. These were called intervention programme arms. The 'baseline season' is the season in the year prior to the introduction of an intervention programme evaluated by the study. An eligible study provided information about the vaccine uptake in the baseline season and the implementation phase as well as the components used to raise vaccine uptake.

According to the design and duration of interventions, we grouped the selected studies into four categories:

- A) Studies that implemented and evaluated one intervention programme in one observation season (1 year before-and-after studies). The baseline vaccine uptake served as a comparison group for the only implemented intervention programme. Effects are given as the percentage point difference.
- B) Studies that implemented and evaluated identical and/or distinct intervention programmes over consecutive observation seasons within the same facility (extended before-and-after studies). The baseline vaccine uptake served as a comparison group for the first intervention programme, and the uptake rates of subsequent intervention programmes were compared with those implemented during the immediately previous season. Effects are given as the percentage point difference.
- C) Studies that implemented and evaluated distinct intervention programme arms in different settings/facilities/HCW groups during the same observation season and with at least one concurrent control strategy for comparison (before-and-after studies with control). In type C studies, the vaccination activities used in the baseline season (baseline programme) may or may not have been continued during the observation season. A randomization step may have assigned study sites to specific strategies. Thus, according to the specific set-up of a study, vaccine uptake in an intervention programme implemented in an observation season was compared with (i) the baseline uptake before the observation season (historical control), (ii) the vaccine uptake of a control intervention programme arm during the same observation season. This control intervention programme arm was usually the baseline programme (continued for another season) or the intervention programme arm with the fewest additional components. Effects are given as the percentage point difference and as the ratio of the odds to be vaccinated in the intervention group in comparison with the control group.
- D) Studies evaluating an intervention programme that was implemented consistently for more than 10 observation seasons. For these long-term intervention programmes, vaccine uptake during the baseline season served as the only comparison. Effects are given as the percentage point difference.

Based on the study analysis, activities used to increase vaccine uptake included 10 intervention components that can be grouped into one of three categories:

Access related

1. Free vaccine: vaccination offered at no cost to the recipient HCW;
2. Flexible and worksite vaccine delivery: provision of convenient access to influenza vaccine at the worksite during different working shifts, typically by using mobile vaccination carts;

Knowledge and behaviour related

3. Education material: dissemination of information to increase awareness regarding the significance of influenza in the healthcare setting and the importance, safety and effectiveness of the vaccine for HCW. Methods included posters, pamphlets, mass mailings, newsletters, flyers;
4. Education sessions: for example, in-service meetings, presentations and lectures;
5. Reminders: distribution of information indicating time and place of vaccine administration. Reminders were delivered verbally, by email and/or on paper;

6. Incentives: for example, distributed during a vaccination fair, gift incentives after vaccination, coupons for the hospital cafeteria, a raffle for a free vacation;

Management and policy related

7. Assignment of dedicated staff: assignment of one or more – mostly specially trained – staff member who organizes and promotes influenza vaccination among peers;
8. Feedback: information to HCW regarding the total rates of vaccine uptake to further motivate vaccine uptake;
9. Signed declination statements: requirement from HCW to sign a statement when the vaccine is declined, for reasons other than medical contraindications such as a religious belief or philosophical reasons; failure to be vaccinated does not result in termination of the contract;
10. Mandatory vaccination: requirement from HCW to receive influenza vaccination as a prerequisite for continued employment, unless exemptions based on medical or religious reasons were granted.

As the effectiveness and specific nature of interventions is very much dependent on institutional and cultural settings, as well as on different baseline approaches, our review did not attempt to estimate the overall magnitude of effect of a single intervention component.

Results

Our initial search in PUBMED yielded 423 published articles. In addition, 58 articles were identified through checking the reference lists of relevant publications. Of these 481 articles, we eliminated 289 articles because they addressed another study question and/or an infectious agent other than seasonal influenza. Other reasons for exclusion were that the study population did not include HCW in acute care hospitals ($n = 91$) or that the article did not provide control data or information about the activities implemented before and during the vaccination strategy ($n = 77$). Following the selection process, we identified 24 published articles describing 25 studies that met our inclusion criteria. These eligible studies evaluated the effectiveness of 45 multiple-component intervention programmes. For the inventory of intervention components, we identified 14 type A,^{18–31} four type B,^{32–35} five type C^{36–40} and two type D studies.^{13,32} Altogether, A, B and C studies evaluated 43 intervention programmes or programme arms.

Of the selected studies, 16 (64%) were conducted in the USA,^{13,18,20–22,24–26,30–32,34–36,40} six (24%) in Europe^{19,27–29,37,39} and one each in Korea,³³ Singapore³⁸ and Brazil.²³ All but three studies^{25,34,40} were carried out in individual hospitals and 14 (56%) in university hospitals.^{13,20,22–24,27–29,31–33,37,39,40} The study populations of 17 studies (65%) were explicitly described as ‘healthcare workers’. However, four of the studies addressed hospital

employees in general,^{27,34,35,38} two non-physician employees,^{25,40} one medical residents²⁰ and one only HCW with direct patient contact.²⁴ Most of the studies ascertained vaccination status either through records of the vaccine provider or a self-administered questionnaire for HCW.

Eight (32%) of 25 studies reported that their baseline programme activities only included the provision of vaccine at no cost.^{20–23,27,28,32} All studies implemented intervention programmes that included more than one of our 10 identified intervention components. On average, a programme included five components. Among the 45 intervention programmes (among all A–D studies) reviewed, the four most commonly utilized components were free vaccine (42 programmes), educational material (39 programmes), reminders (35 programmes), and flexible and worksite vaccine delivery (31 programmes). As a general rule, the vaccine uptake after one intervention season (compared with the baseline uptake) tended to increase with the number of components included in the intervention programme ($r^2 = 0.25$), where each additional component was associated with an average increase in vaccine uptake of 5–6% (Figure 1).

