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## Effects of a multi-faceted program to increase influenza vaccine uptake among health care workers in nursing homes

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*Published in:*  
Vaccine

*DOI:*  
[10.1016/j.vaccine.2010.05.003](https://doi.org/10.1016/j.vaccine.2010.05.003)

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*  
Publisher's PDF, also known as Version of record

*Publication date:*  
2010

[Link to publication in University of Groningen/UMCG research database](#)

### *Citation for published version (APA):*

Looijmans-van den Akker, I., van Delden, J. J. M., Verheij, T. J. M., van der Sande, M. A. B., van Essen, G. A., Riphagen-Dalhuisen, J., Hulscher, M. E., & Hak, E. (2010). Effects of a multi-faceted program to increase influenza vaccine uptake among health care workers in nursing homes: A cluster randomised controlled trial. *Vaccine*, 28(31), 5086-5092. <https://doi.org/10.1016/j.vaccine.2010.05.003>

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# Vaccinating healthcare workers against influenza to protect the vulnerable—Is it a good use of healthcare resources? A systematic review of the evidence and an economic evaluation

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Received 19 October 2005; received in revised form 15 December 2005; accepted 22 December 2005

Available online 9 January 2006

## Abstract

Influenza causes substantial mortality in high-risk groups despite targeted vaccination programmes. This paper considers whether it is worth vaccinating healthcare workers (HCWs) against influenza to protect high-risk patients in a series of systematic reviews and an economic evaluation. Eighteen studies are included. Vaccination was highly effective in HCWs, with minimal adverse effects. Two trials assessed patient mortality after vaccinating HCWs, both of which showed a reduction. Despite recommendations, less than 25% of HCW in Europe and the UK are vaccinated. Five studies looked at programmes to increase uptake; these produced increases of 5%–45%. Published economic evaluations did not include patient benefit; therefore, an economic evaluation using UK data was undertaken. In the base case, vaccination was cost saving (£12/vaccinee). In the most pessimistic scenario it cost £405/life-year gained. Effective implementation should be a priority.

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**Keywords:** Healthcare workers; Influenza vaccination; Systematic review; Economic evaluation

## 1. Introduction

Appropriate policies for healthcare not only require information about effectiveness, safety and cost-effectiveness, but also need adequate implementation. Influenza is an important public health problem and it causes significant mortality particularly in the elderly and high-risk groups [1]. An obvious policy is to vaccinate those most at risk and most countries in Europe and North America have such programmes [2]. Although the benefit of vaccination is

well documented [3,4], there remains significant influenza-associated morbidity and mortality in the high-risk. A complementary approach to protecting the vulnerable could be to provide indirect protection by vaccinating others to reduce transmission of influenza. Vaccination of children has been shown to have the potential to reduce morbidity and mortality in others [5]. Healthcare workers (HCWs) can cause outbreaks in patients in the healthcare setting [6]. Although the World Health Organisation recommends that HCWs should be vaccinated against influenza [1], policy in Europe is variable and uptake poor (less than 25%) [2,7].

Research was commissioned by the European Scientific Working Group on Influenza (ESWI) to look at the effectiveness and cost-effectiveness of vaccinating HCWs as an indi-

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rect means of protecting high-risk patients against influenza. This paper integrates the findings from systematic reviews looking at the effectiveness, cost-effectiveness and factors affecting uptake, and an economic evaluation.

**2. Methods**

*2.1. Search strategy*

We searched electronic databases (Cochrane library, CINAHL, NHSEED, HEED, DARE, MEDLINE and EMBASE to June 2004), Internet sites, registers of trials, citation lists and contacted experts. No language restrictions were applied. (Full details available on request.)

Key words used: influenza; health personnel; health care worker; health worker; care giver; physician; medical staff; nurses; nursing home; homes for the aged; residential home; vaccination; influenza vaccine.

*2.2. Inclusion criteria*

Studies were included if they fulfilled the following criteria:

*Design:* Any

*Population:* HCWs in hospitals, nursing homes or the community in contact with high-risk individuals

*Intervention:* Influenza vaccination

*Comparator:* No vaccination, placebo or vaccine unrelated to influenza

*Primary outcomes (in high-risk contacts):* Culture or serologically confirmed influenza; all-cause mortality; mortality attributed to influenza/pneumonia; influenza-like illness; influenza-related morbidity; cost or cost-effectiveness.

*Secondary outcomes (in vaccinated population):* Effectiveness; adverse events; acceptability; uptake; methods of attaining uptake; absenteeism.

*2.3. Selection, quality assessment and data extraction*

Studies were selected, appraised (using validated checklists [8,9]), and data extracted by two reviewers independently. Discrepancies were resolved by discussion. Results were tabulated and described. Meta-analyses were considered inappropriate because of heterogeneity in populations, settings and design.

