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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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, NIHR, 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
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 with 1.0 days/person compared with 1.4 days/person in the unvaccinated group (RR = 2.1, 95% CI 1.4, 3.4) [28].

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

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of clusters</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Setting</td>
<td>NHS medical long-term-care geriatric hospitals in Scotland</td>
<td>NHS medical long-term-care geriatric hospitals in Scotland</td>
</tr>
<tr>
<td>Intervention</td>
<td>Vaccination routinely offered</td>
<td>Vaccination routinely offered by letter and interview by trained study nurses</td>
</tr>
<tr>
<td>Control</td>
<td>Vaccination not routinely offered</td>
<td>Vaccination not routinely offered</td>
</tr>
<tr>
<td>Vaccine match</td>
<td>Reasonable match</td>
<td>Good match to circulating strain</td>
</tr>
<tr>
<td>Influenza epidemic</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of HCW</td>
<td>1078 identified in intervention group and 653 (61%) agreed to participate and receive vaccination</td>
<td>1217 offered vaccination but number in control group not given</td>
</tr>
<tr>
<td>Health care workers involved</td>
<td>Nurses, doctors, therapists, porters and ancillary staff</td>
<td>Nurses, doctors, therapists, porters and ancillary staff</td>
</tr>
<tr>
<td>Number of patients</td>
<td>1059 (490 intervention, 569 control)</td>
<td>1437 (749 intervention, 569 control)</td>
</tr>
<tr>
<td>Randomisation procedure</td>
<td>Hospital sites stratified by unit policy for vaccination and then randomised to receive intervention or control</td>
<td>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</td>
</tr>
<tr>
<td>Outcomes</td>
<td>1. Patient mortality 2. Influenza-like infection rates—patients 3. Lower respiratory tract infection—patients 4. HCW uptake rate</td>
<td>1. Patient mortality 2. Prospective virological monitoring (nose and throat swabs) during winter epidemic on random sample (50%) of patients 3. HCW uptake rate</td>
</tr>
<tr>
<td>Mortality results</td>
<td>Reduction from 17% (control) to 10% (intervention), ( p = 0.013 ) (OR 0.56)</td>
<td>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 corrected rates significant except when corrected for Barthel score, age, sex and vaccination profile together: OR 0.54 (0.36–0.81) (borderline ( p = 0.052 ))</td>
</tr>
<tr>
<td>HCW vaccine uptake rate</td>
<td>Control = not given</td>
<td>Intervention = 5%</td>
</tr>
</tbody>
</table>

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 £1,400 for a 72-bed ward or £12 per vaccinée. The base case assumes that NHS staff who are absent are replaced. Since this does not always happen 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

<table>
<thead>
<tr>
<th>Study</th>
<th>Brief description</th>
<th>Vaccine match/epidemic</th>
<th>Influenza/ILI rates</th>
<th>Vaccine efficacy (%) (95% CI) (serologically confirmed influenza)</th>
<th>Absenteeism</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilde [12] US</td>
<td>RCT Vaccine vs. placebo 3 years 361 person—winters</td>
<td>Year 1—Partial Year 2—Good Year 3—Partial Good quality trial Epidemic each year</td>
<td>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: 0.5% vaccine vs. 7.1% control cases of flu A</td>
<td>88% (47%, 97%) for Influenza A (H1N2) 89% (14%, 99%) for Influenza B</td>
<td>Mean absence (all illness) days ± S.D. 0.1 days ± 0.35 (vaccinated) vs. 0.21 days ± 0.75 (control) Not statistically different (no p-value given)</td>
<td>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</td>
</tr>
<tr>
<td>Saxen [13] Finland</td>
<td>RCT Vaccine (n = 216) vs. placebo (n = 211) Poorer quality relatively large trial</td>
<td>Good match Low incidence of influenza Not reported</td>
<td>1.8 episodes respiratory infection per person (vaccine) vs. 2 episodes (placebo)</td>
<td>N/A</td>
<td>Mean absence (days) due to respiratory infection 1.0 day (vaccinated) vs. 1.4 days (unvaccinated) p = 0.02</td>
<td>Not reported</td>
</tr>
<tr>
<td>Weingarten [14] US</td>
<td>RCT Vaccine (91) vs. placebo (88) Follow-up completed for 95% patients. Good quality small trial Poor match Epidemic present</td>
<td>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)</td>
<td>N/A</td>
<td>Mean absence (all illness) (hours) (±S.D.) 7.6 h ± 12.1 (vaccinated) vs. 8.2 h ± 18.3 (control). (p = 0.91) Percent employees absent 42.9% (vaccine) vs. 43.2% (control) (p = 0.97)</td>
<td>Sore arm 51% vaccinated vs. 7% control p &lt; 0.05 Erythema, 1% vaccinated vs. 0% control p &lt; 0.05 No other significant effects reported</td>
<td></td>
</tr>
</tbody>
</table>