Of the 25 studies reviewed, six (24%) were tailored to address-specific findings of previous pre-intervention surveys or studies that identified barriers to uptake, for example, information coming from a survey among the hospital’s HCW on knowledge about influenza or the vaccine, or on self-reported reasons to receive or not receive influenza vaccine.^{18,27,28,33,37,40} For example, one study associated with an increase from 21% to 38% based its

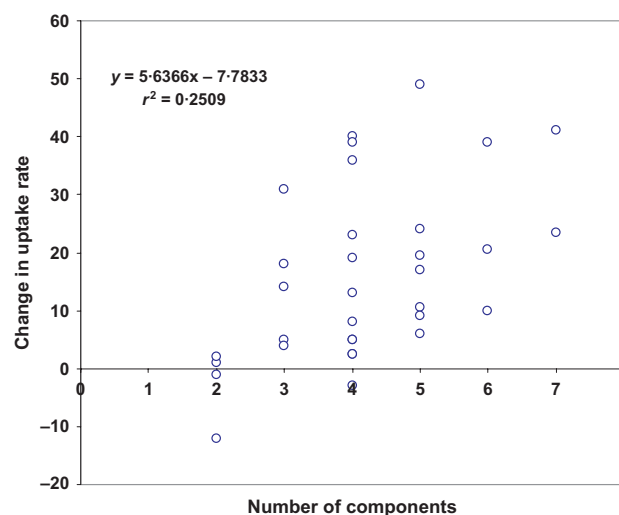


Figure 1. Illustration of the change in percentage points in vaccine uptake among healthcare workers after one intervention season compared with the uptake before the intervention seasons as a function of the number of intervention components used in the respective type A and B studies ($n = 43$).

educational sessions on survey information.¹⁸ In another example, the pre-intervention survey demonstrated important racial disparities that could then be addressed in the intervention programme.⁴⁰

Type A and B studies (1 year and extended before-and-after studies)

Fourteen studies implemented one intervention programme during one season (type A) and four implemented intervention programmes during two, four, four and five consecutive seasons, respectively (type B) (Tables 1 and 2),^{32–35} for a total of 29 intervention programmes. The 18 studies had a median baseline vaccination rate of 29% (range, 2%–73%), including three (17%) with a baseline of <10%.^{23,26,27} Among the 29 intervention programmes, the median increase in vaccine uptake was 17%, ranging from –12% to 49%, compared with the prior season. Eight intervention programmes raised the uptake by more than 30% after 1 year.^{20,22–24,26,33,35,38} The programme that experienced a decrease of 12%³² attributed the decline to a vaccine shortage that impeded timely provision of vaccine to all HCW. Vaccine uptake of the 14 intervention programmes of type A started at a median of 23% (range, 2%–73%) and increased to a median of 45% (range, 4.5%–99%; Figure 1). Three of the four type B studies started at 54% (Figure 1), and all four reached high or very high uptake levels (78%, 98%, 98% and 99%). In general, the addition of more components led to substantial increases in type B studies.

For reasons stated above, we were unable to analyse components independently. Consequently, we describe the characteristics of the individual components without formal analysis:

Free vaccine

In all but one study, influenza vaccine was offered free of charge at baseline before the start of an intervention programme. Those who offered free vaccine as their only strategy at baseline had a median coverage of 19% before new interventions were added. One type B study in Singapore started with giving vaccines at low-cost and implemented different components during 3 years. In the fourth year, free vaccine was added as the only new component of the intervention programme, and this led to a jump in uptake from 42% to 78%.³³

Flexible and worksite vaccine delivery

Twenty-four (83%) of the 29 intervention programme seasons included the organization of flexible and worksite vaccine delivery using mobile carts or a similar approach to reduce inconvenience barriers to vaccination. These intervention programmes were associated with an average difference in vaccine uptake of 20% (range, –12%–49%),

whereas the four programmes not using this component raised vaccine uptake on average by only 9% (range, –1%–23%). All of the seven intervention programmes that increased coverage by more than 30% used, among other intervention component, a flexible and worksite vaccine delivery.^{20,22–24,26,33,35} The drop in coverage experienced by one intervention programme happened during a time of vaccine shortage, as mentioned above.³² Two intervention programmes that used mobile carts or same-service area vaccination as the only newly added intervention component to the previous season's programme had increases of 18% and 19%, respectively.^{19,33}

Educational material/educational sessions

All but four intervention programmes^{20,32} included the use of educational material as a means to improve HCW vaccination rates. Contents addressed the importance of nosocomial influenza, its mode of transmission, the seriousness of influenza especially for high-risk patients, the rationale for vaccinating HCW and the effectiveness and safety of the vaccine. One innovative study involved HCW themselves who described in a humorous way their vaccination experience in weekly 'peer-to-peer' online messages combined with photographs of vaccinated HCW.²⁹ This prompted a discussion on patient safety in the HCW social networks which, after many years of stagnation, was associated with an increase in vaccination rates from 24% to 37%.

Reminders

Twenty-one (72%) of 29 intervention programmes included reminders to HCW for vaccination. Methods varied from sending printed newsletters, email notices, personal letters inserted with the pay check, to posters located throughout the institution.