*2.4. Economic evaluation*

No economic evaluation was found that included indirect effects on patients. A simple decision analytic model of the cost-effectiveness of a programme of vaccinating HCWs, compared to no programme, was constructed in Excel®. It used the key Carman trial [10] (details below) to provide data for effectiveness, resources and costs concerning the vaccine, campaign, staff time, staff ratios and absenteeism. Information from the above systematic review, published literature

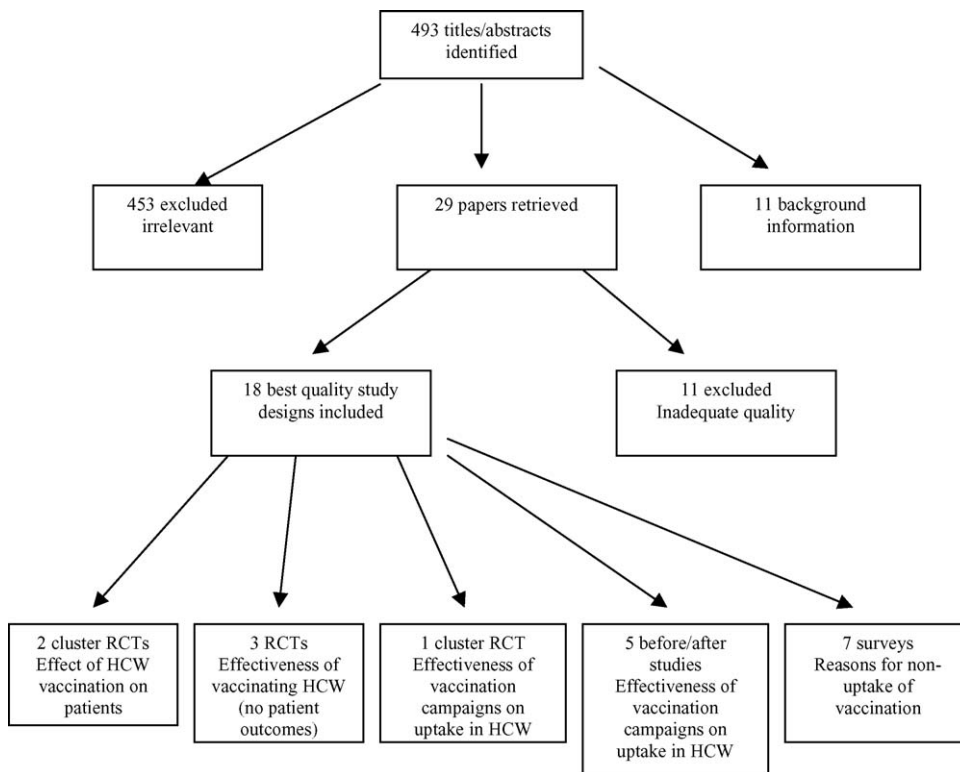


Fig. 1. Flow of study selection for clinical effectiveness.

and routine data informed other parameters. The perspective is that of the healthcare provider—both direct effects of preventing influenza in those vaccinated and indirect effects of protecting patients are included. UK costs are for 2003–2004. Future benefits are discounted at 3.5%. Adverse effects are assumed to be negligible and have no effect on absenteeism. Costs of replacing staff use standard rates (agency rates would be higher giving a more favourable cost-effectiveness ratio for vaccination).

### 3. Results

We identified 493 studies relating to vaccinating healthcare workers. Eighteen met the inclusion criteria [10–27] (see Fig. 1). Details of the studies are given in Table 1.

#### 3.1. Does vaccinating HCWs protect those at risk?

The main evidence comes from two cluster-randomised controlled trials (RCTs) performed in the 1990s in long-term care geriatric hospitals in Scotland: Carman et al. [10] and Potter et al. [11] (Table 2). Both trials were of reasonable quality, of appropriate cluster design (although small numbers of clusters) and used methods to allow for baseline imbalance in potential confounders. In Carman et al. [10] the method of cluster analysis was not clearly reported. Both demonstrated clinically significant reductions in mortality when a staff vaccination programme was introduced. In the Potter trial [11], a reduction from 17% to 10% was reported, with a *p*-value (adjusted for cluster design) of 0.013. The odds ratio (OR) was 0.56 (95% CI 0.4, 0.8) but these confidence intervals did not appear to take account of the clustered design and should be interpreted with caution. In the main trial, Carman, 20 hospitals were stratified, paired for patient vaccination policy and size, and randomly assigned within each pair to a programme of offering vaccination to all HCWs, or no programme. In the programme arm 51% of HCWs were vaccinated, and 5% in the control arm. The vaccine was a good match to circulating virus. Uncorrected mortality was 13.6% in the vaccinated arm compared to 22.4% in control arm (OR 0.58, 95% CI 0.40–0.84, *p* = 0.014). The difference remained statistically significant when the analysis was adjusted for individual confounders. When all confounders, i.e., Barthel score, age, sex and vaccination of patients were adjusted for simultaneously, the result was of borderline statistical significance (OR = 0.61, 95% CI 0.36–1.04).

#### 3.2. Why are influenza vaccine uptake rates low in HCWs?

Ten studies assessed reasons why HCWs receive or decline influenza vaccine using questionnaires [18–27].

Survey methods, setting and staff categories varied widely and studies cannot be directly compared. Response rates

ranged from 34% to 100%. Common reasons for refusing vaccination were:

- fear of side effects (8%–51%) [18–27];
- fear that vaccination would cause influenza (21%–45%) [21,25];
- dislike of injections (5%–27%) [18–21,23–27];
- unaware the vaccine was available/useful (3%–53%) [21,22,25–27];
- forgetting/lack of time (5%–60%) [18,20,22–24,26,27];
- perceived low risk of contracting influenza (5%–29%) [18,20,21].

Those who were vaccinated did so mainly to protect themselves (82%–83%), with 62%–67% wishing to protect patients [19,24].