**RCT** = randomised controlled trial.
Table 4
Effectiveness of promotional campaigns on vaccine uptake in seven studies with control phase/arm

<table>
<thead>
<tr>
<th>Study</th>
<th>Setting and study population</th>
<th>Study design</th>
<th>Study details (n)</th>
<th>Details of vaccine campaign</th>
<th>Uptake rates</th>
<th>Quality issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dey [15]</td>
<td>UK, primary health care teams (PHCT) and nursing homes (NH); all HCW</td>
<td>Randomised/external comparison</td>
<td>Cluster RCT</td>
<td>Large cluster trial; 64 PHCT, 34 NH, (n = 2984 HCW)</td>
<td>Letter ± public health nurse visit and promotion; Vaccination given by GP</td>
<td>PHCT 21.9% intervention, 21.0% control (p = 0.91) NH 10.2% intervention, 5.6% control (p = 0.34)</td>
</tr>
<tr>
<td>Carman [10]</td>
<td>UK, long-term geriatric hospitals, all HCW; data for nurses only</td>
<td>Randomised/external comparison</td>
<td>Cluster RCT</td>
<td>Vaccination programme vs. no programme 10 clusters each (approximately n = 2335 HCW)</td>
<td>Letters and interviews and local vaccination</td>
<td>50% vs. 5% in control, 45% increase</td>
</tr>
<tr>
<td>Taubenbaum [16]</td>
<td>Canada; two nursing homes; all HCW</td>
<td>Randomised/external comparison</td>
<td>Before/after study with control arm</td>
<td>Vaccination programme vs. no programme (n = 260)</td>
<td>Information sessions, posters, memos and vaccination clinics</td>
<td>16% before 26% after in intervention; 17% before 1% after in control; effect-adjusted odds ratio: 2.8 (1.4–5.8)</td>
</tr>
<tr>
<td>Before/after study—internal comparator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooper [17]</td>
<td>Australia; 347-bed hospital; all staff</td>
<td>Before/after study (n = 880)</td>
<td>Mobile clinic ‘needles on wheels’</td>
<td></td>
<td>8% before 49% after intervention (41% increase in all staff; 81% after intervention in staff with patient contact)</td>
<td>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</td>
</tr>
<tr>
<td>Harbarth [18]</td>
<td>Switzerland; 1500 bed University hospital (primary and tertiary care); all HCW</td>
<td>Before/after study (n = 5514)</td>
<td>Main hospital: Adverts, newsletter, personal letters; vaccination in clinic</td>
<td></td>
<td>Main hospital: 23% (vs. 9% in previous year) 14% increase, p &lt; 0.0001 Three targeted departments—mobile vaccination nurse—mobile vaccination</td>
<td>Large, good quality study but cannot assess the effects of potential confounders changing over time</td>
</tr>
<tr>
<td>Thomas [19]</td>
<td>USA; 300-bed nursing home; all staff</td>
<td>Before/after study (n = 195)</td>
<td>Main hospital: Adverts, newsletter, personal letters; vaccination in clinic</td>
<td></td>
<td></td>
<td>Reasonable quality but no statistical analysis and cannot assess the effects of potential confounders changing over time.</td>
</tr>
<tr>
<td>Heimburger [20]</td>
<td>USA, chronic care psychiatric facility; all staff</td>
<td>Before/after study (n = 1293)</td>
<td>In-service meetings, video tapes and pamphlets</td>
<td></td>
<td></td>
<td>Poorly reported study</td>
</tr>
</tbody>
</table>