Incentives

Different forms of incentives were incorporated as a component in 14 (48%) intervention programmes, including free food, movie tickets or health books that were distributed during a vaccination fair. One multi-year study reported that the addition to the previous season of only incentives as a single intervention component raised vaccine uptake from 43% to 56% after it had dropped or stagnated in the previous 2 years.³²

Assignment of dedicated staff

Nine (31%) intervention programmes utilized specially trained or otherwise enlisted staff members dedicated to organizing and promoting influenza vaccination among HCW. Examples included (i) one nurse who was assigned personal responsibility for the vaccination programme and provided vaccine to HCW at their worksites;²⁰ (ii) an employee health nurse who made appointments with each

Table 1. Type A studies ($n = 14$) with one intervention programme in one season (no. 1–14). The column on increase in uptake indicates the difference after one observation season compared with the baseline season

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Intervention components added to previous season	Study population at baseline	Vaccine uptake before intervention	Uptake after one observation season	Increase in uptake after one season
1	Begue (1998) ¹⁸	New Orleans, USA	Yes	Free vaccine, educational material, flexible and worksite delivery, reminders	Educational sessions	1100	21%	38%	17%
2	Bertin (2007) ³⁰	Cleveland, USA	No	Free vaccine, educational material, reminders, incentives, declination statement (paper forms), feedback	Declination statement (intranet-based)	20 170	38%	55%	17%
3	Gaughan (2010) ³¹	Maywood, USA	No	Free vaccine, educational material, flexible and worksite delivery, reminders	Mandatory vaccination	7484	73%	99%	26%
4	de Juanes (2007) ^{19*}	Madrid, Spain	No	Free vaccine, educational material, reminders	Flexible and worksite delivery	5718	21%	40%	19%
5	Fedson (1996) ²⁰	Virginia, USA	No	Free vaccine	Flexible and worksite delivery, assignment of dedicated staff	65	63%	94%	31%
6	Girasek (1990) ²¹	New York, USA	No	Free vaccine	Educational material and sessions, reminders	102	9–11%**	30–36%***	21–25%
7	Hall (1998) ²²	Kentucky, USA	No	Free vaccine	Educational material, reminders, flexible and worksite delivery	2358	34%	83%	49%
8	Lopes (2008) ²³	Sao Paulo, Brazil	No	Free vaccine	Educational material and sessions, flexible delivery	20 000	6%	45%	39%

Table 1. (Continued)

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Intervention components added to previous season	Study population at baseline	Vaccine uptake before intervention	Uptake after one observation season	Increase in uptake after one season
9	Llupia (2010) ²⁹	Barcelona, Spain	No	Free vaccine, educational material, flexible and worksite delivery	Reminders, incentives, feedback	4783	24%	37%	13%
10	McCullers (2006) ²⁴	Memphis, USA	No	Free vaccine, educational campaign	Reminders, flexible and worksite delivery, assignment of dedicated staff, feedback	702	45%	86%	41%
11	Ribner (2008) ²⁵	Atlanta, USA	No	Free vaccine, educational material, flexible and worksite delivery, feedback	Reminders, incentives, declination statement	9214	43%	67%	24%
12	Shannon (1993) ²⁶	Lawrence, USA	No	Free vaccine, educational programmes	Incentives, flexible and worksite delivery, assignment of dedicated staff	1500	5%	44%	39%
13	Smedley (2002) ²⁷	Southampton, UK	Yes	Free vaccine	Educational material and sessions, reminders	6706	2%	4.5%	2.5%
14	Tapiainen (2005) ²⁸	Basel, Switzerland	Yes	Free vaccine	Educational material and sessions, flexible and worksite delivery	554	19%	24%	5%

*This study carried out an intervention measure in the previous season that continued the components already used in the year before and increased vaccine uptake from 16% to 21%.

**9% among nurses, 11% among physicians.

***30% among nurses, 36% among physicians.

hospital department to stress the importance and safety of the vaccine and to ensure on-site vaccination at a time convenient to each shift;²⁶ and (iii) the introduction of 'influenza vaccine champions' (i.e. employee health and infection control staff members) who conducted grand rounds on the subject, distributed notices to all employees by e-mail, attended meetings with nursing supervisors, established a telephone hotline and answered questions at the vaccination clinics.³² Three of the six intervention programmes with a 30% increase above the baseline^{20,24,26}

assigned one nurse the responsibility to raise vaccination rates, resulting in almost universal vaccination uptake in one programme conducted at a general medicine clinic (94%).²⁰ In one study, supervisors were instructed to contact unvaccinated personnel individually and urge them to get vaccinated.²⁴

Feedback

Six (21%) of 29 intervention programmes provided regular feedback to HCW regarding their overall vaccination

Table 2. Type B studies ($n = 4$) with distinct or identical intervention programmes in consecutive years in the same facility (no. 1–15). For intervention programmes 1, 3, 7 and 12 the column on increase in uptake indicates the comparison in uptake to the baseline season; for the other intervention programmes the column indicates the increase to the intervention programme of the previous year

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Intervention components added to previous season	Study population at baseline	Vaccine uptake before intervention	Uptake after one observation season	Increase in uptake after one season
1	Babcock (2010) ³⁴ season 1	St Louis, USA	No	Free vaccine, educational material and sessions, incentives, flexible and worksite delivery	Feedback, declination statement	~26 000	54%	71%	17%
2	Babcock (2010) ³⁴ season 2	St Louis, USA	No	See intervention above	Mandatory vaccination	25 980	71%	98.4%	27.4%
3	Poland (2005)*; season 1 of 4	Rochester, USA	No	Free vaccine	Flexible and worksite delivery	~25 000	54%	42%	-12%
4	Poland (CDC) (2005) ³² ; season 2 of 4	Rochester, USA	No	See intervention programme 1 of 4	No additional components compared to season 1	~25 000	42%	43%	1%
5	Poland (2005); season 3 of 4	Rochester, USA	No	See intervention programme 2 of 4	Reminders, incentives	~25 000	43%	56%	13%
6	Poland (2005); season 4 of 4	Rochester, USA	No	See intervention programme 3 of 4	Educational material, assignment of dedicated staff	~25 000	56%	76.5%	20.5%
7	Rakita** (2010) ³⁵ ; season 1	Seattle, USA	No	Free vaccine, educational material and sessions, reminders, incentives, flexible and worksite delivery, assignment of dedicated staff	Mandatory vaccination	4703	54%	97.6%	43.6%
8–11	Rakita (2010) ³⁵ ; seasons 2–5	Seattle, USA	No	See intervention above	No additional components compared to season 1	4742–4967	97.6%	98.5%–98.9%	0.9%–1.3%
12	Song*** (2006) ³³ ; season 1 of 4	Seoul, Republic of Korea	Yes	Vaccine supply at low cost	Educational material, reminders	1 096	23%	25%	2%