#### 3.3. What are the effects of influenza vaccine on the recipients?

Three randomised controlled trials reported the effects of influenza vaccine on HCWs [12–14] (Table 3). Two were of good quality [12,14]. Randomisation methods, blinding and loss-to-follow up were not adequately reported in the third [13]. One good study [12] reported a statistically significant reduction in rates of serologically confirmed or clinical influenza, (vaccine efficacy of 88% (95% CI 47%, 97%)) for influenza A. The other two trials reported no difference although in one there was a poor vaccine match [14] and in the other the incidence of influenza was low [13]. A high quality systematic review [28] found that vaccination would reduce absenteeism by about 0.4 (95% CI 0.1–0.8) working days per person vaccinated in healthy adults. Only one study reported a statistically significant mean reduction in absenteeism due to respiratory infection in the intervention group: 1.0 days/person compared with 1.4 days/person in the unvaccinated group (*p* = 0.02) [13].

Only one trial reported the adverse effects of vaccination [14]. These were sore arm (51% vaccine versus 7% placebo) and erythema (11% versus 0%). This agrees with the systematic review where soreness was twice as common in the vaccine groups compared with the placebo groups (RR = 2.1, 95% CI 1.4, 3.4) [28].

#### 3.4. Can influenza vaccine uptake rates be improved in HCWs?

Seven studies (with control arms) evaluated whether promotional campaigns could improve uptake of influenza vaccine in HCWs: two cluster RCTs [10,15]; one non-randomised controlled trial [16]; and four before/after studies [17–20] (Table 5). The quality of the studies was limited, partly because of biases and problems of confounding inherent in the study designs, and partly because of poor reporting or execution (Table 4). Direct comparisons are difficult as study design and vaccination programmes were very different. Baseline (control) uptake rates varied from 5% to 17%,

Table 1  
Characteristics of accepted studies

Study	Location	Study design	Setting	Assessment	Outcome measures
Randomised controlled trials					
Carman [10]	Scotland, UK	Cluster RCT	NHS long-term care geriatric hospital wards	Protection of patients by the vaccination of HCW against influenza	Patient mortality; virological monitoring; vaccination uptake
Potter [11]	Scotland, UK	Cluster RCT	NHS long-term care geriatric hospital wards	Protection of patients by the vaccination of HCW against influenza	Patient mortality; ILI infection; LRTI infection; vaccination uptake
Wilde [12]	US	RCT	Two large teaching hospitals	Effectiveness of vaccinating HCW against influenza	Serologically-confirmed influenza; absenteeism; side effects
Saxen [13]	Finland	RCT	Two paediatric hospitals	Effectiveness of vaccinating HCW against influenza	Respiratory infection; absenteeism
Weingarten [14]	US	RCT	One hospital	Effectiveness of vaccinating HCW against influenza	Clinical influenza; absenteeism; side effects
Dey [15]	UK	Cluster RCT	Primary healthcare teams and nursing homes	Effectiveness of campaign to vaccinate HCW against influenza	HCW uptake rates
Non-Randomised controlled trials					
Tannenbaum [16]	Canada	Before/after study with control arm	Two nursing homes	Effectiveness of campaign to vaccinate HCW against influenza	HCW uptake rates
Cooper [17]	Australia	Before/after study	347-bed hospital	Effectiveness of campaign to vaccinate HCW against influenza	HCW uptake rates
Harbarth [18]	Switzerland	Before/after study	1500 bed hospital for primary and tertiary care	Effectiveness of campaign to vaccinate HCW against influenza	HCW uptake rates; reasons for non-uptake
Thomas [19]	US	Before/after study	300-bed nursing home	Effectiveness of campaign to vaccinate HCW against influenza	HCW uptake rates; reasons for non-uptake
Heimbürger [20]	US	Before/after study	Chronic care psychiatric facility	Effectiveness of campaign to vaccinate HCW against influenza	HCW uptake rates; Reasons for non-uptake
Christian [21]	US	Survey	Acute care hospital	Questionnaire of vaccination rates and reasons	HCW uptake rates; reasons for non-uptake
Ganguly [22]	US	Survey	Veterans hospital	Questionnaire of vaccination rates and reasons	HCW uptake rates; reasons for non-uptake
Nafziger [23]	US	Survey	Two hospitals	Questionnaire of vaccination rates and reasons	HCW uptake rates; reasons for non-uptake
Nichol [24]	US	Survey	400-bed hospital	Questionnaire of vaccination rates and reasons	HCW uptake rates; reasons for non-uptake
Stephenson [25]	UK	Survey	Three acute hospitals	Questionnaire of vaccination rates and reasons	HCW uptake rates; reasons for non-uptake
Watanakunakorn [26]	US	Survey	650-bed community teaching hospital	Questionnaire of vaccination rates and reasons	HCW uptake rates; reasons for non-uptake
DeAngelis [27]	US	Survey	Paediatric medical healthcare provides	Questionnaire of vaccination rates and reasons	Reasons for non-uptake

RCT = randomised controlled trial; ILI = influenza like illness; LRTI = lower respiratory tract infection; HCW = healthcare worker.