PHCT = primary health care teams; NH = nursing homes; HCW = healthcare workers.
Table 5
Base case parameters, resources and costs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Resource</th>
<th>Unit cost</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients and staff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients</td>
<td>1437</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of staff and costs</td>
<td>2335</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doctors (n)</td>
<td>117 (5%)</td>
<td>£24 ph (SHO)</td>
<td></td>
</tr>
<tr>
<td>Qualified nurses (n)</td>
<td>747 (32%)</td>
<td>£17 ph (Staff nurse)</td>
<td></td>
</tr>
<tr>
<td>Auxiliaries (n)</td>
<td>119 (51%)</td>
<td>£12 ph (Healthcare assistant)</td>
<td></td>
</tr>
<tr>
<td>Others (n)</td>
<td>304 (13%)</td>
<td>£12 ph (Healthcare assistant)</td>
<td></td>
</tr>
<tr>
<td>Costs of vaccination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccine promotion campaign (admin, stationery, postage)</td>
<td>2335 staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccine cost With campaign</td>
<td>Uptake: 5% (10%) × 2335 staff = 117</td>
<td>Staff = 1191</td>
<td></td>
</tr>
<tr>
<td>Without campaign</td>
<td>5% (10%) × 2335 staff = 117</td>
<td>Staff = 1191</td>
<td></td>
</tr>
<tr>
<td>Vaccine delivery recipient 30 min (include recovery time</td>
<td>Staff proportions and costs as above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccine delivery staff (nurse) 5 min per recipient</td>
<td>Nurse costs as above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absenteeism (h per person) 7h per vaccinated staff, 10h per non-vaccinated staff</td>
<td>Staff proportions and costs as above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs (for 1437 patients)</td>
<td>Campaign = £300449</td>
<td>control = £328344</td>
<td></td>
</tr>
</tbody>
</table>

Net cost (campaign − control costs) = −£27895 = cost saving

Effects
Mortality in patients (campaign, control) 13.6%, 22.4% [10]
Discount rates 3.5% [47]
Percent males 30% [10]
SMR (nursing homes) 600%[a]
Age distribution (m)(f), general population [49][b]
Under 60 3%/1% 9.10/10.96
60–74 28%/11% 4.63/6.02
75–84 40%/36% 2.09/2.69
85+ 26%/52% 1.49/1.83
Mortality reduction: (campaign − control) 22.4% − 13.6% = 8.8%
Life-years gained: (for 1437 patients) 8.8% × 2.75 × 1437 patients = 348

Table 6
Alternative scenarios derived from sensitivity analyses

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Base case</th>
<th>No absenteeism</th>
<th>Pessimistic scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of promotion per recipient (£)</td>
<td>0.70</td>
<td>0.70</td>
<td>2</td>
</tr>
<tr>
<td>Cost of vaccine per recipient (£)</td>
<td>6.59</td>
<td>6.59</td>
<td>10</td>
</tr>
<tr>
<td>Absenteeism reduced per person (h)</td>
<td>3</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Life expectancy (years)</td>
<td>2.75</td>
<td>2.75</td>
<td>1.5</td>
</tr>
<tr>
<td>Mortality reduction (%)</td>
<td>8.8</td>
<td>8.8</td>
<td>4</td>
</tr>
<tr>
<td>Nurse time to vaccinate (min)</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Staff uptake rate (%)</td>
<td>51</td>
<td>51</td>
<td>70</td>
</tr>
<tr>
<td>Discounting (%)</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Additional cost</td>
<td>Saving of £28000</td>
<td>£10000</td>
<td>£35000</td>
</tr>
<tr>
<td>Life-years gained</td>
<td>350</td>
<td>350</td>
<td>86</td>
</tr>
</tbody>
</table>

Result Cost saving (approximately £32/vaccinee) £515 life-year gained £405/life-year gained

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SHO = Senior House Officer.

[a] 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.

[b] Rounding errors in males.
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 service 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 and patients have been shown to increase uptake, perhaps even more pro-active methods are needed. The delivery service 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 not 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 possibly savings to be made.

Acknowledgements

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References