Table 2. (Continued)

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Intervention components added to previous season	Study population at baseline	Vaccine uptake before intervention	Uptake after one observation season	Increase in uptake after one season
13	Song (2006) ³³ ; season 2 of 4	Seoul, Republic of Korea	Yes	See intervention programme 1 of 4	No additional components compared to season 1	1114	25%	24%	-1%
14	Song (2006) ³³ ; season 3 of 4	Seoul, Republic of Korea	Yes	See intervention programme 2 of 4	Flexible and worksite delivery	1114	24%	42%	18%
15	Song (2006) ³³ ; season 4 of 4	Seoul, Republic of Korea	Yes	See intervention programme 3 of 4	Free vaccine	1131	42%	78%	36%

*This peer vaccination programme at the Mayo Clinic (USA) added and evaluated intervention components during four consecutive influenza seasons. During the first intervention (2000/01), vaccination shortages and delays prevented many HCW from receiving vaccination.

**This first mandatory vaccination programme in the USA evaluated the same multi-component intervention measures during five consecutive influenza seasons. Because of a national vaccine shortage, only 29.5% of employees were vaccinated prior to the first intervention season. We have therefore considered the vaccination rate of the previous season (54% in 2003/04) as the baseline rate.

***During four consecutive seasons, this study added two components in the first season, none in the second and each one in the third and fourth season.

rates,^{24,25,29,30,34} for example, by providing periodic updates during staff meetings or in frequented areas of the hospitals.^{24,25} Intervention programmes that included feedback were associated with an increase between 44% and 76% in vaccine uptake.

Signed declination statement

Three intervention programmes included the use of a signed declination statement that required HCW to sign a form when the vaccine is refused, meanwhile ensuring that HCW receive appropriate information regarding the rationale and benefits of vaccination. These three programmes were associated with an increase in uptake from 43% at baseline to 67% (24% increase²⁵), 54%–71% (17% increase³⁴) and 38%–55% (17% increase³⁰). All three programmes had some similarities: they had tried other components in previous seasons, but felt to have reached a limit; were supported by top management; and combined the policy with other concurrent strategies, such as appointment of a special implementation team, additional educational efforts and extensive communication to and with staff. One used an intranet-based tool requiring HCW to document vaccination or declination for medical or other reasons with the dual use to educate staff.³⁰ In consequence, the specific contribution of the declination statement alone is unclear.

Mandatory vaccination

Three studies in the USA evaluated intervention programmes that involved mandatory influenza vaccination policies with resulting vaccination rates of >98%.^{31,34,35} Similar to the programmes that had introduced a declination statement, the policy of mandatory vaccination was accompanied by a number of other components. In 2004, a hospital in Seattle was the first medical centre to make annual influenza vaccination a mandatory requirement of every employee by making it a condition for employment.³⁵ In this study, previous campaigns with a large number of intervention components had been used, but vaccine uptake had remained between 30% and 54%. The multi-component intervention programme was then able to increase vaccine uptake to 97.6%, and to sustain rates of more than 98% during the four subsequent influenza seasons after the addition of a mandatory vaccination policy. The second study that introduced the requirement of a declination statement for non-vaccines was associated with an increase from 54% to 71% in the first season.³⁴ In the second season, mandatory vaccination was implemented and achieved a 98.4% vaccination rate among approximately 26 000 employees.³⁴ Both studies reported that having strong and visible leadership support as well as extensive communication was crucial in improving uptake rates successfully and in overcoming objections raised by

HCW. In the third study, vaccine uptake increased from 73% to 99.2% when mandatory vaccination was added to other strategies.³¹ In all three programmes, exemptions for medical or religious reasons were possible. Employees who were granted an exemption were required or encouraged to wear a surgical mask during the influenza season. Only a very small proportion of employees (0.03%–0.15%) were terminated or left the medical centre as a result of the policy.

Type C studies (before-and-after studies with control)

Five multi-arm type C studies^{36–40} implemented 14 intervention programmes (Table 3). In three studies,^{36,38,40} the baseline approach was continued in at least one site during the intervention season, which allowed comparison of post-intervention vaccination rates of interventions to concurrent control measures.

Similar to the type A studies, flexible and worksite delivery appeared to lead to a substantial increase in uptake. In all five programmes that involved flexible and worksite delivery alone^{38–40} or in combination with either educational sessions³⁷ or incentives,⁴⁰ HCW in the intervention group were more likely to receive the vaccine than those in the historical or concurrent control groups. Three of these intervention programmes resulted in a substantial increase (19.5%–40%) compared with the uptake at baseline.^{37–39} One of these studies reported that the intervention programme that included a mobile cart vaccination programme increased vaccine uptake by 20% in the first year compared with a decline of 3% among those HCW who only had the opportunity to receive vaccine at inconvenient locations.³⁹ A later analysis of reasons for non-acceptance of influenza vaccine found that inconvenient access was one of the main barriers for vaccination. A study from Switzerland implemented an intervention programme that included educational material and reminders in the entire institution, but in three departments with high-risk patients, the authors also organized on-site vaccination and educational conferences to address the issues that were identified in a previous survey as main reasons for non-receipt of vaccination.³⁷ In the departments where these additional intervention components were applied, the mean increase in uptake over baseline was significantly higher compared with that observed in the rest of the institution (24% versus 14% increase, respectively; $P < 0.001$). In a study from Singapore employees who were offered vaccine at their worksites were significantly more likely to be vaccinated compared with those employees who only attended the usual vaccination booths (40% versus 4% increase from 57% baseline respectively; $P < 0.001$).³⁸

In two studies where only the provision of incentives was added to the baseline vaccination activities,^{36,40} only

one⁴⁰ was associated with a significant increase in uptake. The latter compared the rates for educational material and reminders only (arm 1, continued baseline approach), addition of incentives (arm 2), use of mobile vaccination carts (arm 3) or both incentives and mobile carts (arm 4) with the baseline uptake. Although increases in uptake rate were small (5–10%), arms 2–4 significantly increased the vaccination rates compared with the pre-intervention baseline season because of the large number of HCW involved. The increase in arm 1 (2.5%) was not significant. The other study, a randomized controlled trial, showed no statistical difference in uptake rates between the continued baseline programme, the use of incentives (a raffle), educational letters and both combined.³⁶ However, the announcement of an influenza vaccine shortage during the intervention season of this study may have prevented a number of HCW from vaccine receipt as they potentially believed they were not a priority group for vaccination.