Table 2  
 Characteristics of trials evaluating the effect of vaccinating healthcare workers on patient morbidity and mortality

	Potter [11]	Carman [10]
Trial dates	1994–1995	1996–1997
Number of clusters	12	20
Setting	NHS medical long-term-care geriatric hospitals in Scotland	NHS medical long-term-care geriatric hospitals in Scotland
Intervention	Vaccination routinely offered	Vaccination routinely offered by letter and interview by trained study nurses
Control	Vaccination not routinely offered	Vaccination not routinely offered
Vaccine match	Reasonable match	Good match to circulating strain
Influenza epidemic	Yes	Yes
Number of HCW	1078 identified in intervention group and 653 (61%) agreed to participate and receive vaccination	1217 offered vaccination but number in control group not given
Health care workers involved	Nurses, doctors, therapists, porters and ancillary staff	Nurses, doctors, therapists, porters and ancillary staff
Number of patients	1059 (490 intervention, 569 control)	1437 (749 intervention, 569 control)
Randomisation procedure	Hospital sites stratified by unit policy for vaccination and then randomised to receive intervention or control	Random allocation, clusters balanced and stratified for policy of vaccination of patients and size. Cluster paired by these characteristics and one chosen from each pair by random number tables for intervention
Outcomes	<ol style="list-style-type: none"> <li>1. Patient mortality</li> <li>2. Influenza-like infection rates—patients</li> <li>3. Lower respiratory tract infection—patients</li> <li>4. HCW uptake rate</li> </ol>	<ol style="list-style-type: none"> <li>1. Patient mortality</li> <li>2. Prospective virological monitoring (nose and throat swabs) during winter epidemic on random sample (50%) of patients</li> <li>3. HCW uptake rate</li> </ol>
Mortality results	Reduction from 17% (control) to 10% (intervention), $p=0.013$ (OR 0.56)	Uncorrected mortality reduction from: 154/688 (22.4%) control to 102/749 (13.6%) intervention, OR 0.58 (95% CI 0.4–0.84), $p=0.014$ . All <i>corrected</i> rates significant except when corrected for Barthel score, age, sex and vaccination profile together: OR 0.61 (0.36–1.04) (borderline $p=0.092$ )
HCW vaccine uptake rate	Control = not given Intervention arm = 61%	Control = 5% Intervention = 50%

and increased by 5%–45% following the campaigns. The most successful campaign was a mobile clinic in Australia [17]. From a baseline of 8% this achieved a post-campaign vaccination rate of 81% in staff in contact with patients and 49% overall. A similar mobile vaccination cart in the USA achieved 61% uptake in a survey [24], and a subset of a further study also supports this [18].

### 3.5. How cost-effective is the vaccination of healthcare workers?

No studies were found which included the benefits to patients from vaccinating HCWs. Three studies evaluated the cost-benefit of vaccinating HCWs [29,30] or care workers [31]; 11 studies evaluated other healthy adults [32–42]. They had either a societal or employers perspective, although widely different designs, costs and parameters were used. Ten out of these 14 studies (including both on HCWs [29,30]) were found to be cost saving.

In our base case analysis, (Table 5) which included the costs of replacing staff arising from staff absenteeism, a vaccination programme was found to be cost saving, saving approximately £28,000 for 1437 vaccinations (Table 6). This equates to a saving of approximately £1400 for a 72-bed ward or £12 per vaccinee. The base case assumes that NHS staff who are absent are replaced. Since this does not always hap-

pen in practice, an alternative base case excluding the cost of replacing staff was tested. This cost £51/life-year gained as no costs due to absenteeism were saved. Univariate sensitivity analyses for each parameter were undertaken and in a “worst-case” scenario (using the estimates for each parameter that produce a less favourable estimate of cost-effectiveness) the cost was still only £405/life-year gained (Table 6).

## 4. Discussion

### 4.1. Key results

The evidence for the indirect protection of patients at high-risk for influenza and factors influencing vaccine uptake by HCWs have not previously been the subject of systematic reviews. Our review suggests that vaccination of HCWs against influenza protects HCWs and provides indirect protection to the high-risk. It is cost-effective and indeed probably cost saving.

### 4.2. Limitations and strengths

Only two trials examined the impact of immunising HCWs against influenza on high-risk patients [10,11]. Sparse information on primary outcomes is therefore a major weakness.

Table 3  
 Characteristics and summary of the benefits of influenza vaccination in HCWs

Study	Brief description	Vaccine match/epidemic	Influenza/ILI rates	Vaccine efficacy (%) (95% CI) (serologically confirmed influenza)	Absenteeism	Adverse events
Wilde [12] US	RCT Vaccine vs. placebo 3 years 361 person—winters  Good quality trial	Year 1—Partial Year 2—Good Year 3—Partial  Epidemic each year	Overall Serologically confirmed: Influenza A: 1.1% vaccine vs. 8.9% control ( $p=0.001$ ) Influenza B: 0.6% vaccine vs. 5% control ( $p=0.02$ ) Year 2: 0% vaccine vs. 7.1% control cases of flu A	88% (47%, 97%) for Influenza A (H3N2) 89% (14%, 99%) for Influenza B	Mean absence (all illness) days $\pm$ S.D. 0.1 days $\pm$ 0.35 (vaccinated) vs. 0.21 days $\pm$ 0.75 (control) Not statistically different (no $p$ -value given)	Serum sickness, cellulitis and lymphangitis in three controls Other than mild pain or swelling at injection site, the rest of the subjects reported no significant adverse effects
Saxen [13] Finland	RCT Vaccine ( $n=216$ ) vs. placebo ( $n=211$ )  Poorer quality relatively large trial	Good match  Low incidence of influenza	1.8 episodes respiratory infection per person (vaccine) vs. 2 episodes (placebo) Not statistically different (no $p$ -value given)	N/A	Mean absence (days) due to respiratory infection 1.0 day (vaccinated) vs. 1.4 days (unvaccinated) $p=0.02$	Not reported
Weingarten [14] US	RCT Vaccine (91) vs. placebo (88) Follow-up completed for 99% patients. Good quality small trial	Poor match  Epidemic present	No significant differences between trial arms for rates of clinical influenza (23% vaccinated vs. 22% control), duration of flu or fever and severity of flu. ( $p=0.95$ )	N/A	Mean absence (all illness) (hours) ( $\pm$ S.D.) 7.6 h $\pm$ 12.1 (vaccinated) vs. 8.2 h $\pm$ 18.3 (control). ( $p=0.91$ ) Percent employees absent 42.9% (vaccine) vs. 43.2% (control) ( $p=0.97$ )	Sore arm 51% vaccinated vs. 7% control $p<0.05$ Erythema, 11% vaccinated vs. 0% control $p<0.05$ No other significant effects reported

RCT = randomised controlled trial.