Type D studies

Two long-term studies conducted in the USA had observation periods of 12 and 18 years (Table 4).^{13,32} Although these studies started at low baseline uptake levels (<25% and 4%), eventually they achieved coverage rates of approximately two-thirds of the HCW. In the 12-year long study, providing regular feedback was a prominent part of a comprehensive and long-term strategy that was associated with an increase in vaccination rates from 4% at baseline to 67% as well as a significant decrease in nosocomial influenza among patients over time.¹³ The 18-year study established a 'mobile vaccination cart programme' that pre-scheduled vaccination times for all HCW, streamlined documentation of vaccination and trained nurses to educate HCW about additional methods for preventing nosocomial influenza transmission, such as proper hand hygiene.³² The study authors attributed the increase in vaccine uptake to 65% to 'the cumulative impact of ongoing education, communication and access'.

Discussion

Few methodologically rigorous studies have been published on how to successfully and sustainably raise influenza vaccine uptake rates among HCW; however, several insights emerged from our review of the available literature. We found in our limited analysis that programmes using a larger number of intervention components achieved higher vaccine coverage. Among specific strategies reported to have high success rates, the provision of free vaccine seems to be indispensable. The most effective intervention, however, appears to be a mandatory vaccination policy for healthcare workers. The three programmes that used this strategy achieved nearly universal coverage. While most

Table 3. Study type C ($n = 5$; before-and-after studies with control). Type C studies conducted more than one intervention programme during the same observation season. In the second to the last column, the vaccination rates before and after the 14 interventions were used to calculate odds ratios and 95% confidence intervals, showing the effect to improve vaccination rates compared with the historical control (at baseline). The odds ratios in the last column show the effect of intervention programmes ($n = 7$) in comparison with concurrent control measures, that is, where the baseline measures were continued^{36,38,40}

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Components added to previous season in intervention (IG) and control group (CG)	Study population	Baseline vaccination rate	Coverage after one season	Increase after one season	OR (95% CI) cf. to historical control	OR (95% CI) cf. to concurrent control
1	Dorototaj (2008) ³⁶	Cleveland, USA	No	Free vaccine, educational sessions, reminders	CG: no additional components (baseline approach) IG: incentives	200	34%	38%	4%	1.19 (0.77–1.83)	NA
2	Dorototaj (2008) ³⁶	Cleveland, USA	No	See campaign at baseline	IG: incentives	200	34%	39%	5%	1.24 (0.81–1.91)	1.04 (0.68–1.59)
3	Dorototaj (2008) ³⁶	Cleveland, USA	No	See campaign at baseline	IG: educational material	200	34%	42%	8%	1.41 (0.92–2.15)	1.18 (0.78–1.80)
4	Dorototaj (2008) ³⁶	Cleveland, USA	No	See campaign at baseline	IG: educational material, incentives	200	34%	44.5%	10.5%	1.56 (1.02–2.38)	1.31 (0.86–1.99)
5	Harbarth (1998) ³⁷	Geneva, Switzerland	Yes	Free vaccine, reminders	CG: educational material	4356	9%	23%	14%	3.02 (2.66–3.43)	NA
6	Harbarth (1998) ³⁷	Geneva, Switzerland	Yes	See campaign at baseline	IG: educational material and sessions, flexible and worksite delivery	1076	13%	37%	24%	3.93 (3.15–4.91)	NA
7	Lee (2007) ³⁸	Singapore	No	Free vaccine, educational material, incentives	CG: no additional components (baseline approach) IG: flexible and worksite delivery	5946	57%	61%	4%	1.19 (1.11–1.28)	NA
8	Lee (2007) ³⁸	Singapore	No	See campaign at baseline	IG: flexible and worksite delivery	5946	57%	97%	40%	24.39 (20.82–28.72)	20.50 (17.5–24.1)

Table 3. (Continued)

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Components added to previous season in intervention (IG) and control group (CG)	Study population	Baseline vaccination rate	Coverage after one season	Increase after one season	OR (95% CI) cf. to historical control	OR (95% CI) cf. to concurrent control
9	Sartor (2004) ^{†39}	Marseille, France	No	Free vaccine, reminders	CG: educational material	2349	7%	4%	-3%	0.55 (0.42-0.73)	NA
10	Sartor (2004) ³⁹	Marseille, France	No	See campaign at baseline	IG: educational material, flexible and worksite delivery	2216	7%	26.5%	19.5%	4.79 (3.95-5.81)	NA
11	Zimmerman (2009) ^{†40}	Pittsburgh, USA	Yes	Free vaccine, educational material, reminders, feedback	CG: no additional components (baseline approach)	1247	32%	34.5%	2.5%	1.12 (0.94-1.33)	NA
12	Zimmerman (2009) ⁴⁰	Pittsburgh, USA	Yes	See campaign at baseline	IG: incentives	3904	32%	38%	6%	1.30 (1.19-1.43)	1.16 (1.02-1.33)
13	Zimmerman (2009) ⁴⁰	Pittsburgh, USA	Yes	See campaign at baseline	IG: flexible and worksite delivery	2461	30%	39%	9%	1.49 (1.32-1.68)	1.21 (1.05-1.40)
14	Zimmerman (2009) ⁴⁰	Pittsburgh, USA	Yes	See campaign at baseline	IG: incentives, flexible and worksite delivery	6500	31%	41%	10%	1.55 (1.44-1.66)	1.32 (1.16-1.50)

*In this study at an urban tertiary care hospital, four groups consisting of randomly selected HCW of different professional categories were simultaneously exposed to distinct sets of intervention components. Beyond the usual annual vaccination campaign, the intervention groups were randomly assigned to either receive a raffle ticket offer to win a vacation, an educational letter explaining the importance of influenza vaccination for HCW, or both the raffle ticket offer and the educational letter. The control group received only components that were already offered during the annual vaccination campaign (educational posters, newsletters, T-shirts, buttons, department meetings and open access for long hours at multiple influenza vaccination sites).

**This study provided several intervention components at three departments with high-risk patients for nosocomial influenza only, while basic components (education, reminders) were applied in the entire institution. Vaccination rates were then compared between these two areas.

***The reporting rate of employees attending worksite vaccine delivery was 86.9% versus 70.4% at vaccination booths (OR, 2.77; 95% CI, 2.29-3.37). However, only 24% of all employees were reached by worksite vaccination arrangements.

†The table provides the vaccination rates achieved by the employee health unit among all HCW (upper row) and by the mobile cart programme among those who had not been vaccinated by the health unit or otherwise (lower row).

††This study involved non-physician employees in a large healthcare system in the USA. Of the 11 participating facilities, four had incentives including a grocery store gift card and lottery to win a paid day off (second row), while two had mobile vaccination carts only, (third row) three facilities had both incentives and carts (forth row), and two control sites had neither (first row).

Table 4 Study type D. Type D studies implemented and assessed long-term intervention programmes with an observation period of more than 10 years

Programme	Author (year of publication)	Place of study	Tailored strategy	Components used before and continued during intervention programme	Intervention components added to baseline approach	Study population at baseline	Baseline vaccination rate	Coverage after one observation season	Coverage after several observation seasons	Increase after several seasons
1	Nichol (CDC) (2005) ³²	Minneapolis, USA	No	Free vaccine	Educational material, reminders, flexible and worksite delivery, assignment of dedicated staff	3177	<25%	Not indicated	65% (after 18 years)	40% (after 18 years)
2	Salgado (2004) ¹³	Charlottesville, USA	No	Free vaccine, educational material*, reminders	Flexible and worksite delivery, feedback	Not indicated	4%	26%	67% (after 12 years)	63% (after 12 years)

*Summary of CDC guidelines used as annual memorandum.

studies reviewed were implemented during a single season, we found evidence that sustained efforts lead to high and sustained vaccination uptake rates.

Provision of free vaccine was used in almost all programmes at baseline, but was formally evaluated in one study where it appeared to be the crucial component to substantially improve vaccine uptake after other strategies before showed either zero or a lesser success.³³ This finding is consistent with results of a meta-analysis of studies that have investigated self-reported reasons for non-receipt of the vaccine where inconvenient access has been identified as one of the major obstacles, particularly for physicians.¹⁷

Other useful intervention components included flexible and worksite vaccine delivery, the assignment of staff dedicated to take responsibility for the programme, and provision of educational materials. Regarding the latter, an important aspect of designing educational material is that nurses and physicians will likely need to be targeted in different ways.^{21,41} This is supported by several studies that found that the vaccination rate of nurses was significantly lower than that of physicians,^{19,39,41–49} and research indicating large differences in attitudes and knowledge concerning influenza vaccination between nurses and physicians.^{37,41,42,50–55} Educational messages will likely need to be conveyed in many different ways to increase the likelihood and frequency of encounters. A recent meta-analysis on interventions for adult immunization programmes supports the notion of the potential positive effects incentives may have.⁵⁶ Understanding knowledge and attitudes prior to the intervention has been used to tailor intervention programmes and shape the contents of educational activities to local needs and was also assessed by several studies. Although some of these tailored studies reported a substantial increase in uptake, their success could not be linked directly to the conducted survey.^{18,33,37} Because local conditions, peer opinion, cultural, institutional and logistical factors will all lead to differences in knowledge and behaviour and because reasons for refusal of the vaccine cover a wide and diverse spectrum, the use of a pre-intervention survey makes intuitive sense.

Making vaccination a mandatory condition of initial and continued HCW employment is likely to be the most controversial, but also successful method for increasing uptake.^{57–62} A recent survey among US HCW who reported working at a facility where vaccination was required by their employer, 98.1% were vaccinated.⁶³ Insufficient vaccine uptake levels have prompted numerous healthcare facilities in the USA to institute mandatory programmes for their HCW to protect patients.^{62,64,65} Moreover, several US professional societies recommended that influenza vaccination of HCW be made mandatory,⁶⁶ and several studies showed support for this policy among HCW in the USA and medical students in Germany.^{67–70} However, the

vaccination mandate in the USA has met considerable resistance. HCW protested against the implementation of a vaccination requirement and made a successful legal challenge on the basis that the hospital had violated the terms of their contracts.^{57,60,61,71} Opponents claim that a mandate violates HCW personal autonomy and right to make medical decisions concerning their body themselves and that it may 'alienate staff and damage morale', undermine trust and negatively affect employee–employer relationship.^{58,60–62,71,72} Commentators who support mandatory vaccination assume the failure of voluntary vaccination strategies and argue that the benefits for patients outweigh burdens and risks of vaccination on behalf of the HCW and that the restrictions of HCW autonomy and freedom of choice are therefore ethically justified, unless a valid medical contraindication exists.^{62,66,68,73–76} From their perspective, mandatory programmes meet the professional values and codes of ethics adopted by HCW, that is, to do no harm and to act in patients' best interests.^{58,77} However, while the prevention of harm to others is a potential reason for the limitation of autonomy, mandatory measures are only justified under certain conditions.^{71,75,78–80} Successful programmes presented in this review have made substantial organizational and educational efforts prior to the start of the mandatory policy suggesting that a mandatory programme must not be used as the easy, administrative magic bullet, but needs at least contemporaneous or even better antecedent implementation of a multifaceted programme using other elements described in this review to maximize chances for a 'friendly reception' of the policy by staff.