Table 4  
Effectiveness of promotional campaigns on vaccine uptake in seven studies with control phase/arm

Study	Setting and study population	Study design	Study details (n)	Details of vaccine campaign	Uptake rates	Quality issues
Randomised/external comparison						
Dey [15]	UK; primary health care teams (PHCT) and nursing homes (NH); all HCW	Cluster RCT	Large cluster trial; 64 PHCT; 34 NH; (n = 2984 HCW)	Letter ± public health nurse visit and promotion; Vaccination given by GP	PHCT 21.9% intervention, 21.0% control (p = 0.91) NH 10.2% intervention, 5.6% control (p = 0.34)	Good quality although randomisation procedures not given in full
Carman [10]	UK; long-term geriatric hospitals; all HCW; data for nurses only	Cluster RCT	Vaccination programme vs. no programme 10 clusters each (approximately n = 2335 HCW)	Letters and interviews and local vaccination	50% vs. 5% in control; 45% increase	Overall good quality trial although uptake was not main outcome and statistical analysis not performed
Tannenbaum [16]	Canada; two nursing homes; all HCW	Before/after study with control arm	Vaccination programme vs. no programme (n = 268)	Information sessions, posters, memos and vaccination clinics	16% before 26% after in intervention 17% before 10% after in control; effect-adjusted odds ratio: 2.8 (1.4–5.8)	Limited quality. Incorporates changes over time. Adjusted for baseline characteristics. However, only two sites and not randomised. Note only 37% of the intervention group attended the sessions
Before/after study—internal comparator						
Cooper [17]	Australia; 347-bed hospital; all staff	Before/after study	(n = 880)	Mobile clinic ‘needles on wheels’	8% before 49% after intervention (41% increase) in all staff (81% after intervention in staff with patient contact)	Limited quality reporting. Reasonable description but control arm was from 4 years previously and baseline rates not given in staff with patient contact. No statistics carried out. Cannot assess the effects of potential confounders changing over time
Harbarth [18]	Switzerland; 1500 bed University hospital (primary and tertiary care); all HCW	Before/after study	(n = 5514)	Main hospital: Adverts, newsletter, personal letters; vaccination in clinic Three targeted departments: educational conference, visit by special health nurse—mobile vaccination	Main hospital: 23% (vs. 9% in previous year) 14% increase, p < 0.0001 Three targeted departments changed from 13% to 37%, 24% increase, p < 0.0001	Large, good quality study but cannot assess the effects of potential confounders changing over time
Thomas [19]	USA; 300-bed nursing home; all staff	Before/after study	(n = 195)	Educational intervention and staff vaccination fair with vaccine offered	8%–46% (to 54% following year) 46% increase over 2 years (49% of nurses vaccinated)	Reasonable quality but no statistical analysis and cannot assess the effects of potential confounders changing over time.
Heimburger [20]	USA; chronic care psychiatric facility; all staff	Before/after study	(n = 1293)	In-service meetings, video tapes and pamphlets	16% before extended programme and 33% after (following year); 17% increase	Poorly reported study

PHCT = primary health care teams; NH = nursing homes; HCW = healthcare workers.



Table 5  
Base case parameters, resources and costs

Parameter	Resource	Unit cost	Calculation
<b>Patients and staff</b>			
Number of patients	1437 [10]		
Number of staff and costs	2335 [10]		
Doctors ( <i>n</i> )	117 (5%)	£24 ph (SHO) [43]	
Qualified nurses ( <i>n</i> )	747 (32%) [44,45]	£17 ph (Staff nurse) [43]	
Auxiliaries ( <i>n</i> )	1191 (51%) [44,45]	£12 ph (healthcare assistant) [43]	
Others ( <i>n</i> )	304 (13%)	£12 ph (healthcare assistant) [43]	
<b>Costs of vaccination</b>			
Vaccine promotion campaign (admin, stationery, postage)	2335 staff	£0.70 per staff member	Campaign arm = £1634; control arm = £0
Vaccine cost			
With campaign	Uptake 51% [10] × 2335 staff = 1191	£6.59 per recipient [46]	Campaign arm = £7847
Without campaign	5% [10] × 2335 staff = 117	£6.59 per recipient [46]	Control arm = £769
Vaccine delivery recipient	30 min (include recovery time) per recipient	Staff proportions and costs as above	Campaign arm = £8454; control arm = £829
Vaccine delivery staff (nurse)	5 min per recipient	Nurse costs as above	Campaign arm = £1687; control arm = £165
Absenteeism (h per person)	7 h per vaccinated staff; 10 h per non-vaccinated staff [12,28]	Staff proportions and costs as above	Campaign arm = £280826; control arm = £326580
<i>Total costs</i> (for 1437 patients)	Campaign = £300449; control = £328344		<i>Net cost</i> (campaign – control costs) = –£27895 = cost saving
<b>Effects</b>			
Mortality in patients (campaign, control)	13.6%, 22.4% [10]		
Discount rates	3.5% [47]		
Percent males	30% [10]		
SMR (nursing homes)	600% [48] <sup>a</sup>		
Age distribution (m)(f), general population [49] <sup>b</sup>	M/F	Discounted life expectancy taking SMR into account (m)(f) (years) [50,51]	<i>Overall life expectancy</i> = 2.75 years
Under 60	3%/1%	9.10/10.96	<i>Mortality reduction:</i>
60–74	28%/11%	4.63/6.02	(campaign – control)
75–84	40%/36%	2.09/2.69	22.4% – 13.6% = 8.8%
85+	26%/52%	1.49/1.83	<i>Life-years gained:</i> (for 1437 patients) 8.8% × 2.75 × 1437 patients = 348