One alternative or compromise may be represented by a recently published study that implemented a 'multifaceted patient safety programme' combining the institutional responsibility to protect patients from nosocomial infections with the HCWs' right for vaccine declination for any reason.⁸¹ The programme, which was associated with a vaccination rate of 96%, required all employees with direct patient contact¹¹ to choose between vaccination and an 'appropriate non-vaccine alternative', that is, either to wear a surgical mask or to exclude patient contact. Other authors have also made the case for a 'combined approach' using 'opt-out' declination statements in conjunction with the exclusion of unvaccinated HCW from work in defined areas where the most vulnerable patients are cared for, such as ICUs, oncology, transplantation.^{82,83}

There is evidence, however, that sustained efforts of voluntary vaccination programmes are capable of leading to high vaccination rates nevertheless. Two institutions in the USA who observed results of their interventions for 12 and 18 years, respectively, were both able to increase vaccination uptake rates from moderately or very low levels to two-thirds of their targeted health personnel.^{13,32} Moreover, experience from the USA indicates that on a country-wide

scale, it requires many years to raise influenza vaccination rates substantially. In 1989, the national vaccination coverage among HCW was still at the 10% level, but was estimated at 34% in 1997, 44% in 2003 and at 63.5% in 2011.^{16,55,63,84} These long-standing efforts would indicate a degree of management support for the programme, a likely factor in success not explicitly measured in any of the studies reviewed.

Finally, one unique intervention approach not included in our review was tried by the MOH of Germany that conducted a nationwide, low-cost, 2-year vaccination programme targeted to all hospitals in the country.⁴¹ The material included posters, pamphlets and briefing notes for mass mailings and a presentation for informational sessions. An evaluation of a convenience sample of 20 hospitals showed that the uptake rate increased only in those who used the material, albeit by <10% points indicating that such an approach can effectively complement and support efforts in individual hospitals to raise influenza vaccination uptake rates.

The typical study evaluated one intervention programme with multiple intervention components in one facility during a single season and the studies reported a wide variety of interventions. Consequently, our retrospective analysis has a number of limitations. First, the reporting of intervention studies is likely subject to publication bias as studies without an increase in vaccination rate after an intervention are less likely to be published. Second, although we attempted to make interventions more comparable by grouping them into distinct components, it is clear that neither individual intervention components nor intervention programmes can be standardized and any comparisons should be made with caution. Intervention components were not mutually exclusive and often one activity entailed elements of two different components. For example, worksite delivery of vaccines was often combined with education on-site. Furthermore, some single activities had overlapping purposes, so it was difficult to assign them to one intervention component. For example, there may have been reminders that repeated educational messages. Third, each component may be implemented in a number of different ways. For example, the provision of educational material may differ in wording, in the way it is presented, its appropriateness for the target audience, where and how and in which number it is presented or delivered, and of course other often intangible factors. Lastly, comparison of the effect of components also may vary depending on the type of comparison group, if a control group was included in the design, or if settings were randomized. For example, before-and-after studies without comparable control group are logistically easier but do not control for any influence from outside the intervention programme, such as vaccine shortage or changes in awareness over time.

In conclusion, the authors believe that vaccination of HCW is a key part of a strategy to prevent influenza in

groups who are most at risk of complications. The reviewed literature suggests that while no single component is capable of raising influenza vaccination rates in HCW rapidly and to a relevant degree, except perhaps mandatory vaccination, a comprehensive, well-supported, well-staffed and well-planned, multifaceted vaccination intervention programme can raise uptake rates substantially and sustainably. Indeed, it seems likely that in such a multifaceted programme, the individual components described in this review would support each other and perhaps have a synergistic effect. A successful programme would contain as many elements as possible (Text box 1); however, in resource-limited settings, hospital managers might want to focus on two components that seem to be most effective in rapidly raising vaccination rates. First, flexible access to free vaccination is key to overcome time- and access-related barriers to vaccine uptake. Second, the approach for a successful HCW vaccination programme requires culturally sensitive education on the risk of influenza and the overall benefits of vaccination, tailored to specific professional characteristics. Periodic surveys can help to identify specific motivators and barriers of HCW vaccine receipt and to tailor programmes accordingly. Programmes that attain higher vaccination rates can expect in turn to reduce the risk of nosocomial influenza infections and related healthcare costs.^{13,14} It is also worth noting that predictor studies have found consistently that 'history of influenza vaccination' is perhaps the most reliable factor associated with vaccine receipt in the next season.^{43,45,48,85,86} While these previously vaccinated HCW represent 'low hanging fruit' for an intervention programme, it also means that HCW who have rejected the vaccine in previous years may be particularly resistant. Programmes aiming for high rates of coverage will need to target this group of HCW. Hospital managers who consider influenza vaccination uptake rates in their employees as a quality marker for their facility should be prepared to commit the required human and financial resources to meet this goal.

Text box 1. Elements suggested for a successful HCW vaccination programme

1. Commitment of and strong support by the hospital's top management;
2. Pre-intervention information collection to identify important barriers to vaccination with a consequent adjustment (tailoring) of the intervention programme to the gained experience from the pre-intervention investigations (e.g. profession, gender, race sensitive);
3. Provision of free vaccine;
4. Organization of easily accessible vaccine, for example, through flexible and worksite delivery;

5. Organization of several activities belonging to the components educational material, education session, reminders, incentives;
6. Management optimization, such as (i) assignment of (one or more) dedicated staff to organize and actively promote the measure, and/or (ii) giving feedback of vaccination uptake rates during the preparation phase for the influenza season;
7. In a well-prepared setting: requirement of all HCW to become vaccinated against influenza with the possibility to opt-out by signing a declination statement;
8. Continuation of the assessment – planning – intervention cycle for several years.