SHO = Senior House Officer.

<sup>a</sup> To express the value of immediate deaths prevented in life-years gained, it is necessary to estimate the life expectancy of nursing home patients. The standardised mortality rate (SMR) of 600% was applied (as an odds ratio to the annual risk of death) to general population life tables [20,21]. This led to a discounted life expectancy for any age and sex. These were then weighted by the population balance shown in the above table to give the overall life expectancy of 2.75 years.

<sup>b</sup> Rounding errors in males.

Table 6  
Alternative scenarios derived from sensitivity analyses

Parameter	Base case	No absenteeism	Pessimistic scenario
Cost of promotion per recipient (£)	0.70	0.70	2
Cost of vaccine per recipient (£)	6.59	6.59	10
Absenteeism reduced per person (h)	3	N/A	0
Life expectancy (years)	2.75	2.75	1.5
Mortality reduction (%)	8.8	8.8	4
Nurse time to vaccinate (min)	5	5	10
Staff uptake rate (%)	51	51	70
Discounting (%)	3.5	3.5	3.5
Additional cost	Saving of £28000	£18000	£35000
Life-years gained	350	350	86
<b>Result</b>	<b>Cost saving (approximately £12/vaccinee)</b>	<b>£51/life-year gained</b>	<b>£405/life-year gained</b>

Both trials were conducted in long-term geriatric hospitals in the UK and these have tended to be replaced more recently by smaller nursing and residential homes, raising questions about the generalisability of the findings. An ongoing cluster-randomised controlled trial in 48 nursing homes in England (Andrew Hayward, personal communication) should provide further and more appropriate information for the UK. The advantage of our model is that the spreadsheet (available from authors) is simple and transparent, and can be adapted to model different scenarios as more data becomes available or to reflect practice or costs in other countries. Ideally, a more sophisticated model would reflect influenza transmission, however, there is currently insufficient information to support such an approach.

Although only a limited number of studies were identified answering the question of effectiveness, the main findings were generally consistent, despite differences in design, setting and influenza-related morbidity outcomes.

#### 4.3. Policy implications for the future

There is very low uptake of vaccination in HCWs despite this being the official policy in most European and North American countries. In Europe in 2000 only five of the 26 countries responding to a questionnaire survey of influenza vaccination strategies were able to report the rates of vaccination in HCWs. These ranged from 15% in Scotland to 25% in Romania [7]. Low uptake persists in the UK in 2004 [52].

Other things being equal, programmes that are cost saving should be implemented as these save money. The evidence suggests that vaccination of HCWs is likely to be cost saving or, at very least, highly cost-effective (for comparison note the UK NICE Appraisals Committees consider that costs as high as £30,000/QALY represent value for money). The problem does not appear to be about differences in perception about effectiveness or cost-effectiveness, but rather one of policy implementation and persuading HCWs to be vaccinated.

Improving influenza vaccination rates in HCWs may be viewed as a component of infection control; it provides benefits to patients, staff and the health service. HCW are frequently the source of outbreaks in healthcare institutions [6], and therefore, their vaccination is a patient safety issue. Although specific programmes which address misconceptions about, and show the benefits of, vaccination for both HCWs and patients have been shown to increase uptake, perhaps even more pro-active methods are needed. The delivery method should be convenient, for example, using a mobile service [27]. Targets for uptake could be part of performance review structures. Indeed, it has been suggested that vaccination is so important that the expectation should be that HCWs are vaccinated rather than persuading them to opt in (similar to the Hepatitis B immunisation requirements) [53]. Is it now time for countries in Europe to consider the introduction of an “informed declination” system for HCWs with direct patient contact?

New strategies to improve influenza vaccination uptake are required—there is potential for considerable health gain and possible savings to be made.

#### Acknowledgements

This paper was commissioned by the European Scientific Working Group on Influenza and is based on a report available from the University of Birmingham: [http://www.pcpoh.bham.ac.uk/publichealth/wmhtac/reports.htm#REP\\_Reports](http://www.pcpoh.bham.ac.uk/publichealth/wmhtac/reports.htm#REP_Reports). We thank the following: Dr Fujian Song, Dr Rod Taylor, and Professor Nick Freemantle for their statistical and methodological advice; Dr Iain Blair (Communicable Disease) and Dr Richard Harling (influenza vaccine trials) for their expert specialist advice; Dr John Edmunds and Dr Nigel Gay of the Health Protection Agency Modelling and Economics Unit for their economic and modelling advice.

#### References

- [1] World Health Organisation. Influenza vaccines. WHO position paper. *Weekly epidemiological record* 2002;28(77):229–40.
- [2] Van Essen GA, Palache AM, Forleo E, Fedson DS. Influenza vaccination in 2000: recommendations and vaccine use in 50 developed and rapidly developing countries. *Vaccine* 2003;21:1780–5.
- [3] Gross CP, Hermogenes AW, Sacks HS, Lau J, Levandowski RA. The efficacy of influenza vaccine in elderly persons. A meta-analysis and review of the literature. *Ann Intern Med* 1995;123(5):18–27.
- [4] Poole PJ, Cacko E, Wood-Baker RWB, Cates CJ. Influenza vaccine for patients with chronic obstructive pulmonary disease The Cochrane Database of Systematic Reviews 2006; Issue 1, Art no.: CD002733, DOI:10.1002/14651858, CD002733, pub 2.
- [5] Jordan R, Connock M, Albon E, et al. Universal vaccination of children against influenza: are there indirect benefits to the community?: a systematic review of the evidence. *Vaccine* 2006;24:1047–62.
- [6] Health Protection Agency. Influenza A outbreak in a community hospital in south east Wales where few healthcare workers had received immunisation, February 2005. *CDR Weekly* 2005;15(8):Available at <http://www.hpa.org.uk/cdr>.
- [7] Kroneman M, Paget WJ, Van Essen G. Influenza vaccination in Europe: an inventory of strategies to reach target populations and optimize vaccination uptake. *Eurosurveillance* 2003;8(6):130–8.
- [8] Koumounne OC, Guilliford MC, Chinn S, Sterne JAC, Burney PGJ. Methods for evaluation area-wide and organisational-based interventions in health and health care: a systematic review. *Health Technol Assess* 1999;3(5).
- [9] York: Centre for Reviews and Dissemination. Undertaking systematic reviews of research on effectiveness. CRD's guidance for those carrying out or commissioning reviews 2001. CRD Report Number 4 (2nd edition).
- [10] 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(9198):93–7.
- [11] Potter J, Stott DJ, Roberts MA, et al. Influenza vaccination of health care workers in long-term-care hospitals reduces the mortality of elderly patients. *J Infect Dis* 1997;175(1):1–6.
- [12] Wilde JA, McMillan JA, Serwint J, Butta J, O'Riordan MA, Steinhoff MC. Effectiveness of influenza vaccine in health care professionals: a randomized trial. *JAMA* 1999;281(10):908–13.
- [13] Saxén H, Virtanen M. Randomized, placebo-controlled double blind study on the efficacy of influenza immunization on absenteeism