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Annex 1: Search strategy for review of interventions to increase influenza vaccination among healthcare workers in hospitals

To assist in the development of successful vaccination programmes, we reviewed studies where interventions aimed to increase the uptake of influenza vaccination among hospital healthcare workers (HCW). For the inventory of intervention studies, published articles were identified searching PUBMED computerized database from January 1990 to December 2011 with a combination of keyword and subject heading searches using the following terms: 'influenza', 'health personnel', 'vaccination', 'influenza vaccines', 'hospitals'. We also checked the reference lists of relevant publications, including reviews and meta-analyses of interventions aimed at increasing influenza vaccination rates among HCW. The exact search strategy included the following steps (Figure A1):

Step 1

('Influenza, Human'[Mesh] OR 'Influenza B virus'[Mesh] OR 'Influenza A virus'[Mesh] OR 'Influenzavirus B'[Mesh] OR 'Influenzavirus A'[Mesh] OR influenza*[TIAB] OR 'flu'[TIAB] OR 'grippe'[TIAB] OR 'seasonal influenza'[Text Word] OR 'flu'[Text Word]).

Step 2

('Health Personnel'[MeSH] OR 'Allied Health personnel'[MeSH] OR 'Caregivers'[MeSH] OR 'Physicians'[MeSH] OR 'Medical Staff, Hospital'[MeSH] OR 'Health Personnel'[tw] OR 'Healthcare workers'[tw] OR 'Healthcare worker'[tw] OR 'Medical Staff'[tw] OR 'General Practitioners'[tw] OR 'Caregivers'[tw] OR 'Nurses'[MeSH] OR 'Nurses Aides'[MeSH] OR 'Nurse Practitioners'[MeSH] OR 'Nurses'[tw] OR 'Nurse'[tw] OR 'Midwives'[tw] OR 'Nurse Practitioners'[tw] OR 'Nursing Staff'[tw] OR 'Students, Medical'[MeSH] OR 'Students,

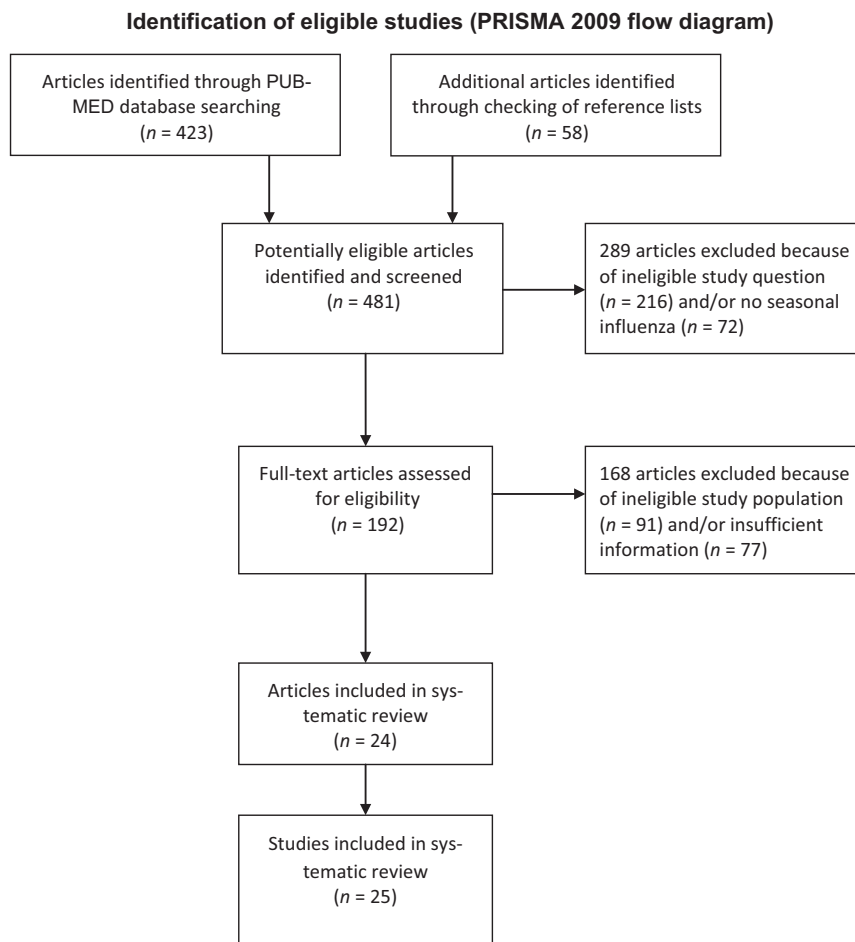


Figure A1. Identification of eligible studies (PRISMA 2009 Flow Diagram).

Nursing'[MeSH] OR 'Medical students' [tw] OR 'Nursing students'[tw]).

Step 3

('Hospital Units'[Mesh] OR 'Hospitals'[Mesh] OR 'hospital' [TIAB] OR 'hospitals' [TIAB]).

Step 4

('Vaccination'[Mesh] OR 'immunization' [TIAB] OR 'immunisation' [TIAB]) OR 'Vaccines'[Mesh] OR vaccination [TIAB] OR vaccines [TIAB] OR vaccine [TIAB]).

Step 5

('Influenza Vaccines'[Mesh] OR 'Influenza Vaccines' [TIAB] OR 'Flu Vaccines' [TIAB] OR 'Influenza Vaccine' [TIAB] OR 'Flu vaccine' [TIAB]).

Combinations

Combo #1 – Step1 and Step2 and Step3 and Step4	489
Combo #2 – Step2 and Step3 and Step5	359
Combo #1 or Combo #2	491

Limits

Publication Date from 1990/01/01 to 2011/12/31 and English, French, German	423
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Additional articles

Additional articles ($n = 58$) that were identified through checking of the reference lists of relevant publications	481
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