- of health care workers. *Pediatr Infect Dis J* 1999 Sep;18(9):779–83.
- [14] Weingarten S, Staniloff H, Ault M, Miles P, Bamberger M, Meyer RD. Do hospital employees benefit from the influenza vaccine? A placebo-controlled clinical trial. *J Gen Intern Med* 1988;3(1):32–7.
- [15] Dey P, Halder S, Collins S, Benons L, Woodman C. Promoting uptake of influenza vaccination among health care workers: a randomized controlled trial. *J Public Health Med* 2001;23(4):346–8.
- [16] Tannenbaum TN, Thomas D, Baumgarten M, Saintonge F, Roban I. Evaluation of an influenza vaccination program for nursing home staff. *Can J Public Health* 1993;84(1):60–2.
- [17] Cooper E, O'Reilly M. A novel staff vaccination strategy [letter]. *Infect Control Hosp Epidemiol* 2002;23(5):232–3.
- [18] Harbarth S, Siegrist C, Schira J, Wunderli W, Pittet D. Influenza immunization: improving compliance of healthcare workers. *Infect Control Hosp Epidemiol* 1998;19(5):337–42.
- [19] Thomas DR, Winsted B, Koontz C. Improving neglected influenza vaccination among healthcare workers in long-term care. *J Am Geriatr Soc* 1993;41(9):928–30.
- [20] Heimberger T, Chang HG, Shaikh M, Crotty L, Morse D, Birkhead G. Knowledge and attitudes of healthcare workers about influenza: why are they not getting vaccinated? *Infect Control Hosp Epidemiol* 1995;16(7):412–5.
- [21] Christian MA. Influenza and hepatitis B vaccine acceptance: a survey of health care workers. *Am J Infect Control* 1991;19(4):177–84.
- [22] Ganguly R, Russell DW, Yangco BV, Chmel H, Cameron DJ, Sinnott J. Influenza vaccination status among health care professionals for prevention of nosocomial infection to hospitalized elderly patients. *Serodiagnosis Immunother Infect Dis* 1990;4(4):309–15.
- [23] Nafziger DA, Herwaldt LA. Attitudes of internal medicine residents regarding influenza vaccination. *Infect Control Hosp Epidemiol* 1994;15:32–5.
- [24] Nichol KL, Hauge M. Influenza vaccination of healthcare workers. *Infect Control Hosp Epidemiol* 1997;18(3):189–94.
- [25] Stephenson I, Roper JP, Nicholson KG. Healthcare workers and their attitudes to influenza vaccination. *Commun Dis Public Health* 2002;5(3):247–52.
- [26] Watanakunakorn C, Ellis G, Gemmel D. Attitude of healthcare personnel regarding influenza immunization. *Infect Control Hosp Epidemiol* 1993;14(1):17–20.
- [27] DeAngelis CD, Raszka WV, Chamberlin SM, Zimmerman JL. Influenza immunization rates among pediatric health care providers. *Arch Pediatr Adolesc Med* 1996;150(12):1311–3.
- [28] Demicheli V, Jefferson T, Rivetti D, Deeks J. Prevention and early treatment of influenza in health adults. *Vaccine* 2000;18:957–1030.
- [29] Parlevliet W, de Borgie C, Frijstein G, Guchelaar H-K. Cost-benefit analysis of vaccination against influenza of employees from an academic medical centre. *Dis Manage Health Outcomes* 2002;10(9):579–87.
- [30] Yassi A, Kettner J, Hammond G, Cheang M, McGill M. Effectiveness and cost-benefit of an influenza vaccination program for health care workers. *Can J Infect Dis* 1991;2(3):101–8.
- [31] Kumpulainen V, Makela M. Influenza vaccination among healthy employees: a cost-benefit analysis. *Scand J Infect Dis* 1997;29(2):181–5.
- [32] Bridges CB, Thompson WW, Meltzer MI, et al. Effectiveness and cost-benefit of influenza vaccination of healthy working adults: a randomized controlled trial. *JAMA* 2000;284(13):1655–63.
- [33] Akazawa M, Sindelar JL, Paltiel AD. Economic costs of influenza-related work absenteeism. *Value Health* 2003;6(2):107–15.
- [34] Levy E. French economic evaluations of influenza and influenza vaccination. *Pharmacoeconomics* 1996;9(Suppl. 6).
- [35] Lee PY, Matchar DB, Clements DA, Huber J, Hamilton JD, Peterson ED. Economic analysis of influenza vaccination and antiviral treatment for healthy working adults. *Ann Intern Med* 2002;137(4):225–31.
- [36] Fitzner KA, Shorridge KF, McGhee SM, Hedley AJ. Cost-effectiveness study on influenza prevention in Hong Kong. *Health Policy* 2001;56(3):215–34.
- [37] Nichol KL. Cost-benefit analysis of a strategy to vaccinate healthy working adults against influenza. *Arch Intern Med* 2001;161(5):749–59.
- [38] Nichol KL, Lind A, Margolis KL, et al. The effectiveness of vaccination against influenza in healthy, working adults. *N Engl J Med* 1995;333(14):889–93.
- [39] Burckel E, Ashraf T, Sousa Filho JP, et al. Economic impact of providing workplace influenza vaccination. A model and case study application at a Brazilian pharma-chemical company. *Pharmacoeconomics* 1999;16(5, Part 2):t-76.
- [40] Campbell DS, Rumley MH. Cost-effectiveness of the influenza vaccine in a healthy, working-age population. *J Occup Environ Med* 1997;39(5):408–14.
- [41] Dille JH. A worksite influenza immunization program. Impact on lost work days, health care utilization, and health care spending. *AAOHN J* 1999;47(7):301–9.
- [42] Wood SC, Alexseiv A, Nguyen VH. Effectiveness and economical impact of vaccination against influenza among a working population in Moscow. *Vaccine* 1999;17(Suppl. 7).
- [43] Netten A, Curtis L. Unit costs of health & social care 2003. Available from URL: <http://www.pssru.ac.uk/pdf/uc2003/uc2003.pdf>. Accessed 20/10/2004.
- [44] Department of Health. Community Care Statistics 2001—Private Nursing homes, hospitals and clinics, 2002. <http://www.publications.doh.gov.uk/public/sb0209.htm>. Accessed November 2004.
- [45] Wood P, Castleden M. Dependency, quality and staffing of institutions for elderly people. *Health Trends* 1993;25(3):97–101.
- [46] British Medical Association & Royal Pharmaceutical Society of Great Britain. British National Formulary. <http://www.bnf.org/bnf/bnf/current/doc/112803.htm> 2004. Accessed May 17, 2004.
- [47] National Institute for Clinical Excellence. Guide to the methods of technology appraisal 2004. [http://www.nice.org.uk/pdf/TAP\\_Methods.pdf](http://www.nice.org.uk/pdf/TAP_Methods.pdf). Accessed October 2004.
- [48] Raines JE, Wight J. The mortality experience of people admitted to nursing homes. *J Public Health Med* 2002;24(3):184–9.
- [49] Information & Statistics Division. The National Health Service in Scotland. Scottish Health Resource Utilisation Groups National Report 1999. [http://www.show.scot.nhs.uk/isdonline/Scottish\\_Health\\_Statistics/subject/SHRUGs/shrugs99.pdf](http://www.show.scot.nhs.uk/isdonline/Scottish_Health_Statistics/subject/SHRUGs/shrugs99.pdf) 2000. Accessed November 2, 2004.
- [50] Office of National Statistics. Interim life tables—England & Wales (females) 2004. <http://www.gad.gov.uk/Life-Tables/docs/wltewf0103.xls>. Accessed 20/10/2004.
- [51] Office of National Statistics. Interim Life Tables—England & Wales (males) 2004. <http://www.gad.gov.uk/Life-Tables/docs/wltewm0103.xls>. Accessed 20/10/2004.
- [52] Elgohari S, Joseph CA, Goddard NL. Three years experience of monitoring influenza vaccine uptake in healthcare workers in acute hospital trusts in England 2001/02–2003/04. Five Nations Health Protection Conference 2004.
- [53] Poland GA, Tosh P, Jacobson RM. Requiring influenza vaccination for health care workers: seven truths we must accept. *Vaccine* 2005;23(17–18):2251–5.